THE BULLETIN

of the

UNITED STATES GOLF ASSOCIATION GREEN SECTION

Vol. 12 Washington, D. C., February, 1932 No. 2

Contents

THE BULLETIN is published monthly by the United States Golf Association Green Section, at Room 7207, Building F, Constitution Ave. and 7th St., Washington, D. C.

Address all MAIL to P. O. Box 313, Pennsylvania Avenue Station, Washington, D. C.

Send TELEGRAMS to Room 7207, Building F, Constitution Ave. and 7th St. N. W., Washington, D. C.

Subscription Price: In United States of America, Mexico, and West Indies, $4.00 per year; in all other countries, $5.00 per year.

Entered as second-class matter, April 21, 1926, at the post office at Washington, D. C., under the Act of March 3, 1879.

The Delicate Question of Watering Turf

One of the most useful and perhaps most abused improvements on golf courses is the modern watering system. The judicious use of adequate water has made it possible to maintain turf in a luxuriant condition throughout most of the playing season whereas if dependent entirely on natural rainfall the turf on many golf courses would be dried out during much of the season. On the other hand one frequently finds at the height of the growing season large areas of dead or badly-weakened turf which can be traced directly or indirectly to the use of too much water, which in many cases has been applied by artificial means. In many cases the loss of turf is attributed to disease, when in reality the disease had probably only a secondary effect and developed to serious proportions only after the grass had been greatly weakened by excessive watering.

The chief reason for watering turf artificially should be to provide sufficient water for the growth of grass during periods when Nature's supply is inadequate. Unfortunately watering systems are not limited to this main purpose of encouraging turf development. In many cases water is used to the disadvantage of grass in an endeavor, by ill-informed greenkeepers and club officials, to use large quantities of water to maintain putting greens soft enough to hold pitch shots. It is argued that golfers generally prefer soft putting greens and that it is impossible to keep the surfaces soft enough to satisfy the majority of club members unless the putting greens are constantly watered. Players contend that the chief purpose of a putting green is to provide the desired playing conditions, that the attainment of that end should receive first consideration from the course maintenance force, and that the growth of grass should be considered distinctly secondary. Players frequently are not aware that the same desirable playing conditions may be obtained by different methods. Any method which gives immediate improvement to playing conditions but at the same time endangers turf must ultimately result in a poor playing condition, for the best enjoyment of the game on most golf courses is dependent on a satisfactory covering of turf.

The modern tendency on American golf courses to place great emphasis on the pitch shot has created a demand from golfers generally for putting greens which can be depended upon at all times to hold pitch shots. Too frequently this demand for holding shots has developed to such extremes that it is apparently desired that conditions be such that the poorly-played shot be held as securely as the well-played shot. Such a viewpoint naturally raises the question as to what is the purpose of golf—whether the emphasis should be placed on skill or whether there should be a certain amount of standardization and simplification of the game to reduce the number of shots and make all shots easier to play effectively. Golfers in general will no doubt agree that if the elements of skill and variety are removed from the game it undoubtedly will lose much of its charm. Yet players constantly are making demands of their green committees and greenkeepers which, if followed out, would rob the game of a great deal of its variety and demand for skill. Elsewhere in this number of the Bulletin two well-known players give their opinions as to the danger of robbing the game of much of its interest by over-emphasizing the pitch shot

and providing conditions such that less skill is desired in playing this important shot. These writers point out the disadvantage of soggy putting greens from the standpoint of playing the game. There have been repeated warnings in the Bulletin against soggy soil in putting greens from the standpoint of maintaining healthy turf.

Unless the soil on the putting green is suitable, it is difficult to properly maintain the best playing conditions. If the topsoil of the putting green is largely clay it will be puddled by the trampling of players and by the machinery and laborers that work on the turf. Puddled clay becomes bricklike when dry, and even the best shots will not hold properly on a putting green with such a surface. When a clay putting green is wet, a pitched ball digs deep into it and leaves bad pockets which serve as a constant menace to putting. Putting

Damaged turf on a putting green caused by excessive watering in an effort to hold a pitch shot under all conditions. The injury first became apparent on the lower areas of the green

greens built of this type of soil are apt to be extremely fast when they are dry and especially slow and soggy when they are wet. On the other hand, putting greens which have a sufficiently thick top layer of good sandy loam do not present the extreme putting conditions that are presented on clay putting greens. Putting greens with a topsoil of sandy loam will hold a ball well even when relatively dry. These same greens will not be as badly scarred with pitch shots during rainy periods or when excessively watered. A good sandy loam with an ample supply of organic material therefore presents a much more desirable surface from the playing standpoint than is provided by a soil with too much clay.

A sandy loam well supplied with organic material is usually a much more desirable soil for grass to grow in than is a heavy clay soil, particularly if the latter is puddled and can not be cultivated. Excessive moisture drains out of a sandy soil much more rapidly than it does from a clay soil and, unlike a clay soil, a sandy loam is not easily puddled and consequently does not produce a hard crust when the sur-

face dries out. A sandy loam soil, therefore, is the type of soil which is generally preferred for the surfaces of putting greens both from the standpoint of play and from the standpoint of grass growth.

In Mr. Welton's article in this number of the Bulletin there is a discussion of soil structure, which contains information such as should enable greenkeepers and members of green committees to choose their soils more wisely. If a desirable natural soil can not be obtained readily, a suitable mixture can be easily prepared if one takes the pains to determine the amounts of the various ingredients needed for the preparation of a good sandy loam soil, using any available soil as a base for the mixture. If more attention were paid to the selection or preparation of soils used in constructing or top-dressing putting greens it is likely that watering costs would be minimized and much less damage to turf would result.

Where soil conditions are unfavorable it is especially important that putting greens be watered carefully. By some simple tests such as are described in this number of the Bulletin it is possible for the greenkeeper to determine which putting greens contain soil in a poor physical condition. Such putting greens should be watered with especial care in order to avoid saturation. On many courses putting greens are watered on a definite schedule with the same definite period allotted for watering each putting green. Such a practice can not be regarded as a sign of good judgment, for the different putting greens usually have differences in the size of the watered area, in the pressure of water at the outlets, in the height of the water table, and in losses of evaporation due to different exposures to air currents and direct sunlight, and many other differences, in addition to the important variation in soils used on the several putting greens. If it is determined that a certain putting green contains soil in a poor physical condition, the men who water that putting green should be instructed to use no more water than is required to keep it in the best condition and to apply the water slowly enough to enable the soil to absorb it readily.

When it has been determined that the physical condition of topsoil in a putting green is unsuitable for providing a playing surface or a medium for grass growth, some intelligent effort should be made to improve this condition of soil rather than to resort to other means, such as excessive watering. In some cases it is practical to remove the turf, change the entire surface layer of soil, and replant. In many instances such drastic methods are considered impractical even though they are obviously the best means for improving existing conditions. When there can be no removal of sod to make way for soil improvement there is still the possibility of improving the top layer by adding properly-prepared top-dressing. The common practice of jumping from one extreme to the other in the selection of materials for top-dressing putting greens should be condemned, for it results in the formation of distinct layers, which are undesirable. It would be better to build up a uniformly-good topsoil by using regularly a tested mixture which is prepared by using properly the fundamental principles of soil physics, such as are brought out in Mr. Welton's article.

In many instances the demand from golfers for soft greens is encouraged by poor approaches. If a hole is designed primarily for a run-up shot the hole should be maintained with that object in mind. Frequently approaches are so badly neglected that they become actual

hazards, and due to the irregularities of their surfaces a player can not possibly predict where his ball will roll even if it is accurately played for a run-up shot. In such cases a player is forced to use the pitch shot. Much of the emphasis on the pitch shot in this country may possibly be due to the tendency in greenkeeping to strive for perfect putting greens even at the expense of neglecting the approaches. If more attention were paid to the improvement of soil conditions and turf on the approaches, with a view to providing the desired accuracy in the bounce and run of a well-placed shot on the approach, it is probable that more golfers would use this method of approaching and there would be fewer demands for soggy putting greens that will stop quickly any kind of shot from almost any distance.

Why Keep Putting Greens Soft?

By Robert T. Jones, Jr.
Atlanta Athletic Club

It is claimed by those in close touch with greenkeeping practices that much of the difficulty in maintaining putting greens is due to the excessive use of water and that greenkeepers and green committees point out that they water heavily in self-defense because golfers want soft greens. I have been asked to say how I regard the practice of keeping putting surfaces soft, even soggy, looking at the question purely from the player's standpoint.

There can be little question that the great mass of golfers in the United States prefer their greens very soft. Such a condition makes the play much easier for all classes of players and is, in a great measure, responsible for the fact that tournament scoring is uniformly lower in the United States than on seaside links in the British Isles. The difference is attributable more to the excessive use of water on putting greens in the United States than to the much-talked-of seaside gales in the British Isles, which, after all, do not blow constantly.

Of our two great American preferences—the one for placing the green-bunkering very close to the putting surfaces, and the other for soggy greens which will hold any kind of a pitch, whether struck with backspin or not—I can not say which induced the other or which came first. The close guarding, in many instances, makes a soft green necessary if the hole is to be playable, and the easy pitching, on the other hand, makes it necessary to decrease the size of the target in order to supply any test.

I quarrel with both ends of this proposition, whichever is to blame. These together are the two reasons, I think, why our golf courses in the main lack the subtlety of British links, and why our golf does not demand the strategy or the intelligent planning which it should. In my opinion, a properly-designed hole should impose a test upon each shot which the player has to make. There should always be a definite advantage to be gained from an accurate and intelligent placing of the tee shot, or a reward offered for a long, well-directed carry over some obstacle. This advantage or reward can be only in the shape of an easier and more open road for the second shot, and when we soak the green with water we absolutely nullify the advantage which the design of the hole has held out.

I do not believe in forcing a run-up shot in preference to a pitch in every case. But, when one goes to the trouble of placing a bunker across the left side of the green in order to force the tee shot toward the right side of the fairway, why destroy its effect by soaking the green so that any sort of pitch over the bunker will hold? Our expert players are in the habit of playing long iron, spoon, and brassie shots bang up to the hole. As long as they can do this no architect can expect them to worry much about placing the tee shots.

The strategy of this 360-yard hole calls for a drive to the right of the fairway. A shot to the left of the fairway requires a difficult pitch-shot approach over the large sand trap. If such a green is kept soggy the purpose which its designer had in mind is largely defeated and the hole loses much of its interest

It seems to me that the ideal green would be sufficiently soft to hold only a properly-placed pitch—and by "hold" I do not mean "to stay within a very few feet." To carry out the intention of the designer, conditions ought to be such that a definite penalty should be sustained by the player who has played himself out of position.

In this connection, I think one of our greatest needs is a fairway grass or treatment which will make the ground in front of our putting greens more reliable. If the greens themselves are maintained in a firmer condition, the need must arise on occasions to drop the ball short of the putting surface, allowing it to roll the remaining distance. I know very few courses where this is possible without great uncertainty.

A golden-leaved maple, a bronze-leaved maple, or a white, gray, or copper birch planted here and there in a woodland border, are exceedingly beautiful.

Plant at least a few trees on your course each year. Like everything else, trees get old, sickly, and die, and it is well to replace them before extensive damage is done.

The Soggy Putting Green

By Alex Pirie

Old Elm Club, Fort Sheridan, Ill.

The watering of putting greens is a problem which demands the most careful consideration. The questions involved are many and varied. Of major importance in studying the problem for a particular putting green are the following considerations: What kind of a golf shot does the green call for? What is the condition of its surface? Is it hard or just dry? Is it soft, soggy, or firmly wet? At what height is the grass cut? What, if any, outstanding features of design does it possess which are likely to affect the action of the ball after it has landed on the surface?

These questions enter prominently into the problem of watering a putting green and should be given careful thought if a condition is to be obtained that is fair to the players and favorable to the turf. Personally, I believe that under no circumstances a soft, soggy, or spongy putting green is advisable from either the player's or the greenkeeper's viewpoint. Such a green does not develop finesse, skill, courage, or strategy on the part of the player, but is merely something into which the ball can be played, almost heedlessly.

None but a pitch shot could be played to this small putting green on a 332-yard hole. With proper soil and structural conditions the turf on this type of green can be maintained so as to hold a pitch shot without excessive watering

Let us assume, for the purpose of this discussion, that the shot to be played calls for a high-pitched ball with backspin from a maximum distance of 140 yards to a small putting green surrounded by hazards. Is it sound golf or good greenkeeping to keep such a green in a more or less waterlogged condition onto which the player can "shovel" his ball with little regard for the finer points of the game, a condition which, moreover, is almost invariably a constant source of worry to the greenkeeper? In my opinion it is not, because, in the first place, it is uncomplimentary to the player. It also is the cause of much annoyance to a player to find his ball in one of the

innumerable indentations caused by the green's being too soft and it is frequently impossible to hole a putt no matter how short the distance when a series of indentations occur between the ball and the hole.

Considering the effect of over-watering purely from the greenkeeper's viewpoint, I believe that many of the turf diseases and other difficulties encountered in producing satisfactory putting turf are to be attributed directly or indirectly to this practice. It is highly conducive to an almost constant "stewing" process during the hot days of summer, which is harmful in that it checks the development of a deep root system and leaves little or no vitality in the grass plants for resistance to disease.

What, then, is the remedy for an unhealthy, waterlogged putting green? The player is certainly entitled to expect that if he plays his shot with a fair degree of skill he will receive an equally fair response from the green when his ball lands and that his ball will stay within a reasonable distance from where it hit provided his judgment and execution were sound. On the basis of my thirty years of observation and practice may I suggest that when a putting green does not properly hold well-played shots some attention be directed to improving drainage, soil texture, and other essentials. If these improvements fail to give complete satisfaction I would suggest, for the particular type of green under discussion, that instead of using excessive water to provide "bite" for the ball the grass be cut from 1/8 to 3/16 of an inch higher than the average height of turf on other greens requiring entirely different shots in approaching them. These putting greens should be watered only when it is necessary to keep the grass in a healthy condition.

There is no good reason why the turf on each putting green should be cut to the same close, uniform height. Such a practice does little to develop the finer points of judgment in play. Allowing the grass to grow a little longer on a green will not detract from fine putting and will provide plenty of "bite" for a well-played shot. It will also, to a great extent, tend to reduce the unfair indentations left by balls, to which I have previously called attention.

Not all insects are to be condemned.—When kept under proper control many insects are of decided help from an agricultural viewpoint. Australia is actually importing plant bugs, caterpillars, scale insects, and beetles to feed on the prickly pear cactus, which has spread so rapidly there as to become a costly weed. In spite of various control methods practiced in Australia, this cactus has increased its range of devastation at the rate of 1,000,000 acres a year. According to recent reports, however, the use of insects as a control measure has been of sufficient success to predict complete control of the prickly pear cactus within 10 years. In Hawaii, also, a number of different kinds of insects have been introduced from Mexico, by the Hawaiian Sugar Planters' Association, to feed on and destroy the lantana plant, and reports indicate that this method of controlling the weed has proved successful. Golfers are still hoping that someone will find a bug that will eat crab grass, clover, and a few other weeds and at the same time spare the bent grasses, bluegrass, and other desirable plants on the golf course.

Structural Requisites of Putting Green Soil

By Kenneth Welton

Cultural practices influence to a large extent conditions which affect the growth and vigor of grass plants and hence the quality of the turf produced. In common with most plants, grass requires, among other things, a suitable substratum in which the roots may obtain anchorage and find a reserve of plant food, air, and moisture with which to carry on the life processes. The physical condition of the soil affects the development of roots and tops as do the cultural practices.

It has been shown that the restriction of the top growth of grasses by constant cutting reduces the root system of the plant in a corresponding degree, due to the depriving of the plant of a certain amount of food which is manufactured in the leaves under the action of sunlight. The root systems, then, are limited in development not only by soil conditions but also by the amount of food which the plant is able to manufacture through the medium of its leaves. Some grasses which provide excellent fairway turf can not be maintained for any length of time under the comparatively close cutting to which they are subjected on the putting green. As a consequence certain species and strains of grasses have been developed which are better adapted to the unusual cultural conditions found on putting greens. Even these species and strains are weakened by frequent close cutting and are rendered more susceptible to turf ailments to which they might be resistant if allowed to develop under more normal conditions.

It is through the root system that plants are able to absorb moisture in which the fertilizer and other salts are dissolved. These salts play an important part in the manufacture of plant food in the leaves. A restricted root system is limited in its ability to supply the plant with the necessary elements. Efforts to give it assistance by supplying fertilizers become increasingly difficult, since the proper concentration of fertilizer must be maintained in the comparatively thin layer of soil surrounding the roots. During hot weather, when transpiration and evaporation are rapid, more water is needed by the plants than at any other time. A dense root system concentrated in an inch or two of the surface soil tends to deplete the soil moisture in the top layer more rapidly than does a root system drawing its water supply from deep in the soil. Evaporation also adds to the loss, necessitating frequent watering to supply the required amount of moisture. Frequent and excessive watering further complicates the scheme of things, because water in the soil, in excess of the optimum amount, displaces from the pore spaces of the soil the air which is indispensable to plant growth.

Soils Must Contain a Supply of Atmospheric Oxygen

The microscopic plant and animal life in the soil is usually referred to under the general term of microorganisms. These are of importance in the soil for a number of reasons, but the extent of their importance in putting green soils is not yet fully understood. Their activities are greatly influenced by changes in conditions. A normal supply of air in the soil favors those forms of microorganisms which are of actual benefit to plant growth by their action in decomposing

organic matter and building up soluble plant foods. When, however, water is present in excess for any length of time, the development of a group of microorganisms which are not beneficial to plant growth is favored.

The condition of the soil for satisfactory grass growth should be such that free or gravitational water will drain from it. The plants therefore depend mostly upon capillary moisture, which remains in the soil against the pull of gravity. Capillary moisture exists only as a film surrounding the individual soil particles and leaves space in the soil for the presence of air. A heavy rain or watering displaces the soil air and a new supply is drawn into the soil when the excess water drains away. Part of the water which has drained to lower depths is available to plants by capillary attraction, which brings it within reach of the roots. This action is best likened to the manner in which ink creeps through a blotting paper.

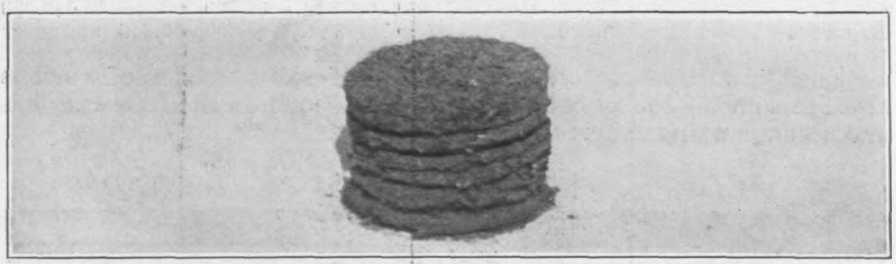
Soils in good tilth have their individual particles grouped or flocculated into crumbs or granules. This arrangement increases pore space and provides a more satisfactory medium for the development of plant roots. Under putting green conditions the soil is often puddled much as bread dough is kneaded. The excessive watering and trampling while the soil is wet help to bring about this condition. The crumbs or granules are broken into the single grains of which they are made, and the resulting structure is much more compact and sticky. Such a condition hinders the percolation of water through the soil, excludes the air to a large extent, and renders the penetration of roots more difficult. Puddled soils become hard upon drying, and excessive watering is required to bring them to the resiliency demanded by the players, and thus a vicious circle is developed. All these related conditions which tend to further restrict normal root development combine to weaken the grass plants so that a period of extreme weather conditions or an attack of disease may prove too much of a strain and the plants will succumb.

A study of the influence of soil conditions on plant growth emphasizes the desirability of providing a topsoil for putting greens which will allow moisture to penetrate to the lower levels in the soil and encourage the maximum growth of roots which the restricted top growth will allow. Such a soil when dry should retain the required resiliency or "give" to hold a reasonably well-played pitch shot.

Soil is made up of weathered fragments of rock and organic material. It may be considered under three general categories: (1) the physical, which includes the size of the particles (texture) and their arrangement in the soil (structure); (2) the chemical, which includes the composition of the particles; and (3) the biological, which concerns the activities of the minute forms of life with which the soil is teeming. The physical properties are important in the building and maintenance of putting greens, for without the proper texture and structure of the soil the chemical and biological processes can not be maintained in a condition most beneficial to the growth of the grass. With suitable soil structure the chemical and biological processes can be influenced by superficial soil treatments, but it is difficult, if not practically impossible, to improve soil structure in a putting green after it is in play.

Soils to be used as top soil, or for top-dressing material, on putting greens, are too often chosen with no appreciation of the qualities

which are essential in putting green soils. The origin of the soil has little to do with its suitability, since in some cases subsoils are superior in this respect to some topsoils. The color, the feel, and the fertility of a soil may have little to do with its suitability, since there are other factors which have a greater influence. Color is an indication of varying amounts of materials which may or may not have a decided effect. The fertility is the potential productivity of a soil, and this can not be fully realized except under ideal structural and climatic conditions. The feel of the soil is the most accurate guide of those mentioned, but is useful only to those who have some knowledge of the physical properties of the soil and understand and appreciate the unnatural conditions under which putting green soils must be productive. The skilled worker is able, by the feel of a soil, to place it as to class and to estimate, to some extent, its behavior under various conditions.



Detrimental layers may be formed on a putting green by the improper use of top-dressing materials. The six clearly-defined layers of soil were formed in as many seasons of top-dressing. A highly plastic soil was used for top-dressing purposes throughout the growing season and each winter a heavy dressing of sand was applied. Satisfactory results would have been attained had the soil and the sand been mixed together for use during the growing season

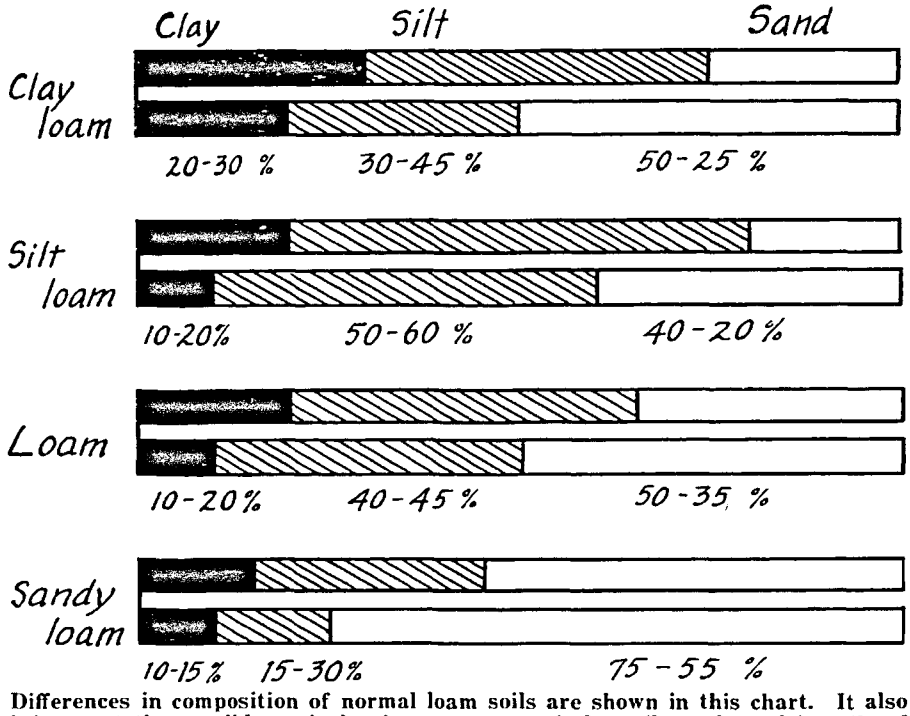
There is a general understanding among greenkeepers of the proper use of the terms sand, silt, and clay to designate soils of different textures. Briefly, the term sand designates the predominance of coarse material; silt, the predominance of material which is finer than sand and coarser than clay; and clay, the predominance of fine material. The term loam designates a more or less balanced mixture of both coarse and fine materials. It has been found, however, that these terms are used to designate different classes of soils in different localities. For example, farmers in an area where clay soils predominate are apt to class soils which are somewhat coarser than their average soils as sandy loams, when in reality they are silt loams. Likewise, in sandy areas there is a tendency to class silt loams as clay loams. Soil specialists can judge with surprising accuracy the class to which a soil belongs by rubbing a sample of the soil between the fingers. However, some soils which are similar in texture can not be accurately classified by field methods, and it is necessary to subject them to a mechanical analysis in order to determine accurately their class. There are practically no pure silt or clay soils, and seldom is a soil found which contains more than 80 per cent of silt or 65 per cent of clay. These materials are usually found in mixtures, and the terms sand, silt, and clay are used to describe qualities which may be easily determined in the field. To avoid misunderstanding, the terms sand separates, silt separates, and clay sepa-

rates may be used to designate these classes of soil particles. The limits in size of the soil separates, as designated by the Bureau of Chemistry and Soils of the United States Department of Agriculture, are given below. The estimation of the number of particles in similar weights of the various separates shows the tremendous differences in fineness of particles.

SIZE OF SOIL PARTICLES

Separates	*Limits in size* Millimeters	*Calculated approximation of No. of particles to each gram* (453.69 *grams equal* 1 *lb.*)
Fine gravel	2.00-1.00 (.078-.039 in.)	200
Coarse sand	1.00-0.5 (.039-.019 in.)	1,700
Medium sand	0.5 -0.25 (.019-.01 in.)	13,500
Fine sand	0.25-0.1 (.01 -.004 in.)	132,000
Very fine sand	0.1 -0.05 (.004-.002 in.)	1,700,000
Silt	0.05-.005 (.002-.0002 in.)	35,000,000 to 65,000,000
Clay	Less than 0.005 (Less than .0002 in.)	45,000,000,000 and over

The proportion of soil separates, or of soil particles of various sizes, in some of the more common soils is shown in the following list and accompanying chart:



Differences in composition of normal loam soils are shown in this chart. It also brings out the possible variation in percentage of clay, silt, and sand in soils of the same class

Sandy loam contains less than 20 per cent of clay, from 20 to 50 per cent of silt and clay, and from 50 to 80 per cent of sand.

Loam contains less than 20 per cent of clay, from 30 to 50 per cent of silt, and from 30 to 50 per cent of sand.

Silt loam contains less than 20 per cent of clay, 50 per cent or more of silt, and less than 50 per cent of sand.

Clay loam contains 20 to 30 per cent of clay, from 20 to 50 per cent of silt, and from 20 to 50 per cent of sand.

Clay contains 30 per cent or more of clay, less than 50 per cent of silt, and less than 50 per cent of sand.

Peat contains 30 per cent or more of relatively poorly-decomposed organic material, sometimes mixed with much sand, silt, and clay.

Muck contains from 25 to 65 per cent of well-decomposed organic material with much clay or silt, and some sand.

There are several methods of making mechanical analyses of soils, such as sieving value and measuring the settling velocity. In the sieve method the soil is put through sieves of various-sized meshes. The meshes, however, can not be made small enough to separate the finer grades of soil particles, and hence some other method is usually used supplementing the sieve method. Finer particles may be separated by suspending the sample in water, since the rate of settling of the soil particles is in proportion to their size, and each successive grade of particle may be determined as it slowly settles. Soil is classified according to the percentage proportion of each soil separate present. The soil classes have been arrived at through the analyses of many soils which are regarded as typical.

The classes of soils have various characteristics which must be considered in cultural practices. The characteristic property of soil which should concern the greenkeeper when selecting or mixing a soil for putting green topsoil is the structure which it will form under putting green conditions. Soil structure is the term used in reference to the arrangement of the various particles, which determines whether it is loose or compact. The choice of a soil for its structure is more complicated than the simple choice of a soil class. The structure depends, apart from proportion and size of particles, upon the factors of plasticity and cohesion, which vary in soils of the same class, especially in fine-textured soils.

Very Plastic and Cohesive Soils are Troublesome

The plasticity of a soil is its ability to allow a change in form without breaking apart. Plastic soil may be compared to putty which has been mixed with the proper proportion of oil for use. The cause of plasticity of soil has long been under discussion, but it is generally accepted that the fineness of texture, along with the colloidal content, affect the soil most vitally in this respect. Soil colloids are usually defined as soil particles which are finer than one micron (1/27,000 inch) in diameter. They are complex substances, usually gelatinous in nature, which tend to bind the soil particles together. There are certain fine-textured soils which are neither cohesive nor plastic. In general, the more finely textured the soil the more colloidal matter it contains and the more plastic it becomes. The more plastic a soil the more likely it is to become puddled by working or trampling, particularly when it has a high moisture content.

Cohesion is the tendency of soil particles to stick together and to conserve the mass intact. It is closely related to plasticity. The cohesion of soil might be made a rough measure of its plastic properties, and vice versa, because, in general, the greater the plasticity of a soil the higher is its cohesion. When a soil is dry its cohesion

is developed for the most part by the drying and shrinking of the gelatinous colloidal matter, and to a lesser extent by the interlocking of its grains and the development of cementing salts. Fine-textured soils, such as clay and silt loams, may be handled in such a way in farming that they may be kept porous in spite of their plasticity and cohesion. By proper cultivation at times when the moisture content is correct, the soil may be maintained in a granular condition. With the putting green, however, cultivation is impossible at any time, and the frequent watering and trampling soon destroy the granular structure and increase the plasticity and cohesion so that the soil becomes puddled. When fine-textured soils are in this condition they are likely to become exceedingly hard upon drying. A coarse or sandy soil, on the contrary, may be worked or trampled while wet, and its structural condition will remain unimpaired, since it has little or no plasticity.

Organic Matter Corrects Many Defects in Soil Structure

Organic matter also plays an important part in soil structure and in the fertility of the soil. Most soils do not contain sufficient organic matter for putting green topsoil. The effects of organic materials on soil and plant conditions are numerous and complex. Since the water-holding capacity of partially-decayed organic material is relatively high, soils which are rich in humus usually possess a high water-holding power. Although the addition of organic materials to soils increases their water-holding capacity, such additions do not necessarily increase the tendency of the soil to become saturated. Organic matter exerts a beneficial action on soil structure. Its water-holding capacity makes possible greater changes in volume both on drying and in the presence of excessive moisture. This action is somewhat similar to the action of freezing and thawing on the soil in opening the soil and increasing its granular structure and porosity. The organic matter also tends to spread the individual particles farther apart, especially in clay and silt soils. There is considerable difference in organic materials and not all of them are suitable for the purpose of improving soil structure. Some muck soils, although high in organic matter, may tend to increase rather than decrease the plasticity of certain soils when mixed with them. Usually the mixing of such peat or humus materials which are now on the market and available to the greenkeeper will tend to lower cohesion at any moisture content ranging from a saturated to a dry condition. Tests have shown that these materials will decrease the plasticity of the finer soils more effectively than will an equal amount of sand.

Texture must play an important part in determining the extent of cohesion which soil is capable of showing. In general, the finer-textured soils, such as clays and silts, show great cohesion, since, whether dry or wet, the forces that tend to hold the soil together are stronger than in coarser or sandy soil. As finer-textured soils dry there is a great increase in the binding capacity of the colloidal matter, but in coarse soil this binding effect is small or entirely absent. The addition of organic material to a soil, by hastening and increasing granulation, will also tend to lower cohesion. Therefore if it is desired to avoid hard-packed soils on putting greens it is necessary to avoid plastic soils and either to select a suitable natural soil or to mix materials, such as sand and organic material, with finer soils to reduce their plasticity and cohesion.

In general, topsoils are more fertile than subsoils, due largely to the oxidation to which they have been subjected, to their greater content of organic material, and to the greater activity of micro-organisms. The greenkeeper should select a topsoil, if possible, which requires the minimum addition of materials to increase or to decrease its plasticity. Since expert soil men may be mistaken on the actual plasticity of soils not in the sandy class, the greenkeeper should not be content with judging a soil merely by its structure or feel, under the conditions in which he finds it. The greenkeeper's choice of the soil to use for mixing might be accurate enough to decide upon the most suitable type available; but before putting either natural or prepared soils on the green, samples should be tested to discover the ultimate cohesion of the material.

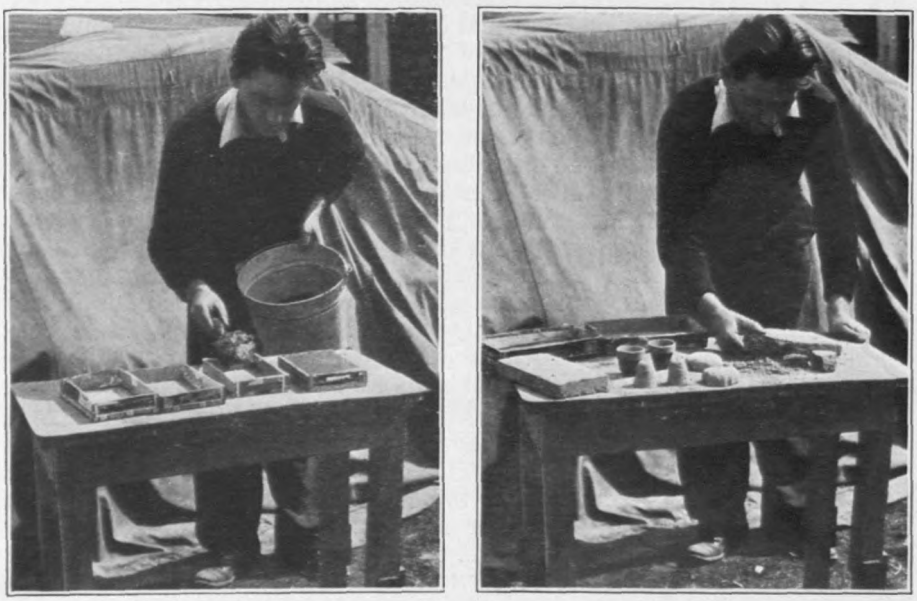
Putting Green Soils Should be Tested for Plasticity and Cohesion

A number of laboratory methods have been devised for determining the cohesion of clays and other soils. Considerable difficulty has, however, always been encountered in measuring natural cohesion of either wet or dry soil. The chief difficulty has been in controlling physical conditions, since the cohesion of the soil depends largely upon the manner in which it has been handled, the amount of water that has been added, the length of time of drying, and the moisture content at which the determinations are made. As a consequence, most tests of cohesion have been made with samples worked to a maximum plasticity and then brought to a required moisture content, or with samples which have been uniformly compacted and then allowed to take up water by capillarity. For accurate determinations of an exact numerical expression of plasticity of various soils it has been necessary to develop a highly-specialized technique. It is possible for the greenkeeper, however, to make more or less rough comparisons of the cohesion of various soils and mixtures at his disposal.

Equal amounts of the various soils to be tested should be procured while in such a condition that they can be handled without adhering to the hands or the equipment. The samples should be put through a 1/16-inch mesh screen in order to granulate the soil and to remove large bits of organic material or rock which might complicate the results of the test by forming lines of weakness through the samples. All except a small amount of each sample should then be placed in similar containers and water added slowly while stirring the soil with a stick. Each sample should be brought as closely as possible to a paste-like consistency. Soil in this condition will not readily flow from the container. It contains less than its maximum water-holding capacity and yet contains enough water so that in clay and silt loams the soil has lost much of its sticky toughness; and although it will coat the fingers if they are thrust into it, it will not stick in large irregular clots. If a furrow is cut through the mass, the soil will just flow together if jarred slightly, leaving a distinguishable line of contact. If too much water has been added and the sample has become too thin, enough of the remainder of the soil should be added to thicken it to the required consistency. After a few trials it will be possible to prepare each sample of approximately the same consistency with about an equal amount of stirring.

The samples should then be troweled into uniform receptacles in order that they may dry in a uniform manner. Small boxes or flower

pots may be used, or, for somewhat less accurate results, mud balls or pies may be molded with the hands into uniform sizes and laid on a board. A record of the samples should be kept and the samples numbered to prevent error. The samples should then be placed under cover in a position where they may dry uniformly. As the samples become dry it should be noted whether certain ones remain moist longer than others, as this factor is important in determining the best sample for putting green topsoil purposes. A sample which remains damp abnormally long may contain too much organic matter. After several days, when it is apparent that the samples have become thoroughly dry, with the exception of any which may contain too much organic matter, they may be removed from the molds or, in the case of mud balls and pies, the samples should be turned. It is usually advisable to allow the samples to dry another day after turning or removing from the receptacles or molds.



In testing the cohesion of a soil, samples of the soil are puddled and then molded either by hand or in several receptacles of the same kind and size. The samples are then set aside until thoroughly dried. Cigar boxes or flower pots are convenient for use as receptacles. On the table at the right are seen also two "pies" molded by hand, and a sample molded in a cigar box being tested by crushing it between the thumb and fingers

By handling the dried samples, the relative cohesion, particularly in the case of extreme soils, should at once become apparent. Samples which are too sandy, or contain too much organic matter, will crumble and fall apart and will not retain their shape even with gentle handling. Samples which have too much cohesion will resemble brick and will retain their shape even when dropped some distance. There is no clearly-defined ideal sample; but by using this method greenkeepers and construction men can discover a mixture which they can use in the putting green with safety. A dried sample

of over an inch in thickness, prepared as above, which can be crumbled by the pressure of the thumb and fingers of one hand, and which does not present a glazed, hard crust, may be judged as a suitable mixture for putting green topsoil, including material for top-dressing purposes.

With adequate fertilizing and watering it will be possible to maintain excellent turf on such a soil mixture without danger of turf injuries due to poor soil conditions. Such a soil will also have sufficient "give" or resiliency, without being spongy, to hold on the green a reasonably well-played pitch shot, and will have present the same qualities in this respect from day to day whether wet or dry.

When Is a Bent Grass a Creeping Bent?

There has been much discussion in the last few years regarding the inclusion of the word "creeping" in the common name applied to Astoria bent, a species of bent grass being grown in Oregon for seed which is a distinct strain of colonial bent that displays pronounced creeping characteristics in the place in Oregon where it is grown. The attitude of the Green Section in this matter is made clear in the article "Classification of Redtop and the Common Bent Grasses" commencing on page 44 of the Bulletin for March, 1930, especially on page 49 in that article. The difference in the points of view in this discussion is largely a matter of contention over the use of words, for both sides are in complete accord as to the character of the grass.

The name "creeping bent" has been handed down to us as a common name applying to a certain group of grasses which botanists have grouped into a single species which, as stated in the Bulletin for March, 1930, is known botanically as *Agrostis palustris.* Unfortunately in this common name the word "creeping" may be construed as an adjective, which is a construction not intended. If the name could acceptedly be hyphenated or compounded, thus appearing as creeping-bent or creepingbent, its meaning would perhaps be less open to misconstruction.

In the use of the common name "creeping bent," if the word "creeping" is to be construed as a descriptive adjective and not as a part of the noun, the confusion which exists in the case of Astoria bent would necessarily enter also into the case of many other grasses of the genus Agrostis. For instance, on many golf courses and experimental turf gardens there are areas of velvet bent turf (*Agrostis canina*) planted with stolons which have developed into thick turf by the creeping habit common to species of Agrostis. At the Arlington turf garden there are two plots of redtop (*Agrostis alba*) which were planted with stolons and which have developed by the creeping habit into thick turf. Using the word "creeping" as an adjective one could not deny that such turf consisted of species of Agrostis which had distinctly creeping habits. In that case therefore we should be obliged to call both velvet bent and redtop "creeping bent." However, no one acquainted with turf confuses redtop and velvet bent with creeping bent.

In the case of Astoria bent, it can not be denied that this grass produces rootstocks and stolons, which are the creeping parts of plants. As a matter of fact, the production of rootstocks and stolons has been frequently demonstrated also in colonial bent grown from New Zealand seed as well as in other kinds of bent. It has therefore always been entirely agreed that Astoria bent was able to creep, and therefore a creeping grass, and logically a creeping bent if the word "creeping" in the name is to be construed as a descriptive adjective. Furthermore it has been admitted that all commercial bent, as well as redtop, is able to creep and is therefore creeping bent under the same use of the word.

The English language is noted for such confusing use of words. There is a strain of crimson clover the flowers of which are pure white. If a grower were raising this strain of clover, of which there can be no question as to color, it is wondered whether one would feel it necessary to insist that it be certified as white clover instead of crimson clover. If an experiment station should attempt to do so it would doubtless find it difficult to induce the farmers or the various state and federal agriculturists to adopt its viewpoint even though the flowers of this white strain of crimson clover are whiter than those of white clover itself. The public generally accepts the name crimson clover for the plant *Trifolium incarnatum* and the name white clover for the plant *Trifolium repens*, regardless of color. Likewise the color of the blossoms of crimson clover is considered deeper red than the color of the blossoms of red clover (*Trifolium pratense*). Anyone is nevertheless quite willing to accept the name red clover as a common name even though in Gray's New Manual of Botany the color of the corolla is given as "magenta to whitish." In the case of vetch the common name hairy vetch is restricted to a particular species of vetch, but there are a good many other species of vetch which are also hairy but which are certainly not referred to as hairy vetch. It is hard to see any blue in Kentucky bluegrass turf or red in redtop turf. There are almost no end of cases such as these that might be cited as apt to cause a great deal of confusion by construing in its descriptive sense an adjective which in reality is a part of a noun. The whole situation reminds one of the remarks of a college professor of history who, when his class would reach the point of discussing the old Holy Roman Empire, would introduce his lecture thus: "Gentlemen, we are now to consider the Holy Roman Empire, which was neither holy nor Roman nor empire. However this name has been handed down to us through the ages, and we will therefore refer to it as the Holy Roman Empire."

Anyone can have good putting greens in May, June, or October. The real test of the greenkeeper is in the period from July to September.

Some one has estimated that United States farmers lose close to $500,000,000 a year through their neglect of farm machinery. On golf courses as well as on farms it pays to keep tractors, mowers, and other equipment in condition for use.

Eighteenth hole (372 yards) Gulf Stream Golf Club, Delray Beach, Fla. Photographed from in front of tee.

Thinking is the hardest work there is, which is the probable reason why so few engage in it.

Henry Ford