JULY 1976

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

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VOL. 14, No. 4 **JULY 1976**

COVER PHOTO—The area is beautiful, but does the grass need regular watering this time of year?

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, Suite 107, 222 Fashion Lane, Tustin, Calif. 92680. Second class postage paid at Far Hills, N.J. and other locations. Office of Publications, Golf House, Far Hills, N.J. 07931. **Subscriptions: $2 a year.**

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Refresh It — Don't Flush It

Good water management calls for good equipment properly used.

by WILLIAM G. BUCHANAN
Mid-Atlantic Director, USGA Green Section

Irrigation on golf courses was unheard of in this country until the turn of the century. At the time, if it was referred to all, it was called watering. The grasses survived as best they could through the stress periods. Needless to say, turf conditions on many greens were on the sparse side by the time summer had passed.

Fred V. Taylor made some studies of golf green construction around that time. He was trying to determine the best way of building a putting green and the best way to maintain it. He noted that watering to keep the seed moist during the first phases of green establishment was very important. At this stage, he was watering the greens frequently, several times a day. After the grass seed germinated and had begun growing, the watering was done only once a day for two hours. This lasted for two to three weeks, then the watering was reduced to two hours every other day for several weeks.

The process of reducing the amount of water continued. After five weeks, the grass was only watered one hour a week. This lasted for several weeks until he felt the grasses were strong enough to do without. After the grasses had matured, they were observed to have root systems of up to 18 inches. Try to remember the last time you observed roots on putting greens that were 18 inches deep. Taylor was very proud of the fact that after several years by summer's end, the greens had a 75 per cent cover. This was considered quite an accomplishment at the time.

One of the most incredible parts of this whole study was that the green he was experimenting on was mowed at a height of 1/8 of an inch. That's extremely close, even today. Can you imagine how fast the greens must have putted with no water and mowed at 1/8 of an inch?

Over the years, watering was increased far beyond the point of Taylor's program. It was called irrigation. At this point we began to introduce new words into the golf course maintenance vocabulary, such as: sprinklers, traveling sprinklers, quick couplers, snap valves, pop-ups, syringing, syringe cycles, and last but not least, overwatering. Once we have reached the overwatering point the matter is academic; the only question is how we are applying the

water. Are hoses and sprinkler still being used, or is the approach more scientific with the use of semi-automatic or automatic systems? It seems that no matter which system is used, the end product is a wet golf course. This condition seems to be practically universal and not peculiar to any type of course whether it has cool season grasses or warm season grasses.

Webster defines irrigate (vb) -gat·ed; -gat·ing 1: wet, moisten: as a: to supply (as land) with water by artificial means b: to flush (a body part) with a stream of liquid (as in removing a foreign body or medicating) 2: to refresh as if by watering vi: to practice irrigation—ir·ri·ga·tion (n)—ir·ri·ga·tor (n).

Irrigation to Mr. Webster apparently means one thing, while to the golf course industry and club members it means quite another. To the golf course industry it means money—irrigation systems and operations are the major expenditure once the course is constructed. To the club member it means green playing surfaces—what makes up the green playing surface is another story. The majority of club members have no idea what grass they are playing on; it could be bluegrass, bermudagrass, bentgrass, *Poa annua,* or any combination. I have seen clubs where they are happy with well manicured weeds. They do not care or mind as long as the color is green and the greens hold.

The superintendent is caught in a different situation. Irrigation systems to him are indeed a friend, because they are labor savers and tools with which he can manage the watering of the golf course. Using this vital management tool, water can be applied at the time it is needed in the amounts required and with a minimum of labor. When used in this manner, irrigation systems are a very worthwhile and necessary investment. The only problem with this type of program is in determining how much water is needed.

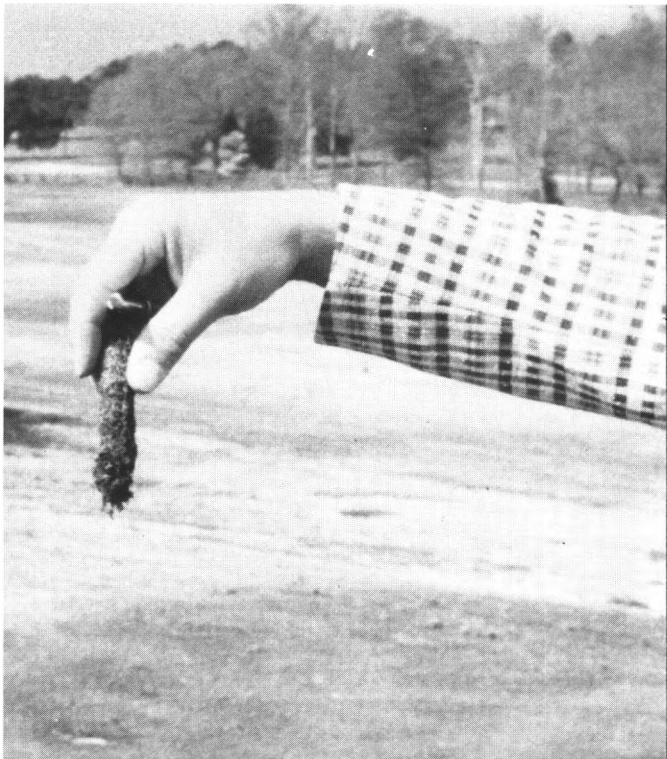
Too many times, Mr. Webster's definitions get confused. Remember, he made a distinction between irrigation of the land and the body. For land, the definition was watering by artificial means and to refresh as if by watering. For a body part, it was to flush with a stream of liquid (as in removing a foreign body or medicating). Gentlemen, contrary to popular belief (although I realize many superintendents become married to the golf course during the summer stress periods and pour their hearts and souls into keeping the turf alive on the course), the golf course is not a body part. The grass and soil are not foreign objects that need to be flushed by a stream of liquid to be removed.

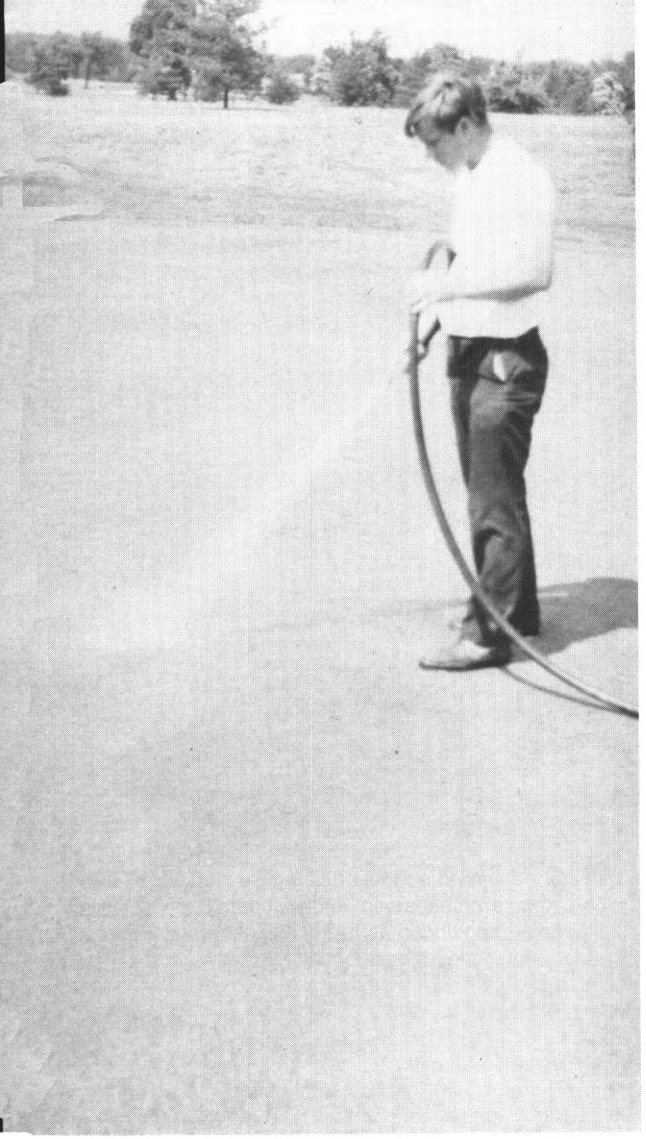
Irrigation can become a foe when not properly managed. Membership pressure as well as non-familiarity with the system can lead the superintendent into poor management practices. Many times, although it is difficult to get anyone to admit it, they do not know how much water is being applied. Sure they know what the system is *designed* to supply, and they know how long the system is programmed to run, but how many know the *actual* amount of water that is being distributed? How many times have cans been randomly placed around the course, on tees, greens and fairways and the actual amount of water applied been measured? I would say relatively few. I would not be at all surprised that if this were done, many people would be amazed that the amount they are applying is greater than what they anticipate.

Probably the best indicator of overwatering, although it is generally noticed too late, is a gradual but significant increase in *Poa annua* population on the course. There have been more areas converted from a high percentage permanent turfgrass surface to a high percentage *Poa annua* playing surface within a few years following the installation of an updated irrigation system that I care to mention. One of the main contributors to this is that the improvements in the irrigation system cost a lot of money. Therefore, pressure is exerted, whether real or imaginary, to run the system frequently to get your money's worth. Another contributing factor is that the new irrigation system is being used, but the old watering practices are also still being used. As soon as either of these situations exist, *Poa annua* percentages begin to increase because the maintenance program has changed in favor of *Poa annua*'s growth.

Overwatering is very seldom by design; it just seems to evolve! The gradual evolution starts when a certain area begins to wilt. This area probably would have not even been noticed ten years ago, because there was not the pressure on the superinten-

Too much water prevents the roots from penetrating deep into the soil.





No! — No!

dent for wall-to-wall green; and besides, there were probably more important jobs to be done. But now at the slightest sign of wilt, not only is that spot watered, but more than likely, the entire surrounding area is watered. This sort of TLC (Tender Love and Care) starts a process of conditioning the area to demand more water. Because the grasses that were not to the wilting point have been gradually conditioned to expect the watering, the entire area becomes weaker. It is being maintained so that the weakest portion will survive. This type of practice can only lead to an overall weaker turf.

It seems that golfers and turf management personnel have lost sight of the phenomenon of natural selection in nature. Some plants are going to be weaker than others, and they will die; then the stronger plant will take over. According to the imposed laws of the golf world, it seems: "All Will Be Green and Live—Forever." There is no allowance for any turf to die, no matter what. Now, I am not advocating that we do not try to keep the golf course a nice healthy green, but I believe there is a limit.

During the spring and fall when the weather is relatively cool and the grasses show some wilt, I suggest we not be too hasty in applying water. Let the turf come under some stress; force the roots to go down into the soil profile and search for water. The only way they are going to go down is if they are forced to do so. If abundant water is available in the top two or three inches of the soil profile, then that is where the roots will remain. Only when the moisture supply is deeper than the roots, will the roots extend to it. Sure some of the grass will not make it, but I bet surprisingly little will not survive this treatment. And once the grasses become conditioned to the treatment, they will be a healthier green with a good root system.

Along with the grass being extraordinarily green, the putting green probably will be soft. The golf course industry has been pushed into believing a soft putting green is a good green. Of course, the easiest way to get the green soft so that it will hold a half-skulled 9-iron or even a 4-wood is to water it until the ball sticks. Invariably, when the water is used to soften an area where traffic is going to be concentrated, such as tees, fairways or greens; there is a problem with the turf. The more water applied, the easier it is to compact the soil and when the soil is compacted, soil structure is destroyed. When soil structure is destroyed, the plant cannot grow as well because of reduced soil air space. Tight soils make root growth more difficult. A short root system requires more frequent watering. It is no longer capable of supplying enough nutrients and water to the plant to withstand the stress periods. More water is needed, which causes more compaction and shorter roots, which brings about a need for more water, which subjects the soils to more compaction and shorter roots, etc., etc., etc.

This is truly a vicious cycle and the longer it goes on, the worse conditions get. Not only do the conditions get worse for the grass but weed infestations are encouraged. Crabgrass, *Poa annua,* and all the other variations of turgrass headaches arrive when the permanent turf is weakened. During July and August it is truly difficult to keep the grass alive. The grass plant does not have enough root system to support its demands for survival from heat, moisture, and traffic stresses being placed on it.

A program of judicious watering during the cool months of the year will firm up the soil, which will allow for more natural growth of the grasses. Almost without exception, golf course personnel know how much moisture is required each week at any given time in their area. The information has been compiled by the Bureau of Plant Industry by using an evaporation pan and by personal observation. These bits of information can be of immeasurable assistance in planning an irrigation program. However, unless the superintendent is sure how much water

he is actually applying, the evaporation information is of little use. Some suggestions therefore to help control the use of water on the golf course are:

1. Determine how much water is actually being applied.
2. Make sure the areas being irrigated are receiving the right amount of water.
3. Keep spring and fall irrigation to a minimum.
4. When irrigating, apply enough water to wet the soil through the root zone.
5. Increase the interval between irrigations.
6. Try to avoid daily irrigation.
7. Try to determine if the grasses are serious about turning blue and dying or just thinking they are going to die. They are in a way like athletes. You have heard athletes say they thought they were going to die when placed under great stress. But they were well-conditioned and survived. Grasses may also survive.
8. Remember Mr. Webster's words in making a distinction between body and land. We refesh for land and flush for body. And to this date, there is no lovelier stretch of land on earth than a well conditioned golf course.

Poa annua *encroachment is a good indicator of overwatering; notice light spots are in low areas where water stays longer.*

From "The National Greenkeeper" circa 1927

James Lathan, of the Milwaukee Sewerage Commission, called the following poem to our attention from "The National Greenkeepers."

The Skipper of the Green by G.A. Farley

For thirty years I sailed the sea,
And every port was known to me;
I was a member of the band
That finds but restlessness on land.

Like every skipper ever born,
I viewed the landlubber with scorn,
And pitied men who chose to toil,
Bound to the tillage of the soil.

But years have taken toll of man
Since birth on land and sea began,
And so I builded me a home
Upon a cliff, lashed white with foam,

Where I could watch the ships sail by,
And hear the seagulls' 'moaning cry,
And keep my faith in dreaming nights
of Southern palms and Northern Lights.

But neighbors interfered, and now
No longer do I scorn the plow,
And ships sail in and out unseen;
They've made me Chairman of the Green.

OVERSEEDING

Bermudagrass Greens for Championship Conditions

by JAMES B. MONCRIEF, Director, Southern Region, USGA Green Section

For golf, bermudagrass is king of the warm season grasses across the southern tier of the United States. From San Diego to St. Augustine it has no equal. Even as a putting surface, many golfers now believe the improved bermuda strains equal the putting qualities of bentgrass.

But one problem remains. The dormant or semi-dormant nature of bermudagrass during the winter playing season calls for overseeding. It is needed not only for winter color, but for a renewable playing surface through the dormant bermudagrass months as well. In fact, overseeding is one of the most important jobs for the southern golf course superintendent.

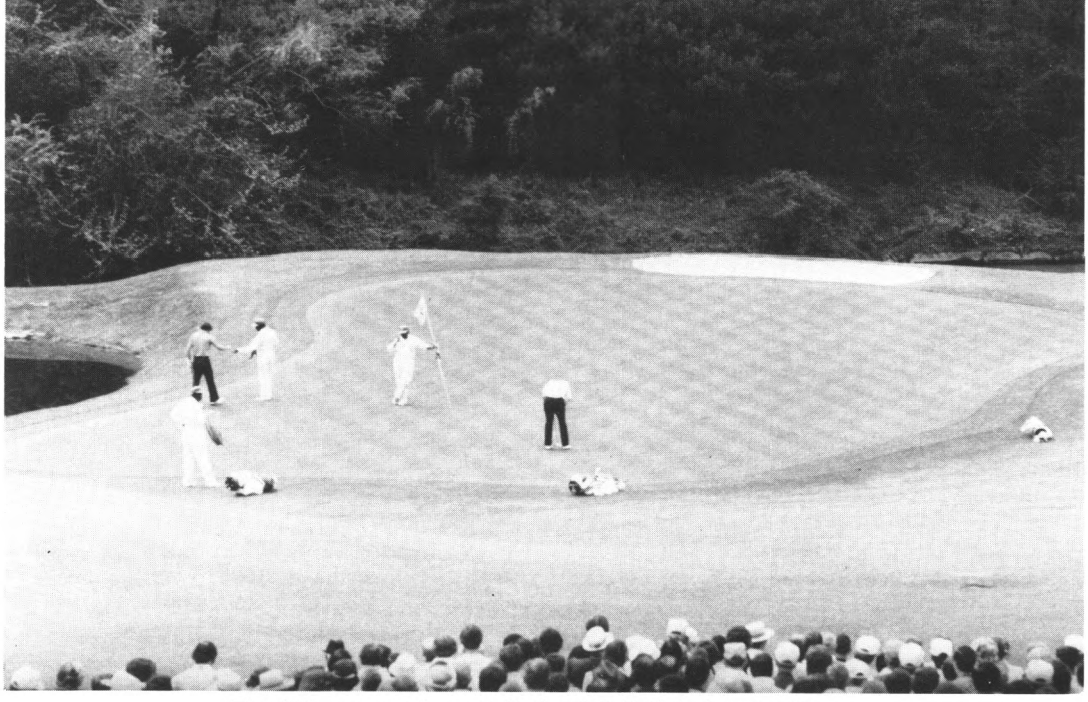
In extreme south Florida bermudagrass can survive without winter overseeding except under the most unusual weather conditions. Gibberillic acid has been tested and used to retain green color when severe cold fronts pass through this area. However, as one moves north, annual fall overseeding of bermudagrass becomes a necessity. If the grass is managed properly, there should be little difficulty in making the transition in the autumn from bermudagrass to the cool season grasses. The golfer should note very little difference in the putting surfaces of overseeded bermudagrass greens and bentgrass greens. The quality of the winter bermudagrass putting green will be determined by the selection of seed and how the greens are managed.

In the past, common ryegrass was used almost exclusively for overseeding greens for winter play but its spring transition period was a dreaded occurrence. Although it is still used on many courses today, improved ryegrass selections are now available and their use is increasing.

Much progress have been made during the past 10 to 15 years in selecting perennial ryegrasses, fine leaf fescues, bents, and bluegrasses for overseeding. These selections alone or in various combinations produce superior putting qualities and give a better transition in the spring with minimum disturbance to play.

The Milwaukee Sewerage Commission started out-field testing of seed selections and combinations on many golf courses in the early 1960s. Since then research has been done by private seed com-

Overseeding bermudagrass greens—one of the most important requirements of the southern golf course superintendent's work.



The 11th green at Augusta National Golf Club, Augusta, Ga.

panies, State and Federal turfgrass research centers throughout bermudagrass country. Extensive out-field testing on golf courses under varying traffic conditions has been one of the best ways to select grasses that give good performance under actual play. Seed production has become a larger and more scientific business with better selection of seed for better putting surfaces and transition on greens.

Some of the factors that have been considered in selecting grasses for overseeding bermuda putting surfaces are:

1. Wear resistant grasses, deeper green in color and the ability to withstand frequent low mowing to produce a true putting surface.
2. Fine leaf textured grasses that hold their color under low temperature ranges and minimize irregular roll of the ball in early stages of establishment.
3. Grasses that die back gradually in the spring so there is a gradual loss of the cool season grasses. Too rapid loss of a grass exposes bare areas before bermudagrass has time to fill in.
4. Selection of cool season grasses that are disease resistant or can be treated with fungicide for minimum loss of seedlings during establishment. Much progress has been made in treating seed with fungicides. Small grass seed is more difficult to treat than larger seed such as ryegrass. Farmers and vegetable growers have used fungicides for years to protect their expensive seed.
5. Uniformity of stand with no grain.

Ryegrasses emerge readily and produce a smooth putting surface within 3 to 5 weeks depending on the management of the green. The first cutting of new selections of perennial ryegrasses should be at about 5/16- or 3/8-inch. This will allow better root development. Gradually lower the cut to minimize irregular roll of the ball. Perennial ryegrasses are more cold tolerant, more disease resistant, and make a finer putting surface than domestic annual ryegrass. However, there can be a variation in the putting quality of perennial ryegrasses.

BUY QUALITY SEED

There is a wide selection of seed mixtures now being used and they are giving excellent results. Seed quality is very important. Only quality seed should be purchased. The seed tag on label will include the variety, purity, weed content, and germination. By becoming familiar with the tag, the amount of pure live seed can be determined and this can mean the difference between a good or poor stand. To find the percentage of pure live seed, multiply purity by germination.

The label will also indicate the weeds to expect in the overseeding. *Poa annua* is considered a weed where bermudagrass is overseeded. Shepherd's purse, chickweed, watercress, and other are frequently found in overseeded greens.

The seed you select should be determined by the total rounds of golf, size of greens, location of golf course, and budget. A partial list of seed used for bermudagrass overseeding is listed alphabetically for reference. No endorsement is intended.

Bentgrasses

Astoria, Emerald, Exeter, Holfior, Penncross, &

Seaside

Fescues, fine leaf

Atlanta, Banner, Barfalla, Cascade, Chewings, Dawson, Golfrood, Highlight, Jamestown, Koket, Pennlawn, Wintergreen

Kentucky bluegrasses

Baron, Common, Park, Prato, Primo, Vieta

Perennial ryegrasses

Barenze, Birdie, Citation, Compas, Derby, Diplomat, Epic, Eton, Game, Lamora, Linn, Loretta, Manhattan, NK 100, NK 200, Omega, Pennfine, Pelo, Splendor, Yorktown

Poa trivialis

Common or Roughstalk.

The seeds listed can be used alone or in combinations for superior putting greens.

Cultivars used alone on greens, pounds per 1,000 square feet:

Perennial ryegrass	30 to 40
Annual ryegrass	30 to 50
Bentgrass	3 to 5
Fine fescues	24 to 30
Poa trivialis	8 to 10

Seeding mixtures and pounds per 1,000 square feet:

Perennial ryegrass & fine leaf fescue	20-10 to 25-15
Perennial ryegrass, fine leaf fescue, bent	20-10-1 to 25-12-3
Perennial ryegrass mixture, 2 to 3 cultivars	30-40
Bent, fine leaf fescue, bluegrass	1-10-4
Bent, fine leaf fescue, *Poa trivialis*	1-10-6

When considering these rates, keep in mind, pure, live seed for best results.

FACTORS AFFECTING A STAND

Several factors affect an early superior playing quality. Buy the best seed available, preferably treated with fungicide. The stand may be sparse if the greens are not seeded at the proper time and may cost more if the overseeding is not handled properly. Bermudagrass becomes very competitive with cool season seedlings if overseeding is accomplished too early and warm temperatures persist. Perennial ryegrasses produce additional stems and fill in voids under favorable growing conditions.

Get the seed down through the turf on the putting surface as close to the soil as possible. If there has been a weekly or bi-weekly light vertical mowing program prior to overseeding, drastic thinning of the grass at seeding time may not be necessary. You may also want to skip mowing for two to three days prior to overseeding. This will allow the seed to sink into the turf and to be covered with sterilized soil. Any cultivation of the green should be done about four weeks before seeding to prevent a spotted effect when the seeds sprout.

Date of seeding can vary very much from extreme southern to the farthest northern region where bermuda is used and greens are overseeded for winter play. Earlier overseeding will be done by September 15 and from north to south there will be a 15- to 20-day difference in seeding dates about every 150 to 250 miles. From the Atlantic to west Oklahoma and Texas, the following general seeding dates are suggested for comparison. There may be individual areas that differ. If a golf course is overseeded more than 9 months, use of bent should be considered. Use Interstate Highways going from

Annual ryegrass seedlings overseeded at 40 lbs. per 1,000 square feet.

east to west as guide lines:

I-40 and south	September 15 to October 1
I-20 and south	October 1 to October 15
I-10 and south	October 15 to November 15
I-4 and south	November 15 to January 1
	or no overseeding.

Many golf courses in extreme south Florida and south Texas do not overseed every year. Many golf courses in the upper south use temporary greens during the winter months, mulch the permanent greens with straw or cover them with black plastic to reduce winter kill.

HELPFUL CHEMICALS

Many fungicides are available to protect seedlings while they are becoming established and to assure a good putting surface. Throughout the winter season, stay on a preventive program to keep disease from becoming a problem. There should be enough material for at least two sprayings on inventory all the time.

There will be greater root development if the first mowing is from 5/16- to 3/8-inch. As soon as possible threafter, begin to lower the height of cut to minimize irregular roll of the ball. The fine leaf grasses reduce variation of roll of the ball.

The dreaded Pythium and dampening off diseases should not be a major problem if fungicides are applied at the proper time. Other diseases may also be a problem but with broad spectrum fungicides they should be kept under control. Ideal conditions for diseases to develop are created by the management requirements of greens.

During the first 10 to 15 days, management of water is very important. Seed should be kept damp by syringing four to five times a day to assure proper

Maintaining and

by STANLEY J. ZONTEK, Northeastern Director, USGA Green Section

In today's modern golf course operation, simple economics have forced mechanization of just about every possible maintenance operation. The triplex putting green mower, mechanical sand trap rake, large hydraulic fairway cutting equipment illustrate the point. The quest is for ease, speed and efficiency. Why then discuss a maintenance operation that almost totally requires time-consuming and expensive hand labor; i.e., maintaining and defining a hazard? Well, it is because one should not lose sight of the fact that a golf course is not a sod farm! A golf course will ALWAYS require hand labor and has built into it features that are only maintainable by hand. One of the situations that require periodic hand maintenance for good looks and hazard defintion is the care and repair of ever-eroding sand bunker faces and lips.

GENERAL TYPES OF BUNKERS

Many of the golf courses in this country have bunkers of the type depicted in Figure 1. They are basically of the design that have essentially flat sand with grass-covered mounts extending down to the sand. This picture from Colonia Country Club, Colonia, N.J., shows the new construction of several of these older but effective and aesthetically pleasing bunker types. As with any new construction, maintenance problems arising from eroding edges are some years away.

Such is not the case on many of the older courses in the country that have had bunkers of this type for many years and eroding banks and lips are indeed a problem that can only be dealt with by renovation or reconstruction.

Figure 2 illustrates the problem. Figure 3 shows what has been done at the Garden City Golf Club, Garden City, N.Y. The grass mound facing (Figure 2) shows the extent of the breakdown and erosion problem. The bunker in Figure 3 has been renovated. Needless to say, a big improvement in the appearance and playability has been made (how would

Figure 1. Old style sand bunkers under construction.

sprouting.

Over a period of years, pre-emergent chemicals have been used 45 to 60 days prior to overseeding to control weeds, mainly *Poa annua*, but some companies do not recommend their chemical for such practices. Perennial ryegrasses seem to tolerate the pre-emergent treatment better than bent, fine leaf fescue, or bluegrass.

Courses with greens overseeded from October through July 1 should consider renovating greens and using bent. Some resort courses are open for their season from December to May 1 and are on standby maintenance the remainder of the year. The program of overseeding will vary for those clubs open for 12 months of play. There are many variables that must be considered in bermudagrass overseeding. But the one goal of the superintendent to provide championship putting surfaces for the winter months never changes.

Figure 2. Deteriorated face of old style bunker, a problem on many golf courses.

Defining A Hazard

Figure 3. Renovation of the old style bunker grass slopes. Certainly an improvement over Figure 2.

you like your ball resting between one of those tufts on the non-renovated mound?).

Problems of this sort may be found on many golf courses. How is the renovation work best accomplished? In this case, the bank was first stripped, removing the thin vegetation and any sand accumulation. Soil was added back to the desired grade and the area resodded. Depending on how the sod is laid, pegging it down may or may not be necessary.

This procedure sounds easy, but in reality it requires much hand labor to keep the areas good looking, playable and maintainable.

Figure 4 is an example of the second basic type of bunker construction . . . sand extending up a face. Some of the problems of this type of design are shown. Although aesthetically pleasing when well-maintained, this type of construction is expensive to sustain especially in areas prone to heavy rains. Rains will frequently wash out the steep sand faces, usually dirtying the sand, and require much hand labor to shovel or re-throw the sand back onto the face again. This style of bunker is also expensive in terms of raking. It does not adapt well to the mechanical sand rake. It requires more hand raking on the slopes than the flatter types.

The solution to the washing problem is not easy. It usually requires reconstruction or recontouring of the subsoil so the slope is less severe, or to reconstruct to reduce the actual sand face surface. Other than this, golf courses having this type of bunker, and liking it, must accept the higher maintenance required by this design.

Figure 4. New design sand bunker, with soil erosion problems.

MORE PROBLEMS

Figure 5 illustrates a problem common to all sand bunker types ... that of sand accumulation on the collar resulting from years of bunker shots. As is usually the case, the collars suffer due to the sand build-up and low water-holding capacity. As is usually the case, the solution to this bunker maintenance problem is not quick, easy or economical. It requires hand-digging and removal of accumulated matter back to the original soil and resodding with new turfgrass. Because this type of problem requires years to develop, corrective measures are only infrequently needed. However, when they are needed, they are in fact and indeed needed.

DEFINING A HAZARD

So far, this article has shown several differing types of sand bunker design and how they may be renovated when deterioration sets in. We are not attempting to judge design but rather to stress the need for continued maintenance of these important play areas. Good looking and playing sand bunkers of whatever design are an asset to any modern golf course.

This final point should be stressed. Sand bunkers are hazards. By definition, a "hazard" is any bunker or water hazard. A sand bunker is an area of bare ground, often a depression, which is usually covered with sand. Grass covered ground bordering or within a bunker is not part of the hazard. (Definition 14a.) A problem can arise if there is no clear boundary to a sand bunker (see Figure 2). If a ball is clearly in a hazard, certain Rules of Golf pertain ... non-grounding of a club, etc. There is a question then, "Is the ball in a hazard or is it not in a hazard?" Keeping lips and margins well defined will reduce or eliminate such questions in the mind of the golfer.

Unfortunately, in today's overall golf course maintenance operations, hand labor of the type needed for good sand bunker upkeep is usually at a minimum. Every type of bunker on a golf course requires maintenance and/or major renovations at some time or another. It is essential that this work be done so that sand hazards will play well, be well defined, and be good looking.

Figure 5. Sand build-up from exploded bunker shots. A problem with any bunker design.

Turfgrass Wear[1]

by DR. JAMES B. BEARD
Department of Soil and Crop Sciences, Texas A&M University

Turf located on public areas such as parks, golf courses, and sport fields will be subjected to increasing traffic in the coming years. These open green areas near urban centers will be used more frequently and intensively than ever before by individuals whose mobility has been restricted by the increased cost of energy for travel to more distant outdoor recreational areas. Discretionary time available for leisure activities is expected to amount to at least as much or possibly more than in the past, thus providing substantial amounts of time for outdoor recreational activities. These increasing traffic pressures on recreational and sport facilities will re-

[1]Data on which much of this article is based is the result of wear investigations supported by a grant from the United States Golf Association Green Section Research and Education Fund. The paper was presented at the 1975 Texas Turfgrass Conference.

quire that the turfgrass manager become more knowledgeable about turfgrass wear tolerance and the cultural practices that can be used to minimize damage from traffic.

Traffic has two distinct effects that should be taken into consideration when interpreting the resulting turfgrass damage. One, called turfgrass wear, is associated with damage to the above ground plant parts. Scuffing and tearing actions of foot and vehicular traffic tends to crush the leaves, stems, and crowns of the turfgrass plant. In addition to these direct effects, the injured tissues are more prone to disease infection and environmental stresses such as drought. The second aspect of traffic involves the "hidden effect" of soil compaction. In this case the soil particles are physically pushed together into a more dense soil that is characterized by reduced aeration and water infiltration rates. Both the wear and compaction components of traffic can be very detrimental to turfgrass quality.

Most research, articles, and lectures have emphasized primarily the soil compaction component of traffic. However with the anticipated increased usage of turfgrass areas, the importance of wear tolerance and its manipulation will have to become better recognized in the future. The following three sections will discuss in detail the major approaches utilized to minimize the effect of wear on turfgrasses.

I. TURFGRASS SELECTION

There are wide variations in the inherent wear tolerance of turfgrass species as shown in Table 1. These differences are significant enough to justify selecting the more wear tolerant species for a particular soil and environmental condition on sites where intense traffic is anticipated. The specific mechanism contributing to this interspecies turfgrass wear tolerance is being investigated through a grant from the U.S.G.A. Green Section Research and Education Fund. Allied research supported by the same agency conducted by Beard, Shearman, and Anda has been directed towards characterizing the wear tolerance among cultivars within a specific turfgrass species.

To establish controlled wear stresses across a series of turfgrass species and cultivars, a wear simulator was developed for small plot use. The apparatus simulated both foot and tire wear on turfs with minimal soil compaction. Foot traffic was simulated by a sled pulled in a circular twisting pattern with a pressure of 4 pounds per square inch being applied. The tire traffic simulator was comparable to that of a riding greensmower.

The comparative wear tolerance of 18 Kentucky bluegrass cultivars was evaluated in July of 1974 by Beard and Anda using the wear simulator. The turfs were five years old at the time the wear stress was superimposed. Cultural practices included mowing twice weekly at 1.5 inches with clippings returned; irrigation as needed to prevent wilt; and nitrogen fertilization at a rate of 5 pounds per 1,000 square feet per growing season. Phosphorus and potassium were applied as needed based on soil tests. Thatch accumulation was minimal and consistent throughout all plots. No pesticides had been applied during the previous four years. At the time the wear simulation treatments were applied, the treatment area was visually free of weed infestation and injury from insets or diseases.

Specific wear tolerance comparisons of the 18 Kentucky bluegrasses are shown in Table 2. There was a five fold increase in wear tolerance from the lowest to the highest listed cultivar in terms of wear tolerance. This study indicates that there are substantial differences in wear tolerance among the commercially available Kentucky bluegrass cultivars which could be effectively utilized in establishing more wear tolerant turfs for intensively trafficked areas.

A similar cultivar evaluation study was conducted on nine bentgrasses maintained under putting green conditions. The turf was six years old and possessed no visual disease or insect injury at the time the wear treatments were applied. Cultural practices included mowing six times weekly at 0.25 inch with clippings being removed; irrigated as needed to prevent wilt; fertilization at 5 pounds nitrogen per 1,000 square feet per growing season; and topdressing twice yearly for thatch control. Phosphorus and potassium was applied as needed based on soil tests.

The comparative wear tolerances of seven commercially available and two experimental bentgrasses are shown in Table 3. Among the commercially available cultivars the striking superiority of Penncross creeping bentgrass is of particular interest. The much lower wear tolerance of Emerald and Toronto creeping bentgrasses should also be noted. Plans are underway through support of the United States Golf Association Green Section to conduct comparable studies on the commonly used warm season turfgrass cultivars. Hopefully these investigations will be underway during this coming growing season at Texas A&M University.

These comparisons among species and cultivars within species are based on wear simulation of mature turfs. It should be recognized that fully established turfs are definitely superior in wear tolerance to young seedlings. Thus it is important for traffic to be withheld from turfgrass stands during the seedling establishment period. Similarly, dormant or extremely slow growing turfs do not have the wear tolerance and recuperative potential of dense, actively growing turfs.

II. CULTURAL PRACTICES

The wear tolerance of a turf increases as the green vegetation or turfgrass shoot biomass increases. Therefore, lower cutting heights increase

the proneness to wear injury. Similarly moderate amounts of thatch accumulation also contribute to a cushioning effect which increases turfgrass wear tolerance.

Wear tolerance is also reduced if the turfgrass leaves are quite succulent and delicate in nature. This condition is most likely to occur under excessive nitrogen fertility levels; intense irrigation; low potassium fertility levels; or under the shaded canopy of trees. The significance of these cultural practices in turfgrass wear tolerance should not be taken lightly. For example, a turf mowed at 1.0 to 1.5 inches, with 0.3 inch of thatch, and fertilized at a moderate level of nitrogen nutrition and a high potassium level can be as much as 10 to 15 times more wear tolerant than a turf mowed at 0.5 inch, with no thatch accumulation, and maintained under high nitrogen and irrigation levels.

III. TRAFFIC CONTROL

Turfs cannot be expected to persist under continuous, intense traffic. Even artificial turfs will wear out within four to five years use. Fortunately turfs have good recuperative potential if the traffic stress can be diverted, withheld, or reduced for a period of time. A preventive approach in which the traffic level is adjusted to a level that the specific turf will tolerate without excessive damage is even more desirable. This traffic control can be achieved through subtle design techniques which disperse traffic over the area or redirect it across hard surface walks or roadways. These techniques involve the proper selection and placement of trees, shrubs, walks, roadways, contour barriers, and bunkers. Designs which offer a large number of alternate routes from one location to another are particularly effective where the site permits such an approach.

Finally, traffic should be withheld from turfgrass areas during periods of severe wilt stress or when the leaves have been frosted during the early morning. This will minimize mechanical damage to the brittle protoplasm which occurs under these stress conditions. Similarly, winter traffic on turfs covered with a wet slush should be avoided just prior to periods of severe freezing.

SUMMARY

The major points discussed in this article only touch the surface of the traffic problem. As further research is conducted, additional guidelines regarding specific turfgrasses and cultural practices that can be utilized to minimize the effects of traffic can be expected. The Texas A&M turfgrass researchers anticipate that this area will receive major emphasis during the next few years.

TABLE 1. The Relative Wear Tolerance of Twelve Turfgrasses When Grown In Their Respective Regions of Adaptation

Relative Ranking	Turfgrass Species	
	Warm Season	Cool Season
Excellent	Zoysiagrass Bermudagrass Bahiagrass	
Good		Perenial ryegrass Tall fescue
Medium	St. Augustinegrass	Red Fescue
Poor	Carpetgrass Centipedegrass	Creeping bentgrass Colonial bentgrass
Very Poor		Rough bluegrass

Adapted from "Turfgrass: Science and Culture."

TABLE 2. A Comparison of Verdure Remaining and Percent Reduction In Verdure for 18 Kentucky Bluebrass Cultivars After 800 Revolutions of a Turfgrass Wear Simulator.**

Kentucky Bluegrass Cultivar	Verdure Remaining (Grams Wet Wgt.)	Percent Reduction In Verdure
A-34	7.88 f*	22.7 ab*
Merion	5.68 e	24.0 ab
Baron	5.45 e	18.4 a
Nugget	4.60 de	45.8 abcd
A-20	4.51 de	31.7 abc
Georgetown	4.47 cde	47.3 bcd
Primo	3.92 cde	33.5 abc
Fylking	3.56 bcd	55.6 cd
Adelphi	3.45 bcd	58.8 cd
Newport	3.45 bcd	57.6 cd
Sodco	3.22 abcd	58.7 cd
Galaxy	3.09 abcd	62.7 d
Bonnieblue	3.04 abcd	65.6 d
Belturf	2.71 abc	53.5 cd
Campus	2.05 ab	58.0 cd
Sydsport	1.96 ab	62.7 d
Kenblue	1.90 ab	44.5 abcd
Park	1.59 a	59.0 cd

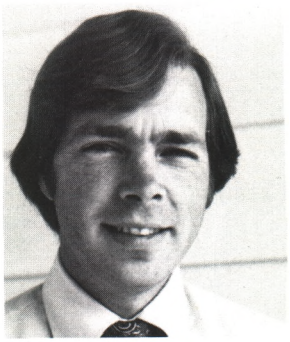
*Any two treatments with the same letter in each respective column were not significantly different from each other, at the 5% level, by Tukey's test.

**From a study by R.B. Anda and J.B. Beard.

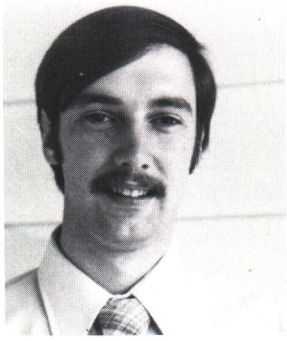
TABLE 3. The Comparative Wear Tolerance of Seven Commercially Available and Two Experimental Bentgrasses After 410 Revolutions of the Wear Simulator

Turfgrass Cultivar	Percent Reduction In Verdure	Verduring Remaining (Grams)
MSU-28-Ap	39.8	6.07
MSU-18-Ap	32.8	3.90
Penncross	53.0	3.64
Pennpar	58.7	3.07
Cohansey	65.9	2.56
Seaside	59.8	2.55
Toronto	53.6	2.46
Emerald	67.7	2.12
Astoria	64.4	1.83

NEWS NOTES FOR JULY



Bill Brewer



Jim Snow

New Green Section Staff Members

Two new Green Section Agronomists have been added to the staff of the Northeastern office, Highland Park, N.J. William S. Brewer, Jr., is a graduate of Cornell University and holds a bachelors degree. After serving with the Navy, Brewer saw duty with superintendents James Fulwilder, Century Country Club, White Plains, N.Y., and Ted Horton, Winged Foot Golf Club, Mamaroneck, N.Y., for four years. He brings practical experience, a fine academic background and a pretty fair golf swing to his new post. He became a staff member on March 15, 1976.

James T. Snow received his masters degree in June, 1976, from Cornell University as well, but actually joined the Green Section staff on April 1. Snow's research project was concerned with nitrogen accumulation in Kentucky bluegrass. He has had four years of on-the-job practical training in golf course maintenance in New York State and along the way has managed to score more than an average number of pars and birdies. Northeastern subscribers to the Green Section Turfgrass Service will come to know and draw on the experiences and suggestions of these men. Stanley J. Zontek is the Green Section Director of the Northeastern Office.

First in 40 Years! Look for New Poa annua Publication

The publication of a new and comprehensive bulletin on *Poa annua* will be mailed to all Green Chairmen and Superintendents of USGA Member Clubs this month. The bulletin is the result of a six-year *Poa annua* study at Michigan State University and was prepared by Dr. James Beard, Dr. Paul Reike, Dr. Joseph Vargas and Dr. Al Turgeon. The undertaking was supported by the U.S.G.A. Green Section Research and Education Fund, Inc. The last complete publication on *Poa annua* was published by Drs. Sprague and Burton in 1937, nearly 40 years ago!

The Green Section staff also contributed practical findings to the new bulletin. This makes it a truly unique publication. For the first time, a complete document on *Poa annua* combining research and practical application will be made available to all USGA Member Clubs!

Be on the lookout for this important document and addition to your turfgrass library. It is another example of the solid return USGA Clubs receive from their support of the total USGA Green Section program.

Thank You, Central Plains Turfgrass Foundation!

Dr. Ray A. Keen, of Kansas State University and Secretary of the Central Plains Turfgrass Foundation, recently wrote in the Foundation Newsletter:

"If the club and professional can't get along without a membership in the USGA, why are you doing without a USGA Green Section visit? We were supported by their research funds for 24 years. They have the best men available to survey your course and support your budget needs. All the better courses have this service to upgrade golf through better turf. Ask Carl Schwartzkopf (Mid-Continent Director for the Green Section) for more dope!"

USGA GREEN SECTION RECORD
JULY 1976

TURF TWISTERS

AVOID OVERIRRIGATION—NO MATTER WHAT!

Question: My present (automatic) irrigation system does not give uniform coverage. The area near each pop-up head becomes too wet if I extend the time to green up the outlying areas; i.e., between heads. What's the answer? (Arizona)

Answer: Assuming the pop-up heads are operating at optimum efficiency: i.e., pressure is adequate, nozzles are not plugged, rotating mechanism is working properly, etc., the irrigation schedule should be adjusted so that the close in areas receive a proper amount of water (not flooded) and the more distant areas are allowed to survive as best they can. This will mean some dry, brown areas. But for golf, "green" does not necessarily equal "good." Most golfers prefer a dry, firm course (even though there is some brown) to a wet, green one. Of course, spot watering the brown areas with hose and hand set sprinkler may smooth out the pattern. Avoid a wet course no matter what!

RETURN OF THE BUG

Question: Last year irregular brown spots developed in our fairways. The loss of turf was diagnosed as chinch bug damage. Will these bugs come back again this year? (Michigan)

Answer: Chinch bugs are always with us. The amount of damage they do in one season depends on the temperature and moisture present. When conditions are favorable, they can do considerable damage. Keep your eyes open for the first sign of irregular brown spots and then look for the small insects in the brown perimeter area. When the symptoms develop, spray an insecticide such as Diazinon or Sevin. These insecticides will also curb sod webworm that is very damaging to turf.

CIRCULAR YELLOW DISEASE PATTERNS

Question: Last summer our greens developed some circular yellow disease patterns, and the turf seemed to need more fertilizer than usual to maintain proper growth and color. Any ideas? (Virginia)

Answer: According to research at Rutgers University, observations at other research stations and on golf courses, a certain type of basaatiomycete is activated by the excessive use of systemic fungicides. These fungus fruiting bodies are yellow and quite often develop in circular patterns much like brown patch disease in size and shape. Lack of proper growth and a general yellowing of the turf could be signs of excessive use of systemic fungicides.