MAY 1973

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

USGA GREEN SECTION RECORD

A Publication on Turf Management by the United States Golf Association

VOL. 11, NO. 3 MAY 1973

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: $2 a year. Single copies: 35c. 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, P.O. Box 567, Garden Grove, Calif. 92642. Second class postage paid at Far Hills, N.J. and other locations. Office of Publication, Golf House, Far Hills, N.J. 07931.

Editor: William H. Bengeyfield

Managing Editor: Robert Sommers

Art Editor: Miss Janet Seagle

Green Section Committee Chairman: Elbert S. Jemison, Jr., 909 Bank for Savings Bldg., Birmingham, Ala. 35203

Green Section Agronomists and Offices

EASTERN REGION
P.O. Box 1237
Highland Park, N. J. 08904
Alexander M. Radko, Director, Eastern Region and National Research Director
William G. Buchanan, Eastern Agronomist
Stanley J. Zontek, Eastern Agronomist
(201) 572-0440

SOUTHERN REGION
P.O. Box 4213
Campus Station, Athens, Ga. 30601
James B. Moncrief, Director, Southern Region
(404) LI 8-2741

MID-CONTINENT REGION
P.O. Box 592, Crystal Lake, Ill. 60014
F. Lee Record, Director, Mid-Continent Region
Carl Schwartzkopf, Mid-Continent Agronomist
(815) 459-3731

MID-ATLANTIC REGION
P.O. Box 5563
Barracks Road Center, Charlottesville, Va. 22903
Holman M. Griffin, Mid-Atlantic Director
(703) 973-8400

WESTERN REGION
P.O. Box 567
Garden Grove, Calif. 92642
William H. Bengeyfield, Director, Western Region and Publications Editor
(714) 638-0962

Refining the

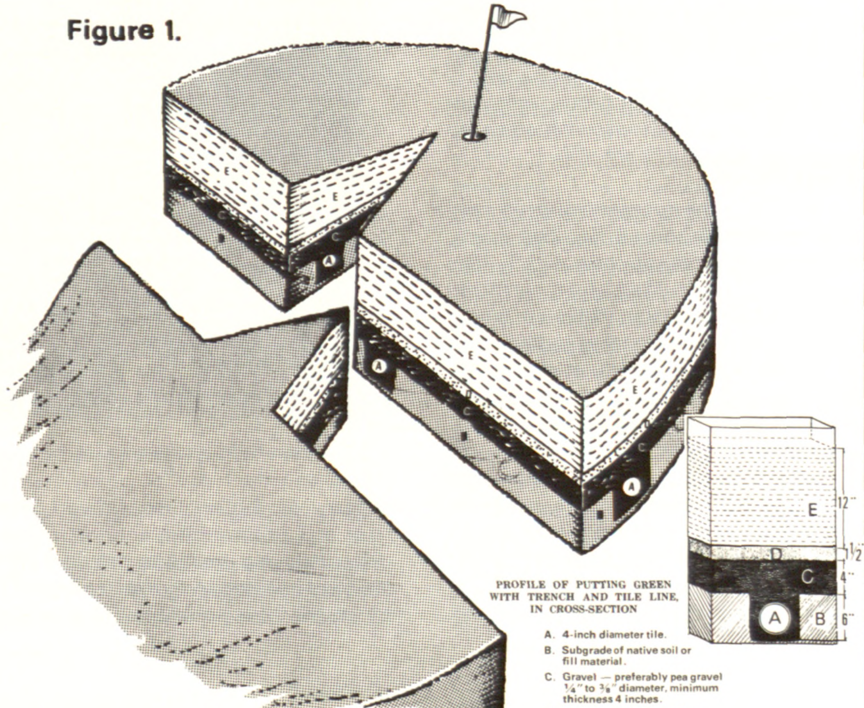
Green Section Specifications for Putting Green Construction

by: THE GREEN SECTION STAFF

In 1960, after years of research, the Green Section of the USGA published its "Specifications for A Method of Putting Green Construction." It was a method that was a departure from what at the time was considered the norm. It advocated the use of much more sand in the topsoil mixture in order to resist compaction and assure good drainage. It prescribed a principle of soil layering that created a "perched water table," which in turn insured a reserve water supply with a soil-water relationship considered ideal for all agricultural crops. It recommended that all soil mixtures be laboratory tested to determine particle size distribution, infiltration rates, and per cent capillary and non-capillary pore space. It stressed the physical as well as the chemical and mechanical tests performed on all top mixtures for greens built to these Specifications. Though backed by solid research, this method was slow to be accepted.

Since 1960, a substantial number of greens have been successfully constructed to these Specifications. During this time new questions arose resulting in additional research to further improve and refine the original technique. For example, construction men asked if the sand layer (Figure 1-D) was necessary. Some found our original water infiltration rates inadequate for their part of the country. Others observed that greens built to these Specifications were slow to provide playing resiliency. The Green Section responded by granting funds for re-

Figure 1.



PROFILE OF PUTTING GREEN WITH TRENCH AND TILE LINE, IN CROSS-SECTION

A. 4-inch diameter tile.

B. Subgrade of native soil or fill material.

C. Gravel — preferably pea gravel ¼" to ⅜" diameter, minimum thickness 4 inches.

D. Very coarse sand, size 1mm. or greater, 1½" to 2 inches in thickness.

E. Topsoil mixture. Minimum thickness of 12 inches.

search projects designed to help answer these questions. As a result of this research, areas of the original Specifications have now been refined. These refinements include:

(1) Increased water infiltration capacity from the range of 1/2- to 1½-inches to between 4 and 6 inches per hour ideally.

(2) Increased amounts of sand and the use of sand of a finer texture. Sand of the brick *or* mason class is preferred. Silica sands are recommended, other sands acceptable only in rare cases where silica sand is unavailable. Ideal sand particle size would be as follows:

100% below 16 mesh (1.0 mm)
35% below 32 mesh (0.50 mm)
15% below 60 mesh (0.25 mm)
5% below 160 mesh (0.06 mm)

(3) The elimination of the 1½ inch sand layer (D—Figure 1) is still to be resolved through additional research. For the present we recommend it be retained.

(4) The collar area preferably should be included as part of the putting green and should be constructed exactly as the green.

To better portray the particle size and number of soil separates involved, we offer this table for your critical examination.

Table 1—Characteristics of Soil Separates

Name	Diameter*	No. of Particles per Gram
Very course sand	2.00-1.00 mm	90
Coarse sand	1.00-0.50 mm	722
Medium sand	0.50-0.25 mm	5,777
Fine sand	0.25-0.10 mm	46,213
Very fine sand	0.10-0.05 mm	722,074
Silt	0.05-0.002 mm	5,776,674
Clay	below 0.002 mm	90,260,853,860

*As established by the U.S.D.A.

Seven steps in construction procedure from the 1960 original specifications with updated refinements are presented herewith.

1. SUBGRADE

The contours of the subgrade should conform to those of the proposed finished grade, with a tolerance of plus or minus 1". The subgrade should be constructed at an elevation 14 inches below the proposed finished grade. The subgrade should be compacted sufficiently to prevent future settling which might create water-holding depressions in the subgrade surface and corresponding depressions in the putting surface.

Where terrain permits, it is possible to build the subgrade into the existing grade or to cut it into the subsoil. It is not necessary to elevate or "build up" the green unless design considerations dictate the desirability of doing so.

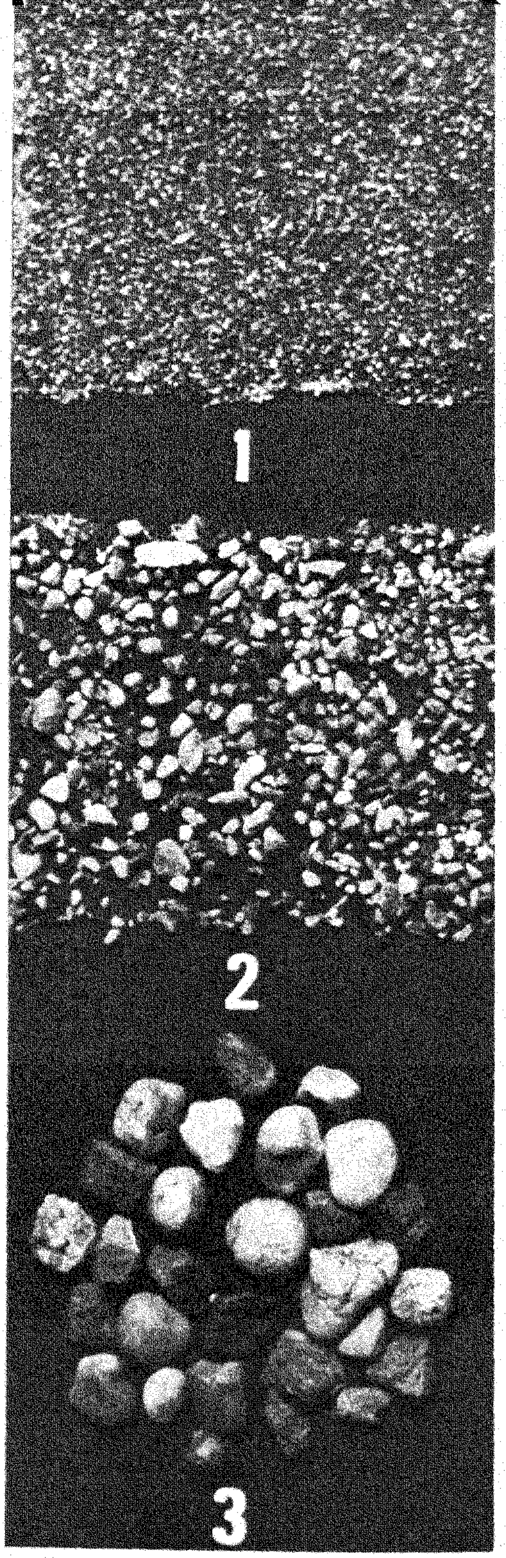


Figure 2: 1. Sand considered ideal for use in the top mixture (layer E in Figure 1). This is classified as a coarse to medium sand.
2. Very coarse sand suited to layer D in Figure 1.
3. Washed pea gravel used in layer C in Figure 1.

It will be noted that layers of materials above the subgrade consist of 4 inches of gravel, 1½ to 2 inches of coarse sand, and 12 inches of topsoil mixture. Thus the total depth will be 17½ to 18 inches. However, this fill material will settle appreciably, and experience indicates that 14 inches will be the approximate depth of these combined materials after settling.

2. DRAINAGE

Tile lines of at least 4 inch diameter should be so spaced that water will not have to travel more than 10 feet to reach a tile drain. Any suitable pattern or tile line arrangement may be used, but the herringbone or the gridiron arrangements will fit most situations.

Cut ditches or trenches into the subgrade so tile lines slope uniformly. Do not place tile deeper than is necessary to obtain the desired amount of slope. Tile lines should have a minimum fall of 0.5%. Steeper grades can be used but there will seldom be a need for tile line grades steeper than 3% to 4% on a putting green.

Tile may be agricultural clay tile, concrete, plastic, or perforated asphalt-paper composition. Agricultural tile joints should be butted together with no more than 1/4-inch of space between joints. The tops of tile joints should be covered with asphalt paper, fiberglass composition, or with plastic spacers or covers designed for this purpose. The covering prevents gravel from falling into the tile.

Tile should be laid on a firm bed of 1/2 inch to 1 inch of gravel to reduce possible wash of subgrade soil up into tile lines by fast water flow. If the subgrade consists of undisturbed soil, so that washing is unlikely, it is permissible to lay tile directly on the bottom of the trench.

After the tile is laid, the trenches should be backfilled with gravel, and care should be taken not to displace the covering over the joints.

3. GRAVEL AND SAND BASE

The entire subgrade should be covered with a layer of clean washed gravel or crushed stone to a minimum thickness of 4 inches. The preferred material for this purpose is washed pea gravel of 1/4 inch to 3/8 inch diameter particle size. If particles of any other size are included, they should be screened out. THIS IS IMPORTANT TO THE PROPER FUNCTIONING OF THE "PERCHED WATER TABLE."

A 1½" layer of coarse sand is then spread over the entire gravel base. This sand should be within a range of five to seven diameters of the gravel. In other words, if 1/4 inch pea gravel (about 6 mm) is used, then the particles of the overlying layer of sand should not be less than 1 mm in diameter. In order to prevent movement of the sand into the gravel, the maximum allowable discrepancy appears to be five to seven diameters.

4. "RINGING" THE GREEN

The earlier Specifications recommended that the collar and apron soils should be put in place prior to placing the prepared top mixture on the green site. We are now refining this recommendation to state that the collar should be constructed to the exact same specifications as the green.

5. SOIL MIXTURE

The success of the Green Section's Method of Putting Green Construction is dependent on the proper physical characteristics of the soil and the relationship of that soil to the drainage bed underlying the green.

Native topsoils that meet these physical characteristics are almost non-existent in nature. Therefore, the putting green topsoil mixture must be compounded from locally available sand, soil and organic amendments. However, because of extreme local variations in these materials, a high degree of expertise is required in compounding topsoil blends with the desired properties. Different lots of sand vary considerably in particle size and shape. Native soils also vary greatly in particle size and shape, as well as in degree of aggregation, acidity, fertility, soluble salt content, and organic matter content. Perhaps the most variable of these materials are the organic amendments. They may differ in plant material origin, degree of decomposition, mineral impurities such as silt and clay, as well as in acidity and fertility. Manufactured, or processed organics also differ widely from natural organics.

It is very unlikely that golf course architects, builders, or superintendents can cope with the variability in construction materials when formulating topsoils and topdresses for greens. Therefore, since successful construction is dependent on the proper combination of physical and hydraulic properties in the topsoil, a physical soil analysis must be made of available construction materials before they are procured. The abundance of each material to complete the job should also be investigated, and representative samples of each material tested by a competent laboratory.

The laboratory tests are concerned with the following data:

Infiltration and Percolation Capacity. When the topsoil mixture is compacted at a moisture content equal to field capacity on the green, and maintained under a constant head flow of water for 24 hours at a temperature of 20.2°C., as described by Ferguson, Howard and Bloodworth, it should have a minimum laboratory infiltration and transmission rate for water of two inches per hour for greens planted to bermudagrass, and three inches per hour for greens planted to bentgrass. The maximum infiltration and transmission rate in the laboratory should not exceed 10 inches per hour with normal materials. Rates of four to six inches per hour are ideal.

Porosity. Compacted topsoil mixtures that have been allowed to percolate water for 24 hours, and then drained at a tension of 40 cm of water, should have a total pore space volume between 40 and 55 per cent. The volume of non-capillary pores at a tension of 40 cm of water should not be less than 15 per cent.

Bulk Density. Topsoil mixtures compounded with sand as the chief component, ideally should have a bulk density between 1.25 and 1.45 grams per cubic centimeter. The minimum acceptable bulk density for such mixtures should be 1.20 g/cm^3 and the maximum should be 1.60 g/cm^3.

Water Retention Capacity. The water held by a soil against drainage is the water that supports growth of the turf. In putting greens the drainage potential from the putting surface to the tile is approximately 40 centimeters (16 inches) without a 2-inch sand layer over the gravel, and 45 centimeters with the 2-inch sand layer.

The available water in the topsoil is estimated to be the water which is held at tensions between 40 cm of water and 15 atmospheres. The topsoil should have a laboratory 40 cm water retention capacity between 12 and 25 per cent by weight on a 105—111° C. oven dry soil basis.

Particle Size. The topsoil mixture ideally should contain no particle larger than 2 mm (9 mesh) in diameter. However, 3 per cent particles larger than 2 mm is permissible if most of these are smaller than 3 mm. The total soil mixture should not contain more than 10 per cent particles larger than 1 mm (16 mesh) and no more than 25 per cent particles smaller than 0.25 mm (60 mesh). In addition, the mixture should contain less than 5 per cent silt (0.002 to 0.05 mm) and 3 per cent clay (smaller than 0.002 mm).

Because of the narrow acceptable limits in the physical properties of the topsoil mixture, **it is extremely important that recommendations based on laboratory analysis be followed carefully when mixing the components for the topsoil mixture.** When it becomes necessary to substitute a new material for one of the original materials in the mixture, the mixture should be retested before proceeding with mixing.

When the proper proportions of the soil components have been determined, it becomes extremely important that they be mixed in the proportions indicated. A small error in percentages in the case of high silt or plastic clay soils can lead to serious consequences. To insure thorough mixing and the accurate measurement of the soil components, off site mixing is advocated. During construction, quality control checks should be made periodically on all soil components as well as the final mix. At this time it is wise also to prepare and stockpile several hundred extra cubic yards of the topsoil mix for subsequent topdressing of greens.

6. SOIL COVERING, PLACEMENT, SMOOTHING AND FIRMING

When soil has been thoroughly mixed off site it should be transported to the green site and dumped at various points around the perimeter. The soil can then be moved more easily from the edges to the center. Many techniques are acceptable for spreading the soil, including shovels, boards and small equipment. A small crawler-type tractor suitably equipped with a blade, for example, is useful for pushing the soil mixture out onto the prepared base. If the tractor is always operated with its weight on the soil mixture that has been moved onto the site, the base of the green will not be

Table 2. Variability in sands selected for putting green construction from different locations.

Sand Source	Particles 0.05 mm and larger	Particles 0.002-0.05mm	Particles less than 0.002 mm	Infiltration in./hr.
Whispering Pines, N.C.	99.0	1.0	0.0	31.2
Birmingham, Ala. #1	97.6	2.4	0.0	16.6
Birmingham, Ala. #2	85.0*	13.2	1.8	0.1
Norcross, Ga.	99.4	0.6	0.0	26.6
Tuscon, Ariz.	88.4	8.8	2.8	7.2
San Diego, Calif.	98.0	2.0	0.0	17.7
San Diego, Calif.	99.5**	0.5	0.0	123.2
Concord, Mass.	98.7	0.0	1.3	9.0
Highland Park, Ill.	97.5	0.5	2.0	12.4
Buffalo, N.Y.	98.4	1.6	0.0	11.4
College Station, Tex.	98.9	1.1	0.0	9.9

*Sand mostly below 0.25 mm **85% from 0.5 to 1 mm

Table 3. Variability encountered in organic amendments for topsoil mixtures.

Organic Material and Source	pH	Titratable Acidity to pH 6.5 meq./100 grams	% Ash
Sewage Waste (Calif.)	7.3	0.0	67.3
Muck—Peat (Ind.)	5.8	5.0	25.8
Muck—Peat (N.C.)	3.8	5.6	73.2
Moss Peat (Ore.)	4.0	30.7	3.9
Sedge Peat (Wis.)	6.0	1.4	12.8
Moss Peat (Ga.)	6.2	2.8	19.4
Lignified Wood (Calif.)	5.6	1.5	1.0
Rice Hulls (Tex.)	6.4	0.0	24.3
Cotton Gin Trash (Tex.)	8.3	0.0	43.3

Table 4. The influence of native soil on infiltration rate of a sand-soil mixture.

Ratio of Components		Bulk Density	Pore Space		Infiltration Rate (inches/hour)
Sand 1/	Soil 2/	g/cc	Capillary	Non-Capillary	
10	0	1.36	13	36	10.4
9	1	1.30	14	37	8.8
8	2	1.39	17	30	4.0
7	3	1.41	25	22	2.2
5	5	1.47	39	6	0.1

1/ Sand contained 22.7, 36.3, 30.0, 7.3, 1.6, 0.0, and 2.1 percent of very coarse, coarse, medium, fine, very fine, silt and clay, respectively.

2/ The soil contained 88.8% sand, 6.3% silt and 4.9% clay.

disturbed.

Grade stakes spaced at frequent intervals on the green site will be helpful in indicating the finished depth of the soil mixture. Finishing the grade will likely require the use of a level or transit.

When the soil has been spread uniformly over the surface of the putting green it should be compacted or firmed uniformly. A roller is not satisfactory because it "bridges" the soft spots. "Footing" or trampling the surface will best eliminate the soft spots. Raking the surface and repeating the footing operation will result in having the seedbed uniformly firm. It is impossible to overemphasize the point that the raking and footing must be repeated until uniform firmness is obtained.

7. STERILIZATION OF SOIL AND ESTABLISHMENT OF TURF

These steps may be accomplished by following well-known conventional procedures.

Opportunities for Error

With the restatement of these procedures, let us re-examine the recommendations step by step and point out some of the opportunities for error.

THE SUBGRADE

When a new green is built there is a lot of fill to be moved away or onto the site as design and terrain dictate. In either case the builder must strive to compact the subgrade as thoroughly as possible. Only in this way will settling be prevented. If uniform layers of gravel, sand, and soil overlay the subgrade, it is obvious that any settling below will result in a corresponding settling of the top. Therefore, a thorough compaction of fill areas in the subgrade is of paramount importance if the green is to maintain the character of contours built into it.

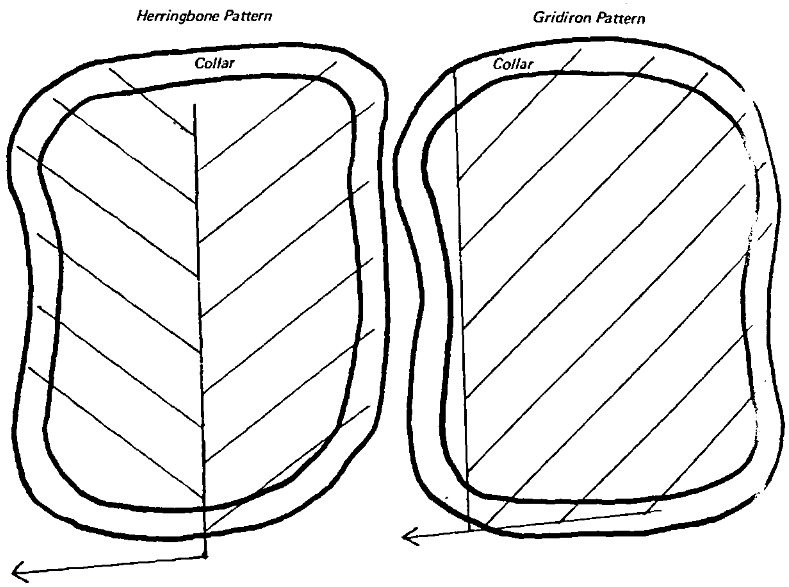
TILE DRAINAGE

It is commonly believed that the use of a gravel layer provides adequate drainage and that the installation of tile is a needless expense. No doubt there is a good reason for this belief in some cases. However, when large amounts of water are moving through soil under conditions of heavy rain or rapid irrigation, and where the water must move a considerable distance to reach an outlet, tile lines aid in speedy removal of excess water. Excess water is efficiently and effectively removed from the approach area by tile whereas with only a gravel layer little control of directional removal of water is obtained. Tile lines, in addition, assist in removing water trapped in pockets if settling should occur. Putting greens are the most expensive golf turf commodity and require the most exacting standards for excellence. The small additional cost of adding tile is very much worth the insurance it provides.

GRAVEL AND SAND BASE

In a few cases builders have used tile and then assumed that there is no need for a gravel layer above the subsoil base (Figure 1—Layer C). This assumption is erroneous. The gravel layer provides a medium whereby water can rapidly move laterally and very easily find its way into the tile lines. The gravel also provides a barrier between the top mixture and the soil

The two most commonly used drainage patterns for putting greens. Four inch diameter tile is spaced at 15 to 20 foot intervals, depending on slope. Approximately 100 linear feet of tile is required for every 1,000 square feet of putting surface to be drained. The collar normally is three to five feet in width.



below to prevent the dry subsoil from drawing water out of the top mixture. The tile and gravel function as a team to provide insurance against water logging of any kind within the putting green profile. Tile is normally placed at the bottom of the gravel layer and is spaced at intervals of 15 to 20 feet, depending on the degree and direction of slope.

The layer of coarse sand (Figure 1—Layer D) used over the gravel base is for the sole purpose of preventing the soil particles from migrating downward into the gravel. There is evidence that with certain conditions the sand layer is not required. This is a parameter under study at present. Until additional areas are researched, we feel it essential to continue with the sand layer as before.

THE COLLAR (APRON) AREA

Establishing a collar or so-called apron to the same specifications as the putting green itself is important to the performance of the total greens area. The same kind of turf normally is grown on the collar as is grown on the putting surface except that it is maintained at a higher cut. The collar is subject to heavy traffic and the same management as the green area, therefore to realize the best from it, construction should meet the same specifications as prescribed for the putting green proper.

The soil at the outer edge of the collar will abut against the native soil which without question will be heavier than the prepared top mixture and may be far less permeable to water. For this reason there could be a decided difference in plant and soil performance in this area. Therefore it is advocated that a strip of polyethylene plastic sheeting be placed vertically between the two soils to reduce chances for problems developing along this line of division between the natural and synthetic soil.

THE INTERFACE

Apparently one of the most puzzling of the principles involved in the Green Section specifications is the function the textural barrier, the boundary between the top mixture and the gravel. Figure 2 is a photograph showing that water does not move from a layer of fine soil into a lower layer of a coarser textured soil until the fine textured soil becomes saturated. The reason for this failure of water to readily cross the "textural barrier" is a matter of surface tension. When sufficient gravitational force (weight) accumulates, the tension force is overcome and water then drains out through the sand and gravel.

The "textural barrier" then can be used to increase the water-holding capacity of a coarse textured soil. If irrigation is stopped just before the soil reaches the saturation point, no drainage occurs. On the other hand, in the case of an excessive rainfall, the soil will not hold too much water. It is paradoxical that the soil overlying such a textural barrier can be made to hold more water than it would without the gravel layer, but it cannot be made to hold enough water to be harmful to plants.

THE TOPSOIL MIXTURE

The proper blend of soil components to use in the top mixture (Figure 1—Layer E) is accurately determined after extensive laboratory tests. Only in this way is it possible for soil scientists to advise what proportions of sand, soil and organic matter are to be mixed to meet the infiltration and physical requirements specified. This is critically essential to the success of construction, and it allows the builder to make the best possible use of materials available within reasonable distance of the construction site. This has favorable bearing on total costs of materials used for construction.

A chemical analysis of the recommended top mixture should then be made for lime and nutrient requirements in turfgrass establishment.

Mixing the materials to the specified ratio is another important step in building. To insure thorough mixing and accurate measurements of the topsoil components (Figure 1—Layer E), off site mixing is advocated. There are several recommended ways of metering the sand, soil and organic matter to specification, but in the final analysis the end result boils down to the competence of the worker on the mixing site. If the worker is not conscientious and informed, the field mixture will never be recognizable as the recommended laboratory soil mix. Whether the sand, soil and organic material is metered onto a stockpile and tumbled two or three times, layered, sliced and tumbled, or shoveled by hand, it is imperative that a thorough mixing be done.

Wet sand mixes easier and more intimately than does dry sand. Since the greater percentage of the mixture will be comprised of sand, moistening the sand at intervals during the mixing process is important. The organic material also should be slightly moistened for better adhesion in mixing.

All laboratory recommendations are specific and refer to parts in 10, by volume. An 8-1-1, for example, refers to an 8 part sand, 1 part soil and 1 part organic matter mixture. Once this top mixture is placed on the site it is important that the green be covered, until planted, with a protective cover such as a polyethylene tarp or similar cover to prevent heavy rains from altering the mixture, especially the upper fraction of the soil profile. A *very light* mulch is recommended during the grass planting operation, except when stolons are used, to help stabilize the soil mixture. Possibilities are asphalt emulsions, sphagnum, wood cellulose, hydro-mulch, or salt hay *lightly* applied. This is also important to the speed of seed germination and turfgrass establishment. Once grass roots are established better stability of individual particles within the soil profile is assured. This is important to the resiliency of the playing surface.

ESTABLISHMENT OF TURF

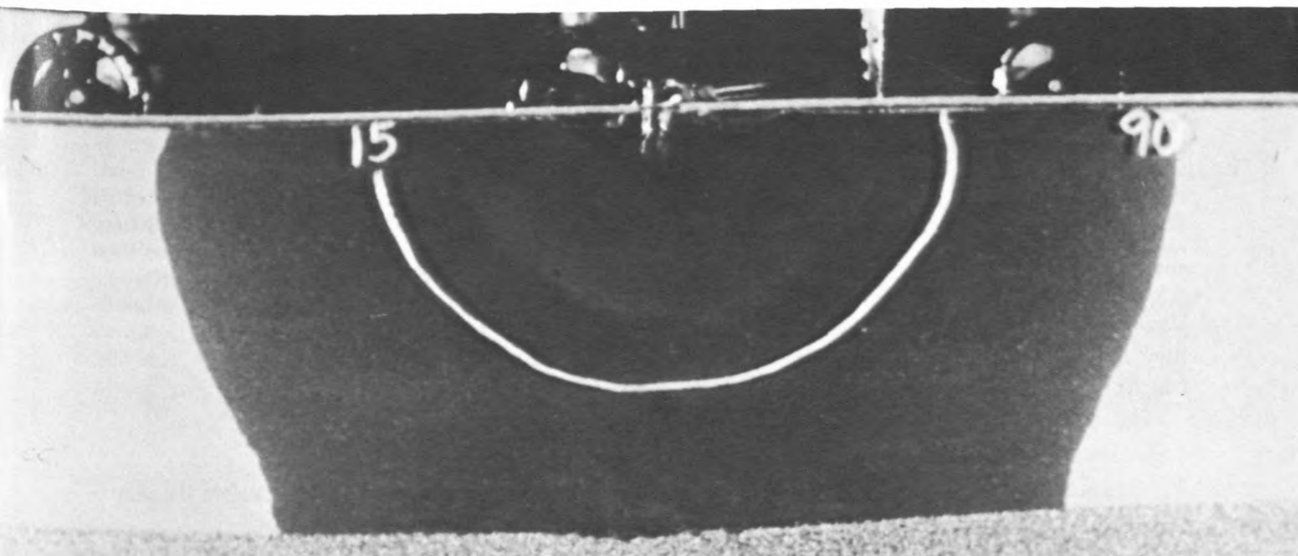
Because soil mixtures prescribed are quite porous, in a number of cases greens have been rather slow to become established. Frequent light fertilization of newly seeded or vegetatively planted greens appears to be one method of speeding establishment. Light watering several times daily is essential to the rapid turf establishment of the newly planted surface. It is necessary to syringe the surface frequently for germination and plant growth initiation. Once plants are established, the danger of soil particle migration is lessened and heavier waterings can safely be accomplished.

In some cases greens built to Green Section specifications have been sodded. This is acceptable **only if the sod is grown on exactly the same soil mixture as is used in the green.** If the sod is grown on any other type soil and is moved onto the porous putting green soil, **failure is a predictable certainty.** Generally speaking, a seeded or stolonized new green more quickly results in a smoother finished surface than one that is sodded.

Be certain also to topdress the green frequently during the first year to promote billiard table smoothness. The topdressing soil should be mixed to the same specification as the original top mixture. Never should a different top mixture be applied to any new green. This refers to all greens, not just those built to Green Section specifications.

These steps for constructing putting greens will provide excellent results if followed *exactly*

Figure 3. Water does not move from a loam soil until the soil becomes saturated. (From W.H. Gardner – 1953)



and *completely.* There are no short cuts to excellence in putting green construction.

HOW EXPENSIVE?

Some clubs have been deterred from building putting greens by this method because they have thought that the construction costs will be excessive. We contend any method that insures that the green will be built right is not expensive; **only greens that are poorly built are expensive.** It is obviously impossible to pinpoint costs in any given region because of variations in the cost of soil materials, gravel, and labor. Some ideas of quantities of materials may help in cost estimations. The following quantities of materials are required per 1,000 square feet of putting surface:

Gravel	4 inch depth—12.3 cubic yards
Sand	1½ inch depth—4.6 cubic yards
Top Mixture	12 inch depth—37.0 cubic yards
Tile	approximately 100 linear feet

Finally, the reader again is referred to the original article published in the USGA GOLF JOURNAL of September, 1960. The same procedures, with refinements, are still recommended and the same criteria for determining soil mixtures are still being used. The original publication contains a list of references which will provide informative background reading. In the same issue, there is an article describing laboratory methods used in soil mixture evaluation. Field experience since 1960 from throughout the United States provides abundant evidence of the merit of this method of putting green construction.

The Green Section staff gratefully acknowledges assistance from Dr. Kirk W. Brown and Dr. Richard L. Duble, of Texas A&M University, and Dr. Rollin C. Glenn and Dr. Coleman Y. Ward, of Mississippi State University, in the refined revision of these specifications.

SOIL TESTING SERVICE OFFERED BY MISSISSIPPI STATE AND GREEN SECTION

The Green Section provides a soil testing service for USGA Member Clubs. The service consists of laboratory studies of sands, soils and organic materials, the synthesis of trial mixtures, and recommendations of a suitable mixture for putting green construction. For this complete study and recommendation a charge of $100 is made and payable to Mississippi State University. Additional services are available, such as sand assays for $10 per sample; also mixtures from the putting green site retested for conformity to original recommendations at $25 per sample. After laboratory services are completed, the sender and the Green Section staff agronomist in the region involved will be notified of the results.

WHAT IS NEEDED

A laboratory analysis will require a minimum of two gallons of sand, and one gallon each of soil and organic matter available at your club. If there is a choice of sands, soils, and organic materials, send samples of each along with a note indicating your preference based on cost, easy accessibility, etc. The laboratory will attempt to use your preferred materials in the recommended mixture.

All materials should be packaged separately and securely. Strong plastic bags inside cardboard cartons or metal cans are most satisfactory. Do not put moist soil or sand in a paper bag—it rarely arrives intact. When materials arrive broken and mixed, the laboratory simply must request more material. This sort of delay can be inconvenient, aggravating and time consuming.

Paper labels packaged with moist materials deteriorate very rapidly. It is a good idea to use plastic labels inside the package and also to mark the outside of the packages. The more information you can send, the better.

HOW TO SEND

Use United Parcel Service preferably; if within 500 miles of Mississippi State University, use the Trailways bus system; and if sent by mail, allow double the estimated time—experience shows it to be much slower than other choices listed.

WHERE TO SEND

If materials are being sent via United Parcel, send to this address:

Dr. Coleman Y. Ward
Room 364, Dorman Hall
Mississippi State University
State College, Mississippi 39762

If materials are being sent via other carriers (Trailways, Air Express, mail, etc.), send to this address:

Attention—Dr. Coleman Y. Ward
Box 5248
State College,
Mississippi 39762

Who In The World Put The Hole There!

The turf around the hole should be in good condition, free of imperfections that might change the direction of a rolling ball.

by **FRANK D. TATUM, JR.,** Member, USGA Executive Committee

The Open had reached its most dramatic moment. As Jack Nicklaus crouched over an eight-foot putt on the 12th green at Pebble Beach, Arnold Palmer hunched over an eight-footer on the 14th. Nicklaus needed his putt for a bogey 4, Palmer needed his for a birdie 4, and if Arnold made and Jack missed, Palmer would lead the Open by a stroke.

Both tapped their putts at about the same instant, and both putts ran practically straight at the hole. As everyone with any interest in these things knows by now, Nicklaus holed and Palmer missed, and Jack won his third Open.

What some spectators found a bit unusual, or unexpected, was the paths of these putts. They had not expected them to run so straight. Their experience with other tournaments had conditioned them to expect holes to be cut in hillsides, behind bunkers or next to creeks, in places where only a lucky putt goes in or a lucky shot ends up in birdie range. They came prepared to condemn the man who put the hole there as some kind of a fiend.

They should not. He deserves not condemnation but pity. He is up before daylight, ready to start setting the holes as soon as light will permit. His early start expresses his concern that the players with the early starting times will have an equal opportunity with the late starters to see how the course is set up. He struggles with intense care to get it right. If he succeeds, he is blissfully ignored; if he fails, recognition is immediate, universal, bombastic and blasphemous.

I do not seek sympathy for these men. Theirs is a vital function. They can emasculate a great design, or they can accentuate its greatness. To assume such responsibility necessarily includes accepting its consequences. Like bad art, there is too much bad pin setting afflicting the championships to combine the art and the science of locating the holes so as to bring out all the qualities of the course on which they are played. Hopefully, the principles applied by the USGA will be useful to others who squint into the rising sun hoping to find that small plot of good grass and terrain in the right part of the green for that day's play.

The first principle is to be fair. Never pick a placement that will not fully reward the properly struck shot played from the right position. The hole setter, therefore, must not only appreciate the design of the hole, but he must also weigh such factors as weather, wind direction, and firmness of the turf, and determine in advance how that particular hole will play on that particular day. He must have done some planning. In a four-day championship, for example, this means he must have analyzed the course and generally determined the four areas on each green providing hole locations appropriate for the particular tournament. He must then plan his practice round settings so that those areas will be preserved for tournament play.

He should set up a balanced course for each day's play. A common error is to set up the course to play progressively more difficult each day by using all the easiest pin placements on the first day and proceeding progressively to all of the most difficult settings on the last. This tends to distort the course, at least on the first and last days. In a four-day championship the USGA will evaluate each of the four areas preplanned for each green, rating the most difficult as 1, the easiest 4 and assessing a 2 and a 3 for the intermediate areas. Each day's setting process involves planning to avoid something like an "18" course (i.e. 18 number 1 settings) on the one hand, or a "72" course (i.e. 18 number 4 settings) on the other. The optimum for each day would be a "45" course, and the effort each day is made to get as close to that number in the total course settings as conditions that day will allow.

There are other balance factors to be considered, such as avoiding too many left side, right side, front or rear settings sequentially.

After a particular area has been selected for a placement on a given green, care must be given to picking the right spot. Here too a number of factors should be weighed. The USGA recommends at least 15 feet between the hole and green edge. Ideally, for a radius of 3 feet around the hole there should be no changes of slope. This does not mean that such area must be flat; it rather means that there should be no change in the angle of slope over the area. The angle of slope, too, is an important factor. There have been instances where holes have been set on slopes so severe that as the green dried out it would not hold a ball. One occurred in a recent regional amateur competition where one contestant 7-putted (!) a green and the tournament winner took 4 putts there.

The area around the hole should be as free as possible of ball marks, other blemishes and changes in grass texture. It is right around the hole where the ultimate action takes place; the particular spot should be selected with commensurate care. The location should "look" right. Care should be taken to avoid placements which, from the player's point of view, present a distorted picture. Golf is a visual game, and the ultimate vision is of the location of the hole.

To assess the player's point of view, the person setting the hole should bring along a putter (and, hopefully, a reasonably representative stroke) to roll the ball at the selected spot before the hole is cut to assure that it will, in fact, play properly.

Perhaps pity is not what the poor pin setter deserves. He experiences the quiet beauty of a superb golf course shimmering in the early morning light. And if he does his job properly he will have planned and worked and placed the hole so that it will add the final touch to the artistry of the course designer and of the shot-maker; so doing should be deeply satisfying.

The area around the hole should be level and free of sudden changes in the degree of slope.

Transition—Some Rethinking

by **F. B. LEDEBOER,** Asst. Professor, Department of Horticulture, Clemson University

Quite contrary to the current "hot" topic at turfgrass meetings in the Southeast—bentgrass for putting greens—the hybrid bermudagrasses are going to prevail for a while longer as the predominant varieties. Therefore, with them we will continue to be faced with annual fall overseeding with various cool season grasses. Fortunately, though, the picture is rapidly changing. The worries over success are becoming less each year. Machines, techniques, fungicides and grass varieties have improved and are continuing to do so.

The days of common annual or Italian ryegrass for greens overseeding appear to be ending and with it will go many a sleepless night, ulcers and gray hair. Because the old ryegrass is so unpredictable during the spring as temperatures reach into the 80's, it may be well if its primary use be returned to hay and grazing purposes.

With approaching warm spring weather the superintendent had to worry daily about the sudden loss—overnight—of the ryegrass often before the bermudagrass could make sufficient recovery to maintain an adequate putting surface on its own. Thus he had to make every effort to bring the bermudagrass back as quickly as possible on one hand; on the other he had to intensify his fungicidal spray program to hold the ryegrass beyond its natural warm weather tolerance by trying to prevent severe disease outbreaks.

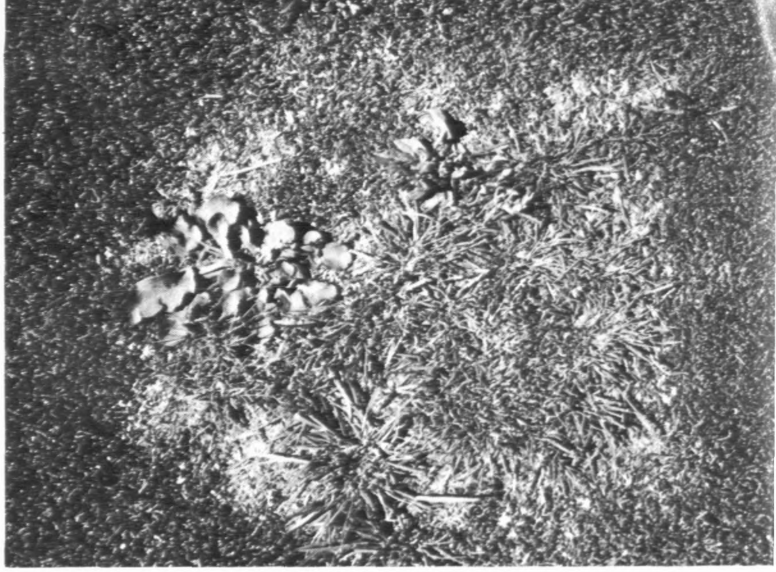
For most golf courses these are just bad memories, and that's all they should be because much better grass varieties have taken the place of the old annual ryegrass. The names are already familiar: Manhattan, Medalist 2, and Pennfine perennial ryegrasses; Pennlawn red fescue is now joined by Jamestown and Dawson as excellent varieties of very fine texture; Penncross and Seaside bentgrass also present excellent possibilities.

What are the advantages of these grasses over annual ryegrass? The answer to this question is the essential key to the title of this article. They are **more dependable** under stress periods that in the past destroyed annual ryegrass so quickly. The fact is these new varieties hold up so well that some superintendents feel they would persist all summer in areas where it does not get extremely hot and humid.

The spring transition period is then the area where we possibly should do some rethinking on our management philosophies, in particular how to handle the grasses during the spring. In general, superintendents, I feel, are somewhat impatient and want to bring back the bermudagrass quite early. They become frustrated and worried when they meet with little success because the winter grasses continue as a thick, healthy cover despite repeated thinning by verticutting. The new worry now is that the bermudagrass may not come back at all.

Our work at Clemson University with overseeding of Tifgreen, Tifdwarf and Pee Dee 102 over the past two years indicates that these worries are really unfounded if the bermudagrasses remain healthy during the dormant period. In direct comparisons of plots overseeded with annual ryegrass with those overseeded with perennial ryegrasses and red fescues, the transition has been almost unnoticeable with the latter. It occurs very gradually without abrupt changes in color or texture over a period of several weeks. On the other hand, annual ryegrass plots under the same treatments underwent the typical, very quick fade-out. The bermudagrass in these plots was very spotty and irregular in appearance. It was entirely unsatisfactory for golf use for several weeks.

How do we now look at our management program of overseeded greens during the spring transition? We know that such varieties as Manhattan, Pennfine, Jamestown, Dawson and the bentgrasses are going to persist considerably longer into the warm weather period than we have been used to with annual ryegrass. So, our



Weeds take over in spring deadspot if the bermuda is not overseeded.

thinking is now to let these winter grasses continue to grow so long as they provide us with a good putting surface. At the same time—over a period of four to eight weeks—we let the bermudgrasses recover at the pace dictated by soil temperature, winter grass competition, and fertility conditions. We use the aerifier and remove the cores completely to allow the green to dry a little quicker. Aerifying twice at an interval of a month has been considerably better than a single operation. At present we feel this is the most important practice to assure good bermudagrass recovery.

The effects of verticutting to thin the winter grasses in the spring have been different from what we expected and completely different from the results on annual ryegrass. The new perennial ryegrasses, red fescues and bentgrasses are much better adapted perennial turf varieties, all of which have the ability to regenerate new tillers quickly in contrast to annual ryegrass. If the latter is being thinned by verticutting in the spring it will be quickly forced out, but the perennial grasses will respond with tiller growth, if temperatures are not too hot, and continue to hold a very dense and fine turf.

Verticutting to seriously thin out these new varieties and really reduce their competitive effect should probably not be done until the bermudagrass is really ready to take over again. For as long as temperatures remain on the cool side, these winter grasses are being stimulated more by the action of the verticutter and the help for bermudagrass recovery is negated. Periodic light verticutting to reduce grain is, of course, advisable especially for bentgrasses which begin to creep quite rapidly during spring.

So, our philosophy of greens management during spring transition has changed considerably, primarily with regard to verticutting. We do it now about a month or six weeks later than usual or at least not until the soil temperatures have warmed up sufficiently for good bermudagrass growth. There seems to be little benefit in verticutting for bermudagrass recovery earlier; these more durable perennial winter grasses just will not be discouraged that easily.

A very interesting side benefit from these longer lasting winter grasses has also developed. How important and practical it will be only the future will tell. In the spring dead spot (SDS) belt of the Southeast, the readily visible effects of this malady of hybrid bermudagrasses on putting greens have been largely obscured. Without severe verticutting, SDS areas remained covered by winter grasses for most of the summer in 1971. The fact that SDS was present was only discernible by the trained observer but generally not by the golfer. The picture has been much the same this year in comparison to areas that were overseeded with different winter grasses. Perennial ryegrasses and red fescues persist well into the summer and cover up SDS areas, while plots with annual ryegrass overseedings have been showing the detractive symptoms of the disease since April. Under both conditions the rate of bermudagrass invasion back into affected areas is about the same.

The new thought with spring transition is that superintendents may want to exercise more patience and let the bermudagrasses recover more at their own speed. The new winter grasses are not going to leave after the first few warm days. When the weather does get warm and the bermudagrass comes through the winter in good condition, it will effectively compete with the winter grasses and re-establish itself very well during the summer. The real anxieties should almost vanish if the superintendent learns how to properly handle his greens when he uses the more attractive, better winter grass varieties for green overseeding.

NEWS NOTES FOR MAY

Green Section Educational Program at U.S. Open Championship

Elbert S. Jemison, Jr., of Birmingham, Ala., Chairman of the USGA Green Section Committee, has announced an entirely new and different Green Section Educational Program to be held on June 13, 1973. It will be presented one day prior to and at the site of the U.S. Open Championship (June 14-17), Oakmont Country Club, Oakmont, Pa.

The innovative full day meeting will include, in addition to informative papers by the Green Section Staff, an actual tour of Oakmont as it is conditioned for the Championship. Superintendent Lou Scalzo and Harry Gray, Club Manager, will be on hand to answer questions during the tour.

The program, developed by the Green Section's Mid-Atlantic Director Holman Griffin, is designed for both Green Chairmen and Superintendents. Further details of the meeting and hotel reservations are available from Golf House, Far Hills, N.J. or your Regional Green Section Office (please see inside front cover). Advance reservations will be necessary.

$52,050.00—New High in Green Section Research Support

The U.S.G.A. Green Section Research and Education Fund, Inc. has awarded $52,050 in turfgrass research grants for 1973. A. M. Radko, National Research Director for the Green Section, announced this as a record figure in research support. Eighteen universities throughout the United States will participate in the grants.

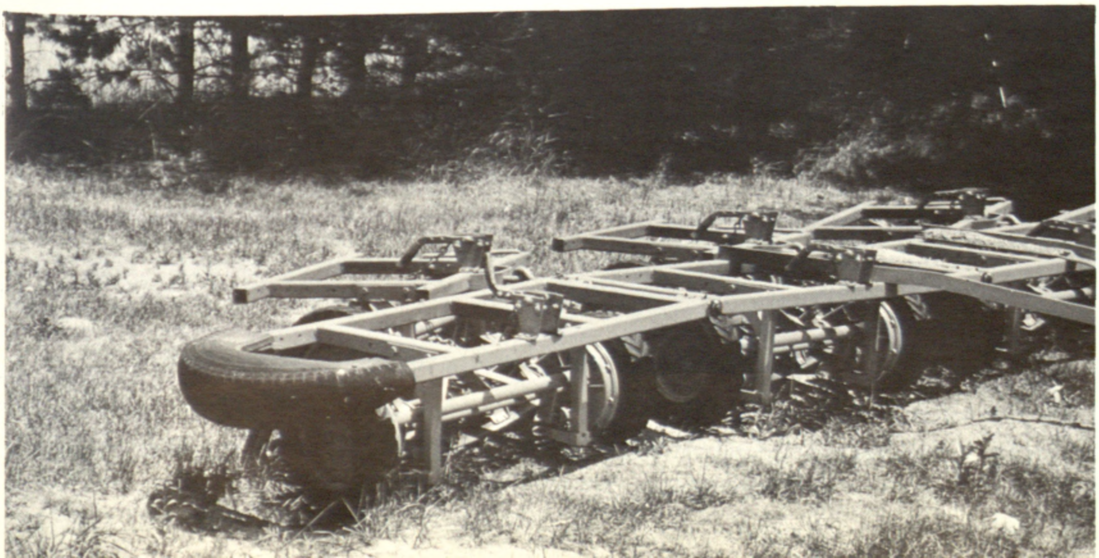
To avoid duplication of research efforts, cooperation and consultation has been established by the three major national research funding agencies; Dr. Paul M. Alexander, of the GCSAA; Charles G. Wilson, of the O. J. Noer Research Foundation, Inc.; and A. M. Radko of the USGA Green Section. In all, the three agencies will distribute $76,220 for turfgrass research this year.

New Correspondence Course in Turf Management Available

A new correspondence course in turf management has recently become available from Washington State University. It is offered for university credit and administered by Dr. Alvin G. Law and Kenneth J. Morrison of the University staff. Further details are available from Kenneth J. Morrison, Extension Agronomist, 169 Johnson Hall, WSU, Pullman, Wash. 99163.

A TURF TIP FROM *BERT:*

Bert Rost, Superintendent at Elcona Country Club, Elkhart, Ind., has bolted sections of a rubber tire to the frame of his rough mowing units to serve as bumpers. These bumpers are helpful in avoiding damage to trees. The cost of the bumper or tree guard is minimal; all that is needed are old tires and a few bolts.



TURF TWISTERS

ANY SHADE OF GREEN WILL DO

Question: Each spring I strain my eyes for the first signs of green growth in my bermuda fairways. Is there a way to tell if it is still alive before it greens up? (Maryland)

Answer: Yes. You can put plugs in a greenhouse and see if they will initiate growth, or in the field, take up some stolons or rhizomes and see if they are healthy looking. Any shade of green is desirable, but brown to black is doubtful or dead. If a milky white stolon snaps when it is broken and has juice or fluid inside, chances are it is healthy.

RED IS FOR RESPIRATION

Question: What is the TZ test; (New Jersey)

Answer: A TZ test provides a quick reading on the viability and quality of seed. TZ stands for tetrazolium chloride which is a color indicator. In the process of respiration of living tissue, hydrogen ions are given off which react with tetrazolium chloride (a colorless liquid) to form a red stain. When seeds are soaked in tetrazolium chloride: if tissue is alive, a pink stain results; if the seed is dead, no stain is produced; if the seed is injured, respiration is accelerated and a darker red stain results.

BERMUDAMITE DYNAMITE

Question: What is new on control of bermudamite? (Texas)

Answer: There is nothing better at this time than four pounds of actual ingredient AG 500 diazinon per acre. Bermudamite was most active during 1972 and may be more widespread than ever in 1973.