JANUARY 1969

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

Top-dressing — an old art finding new life!

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THE GREEN SECTION OF THE UNITED STATES GOLF ASSOCIATION

This Year:

Top-Dress Greens and See the Difference

by WILLIAM H. BENGEYFIELD,

Western Director, USGA Green Section

"Up, up and away." One method of mixing top-dressing material.

"The easy way is efficacious and speedy — the hard way arduous and long. But as the clock ticks, the easy way becomes harder and the hard way becomes easier. And as the calendar records the years, it becomes increasingly evident that the easy way rests hazardously upon shifting sands, while the hard way builds solidly a foundation of confidence that cannot be swept away."

Daniel Rand

In this age of science and technology, where man's knowledge is increasing at a great rate, it is still difficult to improve upon some things. Top-dressing greens is one of them.

Last October at the Northwest Turfgrass Conference Dr. John Escritt, Director of the Sports Turf Research Institute, Yorkshire, England, was telling his audience of his observations of turf management practices in the United States:

"Americans," he mused, "seem to want to overdo everything! For example, I feel you are overdoing putting green fertilization. You apply far too much water. You are constantly spraying fungicides and insecticides. You seem forever to be verti-cutting and aerifying greens. But there is one important practice you *should* be doing and are not doing at all: —top-dressing greens!"

Many agronomists in this country will heartily agree. His point is valid. Top-dressing is not easy. It may seem expensive, but properly done it is worth every effort *and* the money if your goal is championship putting turf. It is one management tool your golf course should use even though your neighbors have been overlooking it for the past three decades.

In the early days of greenkeeping, the ritual of top-dressing was carried out every few weeks. The old-timers may not have known all the reasons why, but they knew that it worked. World War II put an end to that. Shortages of labor, equipment, and material practically eliminated the practice, and it has never regained popularity. The advent of the mechanical aerifier in the late 1940s further discouraged a return to top-dressing. The soil cores, it was believed, would do the job for us. Only in recent years have the better managed golf clubs returned to sound top-dressing practices.

Why is top-dressing important? How does it work? What are proper top-dressing procedures? Are there really major advantages for today's golfer and course superintendent

Screening the final product. Top-dressing then should be composted for several months before use.

in a top-dressing program? There is much to be said on the subject.

WHY TOP-DRESS AT ALL?

Golf has expanded so rapidly in the past 20 years that the technical advantages of top-dressing have perhaps been forgotten by the old, and never fully appreciated by the new. Ask ten turf managers "why top-dress?" today and at least nine will reply, "to smooth the surface." But the story has far greater dimensions than this.

"The principles behind top-dressing originate deep in the basic tenets of agriculture, and anyone who manages fine turf would do well to learn the real reasons for the practice," says turfgrass agronomist Bob Wiley.

More than merely "to smooth the surface," the following amazing advantages also await the top-dressed green:

Tighter, Finer-Textured Turf: By following proper top-dressing techniques, the fresh soil material encourages new growth of grass shoots and stems. A dense, fine-bladed turf results.

Grain Is Checked: Whether your greens are bentgrass, bermudagrass, or *Poa annua,* certain strains of any grass type are going to be more vigorous, more inclined to lay down than others. Top-dressing encourages upright growth and checks grain development in any type of turf.

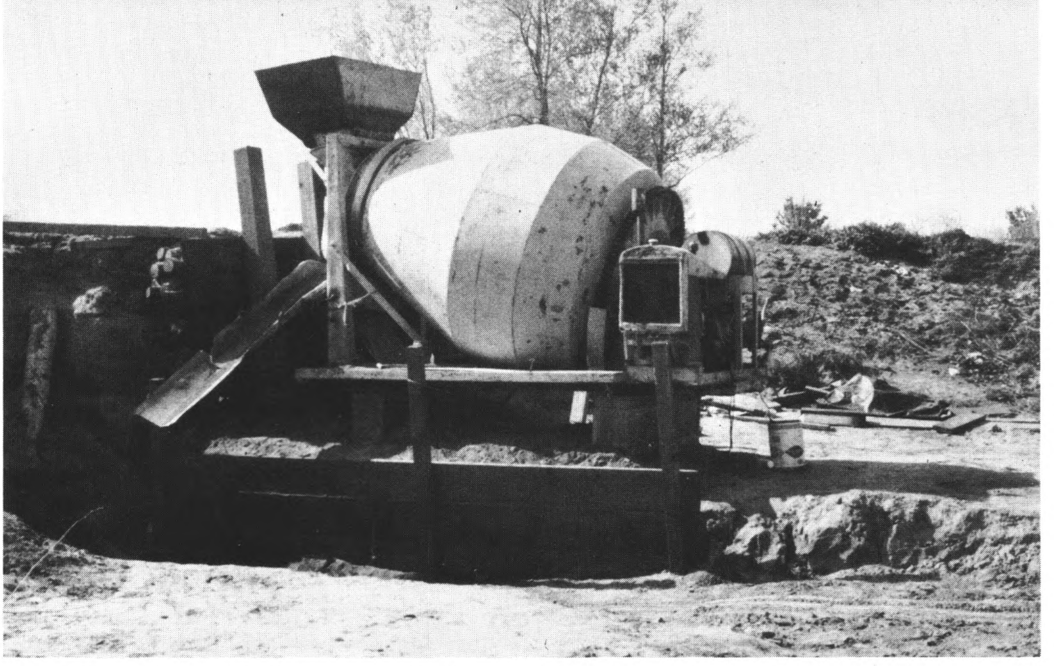
Thatch Control: With heavy fertilization, high or infrequent mowing, etc., aggressive grasses soon form a spongy layer known as thatch. Top-dressing checks dense thatch accumulation by intermixing soil materials with plant materials. It encourages new microbiological activity, which in turn breaks down thatch, and converts it into valuable soil humus.

Less Disease: Thatch is an ideal medium for disease organisms and insect activity. With thatch under control, this problem is reduced.

Better Water and Fertilizer Infiltration: Because top-dressing checks heavy thatch accumulation by actually separating the plant residues, tight turf matting is prevented. The passages for air, water, fertilizers, etc., are preserved in the turf soil profile. Localized dry spot problems are reduced, and better overall irrigation infiltration is achieved.

Alleviates Compaction: Top-dressed greens have better "holding qualities" for the golfer. The material physically supports the grass plant and thereby helps it absorb compacting forces. It develops resiliency. On heavily played greens, this point is of particular importance.

Protects Against Winter Kill: Years of experience and research have shown that greens top-dressed just prior to the winter have fewer problems from desiccation and



Another method of obtaining a uniform mixture of top-dressing components. This concrete mixer cost the club $350, including repairs. Note upper hopper for loading components and the lower chute for the mixed material.

winter injury. The crown of the plant is protected from the winter's drying winds and wide temperature swings.

THERE'S A TECHNIQUE TO TOP-DRESSING

The success of any top-dressing program depends on how well it is carried out. Poor top-dressing procedures are worse than no top-dressing at all.

At the very beginning, the soil material to be applied must be "standardized," that is, made of uniform quality from one year to the next. Turfgrass agronomist Charles G. Wilson put it best when he said, "Each club should require an act of Congress before anyone is permitted to tamper with or alter the soil mixture decided upon, no matter how well-meaning he may be."

If the present soil in greens has a history of success (good drainage, deep rooting, minimum compaction, etc.), the top-dressing material should be of the same general nature, if available. On the other hand, if it is not available, or if greens do not have a good soil, then an additional effort is needed. In this situation, a physical soil analysis (see "USGA Green Section Specifications for a Method of Putting Green Construction") should be made of those materials that are and will be available at a cost within budget means. The physical analysis will determine what mixture of soil, sand, and organic matter is best for your program. This mixture then becomes *THE permanent mixture* for all future top-dressings and construction.

The physical mixing of these components is less tedious than it once was. Large quantities can be fairly rapidly mixed with today's front-end loaders, power shredders, screens, and other modern equipment. Time and labor costs have been enormously reduced.

Now two additional steps are needed before this "soil mixture" becomes eligible for "top-dressing" status: sterilization and composting. A weed-free mixture can be obtained by several sterilization methods. Methyl bromide, calcium cyanamid, Vapam, steam, and other techniques have been used.

Finally, there is but one factor that can change a soil mixture into a top-dressing soil: —TIME. It is too often overlooked.

Composting was known even to gardeners in the early 1700s. It remains of extreme value today. Top-dressing material should be mixed and composted for at least eight or 10 months before it is used on a green. The top-dressing soil should be properly stored (soil sheds are best) and kept dry enough to insure free flow at application time.

LIGHT AND EASY DOES IT

The question of "how much top-dressing and how often" is always good for spirited debate. But with the advent of today's power top-dressing machines, a program of light, but frequent application is recommended, and

Improper top-dressing techniques of the past lead to soil layers and, eventually, trouble.

Thatch and mat removal from a Penncross bentgrass apron amply illustrates how a thatch problem can easily develop.

is important. For example, four dressings at ¾ cubic yard each are far more effective than two dressings at 1 ½ cubic yards each. Certainly, a top-dressing should never be so heavy as to bury the grass plant.

Depending upon the size of the green and normal circumstances, an optimum schedule might be one of applying ½ to ¾ cubic yards per 5,000 square feet of green on four occasions spaced throughout each growing season. This 'light but frequent' approach allows each dressing to sift into the turf, mingle with the grass, and carry out its many important functions.

Because of the frequency required and the great need for uniformity of application, a power top-dressing machine is an absolute necessity. It will more than pay for itself in any serious top-dressing effort. Hand spreading is of a bygone era.

The use of flat boards, or the back of rakes are needed for the "boarding" operation. They move the top-dressing more uniformly over the surface. The boarding or matting operation must be done very slowly, carefully and in several directions. If it is done rapidly, it does not move the new material unformly over the turf. Uneven coverage produces irregular surfaces, rather than smooth surfaces.

AERIFICATION AND VERTICAL MOWING?

Aerification and vertical mowing are now considered practically synonymous with top-dressing, but this need not necessarily be the case. Certainly aerification will continue to be important for most good putting green turf, but it need not accompany every top-dressing. In fact, two aerifications annually are generally accepted as standard practice today, unless a special problem exists.

Light or moderate vertical mowing prior to top-dressing (as well as regular mowing) is desirable. However, it is not mandatory. The absence of any of these practices should not be used as an excuse for not top-dressing.

IS IT WORTH $500?

Is top-dressing worth the expense? Many of this nation's better golf course superintendents and agronomists firmly believe it is. In fact, there is substantial evidence for believing that a good top-dressing program can reduce other costly maintenance practices. At the same time, it will produce better turf on better greens.

Although costs vary, recent figures in California place the total expenditure of top-dressing 18 greens at $500 per application. This is an average cost of $4.50 per 1,000 square feet. Labor as well as material costs are included in the figure.

IN SUMMARY

One might say many things for or against top-dressing. Some may consider it expensive and labor consuming. It does require advanced planning and organization. Although it does not produce immediate miracles, its long-range benefits are undeniable. But the strange and unbeatable fact is that, as of this moment, no substitute has yet been found for it in the production of high quality turf. And today's golfer expects—yes, deserves—just that! This year, top-dress greens and see the difference.

FIRST AID:
For a Faulty Water Supply

Laying plastic sheets. Partial covering with soil in foreground.

by ELMER J. MICHAEL and JAMES DEBOTTIS*

In 1937 the Country Club of Rochester, Rochester, N. Y., installed an irrigation system using water from the municipal mains. As the suburbs expanded the supply became less dependable, and water rationing during dry years became a serious problem.

Several studies were made over the years for securing water from other sources. Several wells were drilled, but little water was found.

In 1957 it was decided that we should try to secure water from a creek about 400 feet from our property. However, the owner of the land where the creek was located refused to let us construct a pump house or lay pipe line through his property, but agreed to let us draw from the creek if we could figure out how.

Running across our property and the property adjoining the creek was a drainage ditch. We were allowed to lay a suction line through this ditch. Since our land was only 11 feet above the water level in the creek, this was possible.

Now we had a way to get water, but we were only allowed to draw 200 gallons-per-minute from the creek, far short of our 550 gallons-per-minute requirement. Therefore, our next problem was storing water. This was solved by constructing a pond with a half-acre surface and an average depth of three feet. This gave us a capacity of approximately 500,000 gallons. The pond also added to the strategy of the course; it now serves as a water hazard for holes No. 11 and 14.

With the pond being constantly supplied by a 200-gallon-per-minute pump at 20 psi through a six-inch suction line 400 feet long, we were able to operate our irrigation system with a 550 gpm pump at 125 psi for nine hours, a complete cycle, and only lower the pond level about one foot.

The first year after construction our change from city water to creek water effected a saving of about $1,600.00, since the normal cost of water had been around $2,400.00 and the power to draw creek water cost only $800.00.

Just when we were congratulating ourselves on being able to do an efficient job of watering, the pond began to leak. The leaks became worse as time passed.

In our first attempt at sealing the pond, we drained it, searched out the holes, and filled them with cement. Two years later we were again drawing water from the municipal supply to keep our pond full, and the cost of irrigation rose.

In our next attempt we packed the pond bottom with Bentonite clay, but this too, was unsuccessful. In 1965 we decided to try a plastic liner on half the pond.

We drained the pond again and let the soil dry. When the soil was dry enough to work, we used a small bulldozer to remove the top six inches, and piled it on the half of the pond not to be lined. The area was harrowed and raked several times, and all stones and other objects which might puncture the plastic were removed. We then rolled the soil to break-up the large clods, graded the pond slopes to a maximum of 35 degrees so that the soil placed over the plastic would not slide down, and we were ready for the plastic sheets.

The polyethylene sheets used were six mils thick and measured 40 x 100 feet. It was necessary to cover the sheets with soil as quickly as possible to avoid displacement by wind. Two layers of sheets were put down, and they were laid like shingles on a roof. We felt that the two thicknesses would be less likely to puncture, and that this type of overlapping would keep us from having to cement the sheets together.

To cover the sheets of plastic with soil we used a tractor with a front-end loader to dump the soil, and four men to smooth it out in a six-inch depth so that the tractor could ride on top of soil previously placed. We covered the plastic with roadways at first to hold it down and then filled in between.

We held down the excess sheeting around the pond edge by digging a trench along the high water mark about one foot deep, placing the trimmed plastic in the ditch, and covering it. The entire area was then more carefully graded and the pond was filled with water.

For equipment, we used a bulldozer, tractor with front-end loader, dump truck to haul away debris, a York rake, and a heavy roller. The weather was ideal, and it took four to six men about five days to do the job.

Sealing half the pond reduced the water loss to a point where we felt justified in completing the job. Therefore, in 1966 we sealed the other half in the same manner.

Since then we have had no trouble maintaining the water supply.

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* Elmer Michael, now retired, received the Green Section Award in 1967, and James DeBottis is superintendent of the Country Club of Rochester, Rochester, N. Y.

COMING EVENTS

PENNSYLVANIA STATE UNIVERSITY TURFGRASS CONFERENCE

February 10-13, 1969,
University Park, Pennsylvania
Chairman — Dr. Joseph M. Duich

CORNELL UNIVERSITY TURFGRASS CONFERENCE

February 24-27, 1969, Cornell University,
Ithaca, New York
Chairman — Dr. John Cornman

RUTGERS UNIVERSITY TURFGRASS CONFERENCE

February 19-21, 1969, Holiday Inn, Route 1
New Brunswick, New Jersey
Chairman — Dr. Ralph E. Engel

UNIVERSITY OF MASSACHUSETTS TURFGRASS CONFERENCE

March 5-7, 1969, University of Massachusetts,
Amherst, Massachusetts
Chairman — Dr. Joseph Troll

Fusarium Blight and Merion Bluegrass

by Dr. JOSEPH TROLL, University of Massachusetts

Diseases of turfgrass are caused by fungi, and controlling them is often perplexing and complex.

During the years of low rainfall, in 1960-1966 in Massachusetts, a species of Fusarium appeared to be causing a severe disease of Merion Kentucky bluegrass and, to a lesser degree, it also infected annual bluegrass and creeping bentgrass.

In 1959, Houston B. Couch, of Virginia Polytechnic Institute, first described the symptoms of this turf disease, known as Fusarium blight, incited by *Fusarium roseum*. In an overall view, infected turfgrass first shows scattered light green to grayish green patches 2-6 inches in diameter; the color of these patches changes in a 24-48 hour period to a dull reddish brown, then to tan, and finally to a light straw color.

The shapes of the infected areas, as described by Couch, are either elongated streaks, crescents, or circular patches. Leaf lesions which may occur at the cut ends, or randomly over the grass blade, are typically white-centered, surrounded by light to dark brown colored tissue.

Once the organism has successfully entered the plant, it moves inter- and intracellularly upward into the leaf tips and downward into the crown bud region. If environmental conditions necessary for the organism change, and the crown bud region has not been infected, the plant may live; if not, *Fusarium roseum* will actually cause death of the grass plants via crown rot and foliar cortical decay.

Fusarium species have been described by a number of investigators to be ubiquitous in nature, but the presence of these organisms does not always cause disease. Investigations by plant pathologists have shown that soil-inhabiting organisms have specific requirements for growth, such as, carbohydrate:nitrogen ratios, oxygen, micronutrients, etc. However, even when all nutritive demands have been met, a pathogen may still not pass over into a disease state, but instead remain saprophytic. *Fusarium roseum* is a fungus that changes from non-infectious to an infectious organism, but what causes it to change is not yet known.

A fungus growing and multiplying in a pure culture, i.e., on agar, is quite unlike a fungus co-existing in the soil with other organisms. Once within a living host, perhaps, an organism may not have competition other than outside environmental stresses. In the soil, the fungus may experience severe competition with its co-inhabitants, which it may or may not overcome in order to meet nutritive requirements. Whatever the condition is, it is most likely not an isolated one, but perhaps part of a chain in the ecological system.

It has been shown by investigators of certain other plants that it might be possible to control a pathogenic organism by influencing populations of microflora lytic or competitive to the pathogen responsible for a disease (1,4,5). Their investigations evolved from a hypothesis that if a certain material in a relatively pure form was added to a soil, then organisms that possessed an enzyme capability of utilizing this material might build up their population either to the exclusion or the detriment of the hostile pathogenic organism.

For example, ground lobster shell was selected by these investigators as a soil amendment. The lobster shell is rich in chitin and Fusaria species contain chitin as a component of their cell wall. Therefore, with the addition of lobster shell it was postulated that chitinovorous organisms would be stimulated, and once large populations were built up, these organisms would utilize any chitinaceous material in the soil, and perhaps lyse those organisms that possessed it.

Based on the above, Joseph Keohane, as part of his master's degree program at the University of Massachusetts, investigated Fusarium blight. He studied the influence of lobster shells, sucrose, fungicides and an organophosphate insecticide on the soil microflora, which included *Fusarium roseum* infecting Merion Kentucky bluegrass. He also investigated the influence of soil moisture systems which appeared to be the most interesting phase of the study.

It was established that *Fusarium roseum* was causing Fusarium blight on Merion bluegrass in Massachusetts. This was proven by isolating the organism, growing it in pure culture, and comparing the cultures taxonomically and physiologically with known cultures. The pathogenicity of these isolated cultures was also determined by inoculating pots of Merion.

A higher percentage of inoculum take was found in pots of grass which were cut by a razor and then inoculated. Infection signs also appeared only 30 hours after inoculation, whereas it required 50 hours to appear in plants cut with shears, or uncut plants. Possibly the razor-cut grass blades exuded more sustenance for a longer time than the duller tearing action of shears.

The investigations of the influence of soil amendments on the soil microflora were carried out on newly established turf grown in soil contained in boxes and inoculated with *Fusarium roseum*. Lobster shell, sucrose, insecticide and fungicides were also applied to plots of Merion bluegrass growing on a football field and not infected with Fusarium, and to Merion in a home lawn that was infected.

The addition of even small amounts of some of these above-mentioned amendments did induce broad changes in the spectrum of the soil microflora. In general, the insecticide did not stimulate fungal response; it did depress actinomycetes and enhanced the appearance of a few dominant types of bacteria. The addition of lobster shell stimulated actinomycete growth, but none of the materials appeared to bring about a decrease in Fusarium infection.

The infection by *Fusarium roseum* of the Merion bluegrass lawn appeared to be most prevalent close to a tree trunk, along the edge of a driveway, and in other areas that were well drained. The lawn had received ample applications of lime and fertilizer. The lawn apparently was healthy, but it had a layer of thatch. The turf was growing in a sandy loam soil which was on the dry side but was irrigated periodically until a local water ordinance forbade its use.

Fungicides, as well as the afore-mentioned amendments, were applied to plots, but none stopped the spread of the disease. As the drought persisted, the soil became increasingly dry although not to the permanent wilting point. The incidence of disease increased during this period. However, after a thunderstorm producing 1.75 inches of rain it was observed that fungal activity slowed down, but increased again as the soil dried.

Investigations of the presence of other organisms in the plots showed that an organism known as *Trichoderma viride* was present wherever Fusarium was active. However, it was not found in any foliar samples. Tests in the laboratory showed that Fusarium and Trichoderma exercised little influence on each other.

Because of the effect soil moisture appeared to have on the incidence of Fusarium blight and the presence of *Trichoderma viride*, a greenhouse study was undertaken to determine their relationships. Composite samples of sand, silt and clay were mixed in varying amounts to obtain a relative degree of moisture equivalence. Soils having a moisture equivalence of 20, 40, 60 and 80 per cent were placed in pots and then seeded to Merion. Soil from diseased lawn turf area had a moisture equivalence (m.e.) of 34 per cent. Four pots within each moisture regime, were inoculated with Trichoderma alone, four with Fusarium alone, and four received a combination of both organisms.

Within 72 hours Trichoderma plus Fusarium pots at 20 and 40 per cent moisture showed infection; lesions were observed on the leaves. Twenty-four hours later all plants were cut to 1 ½ inches; eight hours following this, some lesions were on the leaves at all m.e. level treatments where Fusarium was included. Lesions and signs of fungal infection or proliferation did not persist at the higher moisture levels of 60-80 percent. The disease did not increase in intensity in those pots in which only Fusarium had been added; and most of these plants so inoculated appeared to recover after clipping. The clipping evidently aided removal of active Fusarium stages.

In the combined treated pots, *Fusarium roseum* was identified as the pathogen, and apparently was the sole pathogen. Disease symptoms found in Trichoderma-inoculated plants appeared to be more the result of a distress condition engendered by chlorosis in the leaves. There was no general plant debilitation even in the 20 per cent m.w.-treated pots after 40 days.

The incidence of disease in pots inoculated with *Fusarium roseum* showed that the immediate effect was not as rapid as that which occurred when Trichoderma was present. There was no recovery where lesions, mycelia, and spores of Fusarium were observed throughout the plants. Once a plant had been killed, close-growing grass plants did not spread or grow into the void left by the dead plant.

The results showed a highly significant effect of both the soil moisture and the interaction of the dual inoculation. From their investigation of Fusarium blight, Couch and Ellis R. Bedford stated that under three soil moisture regimes, no significant difference in the incidence of the disease occurred. Their study might have been carried out with a single fungal parasite and without regard to the possible role of other organisms. It is quite possible, as shown by Keohane's work, that moisture is only one of a number of stress situations and that microbial interrelations may be the second group of determinants.

It should be added that in 1967 the drought in Massachusetts was broken, and the home lawn mentioned above did not show any symptoms of Fusarium blight. However, in 1968 the early spring was dry, and this was followed by a considerable amount of rain in the late spring, followed by a dry summer. During the dry period this same lawn again exhibited symptoms of the disease, but the incidence was less than in 1966. Did the lawn soil also contain a large population of *Trichoderma viride* in 1968? Diseases of turfgrass and their control certainly appear to involve the sum total of the ecological system.

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Correction and Additional Information

In the article "Reorganization Moves Green Section Ahead" (November, 1968, USGA Green Section Record), the annual fee for the USGA Green Section Visiting Service program was stated to be $225 for an 18-hole course. This is incorrect. The following rates apply to the various classes of courses:

Less than 18 holes	$175
18 to 27 holes	$200
36 holes	$225
Per regulation course in addition to 36 holes	$ 60

USGA Member Clubs wishing to take advantage of direct Green Section Turf Management Visits should contact the nearest Green Section office (please see inside front cover) for full information.

Unbiased recommendations, interpreted research information, and an exchange of turf management techniques is the end product of each visit and report.

To obtain even distribution of materials, divide total quantity in half and spread in two directions.

Management Basics for Bent Greens In Southern Areas

by HOLMAN M. GRIFFIN, Southern Agronomist, USGA Green Section

Once upon a time bentgrass was only for northern climates. As the desire for the ultimate in putting surfaces spread, the use of bentgrass on putting greens spread as well. Today it may be found in all but a few of the hottest and most humid Gulf Coast states. Even some Hawaiian courses have bentgrass greens. It is THE grass for championship putting surfaces.

There is a considerable amount of interest in, and much more to be learned about, growing bentgrass on putting greens in warmer areas. An examination of a few basics in bentgrass management will illuminate the subject.

SOILS

One of the major requirements for good bentgrass greens is the media in which the turf has to grow. For some years the USGA Green Section has advocated greens with adequate drainage, both on the surface and throughout the soil itself. Without doubt the amount of maintenance required for a bentgrass green, and in many cases the very success or failure of the green, depends upon the percolation of the soil. This was a paramount consideration when the Green Section specifications for a method of putting green construction were developed in 1961.

It has often been said that bentgrass can survive on the oxygen in fresh water if no other oxygen is available. But the key word here is "fresh." Nothing puts bentgrass out of commission faster than water standing on the surface. Weekly spiking of bentgrass greens in hot weather is a very definite aid to better movement of air and water into the soil by breaking up soil crusts which may form.

WATER

The principles of watering bentgrass greens are the same as watering all other grasses, but sometimes we are forced to make slight alterations. Basically, bentgrass greens should be watered deeply and at a low rate of precipitation. Excess water standing on the surface must be avoided. The turf should then go as long between waterings as nature will allow: the turf should begin to show some signs of stress before more water is applied.

A blue-grey color and/or foot printing in the heat of the day are the first signs of turfgrass moisture stress. Bentgrass greens should be syringed immediately when this occurs, giving each green of 5,000 square feet about five minutes of water. The more water pressure the better. High pressure breaks up the droplets into a mist when a rose nozzle is used. The nozzle should be pointed upward and kept moving at all times. If it were possible, we would like to get water on the leaves to cool them, but leave the soil dry.

A good water man knows from experience how much water a green should have, about how long it will last, and where to put it. For instance, he knows that if you give more water to the high spots, the low spots will take care of themselves. He would never start by watering the front of a green pitched from back to front and he instinctively knows that greens usually dry from the outside in. The proper placement and timing of watering is just as important as water itself.

Never water greens to soften them and to make them hold a shot. By watering greens to soften them, you water to saturation, and thereby exclude oxygen from the soil pores. When oxygen is excluded the grass roots sluff off and grow only near the surface, which means the shorter the roots, the more often you have to water. It goes on and on, and you eventually lose. In this kind of situation, your greens may always hold a shot, but with a little adverse weather the holding surface may soon be without bentgrass.

Another reason for letting the greens go as long as possible between waterings is that when they are kept saturated, the water acts as a lubricant between the soil particles, and may puddle the soil. Puddling in this case means that saturated greens under golfer traffic only get harder as more water is applied.

FERTILIZER

Different bentgrasses have slightly different fertilizer requirements. Overstimulation is as bad, if not worse than starvation. When bentgrasses are overfed, they tend to become lush and succulent, and are therefore less resistant to traffic and more prone to wilt and disease. Clipping yield, color, and vigor are the main guidelines to proper green fertilization. The number of pounds of nitrogen applied per 1,000 square feet per year will vary with the length of the growing season in various parts of the country. Ideal growth in bentgrass occurs around 75 degrees F., and you had better be careful with nitrogen feedings when temperatures climb.

To maintain color without pushing bentgrass in the hot months, one ounce of iron sulfate or magnesium sulfate per 1,000 square feet may be helpful. These materials should not be used on a regular basis on greens because the normal green color should be a characteristic of properly fertilized turf. Their use on special occasions will help to avoid overstimulation and still give the desired color.

Bentgrasses reportedly consume nutrients in an approximate ratio of 4-1-2, although there is some disagreement among authorities. In any event, a soil test is most helpful in evaluating your nutrient needs, and will also help in maintaining the proper pH level. However, the soil tests should be used only as a guide and should not be considered the final and absolute answer in determining putting green nutrition.

Bentgrass will tolerate a wide variety of pH levels, but we believe that a pH of approximately 6.2 is best. Bentgrass prefers slight acidity, and nutrient availability is also greatest near a pH of 7.0.

MOWING

Mowing frequency and direction is important on bentgrass greens. Greens mowed every day present the most desirable putting surfaces. However, four-times-a-week mowing is usually the most acceptable, budgetwise. Mowing direction is important and should be changed each time to reduce grain. This problem of grain development and mowing direction may become more serious as we move toward the use of larger triplex mowing units. Direction changes are extremely important.

Vertical mowing is not only accomplished to check grain development, but also to clip off *Poa annua* seedheads, and to smooth and

Weekly spiking during the summer aids air and water penetration, and breaks crusts.

speed the putting surface as well. Care should be taken to avoid vertical mowing damage to the putting surface. Usually, the mower is set just to comb the ends of the grass blades. Deeper slicing should be done at the right time and with the more powerful vertical slicing machines designed to remove thatch. The vertical slicing machine should be set actually to slice the turf, and yet to do a minimum of damage to the putting surface. Slicing operations should be followed by top-dressing to smooth the putting surface and encourage the turf to heal quickly.

WEED CONTROL

A good green should be weed-free. Nevertheless, weed problems develop. Usually the use of unsterilized top-dressing material is the prime source of the seed. Clover, chickweed and crabgrass are the three main weeds which trouble greens. Mecoprop will control clover and chickweed in most greens if applied at the proper rate and at the proper time. Arlington and Congressional bentgrasses have been reported to be sensitive to Mecoprop, and hand weeding must be considered where they are present.

As for crabgrass control, a number of materials may be used with satisfactory results, but each material has its own characteristic action.

Phenyl mercury (PMA) is an effective crabgrass control and fungicide agent, but it must be applied when crabgrass is in the early seedling stage. This chemical can produce a turf burn in hot weather.

DCPA (Dacthal) is a good pre-emergence control material for all crabgrasses. It was not originally recommended for use on bentgrass greens, but experience now proves that it has a wide margin of safety on all but Cohansey bent. As with most preemergence materials, the soil should be undisturbed until the crabgrass germination period has passed.

INSECTS

Most insects are controlled by timely applications of the chlorinated hydrocarbon material (Chlordane). The wettable powder formulation is preferred because of the increased safety to bentgrass.

Several newer insecticides, such as Diaznon or Sevin, have also been proven to be very effective. Because these materials have only a short residual life, they are recommended on a curative basis, rather than for preventative insect control.

FUNGICIDES

A fungicide program, whether curative or preventative, is essential for good bentgrass greens in most sections. There is an array of broad-spectrum and specific disease fungicides for golf course use available today. They will give good control of most turfgrass diseases when properly employed.

THE BENTGRASS TO USE

Many good bentgrass strains are now available for use on putting greens (see "Story of Cohansey" in the September, 1968, USGA Green Section Record). Creeping bents make up the majority of the turf on greens, and only seaside and penncross of the creeping bentgrasses can be seeded. This gives them an advantage over the selected strains of bentgrasses which must be propagated by stolons.

These special bentgrass strains were originally selected for certain desirable characteristics in a particular region. You may select your own strain of bentgrass based on color, disease resistance, vigor, growth characteristics, or any number of other features. In the final analysis, however, its performance usually depends upon the management it receives.

STATEMENT OF OWNERSHIP

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I certify that the statements made by me above are correct and complete.
Robert Sommers, Managing Editor

TURF TWISTERS

SUN (DESICCATION)

Question: Desiccation is a serious winter problem for us. What causes it, and is there any way we can safeguard our greens? (New Hampshire)

Answer: There are many contributary factors relative to desiccation (drying up) of putting green grasses. Factors such as overstimulation of turf going into the winter, inadequate soil moisture going into the winter, lack of snow cover, drying winds, greens situated in open or unusually high areas, and lack of protection from trees or wind breaks. One of the best safeguards is to insure adequate soil moisture throughout the winter season—even if it means irrigation in January. Top-dressing each green that is subject to desiccation just before cold weather sets in will also prove effective.

SAND (DEPTH)

Question: How deep should sand be in bunkers? (Arizona)

Answer: Sand depth must be adequate for the deepest anticipated "explosion shot." Usually four to six inches of sand will handle the situation.

SEASON (DISEASE)

Question: Is it important or necessary to apply fungicides in late winter or early spring when turf is initiating reduced growth? (Iowa)

Answer: We have observed that disease caused from the activity of various types of *Fusarium* can be extremely damaging at this time of the year. It is entirely possible that an application of a fungicide for specific control of *Fusarium* can be one of the most important applications throughout the entire growing season. By all means apply a suitable fungicide at this time.