Soil Structure of Putting Greens

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IT SEEMS most appropriate that the subject, "Soil Texture of Putting Greens," be brought to your attention at the commencement of a conference during which the putting green will probably receive major consideration. In the study of any subject it is always well to start at the bottom and recognize the fundamental facts concerning it before progressing to the many phases which will develop later. Following this line of reasoning we will commence far below the putting surface, with the fill or sub-soil.

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The sub-soil is important to the turf on the green insofar as it influences drainage and the rise of water from below by capillary attraction. We require large quantities of sub-soil or fill in building putting greens and fortunately it does not matter a great deal what type of material we use since we can modify the construction to suit the soil. When using fine soils, such as clays or silts, we should pay particular attention to procuring uniform drainage from the top of the fill. In other words the fill should have good surface drainage before the topsoil is put on it. No depressions or pockets should be left to collect water and toxic materials, and no sharp or high mounds should be left to shed water and dry out quickly.

For safety's sake tile underdrainage should be put in clay and silt sub-soils. Layers of various materials, such as cinders, sand, gravel and peat, should not be laid between the topsoil and the sub-soil. In the past this was common practice but most greens with such construction have had to be rebuilt. Such layers interfere with the natural rise and fall of soil moisture. Porous layers drain the topsoil too thoroughly and cut it off from the reservoir of moisture and fertilizing elements which rise from the soil below much as ink rises on blotting paper.

Lines of tile quickly carry away excess water and do not interfer with the rise of capillary moisture in the soil. Layers of clay or peat are sometimes put on sand fills to preserve moisture but these layers are as bad as layers of cinders or sand on clay fills. They prevent natural drainage and elimination of toxic materials from the topsoil. It is better to use the clay or humus to prepare a deeper topsoil on a sand fill.

We now come to that important part of the putting green which surrounds the roots of the turf and supplies the plants with food and water—*the topsoil.* Let us first consider the topsoil from the golfer's viewpoint. We all know how important modern golf architecture is in making the pitch shot. And we know that by far the large majority of golfers use that shot either from necessity or preference in the approach to the putting green.

If the soil is as hard as concrete it is impossible for the average player to hold the green. Hence, when greens become in such a condition a great cry arises from the indignant players and the greenkeeper is forced to soften the offending greens by pouring water upon them until the soil is saturated and muddy. The players trample the greens while in this condition and the soil become more packed or puddled and if allowed to dry it is harder than ever. It is expensive to water greens frequently, but if that were the only disadvantage to keeping

greens wet very few clubs would object.

The truth is, however, that such greens are always going from one extreme to another. The players cannot tell from day to day how different putting greens will act. And more important still is the fact that good turf cannot be kept for long on greens which require such treatment.

Now, let us consider the topsoil from the greenkeeper's viewpoint. The greenkeeper knows that the soil is porous and that these pore spaces should be filled with air since roots require an almost constant supply of oxygen. The greenkeeper also knows that the soil must be loose enough for the roots to grow and forage in search of moisture and plant food.

If the pore space in the soil is filled with free water for too prolonged a period the roots are affected and the plant sickens and dies. If the soil puddles and packs while wet the soil becomes a solid mass and the pore space, and hence the oxygen in the soil, is greatly restricted. If the soil becomes as hard as brick when dry the roots are sealed and cannot grow. Obviously a topsoil which exhibits the above characteristics is unsuitable both from the players' and the greenkeeper's point of view, and we must select or mix a soil which is suitable.

STUDY OF SOIL IS MOST INTERESTING

BEFORE speaking of topsoil preparation I would like to remark that soil is not the commonplace ordinary material which some think it to be. The study of soil is a most interesting one, and anyone who follows the study to its ultimate conclusions will find it as highly technical as desired. The more familiar greenkeepers become with soil phenomena the more intelligently they will be able to attack the many problems in plant growth.

The soil layer is a comparatively thin one covering the solid part of the earth below. This layer originated from broken and weathered fragments of rock. At first simpler forms of vegetation grew on the pulverized rock, then more highly developed forms. Each tribe of plants has taken mineral matter from the disintegrated rocks and carbon and oxygen from the air until the soil has accumulated a great store of organic matter and a teeming population of microscopic life.

The soil has three general phases: the physical, which has to do with the size and shape of the particles, the movement of air and water in the soil and other physical aspects; the chemical, which deals with the composition of the particles; and the biological, which deals with the minute forms of life which are of great importance in manufacturing food for plants. The greenkeeper is concerned with all these phases but chiefly with the physical since he can influence the other phases sufficiently with his cultural practices providing he has the proper soil texture and structure to start with.

Soil texture refers to the six of the soil particle. Soil is classified into various types such as sand, silt and clay according to its texture—the sand being the large, coarse particles, silt finer particles and clay still finer. There are numerous classifications or soil types depending upon the proportion of particles of various sizes. Loam soils are mixtures of coarse and finer particles along with more or less organic matter. Soil structure is the arrangement of the particles in the soil, and the arrangement may be such that the soil is crumbly, open, and porous; or tight and compact.

Soil plasticity and cohesion have a great influence on soil structure. Plasticity of soils enables it to be molded into various forms without fracturing much as can be done with putty. Cohesion is closely related to plasticity and is the tendency of the particles to stick together and preserve the mass intact. Plasticity will allow soils to lose their crumbly nature and become puddles when wet and cohesion will hold the soil mass intact like rock or brick when it is dry.

Soil structure is largely dependent upon plasticity and this in turn is largely dependent upon soil texture since plasticity is most marked in the finer particled soils such as silts and clays. In coarse sandy soils plasticity is nil.

Organic matter plays an important part in the fertility of the soil. It is necessary for the microscopic life in the soil, and has a marked effect on the structure and water-holding capacity of the soil. On account of the affinity of organic matter for moisture, the moisture is held within the organic matter and a certain amount of organic matter in finer soils increases the drainage and loss of free water by keeping the finer particles from settling together into a more or less compact mass. Soils with sufficient organic matter do not dry so quickly

and hence they do not solidify by cohesion so readily.

Due to its water-holding capacity comparatively large changes in volume occur in organic matter and such changes in the organic matter in the soil have somewhat the same influence as freezing and thawing do on the soil and hence increase its granular structure.

MUCK SOILS NOT SUITABLE

THERE are certain muck soils which, although they may contain considerable organic matter, are not suitable for improving soil structure. Some mucks have high mineral and colloidial contents and may tend to increase rather than decrease soil plasticity and cohesion. Most commercial peat, humus, and peat moss on the market are suitable sources of organic materials for improving the structure of silt and clay soils.

It has been found that the addition of organic matter to most clay and silt soils has more effect on decreasing their plasticity and cohesion than has sand. But it is seldom advisable to add more than one-third organic matter to putting green topsoil mixtures.

Since sand and some organic materials exhibit little plasticity and cohesion it seems probable that there are soils which contain sufficient of these materials to make them suitable for putting green purposes. If such a soil cannot be readily procured sand and organic matter may be mixed with silt and clay soils in sufficient amounts to make ideal soils for putting green purposes. It is, however, very difficult to describe a certain type of soil which, from all sources would be suitable. Soil classification does not include the percentage of organic matter in soil, also there may be a considerable variation in the amount of finer materials in soils of the same type.

Two soils from different locations which are classified as the same soil type may exhibit marked differences in their plasticity and cohesion and hence in their ultimate structure in the green. In a general way it is safe to state that soils classifying as sandy loams and which contain sufficient organic matter are suitable for putting green topsoil.

Soil experts would be able to judge more accurately how a soil would act under putting green conditions by handling the soil than they could by

being shown the results of a soil analyses alone. Some soils examined while under field conditions may appear open and friable and in excellent physical condition, but that is no guarantee that this soil will not become as hard as brick under putting green conditions. Other soils are highly fertile and desirable for agricultural or gardening purposes.

Fertility, however, is what a soil is capable of producing under best possible conditions and in the putting green these soils may lose the structure they were maintained under in the field and in the garden and become infertile in the green. It is, therefore, advisable for the golf course constructor or the greenkeeper to subject his putting green topsoil to some test calculated to show in a short time what structure it may be expected to exhibit in the putting green after it has been in use some time. The best method of doing this is to test its plasticity and cohesion. There are numerous reasons why it is difficult for experimenters to arrive at exact numerical expressions of plasticity with soils. It is possible, however, to arrive at the relative plasticity and cohesion of different soils even by simple methods.

SIMPLE METHOD OF TESTING SOILS

EQUAL quantities of the various soils or mixtures should be procured while dry enough to handle. They should then be wet and puddled in a uniform manner. It is important that the samples be handled alike as difference in wetting and mixing may confuse the results. A practical manner of handling the samples alike is to pour a similar amount of each sample into a similar container. A quart of soil in a 12-quart bucket is easily handled. Then add water slowly while mixing and churning with a stick until the soil will absorb no more water. If too much water has been given, a little more of the same soil can be added to take up the superfluous water. With a little practice it will be possible to bring each sample to such a condition with equal handling that it will just flow from the pail when agitated. No record need be kept of the amount of water added to the different samples, the point is to add enough water to put each of them in the same plastic condition.

The samples should then be poured into uniform molds. Little troughs of equal size may be made for this purpose or small flower pots or small boxes of the same capacity, shape and material may be used. The tops of these samples should then be trowled to smooth them and the samples set under cover to dry. After a few days the samples may be removed from the containers and allowed to dry further. The time of drying of various samples should be noted. Samples containing too much organic matter will show up as they will take overlong to dry.

After the samples are thoroughly dry they may be handled and it will at once become apparent if some samples are unfit for putting green purposes. Soils too high in sand or organic matter, or both, will not stand handling and may break while being removed from the mold. Samples which exhibit too much cohesion will be difficult to break. Samples which took a reasonable time to dry, which could be removed from the mold without crumbling and which could be broken down readily between the fingers and thumb, are at, or approaching, the correct texture.

It will be found by this method that about one third of clay or silt loam soils mixed with a third coarse sand and a third organic matter such as cul-

tivated peat, humus or ground peat moss, will approach the condition described.

This method of testing soils for putting green purposes may seem very simple but it is surprising how few golf course constructors will bother putting their soils to any plasticity test before using them on the putting green. This does seem negligible when one considers that the putting green is not dug up or cultivated from year to year and hence there is little opportunity to improve the soil once the green is in turf. Also, many greenkeepers kick about the tendency of their putting greens to form a hard crust on the surface, but although they mix soil for top-dressing purposes many times a year they never go to the trouble of testing the soil except by its feel when it is in that fine, floury condition just after it has been put through the screen.

Many greenkeepers realize that poor topsoil conditions are responsible for a good portion of their putting green troubles, and I have tried to bring out the fact that one good reason for these conditions is that no adequate tests were made in selecting the soil or soil mixture. If we use the right kind of topsoil in building and topdressing the putting green it will drain well enough that the surface will not be soggy even an hour after a heavy rain and yet the soil will not dry out quickly, nor will it become too hard. It will have sufficient resiliency to hold properly-played pitch shots and will be of proper structure for satisfactory plant growth.

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