A Publication on
Turfgrass Management by the
United States Golf Association®

July/August 1991

USGA®

Green Section RECORD

Tools for Maintaining Bermudagrass Greens

USGA®

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Vol. 29, No. 4
JULY/AUGUST 1991

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Groomer attachments can make a world of difference in producing high-quality bermudagrass greens.

GREEN SECTION RECORD (ISSN 0041-5502) is published six times a year in January, March, May, July, September and November by the UNITED STATES GOLF ASSOCIATION®, Golf House, Far Hills, N.J. 07931. Subscriptions and address changes should be sent to the above address. Articles, photographs, and correspondence relevant to published material should be addressed to: United States Golf Association Green Section, Golf House, Far Hills, N.J. 07931. Second class postage paid at Far Hills, N.J., and other locations. Office of Publication, Golf House, Far Hills, N.J. 07931. **Subscriptions $9 a year. Foreign subscriptions $12 a year (surface mail) or $21 a year (air mail).**

Severe verticutting is a basic ingredient for maintaining top-quality bermudagrass greens.

Going for the Gold with Bermudagrass Greens

by JOHN H. FOY
Director, State of Florida, USGA Green Section

FOR QUITE SOME TIME, bentgrass greens have remained the benchmark regarding putting green quality. Compared to bentgrass greens, bermudagrass greens have always been considered second rate. Standard complaints have been that bermudagrass greens are slow and grainy. In the past, when equipment limitations made it impossible to mow greens below 3/16 inch, the coarser, stiffer leaf blades of bermudagrass resulted in significantly slower putting speeds. Even today, whenever a professional tournament is played on bermudagrass greens, television commentators still mention the need to allow for the grain in the greens. Let's face it, though. When any turf variety is mowed to 1/8 inch or less, is there really enough leaf surface left for grain to be a factor?

Most golfers still hold the opinion that bermudagrass greens produce an inferior play surface. As a result of this perception, efforts persist to establish bentgrass in areas where it simply is not well adapted. While breeding efforts have modestly increased the stress tolerance of some bentgrasses, the inevitable loss of some pesticides and reductions in water availability make it unrealistic to expect that bentgrass greens can be maintained in some geographic locations. The southeastern United States and tropical-to-subtropical areas of the world are examples. In these areas, high temperatures and relative humidity limit the health and persistence of bentgrass turf. Golfers

should understand that the best adapted turf for these regions remains bermudagrass.

As in all aspects of golf course management, great strides have been taken in improving bermudagrass greens during the past 10 to 15 years. The following paragraphs review what it takes to produce consistent championship green conditioning.

The Basic Ingredients

Back in the "good ol' days," when the standard mowing height of bermudagrass greens was ¼ inch and tournament height was 3/16 inch, the soil used in green construction was not so critical. The hardy nature of bermudagrass allowed it to survive in very poor quality soils. Today, however, low mowing heights place much more stress on the turf, and a poor medium can be a limiting factor to bermudagrass quality.

In Florida, some people mistakenly question the need for USGA specifications when it comes to green construction. Besides providing the proper physical characteristics for healthy turf growth, though, the moisture conservation aspect of USGA greens becomes more important in Florida due to the prospect of permanent irrigation restrictions. Quite simply, if healthy turf growth and top-quality green conditioning is to be provided, proper construction is essential.

Other factors that limit the growth of healthy turf also must be eliminated. One of the most common obstacles is excessive shade. Bermudagrass is one of the least shade-tolerant turfgrasses and requires a minimum of six to eight hours of direct sunlight each day to sustain healthy growth. Early morning sun is especially important for reducing the presence of free moisture, which increases the potential for disease outbreaks and surface algae. Winter, spring, summer, and fall shade patterns should all be evaluated, and good air circulation, while not quite as critical as with bentgrass greens, should not be overlooked when considering the needs of bermudagrass.

At the present time, two hybrid bermudagrass cultivars are available for use on greens. Tifgreen (Tifton 328), from the research program of Dr. Glenn Burton, was released jointly by the USGA and USDA in 1956. It was a tremendous improvement over the bermudagrasses available at the time and has been used extensively. In 1965, Dr. Burton released Tifdwarf, which was actually a mutant strain taken from several Tifgreen greens. While Tifgreen has been a very good turfgrass, it is not as well adapted as Tifdwarf for meeting current demands. Primarily, Tifgreen does not tolerate a mowing height below 3/16 inch for any length of time, especially if other stress factors come into play. Tifdwarf, on the other hand, can tolerate a mowing height below 3/16 inch on a continuous basis, and its higher shoot density and finer leaf texture make it the best cultivar available for top-quality greens.

That's not to say there are no potential drawbacks with the use of Tifdwarf. Concerns have been expressed about its cold temperature sensitivity, reduced wear tolerance, higher incidence of surface contamination, and resistance to winter overseeding establishment. While it's true that Tifdwarf will go off-color more quickly than Tifgreen when temperatures reach the mid-50s, it actually possesses better winter hardiness and starts to recover from winter dormancy 10 to 11 days earlier than Tifgreen. As far as its wear tolerance and overseeding acceptance are concerned, proper fertilization and improved overseeding methods and materials have eliminated these issues. "Off-type" strains occur in both Tifgreen- and Tifdwarf-based greens, and an annual summertime program of spot removal must be practiced to maintain surface purity. So comparing one to the other, Tifdwarf is the better bermudagrass for producing top-quality putting green surfaces.

The other basic ingredient for success with bermudagrass greens is a capability and willingness for some work. With proper construction and a Tifdwarf base turf, maintaining a dense, healthy turf cover is not that difficult. The big difference between bentgrass and bermudagrass greens is the effort that must be put into grooming the bermudagrass for surface smoothness and speed.

At courses where the best-quality bermudagrass greens are maintained, continuous attention is given to surface grooming programs. This situation requires the standard complement of green management equipment, as well as an array of grooming tools. Among the basic items needed are verticutting units, brush attachments, and a top-dressing application setup that can be calibrated to apply light rates in a timely and efficient manner. Also, adequate time and manpower must be available to carry out the necessary programs.

Grow the Grass First

Unlike maintaining bentgrass greens, where low fertility has been used to maintain fast putting speeds, bermudagrass greens need to be fed. Bermudagrass has a high nitrogen requirement, and the old rule of thumb of using 1 pound N/1000 sq. ft./month during the growing season still applies. When managing a high-sand-content rootzone, maintaining adequate potassium levels is very important. A 1:1 or even 1:2 nitrogen-to-potassium fertilization ratio has been found useful in maintaining healthy turf.

Controlling thatch is another essential management practice for maintaining good bermudagrass greens. Excessive thatch accumulation is a problem inherent in all of the hybrid bermudagrasses. Since most bermudagrass greens are overseeded for the winter months, year-round turf growth occurs on greens. Core aerification and core removal, therefore, are necessary to physically reduce and control organic matter accumulation. A minimum of three corings each summer is required. When bermudagrass greens become two years old, a straight sand top-dressing program is the standard approach for dealing with thatch.

To the average golfer, a lush green turf is a characteristic of the ideal green. To provide this appearance, many superintendents feel forced into watering their greens too much, resulting in a shallow root system and overall weak turf. The bermudagrasses possess good drought tolerance, and less frequent, deeper watering of bermudagrass greens is the best strategy for maintaining a healthy turf and optimum surface conditioning.

Surface Grooming

As noted earlier, bermudagrass requires very intensive surface grooming programs to produce a smooth, true ball roll and a medium-to-fast putting speed. Some of these practices, unfortunately, temporarily disrupt green playability and are an inconvenience to the golfers. When these programs are not carried out on a regular basis, however, problems eventually occur in maintaining the desired level of turf health and green quality. Many older superintendents will tell you that the more you "beat-up" bermudagrass greens, the better they perform.

In late spring or early summer, after the bermudagrass has exhibited sustained active growth, the greens should be severely verticut once or twice. These

severe verticuttings accomplish several things. They aid in reducing thatch that has built up during the fall, winter, and early spring, and they help complete the transition from the winter overseeding cover to the dominant bermudagrass turf cover. Most important of all, severe verticutting stimulates dense, upright, juvenile shoot growth and eliminates grain that has developed.

A self-propelled verticutting/dethatching unit, such as the Ryan Mat-A-Way, is generally considered the best for accomplishing these severe operations. However, another verticutting unit can do a satisfactory job. The verticutting blades should be adjusted so they only cut into the soil/thatch layer of the upper root zone. Typically, this operation is performed twice at 90-degree angles.

The best results occur when two severe verticuttings are performed in conjunction with the first two corings of the greens. If only one severe verticutting is scheduled, it should be done between the first and second corings of the greens. A tremendous amount of debris is generated from these verticuttings and must be removed.

The typical sequence is to verticut, remove the debris, core aerify, remove the cores, apply a heavy topdressing, and then work the material into the surface of the greens. For anyone who has never observed severe verticutting of bermudagrass greens, their reaction is that the turf has surely been killed and the greens destroyed. Granted, the end result is not a pretty sight, but within 14 to 21 days the greens will have fully recovered and will provide an excellent putting surface.

In addition to the one or two severe verticuttings, bermudagrass greens require regular, light verticutting through the summer growing season. This program is necessary to maintain upright shoot growth and help prevent excessive thatch accumulation. During periods of active shoot growth, bermudagrass greens should be lightly verticut at least once per month, preferably every 7 to 10 days. A triplex greensmower with verticutting reels installed is the standard unit for accomplishing these light verticuttings. The vertical blades should be set so that they are operating at 1/16 to 1/8 inch below the base of the bedknife. When done properly, the average golfer should not be able to tell that anything has been done to the greens by the next day.

The groomer attachments that are available for most greensmowers are also quite useful in the management of bermudagrass greens. Putting green speed can be increased from 6 to 12 inches with regular use of these attachments. A slightly higher mowing height also can be practiced, thereby reducing the amount of mechanical stress on the turf. Groomers are generally used up to three times per week, and the blades are set to operate at about 1/64 inch below the effective mowing height of the greens. It must be stressed, however, that use of these groomer attachments does not take the place of a regular light verticutting program. Bermudagrass greens still need to be verticut at least once a month to control thatch accumulation.

Topdressing is another good program for controlling thatch and improving surface smoothness and speed. In addition to heavy topdressing applications made after aerification, regular light applications should be scheduled throughout the year. These "dustings" of 0.1 to 0.3 cubic yards of material per 1,000 sq. ft. help maintain a smooth, true ball roll and good putting speed. Following application, the material should be worked into the surface of

Shade and bermudagrass greens just don't mix!

A poor root zone causes shallow-rooted turf that can't survive pressures from traffic, low mowing heights, and environmental stresses.

the greens with a dragmat or light irrigation.

Application frequency should coincide with the growth rate of the turf so that a homogenous soil profile is maintained. In the summer months, bermudagrass greens usually should be lightly topdressed every two to four weeks. Improvement in playability usually peaks approximately five to seven days after application, a fact that should be kept in mind when planning for special events or tournaments. The importance of using a consistent, high-quality topdressing material with the proper physical characteristics cannot be overemphasized.

A special note for Tifgreen bermudagrass greens: Even though warm-season turfgrasses require temperatures in the mid-80s to 90 degrees for optimum growth, Tifgreen greens can suffer from heat stress. In the mid-to-late summer, when temperatures and humidity can be extreme, heat stress can predispose Tifgreen greens to damage from other stresses such as low cutting height. Under these conditions, Tifgreen greens should not be mowed below 3/16 inch and should not be verticut intensively. To compensate for the higher cut and the lack of verticutting, superintendents at several Florida golf courses have successfully improved surface playability by topdressing more frequently. Biweekly or weekly light topdressings during late July, August, and early September is a common regime, though care must be taken to avoid applying too much material.

When consistently fast greens are demanded, there are several other practices that should be considered. The use of walk-behind greensmowers on bermudagrass greens is becoming a popular way of reducing wear and producing a better-quality cut. For the sake of consistency, greens need to be mowed on a daily basis when active growth occurs. Double cutting of the greens represents another excellent strategy for gaining 6 to 12 inches on the Stimpmeter, without reducing the mowing height. In the past, multiple mowings have been practiced just prior to and during the play of special events. To meet the demands of the golfers at some courses, however, double cutting is done on a more regular basis.

Finally, to obtain the best possible speed and smoothness from bermudagrass greens, surface rolling is becoming a more common practice. Both walk-behind and larger rolling units are utilized, offering a few more inches on the Stimpmeter. Due to the additional manpower required, though, this operation is generally reserved for special events or tournaments.

Conclusion

In no way should this article be interpreted as condoning very fast speeds for all courses with bermudagrass greens. Speed kills! However, television coverage of professional tournaments has convinced golfers that fast greens are the best, and golf course superintendents have to learn to manage these demands within reason. In reality, the main objective should be a smooth, true ball roll and a consistent putting speed through the course.

There is no denying that bentgrass greens are probably better suited for meeting present-day player demands for green conditioning. However, bentgrass greens cannot be maintained in some areas of the country without the clear risk of failure, environmental impacts, and increased cost. In keeping with sound agronomic practices, bermudagrass is the best-adapted turf for greens in the warm, humid regions of the country. With the proper resources and good management, bermudagrass can produce outstanding playing surfaces for regular play and for championship events as well.

A tennis court roller can help produce those last few extra inches in putting speed.

Emirates Golf Club is located next to the Arabian Gulf and stands out in its surrounds.

THE GRASS DOESN'T CARE

by BARRY CARTER
Golf Course Superintendent, Emirates Golf Club, Dubai, United Arab Emirates

WHEN August 2, 1990, rolled around, everything was going along smoothly at the Emirates Golf Club, in Dubai. Most of the summer projects were well underway, the annual renovation and cultivation program was right on schedule, and the persistent 120°F midday temperature was the focus of our greatest concern. With the news of the invasion of Kuwait, reactions and appraisals ranged from one extreme to the other, from those who prognosticated like Doomsday prophets, to those people who simply shook their heads and said not to worry.

In the midst of all this uncertainty, a very special golf course reality occurred, best described by a saying often used in our work — "The grass doesn't care." This phrase was used many times, virtually like waving a magic wand in the faces of the club's management and members, when justifying course needs in the light of Mother Nature's unrelenting demands. The course had to remain operating in an area shadowed by war, with no idea what kind of adaptation would be necessary. The grass was going to keep right on growing, and answers for whatever problems might come would be required.

Fortunately, a sense of confidence was felt because of the support from the club. From the board of directors, the club management, and members, the attitude had always remained to do everything first class. The Emirates Golf Club was considered to be the focal point of Dubai, and every effort would be made to keep its reputation intact. Everybody felt that the club should be a sign of stability in a difficult time. While there was imminent danger in Dubai, there was no way to predict what ramifications might occur by such close proximity to the hostilities.

The first signals of change came from the shipping companies in Dubai. Not only did they indicate that the flow of goods might be reduced due to the presence of warships in the Arabian Gulf, but their insurance underwriters

In spite of the war and 120° heat, "the grass didn't care" and still needed to be mowed daily.

began an immediate escalation of fees. Indications were that these surcharges could run as high as 150%. The first dilemma was whether to go ahead and order large quantities of goods at an already modestly inflated rate, or play a "wait and see" game, gambling that any war risks would be short-lived. As the only grass golf course in the Middle East, it would not be possible to simply step next door to the neighboring superintendent's course and borrow a bit of what was needed.

The timing of the situation couldn't have been worse because we were just entering the peak growth period for the year. The months of September through November represent the main recovery period from cultivations and the annual wear and tear on the turf. The course is grassed with 328 Tifgreen bermudagrass on the greens and 419 Tifway everywhere else, and the temperature and humidity at this time make for a turf that is hungry and aggressive. There was just enough fertilizer in stock for three months of hard growing.

Fertilizer availability was complicated by the Desert Classic, a European Tour stop played at the Emirates Golf Club. This year's tournament was slated for February 12-17, and the maintenance program for prepping the course was well underway. If the budgeted allowance of fertilizer was not purchased, the quality of the course might drop appreciably from what had been produced the past two years. Then again, if the war was abruptly over in four or five months and the Desert Classic went full steam ahead, problems were inevitable. Lead times for shipping to Dubai from the UK and the United States are usually six to eight weeks at best, so only a one-month grace period existed before minimum reorder time. When shipping costs soared 150% in the next few weeks, it was time to start hedging all bets.

During the months of September and October, a 100% fertigation program was started, choosing to save the granular products for November and December. In the past, a granular ammonium nitrate was used as the fertigation base. Unfortunately, this product was made in Kuwait and was no longer available. After some searching, another source from Bahrain was found that looked almost as good, and enough was ordered to apply one pound of nitrogen per 1,000 square feet per month for the next six months. This quantity was supplemented with phosphoric acid and potassium nitrate products that a local chemical company was able to produce on demand. One of the Dubai vendors also had stocked minor fertilizers, in anticipation of the Desert Classic, so fertigating iron, magnesium, and manganese was possible.

FORTUNATELY, a good stock of pesticides was available. A severe outbreak of grubs and worms had occurred during the previous fall, and the major shipment for the year had already been received. Survival for three or four months on the existing inventory was expected, providing protection into the cooler, less troublesome months.

The next critical problem was dealing with crew morale. It was only natural for everyone to feel a degree of uncertainty during the crisis. To see warships passing within sight of the shore, and to watch the daily overhead flights of F-15s and F-16s were not

(Above) The postponement of the Desert Classic was uncertain for a while. This put more challenge into long-term management decisions.

(Left) The crew party helped keep morale up during the Gulf Crisis.

things that could be ignored. Although it gave us a sense of security to know it was our guys out there, the best way to reduce tension was to keep everyone well informed and updated as much as possible. A 10-band radio was played continuously throughout the day, and all of the pertinent newspapers were purchased each morning. Frequently held crew meetings kept everybody advised of the club's emergency plans.

As the crisis dragged into the second and third months, it was apparent that the continuing tension was dragging everyone down. In response, a combination crew party, ping-pong tournament, and talent show was arranged. It was amazing how much good this one-day break from the routine did for the crew. They seemed to stay geared up throughout the rest of the turmoil.

IT SHOULD come as no surprise that the Gulf crisis caused the club to go through some significant — albeit temporary — changes. The club had been built primarily to attract tourists to Dubai, so tourism had always been high on the list of priorities. During the war, however, tourism slowed dramatically. Despite expectations that play would drop off, we found to our surprise that it actually picked up! Since most of the members are businessmen, and since business was slow due to the uncertainty in the region, there was now much more free time to play golf. It seemed that every tee time from sunup to sundown was taken.

As the crisis dragged into November, another problem surfaced. The Desert Classic was still scheduled, but equipment overhaul was required. Summer programs and the non-stop maintenance of the course had taken a big toll on the fleet. Lead times for securing replacement parts were being extended every day and, in fact, it became clear that air freight, at exorbitant prices, was becoming more and more a necessity. To help offset the time and money restraints, the shop was reorganized and a fabrication unit was installed. One of our crew was very gifted at metalwork and was able to turn out the materials we needed. The sounds of drilling, grinding, sheet metal cutting, welding, and the like were incessant for three months. Both the quantity and quality of parts turned out were exceptional, from topdresser beds to greensmower handles to a complete new set of course benches.

A few other tricks were tried to reduce the need for machinery upkeep.

The Chairman of our Board, H. H. Sheikh Butti al Maktoum, presenting a competition trophy. Sheikh Butti is also Major General of the Central Military Command of the Emirates, which gave us an added sense of security.

Fertilization with more iron and magnesium, and less nitrogen, maintained course color while reducing the growth of the turf. Fairway and rough cutting heights were raised to reduce cutting frequency. It was interesting that the members actually noticed these changes and supported them, making the job a lot easier.

One of the exotic aspects of the Emirates is the wildlife on the course. In the freshwater lakes, several thousand Japanese koi fish create quite a stir when they cause the water to "boil" at their morning feedings. There is also a large group of flamingos that stroll around the course. Both the koi and the flamingos take regular monitoring and feeding to ensure their well-being. This care had been difficult even in the best of times, but when shipments from the U.S. became intermittent, improvisation with various kinds of bread, rice, and even pet-shop substitutes was necessary.

It was the beginning of January when the decision to postpone the Desert Classic arrived. At first it was a bit of a letdown for the crew, but when January 16th came, the decision looked good in hindsight. Instead of backing off on the course maintenance, however, it was full steam ahead. The club management wanted to keep the course in top tournament condition, proof that life in Dubai was proceeding in a normal manner. Granular fertilizers were applied, with special emphasis on the color and definition of the course. It was important for our members, the servicemen, and the media who were playing and visiting the course to enjoy a feeling of life as usual.

THIS ENVIRONMENT didn't mean we were oblivious to the situation "up the road." Two crew members patrolled the golf course every night with a special watch on the clubhouse and crew accommodations, and the greens staff had designated uniforms to wear on the property so they could be easily recognized. Special care was taken to look for anything that seemed unusual.

The last major concern to face was the irrigation system. Our irrigation water comes from a local desalinization plant. A potential disaster appeared with the oil slick moving in the Gulf. If the slick reached the course, a cutoff of water was likely, or at least severe rationing would occur. Fortunately, several well points had been placed in the ninth fairway during construction, with the hope that over a period of time a fresh water "lens" would develop to augment the normal irrigation water supply. After two weeks of overhauling, a vacuum pump dedicated for tapping the fresh water lens was ready for testing. For about 30 minutes we watched horrible red, rusty water pour out of the test pipe, but then a clear, fresh stream emerged. When a sample was run through the salinity testing unit, the water contained only 1,200 ppm soluble salts. A contingency plan was developed for what could have been a great disaster for the turf.

It wasn't long before the war came to a close, and it was apparent that neither the oil slick nor the war clouds over Kuwait were going to affect the course. As life returned to normal, several things became apparent. A healthy rapport had developed at all levels of the club, between the members, the management, and the crew. A feeling of having surmounted the crisis together was present, even if unspoken. A first-class lesson also had been learned in how to improvise. This fact will not be forgotten.

Even now, manufacturing fertilizers and fabricating spare parts continues, and our next crew party promises to be a humdinger!

The Coarse Sand Layer — A Look at Installation

by **ROBERT A. BRAME**
Agronomist, Mid-Atlantic Region, USGA Green Section

LOOKING for an unpopular topic in the golf course construction business? Select "the intermediate coarse sand layer" in putting green construction and your search is over!

The Green Section first published its specifications for putting green construction in 1960. The current volume, *Specifications for a Method of Putting Green Construction*, is a detailed, step-by-step guide to putting green construction. Cited by most experts as the best method, there are those critics who might argue with the necessity of including all of the components of a "spec" green. Even the skeptics, though, would acknowledge that USGA Green Section Specs have set a high standard for putting green construction.

Shortcuts may help you beat the traffic on the way to work, but shortcuts in putting green construction will often cause long-term problems with maintenance and putting green quality. Poorly built greens also are more expensive to maintain, and many eventually have to be rebuilt. The higher cost of maintenance more than offsets any savings created by taking shortcuts during construction.

One of the most common shortcuts in building USGA spec putting greens eliminates the coarse sand layer. It is sometimes called the "choker layer," a great misnomer since it does not choke anything. Much discussion through the years has evolved about the importance of this coarse sand layer in green construction. Until there is a fool-proof method of determining that the layer is not needed in a particular situation, however, it will remain a requisite of a USGA spec green. The focus of this article is not to argue the importance of the coarse sand layer, though, but rather to look at a few methods of installing this critically important component.

Installation of the coarse sand layer can be divided into two general categories; the more traditional methods (hand and/or small equipment), and new techniques (blowing it in and the conveyor belt).

Traditional Methods

For years, it has been argued that the 2″ to 4″ layer in a USGA green should be installed completely by hand. Many observers still feel this way. Typically, this process involves dumping piles of coarse sand in several convenient places around the green. Care is taken not to damage the green banks, bunkers, irrigation system, or other features. Sand is then moved from these piles onto the gravel base with wheelbarrows. It is dumped into small piles and hand raked into place. Sometimes 2″ × 4″ planks are used to create a parallel grid (much like concrete forms), ensuring a uniform depth as the sand is smoothed into place. Grade stakes with the appropriate markings for the gravel layer, coarse sand layer, and topmix provide reference points for the 2″ × 4″ planks. Though effective, this technique is slow and laborious.

Variations of this method have evolved over the years. Some builders use small utility trucksters instead of wheelbarrows to move the sand onto the gravel base. Those people who use this approach feel strongly that the gravel layer is not being disturbed. Others like the concept of using lightweight trucksters, but they take the precaution of putting down planks or plywood runways on which the vehicles can travel.

More and more contractors use heavier equipment with success. Dump trucks drop the coarse sand at the edge of the green, and a skilled operator uses a small dozer to push the material onto the gravel base. The operator stays on the sand, working the material from the edge in toward the middle. This technique allows the sand to be spread without tracking directly on the gravel.

Still others use rubber-tired articulating loaders or skid loaders. It is essential that the gravel base not be disturbed during the installation of the sand layer. The use of these larger pieces of equipment to install the sand layer is contingent on having the appropriate equipment and, even more important, having an experienced and skilled operator.

A variation on the final step of hand raking and smoothing is the use of a small riding bunker rake with a plow attachment. Here again, use of a skilled operator is critical for success.

In surveying several contractors and golf course superintendents, the differences reported in the time needed to complete the installation of the coarse sand layer were significant. In most cases, the construction crew ranged from four to six people per green, including equipment operators. Given four to six people and a 7,000 sq. ft. green, the time needed to install the sand layer ranged from 90 minutes to one full day. Obviously, variations in installation techniques accounted for these differences.

A good rule of thumb, based on this information, would be that five people can install the coarse sand layer on a 7,000 sq. ft. green in half a day, or approximately 20 man-hours.

Another factor to keep in mind concerns the depth of the course sand layer. A depth of 3″ to 4″ is much easier and quicker to install than a 2″ depth. The improved efficiency gained with a slightly deeper layer can be more than offset, however, by the increased cost of the material, depending upon its availability in the area. If cost considerations dictate a 2″ depth, machinery of any kind is more difficult to use. Conversely, a 3″ to 4″ depth allows safer use of larger equipment.

New Techniques

Two other methods of coarse sand layer installation involve newer techniques. The blowing-in method features sand blown through a large hose onto the gravel base. This process eliminates the need for large equipment or wheelbarrows to transport the sand onto the gravel. It is capable of putting down a consistent and uniform layer, but final raking often is needed. Those who have employed this method feel blowing-in takes as long or longer than the more

(Top) The construction crew hand rakes the coarse sand layer to a uniform 2" to 4" depth.

(Above) A small dozer is an alternative for working the coarse sand into place. The operator remains on the sand, working the material from the edge to the middle.

(Right) A 600 CFM compressor can be used to blow the sand through a large hose onto the gravel.

traditional techniques, but sometimes the crew size can be reduced.

The use of a long conveyor belt is another interesting new technique. Again, equipment is not needed to haul sand onto the gravel layer, and this minimizes the disturbance to the gravel and coarse sand layers. The conveyor can be set up at different locations around the green, using the long-arm reach to apply material to the gravel base. By working the arm back and forth, a uniform layer can be applied. A smaller crew may also be possible with this method. Time needed to complete installation using this approach is usually comparable to that of the more traditional methods.

Blowing-in the sand layer or use of a conveyor-arm is probably more practical for larger projects (building 9 or 18 greens). When building just one or two greens, setup costs would quickly offset any savings in time.

The coarse sand layer is a key ingredient in *Specifications for a Method of Putting Green Construction*, as published by the USGA Green Section. If you want a quality putting green that has the best chance of succeeding, *do not* cut corners. The least expensive green is one that is installed properly the first time, and when building a USGA spec green, the intermediate coarse sand layer is an essential component. Budget considerations and the availability of appropriate equipment and skilled operators will determine the best technique for installation. The coarse sand layer seems destined to be an unpopular step in green construction, but perhaps the installation techniques described here can help you sort out the best method for your particular circumstances.

Another Look — Turf and Salinity

by DR. GARALD HORST
University of Nebraska

ONE OF THE most difficult challenges in the field of turfgrass management deals with soils and water that are high in salts. Previously arid and semi-arid regions were the primary areas where salinity and water quality problems were encountered. Salinity problems also appeared in humid, high-rainfall climates, particularly among coastal areas where saline groundwater intrusion occurred. Now, however, due to degradation of ground and surface water supplies, salinity problems appear where these difficulties have not been encountered before.

Salinity problems can be caused by a number of factors. Sometimes the soil itself is high in salts as a result of environmental conditions. Occasionally, problems arise from cultural practices, such as improper irrigation or the use of water high in salts. Although good-quality effluent water is a resource that should be used more often for irrigation, effluent supplies that are high in salts are not uncommon.

There are complex interactions between the turfgrass plant and salts in the water and/or the soil. While "quick fixes" are often promised, they cannot alter the basic laws of chemistry. It's a little like losing weight. Fad diets come and go, but unless you take in fewer calories than you burn off, your jeans won't fit any better. Let's take a brief look at some basic facts about salts so you can be better prepared to meet this challenge.

Salinity Effects on Turfgrasses

Soluble salts in saline soils injure plants because of the increased salt concentration in the soil solution. Turfgrass responses vary depending on the turfgrass species, soil texture, salt distribution in the soil profile, and types of salt ions present.

Salts affect plants by making water and nutrients less available for growth. High salt concentrations in the soil solution create osmotic pressures that decrease the amount of water available

Salt accumulations around an irrigation pond are caused by poor water quality and high evaporation rates. Note the absence of turf near the water's edge; when used for irrigation, turfgrass quality suffered.

for plant growth. Turfgrass plants growing under these conditions are particularly susceptible to wilt and drought, and the problem is especially apparent during turfgrass establishment. Frequent, light irrigations with poor-quality water and/or the presence of saline soils often results in reduced rooting, impaired topgrowth, and poor turfgrass density.

Turfgrass injury as a result of high osmotic conditions is called physiological drought. This phenomenon occurs when plants cannot take in enough water to meet growth requirements through cell expansion and normal processes such as respiration. Injury from physiological drought also occurs when soluble salt concentrations build up on the external surfaces of leaves as a result of desiccating weather conditions, improper irrigation practices, or exudation.

Certain soluble salts in the soil solution can restrict the uptake of essential nutrients for plant growth by occupying nutrient absorption sites on turfgrass roots. Such secondary induced salt injuries most commonly result in potassium and/or phosphorus deficiencies.

Visual symptoms of salinity effects on turfgrasses include wilting and a blue-green appearance of the leaves, followed by irregular shoot growth. Higher salinity levels cause leaf tip burn and eventually thinning of the turf. Root growth is shallow and stunted, with individual roots sometimes enlarged.

Bentgrass establishment can be reduced by salt accumulations caused by poor-quality water containing bicarbonates and other salts.

Reading the Test Results

Three of the most useful and informative measurements for evaluating salt effects are Electrical Conductivity (EC), Sodium Absorption Ratio (SAR), and Exchangeable Sodium Percentage (ESP).

Electrical Conductivity (EC)

Salinity is measured as electrical conductivity (EC), and is reported in the scientifically preferred term of decisiemens per meter (dS/m). Salinity is also reported in other units as millimhos per centimeter (mmhos/cm), parts per million total dissolved solids (ppm and/or TDS ppm), and total dissolved solids as milligrams per liter (TDS mg/l). Keep in mind, salinity units are all interchangeable by the following conversions:

$$dS/m = mmhos/cm = \mu mhos/cm \times 1000$$

$$dS/m \times 640 = TDS\ ppm = TDS\ mg/1$$

$$TDS\ (ppm) / 640 = EC\ (mmhos/cm)$$

A good guideline for evaluating reported EC results is listed below.

	Degree of Problem		
Salinity	None	Increasing	Severe
EC (mmhos/cm)	<0.75	0.75 - 3.0	>3.0
TDS (ppm)	<480	480 - 1920	>1920

Sodium Absorption Ratio (SAR)

SAR is the ratio of sodium to calcium and magnesium ion concentrations. The following formula calculates SAR when sodium (Na), calcium (Ca), and magnesium (Mg) are expressed as meq/l (milliequivalents per liter).

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{2+} + Mg^{2+})/2}}$$

SAR is a good relative indicator of the sodium hazard or danger to soil permeability. Irrigation water used with SAR values greater than 4 may result in sodium accumulations in the soil profile. This factor can enhance the salinity problem by causing deflocculation of clay and clay-loam soils, resulting in reduced permeability. Coarse-textured soils, such as those on golf greens constructed of a high percentage of sand, may be able to withstand irrigation water with SAR values in excess of 9, without experiencing severe permeability problems.

Exchangeable Sodium Percentage (ESP)

The degree of saturation of the soil exchange complex with sodium is referred to as Exchangeable Sodium Percentage. It is calculated as follows:

$$ESP = \frac{\text{Exchangeable sodium (meq/100 gm soil)}}{\text{Cation exchange capacity (meq/100 gm soil)}} \times 100$$

On most soil tests, this figure is reported as a percentage of the base saturation. When sodium begins to occupy more than 3% of the total base saturation, degradation of soil structure can begin.

Saline Soils

Saline soils usually have a pH of 8.4 or less. The electrical conductivity (EC) of a saturation extract from saline soils will be greater than 4 mmhos, and the exchangeable sodium percentage (ESP)

Calcium and magnesium salts accumulated along a seepage zone next to the cart path. Seepage occurred from excess irrigation applied to the adjacent landscaping.

will be less than 15. Major ions present in these soils are calcium, magnesium, sulfate, chloride, and sometimes nitrate. White crusts, as a result of ion accumulations, are usually visible around irrigation lakes where saline conditions are prevalent. Sufficient concentrations of these soluble salts can cause turfgrass injury.

Arid and semi-arid regions exhibit characteristic saline soils by the white salt accumulation on the surface. This process of salt accumulation is called salinization. Factors that affect salt salinization include: a) natural weathering of existing soils; b) evaporation rate; c) rate of water movement to the soil surface; d) salt content of ground and irrigation waters; e) amount of applied irrigation water; f) soil permeability; and g) quantity and quality of surface drainage water.

Soil salinity problems may also develop from improper irrigation practices and/or poor-quality irrigation water. Groundwater resources in some areas have tested as high as 22 tons of salt per acre-foot of water. This groundwater source could not be used for irrigation without major modification. Many irrigation water sources range from 0.1 to 5.0 tons of salt per acre-foot of water.

Sodic Soils

Another soil condition is sodic or alkali soils, where the principal soil cation is sodium. These soils have an ESP greater than 15, and pH is usually 8.5 or higher. In sodic soils, more than half the soluble cations in the soil solution are sodium. Sodium influences soils by inhibiting clay flocculation and promoting soil structure deterioration. The major consequence is very low water permeability in the soil. In addition to the indirect soil effects, the sodium concentration in the soil solution is usually high enough to influence adversely turfgrass growth and quality.

Reducing Salinity Problems

The first step in reducing salinity problems is to confirm that a salinity problem exists or that the factors present will eventually cause problems. Obtaining soil and/or water chemistry tests from a reputable laboratory will help accomplish this goal. Be sure to collect representative samples for testing and use the same lab for subsequent testing for the sake of continuity.

Drainage, proper irrigation, and irrigation water quality are key factors in managing salinity problems. Excess salts may be leached out of turfgrass root zones with proper application of irrigation water or by natural rainfall. However, if irrigation water has excess or undesirable dissolved salts, the water should be carefully evaluated before it is used for irrigation purposes. It is a good idea to monitor water quality throughout the year, since changes can occur. Good-quality water should have an SAR no greater than 4. Irrigation waters with high EC values can be used if the soil has a high infiltration rate, an adequate internal drainage system, and the irrigation delivery system can supply excess water during all seasons. This situation means the safest place to use poor-quality irrigation water is on properly constructed USGA greens. Greens that suffer from poor internal drainage and/or a lack of good surface drainage should be rebuilt as soon as possible. In the meantime, deep mechanical cultivation, flushing the soil profile with deep irrigations, and the use of soil amendments remain the best hope.

Sodic and Saline Conditions

When a soil has an EC greater than 4 mmhos/cm and an ESP greater than 15, it is classified as saline-sodic or saline-alkali. In areas of poor-quality irrigation water or low rainfall, soils may accumulate high quantities of dissolved minerals. Saline soils usually contain large quantities of soluble minerals or salts that influence turfgrass and ornamental plant growth and development. Both saline and sodic conditions require special cultural practices to maintain turfgrass growth and quality. Predictably, saline-sodic soils are among the most difficult to manage.

Conclusion

Confused? Well, don't feel too bad. The chemistry involved in dealing with salts in soil and water will challenge even the best soil scientist. If you're looking for a little late night reading, you might pick up Agriculture Handbook No. 60, "Diagnosis and Improvement of Saline and Alkali Soil," from the United States Department of Agriculture. In the meantime, always remember, there are no quick and easy "fixes" to poor water quality or soils. Correction, or at least management of these problems, takes time and work.

ON COURSE WITH NATURE

The Nest Box Project

by NANCY P. SADLON
Environmental Specialist,
USGA Green Section

A handmade bluebird box by Colonel Robertson represents one design alternative. The ventilation slits improve airflow and provide a light source to encourage the bluebird to enter.

SNAGS AND tree cavities once provided many areas of suitable habitat for cavity-nesting birds, but land development and more manicured maintenance trends have reduced these habitat sites. For example, the North American bluebird has experienced a 90% decline in the past 50 years, and habitat loss has been a significant cause of this decline.

Artificial nest boxes can provide alternative nest sites, enticing birds to occupy new habitat areas. Besides cavity-nesting species, birds that usually nest on tree tops, such as osprey, eagles, and owls, have been encouraged to use artificial nests with imaginative designs. Waterfowl also can be encouraged to nest on artificial floating islands. Participation in a nest box project is an easy and economical way to increase bird nesting success, help balance loss of natural habitat, and offer an opportunity for superintendents to take an active role in conservation and enhancement of the environment.

Nest box position is one of the most important considerations in attracting birds. Specific nest site characteristics for each species vary, based on instinct, habitat site, and nesting characteristics. It is important to pay attention to the correct habitat (i.e., open fields, wooded area), as well as species preference for nest height above the ground, distance to dense cover, spacing between boxes, etc.

Bluebirds

Nest boxes are a familiar subject to Colonel W. R. Robertson, active for 20 years with the North American Bluebird Society (NABS), who has encouraged bluebird nesting in Georgia. At 80 years old, Colonel Robertson has constructed over 1,000 nest boxes and still sells a few each year. He continues to monitor 60 boxes on three different Georgia golf courses: Cherokee Country Club, Polo Field Club, and Brookfield West Country Club.

Colonel Robertson's first nest boxes were placed in a nearby cemetery, which provided acres of short grass and an ample supply of insects. This effort, however, resulted in failure as many of the boxes were stolen. Recognizing this problem, the golf course was identified as an excellent location for providing both security and bluebird habitat. It took only a short time to learn how to build bluebird boxes and where to place them so they did not interfere with golf and yet were desirable to the bluebirds.

He emphasizes, as does NABS, that bluebirds can help reduce certain insects on a golf course, and thus reduce the volume of chemical usage necessary to

DIMENSIONS FOR TAILORING NEST BOXES

BIRDS USING SINGLE-ENTRANCE BOXES	ENTRANCE Diameter Inches	ENTRANCE Above Floor Inches	DIMENSIONS Floor Inches	DIMENSIONS Sides Inches	Location Height Feet	Preferred Habitat Codes
Barn owl	6	4	10 × 18	15 to 18	12 to 18	4
Bewick's wren	1 to 1¼	1 to 6	4 × 4	6 to 8	6 to 10	2, 6
Bluebird	1½	6	5 × 5	8	5 to 10	1
Carolina wren	1½	1 to 6	4 × 4	6 to 8	6 to 10	2, 6
Chickadees	1⅛	6 to 8	4 × 4	8 to 10	6 to 15	2
Crested flycatcher	2	6 to 8	6 × 6	8 to 10	8 to 20	1, 2
Downy woodpecker	1¼	6 to 8	4 × 4	8 to 10	6 to 20	2
Flickers	2½	14 to 16	7 × 7	16 to 18	6 to 20	1, 2
Hairy woodpecker	1⅛	9 to 12	6 × 6	12 to 15	12 to 20	2
House wren	⅞	1 to 6	4 × 4	6 to 8	6 to 10	2, 6
Nuthatches	1¼	6 to 8	4 × 4	8 to 10	12 to 20	2
Purple martin	1¾ (min.) 2 to 2¼ (recom'd.)	1	6 × 6 (min.) 6½ × 9 (recom'd.)	6	10 to 20	1
Redheaded woodpecker	2	9 to 12	6 × 6	12 to 15	12 to 20	2
Screech owl	3	9 to 12	8 × 8	12 to 15	10 to 20	2
Sparrow hawk	3	9 to 12	8 × 8	12 to 15	10 to 30	1
Titmouse	1¼	6 to 8	4 × 4	8 to 10	6 to 15	2
Tree swallow	1½	1 to 5	5 × 5	6	10 to 15	1
Wood duck	4	17 to 19	12 × 12	22 to 24	10 to 20 above ground 6 above water	3, 5

Preferred Habitat Codes:

1. Open areas in the sun (not shaded continually)
2. Woodland clearings or the edge of woods
3. Above water, or if on land, the entrance should face water
4. On trunks of large trees, or high in little-frequented parts of barns, silos, water towers, or church steeples
5. Moist forest bottomlands, flooded river valleys, swamps
6. Backyards, near buildings

control these pests. From considerable experience as both golfer and bluebird expert, he recommends:

- Use an average of 13 to 14 bluebird houses per 18-hole golf course.
- Place the box to the side or back of tees, out of the golfers' way. (Use of nest boxes as 150-yard markers has not been successful for Colonel Robertson, as they get hit by golf balls, annoying both golfer and bird.)
- Mount on a metal pole, one inch in diameter. Trees represent natural passageways for predators, allowing raccoons, opossums, and snakes to reach the nest.
- Locate boxes no closer than 100 yards apart; 200 yards is better. Closer placement violates feeding territories, causing birds to fight.
- Choose an open area not shaded completely by trees.
- Use ¾″ weather-resistant wood and paint the exterior a neutral color that simulates bark.

Provide ventilation, drainage, and a predator guard to the nesting box. Ventilation improves temperature and airflow, as well as providing a light source. Light is important to encourage birds to enter the box. The bluebird box should be in place by the end of March, but it's never too late to get started. Many species look for future nest sites during migration. Most of all, be patient. It takes approximately two years before your nest boxes will attract a noticeable population.

Don't forget about the nest boxes once they have been constructed and mounted. Monitoring the boxes remains an important aspect of the project. Careful observation of nest box activities allows you to determine and correct problems with predators, parasites, or competitors.

Share Your Stories

Reporting your successes or failures is important to help others incorporate the right elements into habitat projects. The USGA and the Audubon Society of New York want to encourage your participation in other projects through the Audubon Cooperative Sanctuary Program, and we would like you to share your successes with us in future "On Course With Nature" articles. As a participant in the Audubon Cooperative Sanctuary Program for Golf Courses, you will automatically be connected with the Nest Box Network, which surveys and reports on members' nest box efforts and observations.

For more information, contact:

- Audubon Cooperative Sanctuary Program, Hollyhock Hollow Sanctuary, Route 2, Box 131, Selkirk, NY 12158 (518/767-9051).
- North American Bluebird Society, P.O. Box 6295, Silver Spring, MD 20916-6295 (301/384-0744).

Monitoring the bluebird box is an important aspect of the project. Active bluebird conservationist Colonel Robertson checks his nest boxes for activity.

ALL THINGS CONSIDERED

Looking for a "Fast Food" Version of the USGA Spec Green

by JAMES T. SNOW
National Director, USGA Green Section

IT'S COME to this: After listening to golf course architects, builders, superintendents, and others complain endlessly about USGA specifications for green construction, and watching them modify the specs a hundred different ways to meet their own desires and beliefs, I've decided that what these people must really want is a "fast food" version of the specs!

What constitutes my definition of "fast food" specs, you ask? It's simple. Green construction according to the "fast food" method must be all of the following:

- EASY
- FAST
- CHEAP
- FOOLPROOF

Unfortunately, building greens is not the same as flipping burgers. If you look around long enough and set your taste standards low enough, it's possible to find restaurants that serve food that meets all four performance characteristics. If anyone tells you he can build greens that meet all four standards, though, my advice would be to look elsewhere.

It's not hard to find greens built with the first three characteristics in mind — EASY, FAST, and CHEAP. They're the ones that often fail and must be rebuilt, or else cost many times their original expense in terms of extra maintenance costs, poor-quality turf, aggravation, and unhappy golfers.

The fourth characteristic — FOOLPROOF — is the standard the smart money goes with. It means building a green according to the method most likely to succeed, a method that ensures good drainage, resistance to compaction, consistently good turf conditions, and, with judicious maintenance, decades of good performance. It means a method of construction based upon good scientific principles and years of proven field experience; in other words, the USGA recommended method of green construction.

Why wouldn't everyone build FOOLPROOF greens? Some critics say that USGA greens are too difficult, time-consuming, and costly to build. But are these criticisms justified? Let's take a look, comparing USGA specs to other methods of green construction.

EASY — USGA greens are fully described in a 24-page booklet and a 25-minute videotape. Laboratory personnel and Green Section agronomists are available to answer questions and provide other assistance. Sure, it takes some planning and coordination to build USGA greens, and it takes more steps than the alternative fly-by-the-seat-of-your-pants method. But which method is actually easier? With USGA greens, all you have to do is follow the directions. One point in favor of the USGA specs.

FAST — It's true, building a USGA green is not the same as deciding to get in your bulldozer, pushing up some "native soil," planting some grass seed, and calling it a green. It requires seeking out the best materials, allowing time for laboratory testing, mixing the components carefully, and following through with all the details to ensure success. One point in favor of the critics, but nothing that some planning couldn't change.

CHEAP — Okay, okay, the best materials sometimes cost more (but often not), and it could cost a few hundred dollars for laboratory testing and a few thousand dollars more for the time needed to put down the intermediate coarse sand layer. And let's really go first class and hire a quality-control person for $40,000 on a $500,000 (or more) green construction project. The extra cost for doing it the right way to ensure long-term success is usually less than 10% of the total. Another point in favor of the specs.

FOOLPROOF — Admittedly, there is little that is foolproof in the world, but USGA greens are by far the safest bet when it comes to green construction. For all of the criticism, no one has come forward with a scientifically based, time-tested method that's better, or even comparable.

During the past year, we've heard from every imaginable corner of the game about how the USGA ought to change its specs to make them easier, faster, and cheaper. Not surprisingly, most recommendations best served an individual's needs, rather than the needs of golf courses for top-quality greens. Rest assured, however, that the USGA is not going to put its name on construction methods designed primarily to make green construction easy, fast, and cheap, without including the foolproof. If we ever endorse "fast food" green construction techniques, it only will be after extensive scientific investigation and extended field testing, and after the fat and cholesterol have been removed, too.

USGA GREEN SECTION RECORD
JULY/AUGUST 1991

TURF TWISTERS

BANK ON IT

Question: I keep hearing about clubs installing perimeter systems for the banks and perimeter areas around greens. Is this really necessary? (New Jersey)

Answer: In many cases, a perimeter irrigation system is a real aid in water management. The grasses on banks and surrounds often require additional water because of exposure, slope, and other factors. Furthermore, the banks often receive less water than the greens because of the irrigation head arrangement. With conventional systems, it is often necessary to over-water the greens to keep the banks in good condition. A perimeter irrigation system can independently keep the bank areas watered while not over-irrigating the green.

THIS NEW FEATURE

Question: With all of the interest in the environment and the Audubon Cooperative Sanctuary Program, why don't you start featuring projects that golf courses can do to participate? (Iowa)

Answer: Beginning with this issue of the GREEN SECTION RECORD, you are going to see just that! "On Course With Nature" will be a new section featuring environmental projects that superintendents can easily incorporate on their golf courses. These projects offer an opportunity for you and your course officials to take an active, leadership role in habitat preservation and environmental awareness.

PRODUCES HOLE-Y WATER

Question: We have all heard recently about the use of water for aerification on greens. Will this totally replace standard aerification practices? (California)

Answer: This method of aerification looks promising and is certainly alluring. While golfers would just as soon discard the standard method of aerification, do not discard the programs that have worked in the past. The best advice we can give is to evaluate your aerification needs, and incorporate water aerification into your program if it would address the problems you are having.