The Soils Controversy - Mixes for Green Construction and Topdressing

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IN BUILDING and maintaining a golf green, there is one major objective: the green must provide a satisfactory surface for playing the game. The surface must be as free of blemishes as possible. It must hold a well-played approach shot without being severely marked, and it must allow a putt to roll true. These requirements are met by growing a dense, tight, well-mown turf on a firm, uniform soil.

These requirements are simple to state, but they are often quite difficult to provide. The turf manager begins to achieve his objective by choosing a grass that lends itself to the management techniques that must be imposed to produce a satisfactory playing surface. He then must strive to manipulate the environment so as to enhance the ability of the plant to grow under the conditions imposed upon it. The grass plant is an exceedingly complex organism, and an understanding of its needs is a necessary part of the turf manager's qualifications.

One major component of the grass plant's environment is the soil upon which it grows. Soil contributes four major factors to plant growth.

- The soil provides an anchor.
- The grass roots penetrate the soil mass and physically bind the grass to the soil.
- The soil provides nutrients, water and air.
- In addition to these needs of the plant, a soil for putting greens must also be stable and firm.

Let us examine each of these matters. Most soils will provide adequate support for the plant roots unless the soil is so dense that roots are physically impeded from penetrating the pore spaces.

Nutrients are an important function of soils in most plant growth situations. In the case of putting greens, the total area is relatively small, but the importance of the area justifies very intensive care. In this context, the total nutritional needs of the plant may be supplied by the addition of fertilizers.

Water and air are the other two factors supplied by the soil. Both are necessary for roots to function properly. Water acts as the solvent for nutrients; it is necessary for the maintenance of turgidity in leaves and other plant tissues. The transpiration of water through leaves tends to cool the leaf surfaces and the air immediately surrounding them.

Air (oxygen) must be present in the root environment for the roots to absorb water and nutrients. Without air the cell membranes of the root system become impermeable and uptake ceases. Water loss at the leaf surface without water uptake by the roots leads very quickly to wilting. "Wet wilt" or "scald" is the result.

These things that the soil contributes to plant growth are all related to the porosity of the soil. The roots that anchor the plant grow in the pore spaces between the soil particles. Available nutrients dissolved in water make up the soil solution. This soil solution, together with air, fills the pore spaces within the soil.

Porosity is one of the most important considerations in a putting green soil. In a good agricultural soil, the solid particles of matter occupy about 50 percent of the space. The remainder of the volume is voids or pore spaces. Normally, an agricultural soil will have large pores and small pores in about equal proportions. When the soil is well-drained, the large pores hold air and the small pores hold water. Such soils depend upon structural characteristics to maintain this water-and-air relationship. Loam soils will contain sand, silt, clay, and organic matter. These solids are aggregated into small clods or crumbs. The particles fit together to provide both large and small pores. The desirable arrangement of these crumbs or aggregates of soil is maintained by tillage practices.

While soils such as these are excellent from the standpoint of all the plant's needs, they are rarely satisfactory on a golf green. Putting surfaces are subjected to traffic, which tends to press the particles together. As the solid particles are compressed, the individual particles become rearranged as the aggregates are crushed and flattened. Naturally total pore space is diminished. The large pores tend to be diminished disproportionately. Sometimes the small pores may actually increase as a percentage of total volume. This compaction then reduces the amount of space available for air, and because water drains more readily through the larger pores, the drainage characteristics of the soil are impaired.

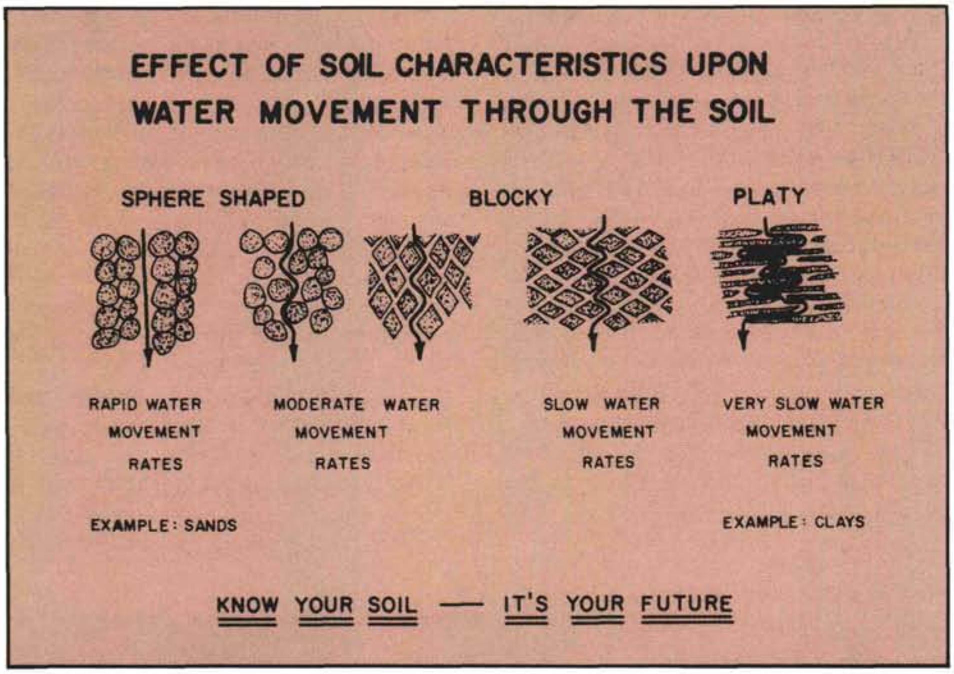
THE RECOGNITION of the facts that have been stated led to an increased interest in the role of sand as a putting green medium. In 1953, the USGA Green Section established a research fellowship at Texas A&M University for the purpose of investigating the physical characteristics of putting green soils. Raymond Kunze was the first student to study under that program. He was followed by Leon Howard and Cecil Brooks.

In the course of these investigations, it became apparent that in order to compound a soil mixture that would be stable, the major component must be sand. Inasmuch as the maintenance of soil structure depends upon tillage, and because it is virtually impossible to provide adequate tillage on a golf green in play, it is obvious that texture of soil materials is the only reliable characteristic upon which stable porosity may be based.

One of the problems encountered in using high proportions of sand is the tendency of such mixtures to be droughty. They simply do not hold enough available water to keep grass from wilting on a hot day without frequent sprinkling. It was found that this problem could be mostly overcome by the use of layers of different texture at relatively deep positions in the soil profile. In this case, a gravel blanket at a depth of 12 inches was used.

The gravel blanket serves a dual purpose. It acts as a safety valve to drain water rapidly from a green when the soil becomes saturated. Water moves laterally through the gravel to tile lines and then away from the green. On the other hand, water does not move readily from a sandy soil mixture into the gravel. Because of the textural differences, water is held in the smaller pores of the sandy mixture until it saturates the zone above the interface. Only then will the gravitational force of the water overcome the tension exerted by the finer pores of the sand mixture. Then drainage occurs.

By making use of this phenomenon, it is possible to irrigate enough to wet the rootzone but not enough to cause drainage to occur. Thus by use of a perched water table, the sandy mixture will hold more water than it normally would be capable of holding. Careful irrigation also serves to maintain the nutrients in the soil solutions of the rootzone. Only when heavy rains or heavy irrigation causes water to flow out through the tile lines will nutrients be leached.



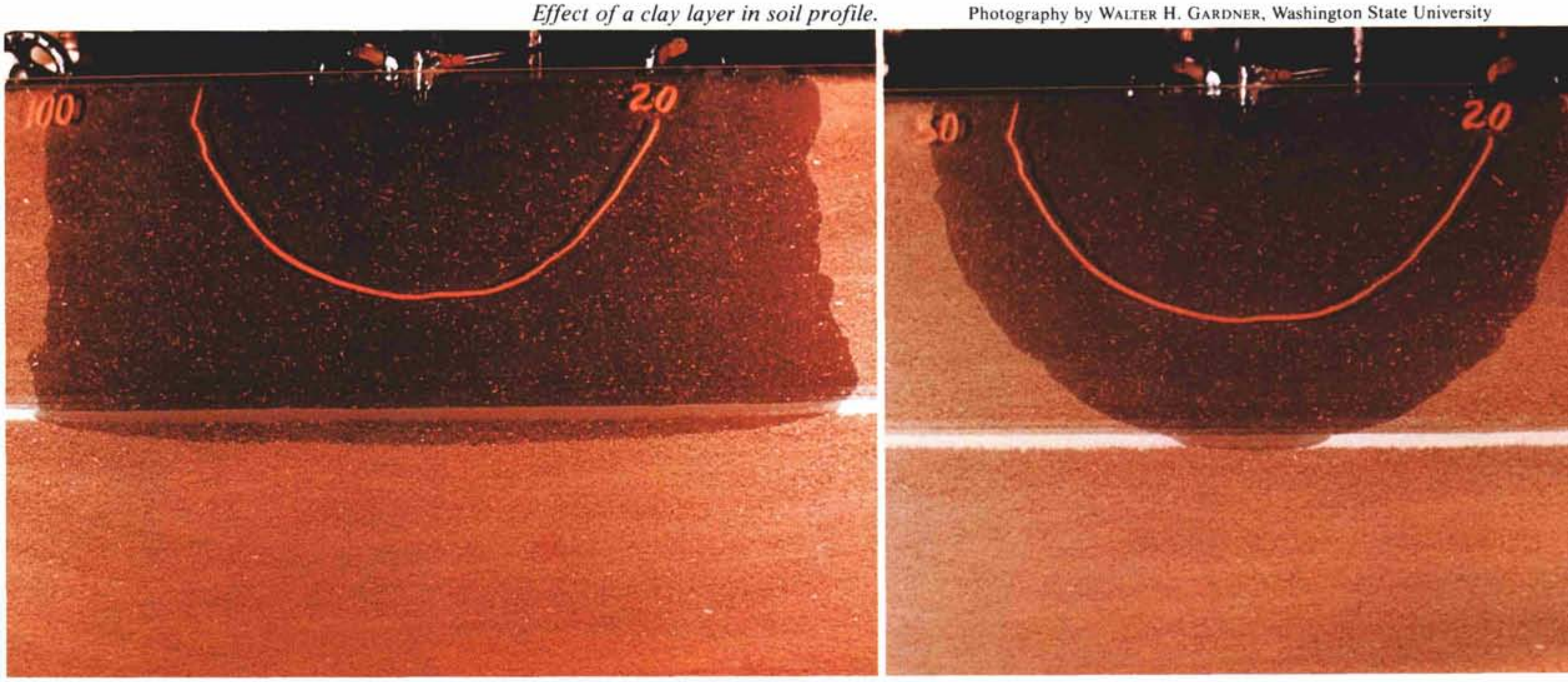
When high sand mixtures first came to be used, a great deal of skepticism was voiced. More accurately, the issue became extremely controversial. As is usually the case, controversy led to investigations by numerous research organizations. Eventually it was found that the advantages of sand mixtures outweighed the disadvantages, and many of the golf course builders began to accept that concept.

Unfortunately, in mixtures of sand, soil and peat, soil very often contained a great deal of silt, and it has been observed in the laboratory that silt tends to migrate downward through the sandy mix when water is passed through the profile. Builders have been advised that if only a high-silt-content soil is available, they should use only sand and organic matter. Another problem encountered by contractors is trying to uniformly mix a relatively small amount of soil with organic matter and sand.

After a substantial number of greens were built of sand and organic matter

Effect of a clay layer in soil profile.

Photography by Walter H. Gardner, Washington State University



and had been maintained for awhile without serious disadvantages, the trend toward the use of sand and organic matter alone has gained momentum. Impetus has been given to this trend by research work in California, which indicates that light, frequent topdressing with pure sand gives very good results.

In most locations, sand of suitable quality is available. A mixture of sand and organic matter is relatively easy to make. As the trend to more sand in the mixture has developed, the desire for rapid permeability has grown.

RAPID WATER movement in the soil depends upon the presence of a relatively high percentage of large pores. It is desirable to remove excess water from the soil surface quickly and to void the large pores so that air will be brought into the rootzone. However, it is questionable whether very high rates of permeability are either necessary or helpful. The upper range of permeability that has been suggested is about 10 inches per hour. Some contractors and architects have asked for even higher rates. Neither rainfall nor irrigation is ever likely to impose that kind of water transmission load on the soil. In the case of heavy rain or rapid precipitation rates from irrigation, much of the water is removed by surface drainage.

When a large part of the pore space is composed of pores large enough to facilitate very rapid water transmission, then the percentage of pores of capillary size is reduced. Water retention capacity declines when the percentage of capillary pores is reduced.

Both sizes of pores are important. Both depend upon particle sizes of materials incorporated into the mixture. When only sand and organic matter are used, then the choice of sand with suitable particle sizes is extremely important.

With the growing trend toward topdressing with pure sand, the question is being raised, "Why not build the green with pure sand?" A great many greens have been built completely of sand. After a few years they appear to be not much different from greens built of sand and organic matter. The stability of organic matter in the soil varies with the geographical and climatic conditions that exist. In the South, organic matter decomposes quite rapidly. Eventually, the amount of organic matter that exists depends upon the production and subsequent death of grass roots, stems, and such leaves as may come in contact with the soil. In cooler regions, organic matter may increase as a percentage of the total rootzone medium, and its presence may result in a problem with spongy playing surfaces.

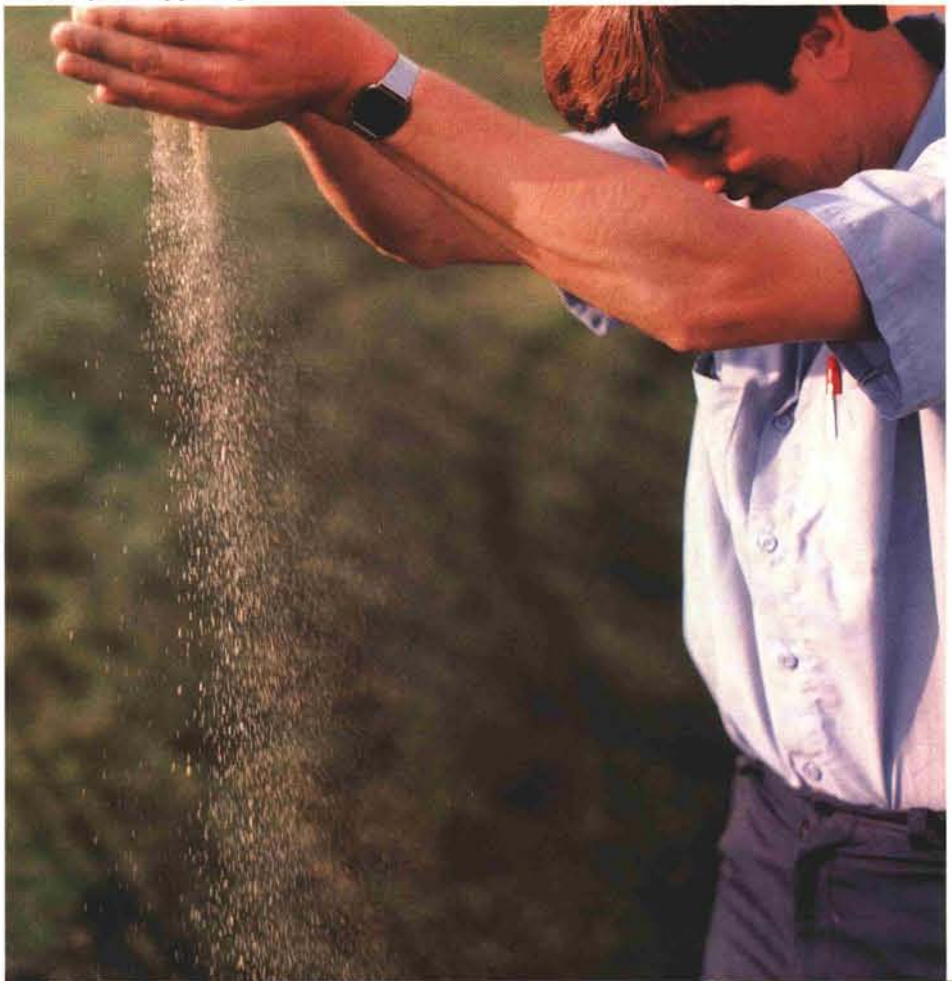
At the time of establishment, the inclusion of organic matter helps in several ways. It tends to provide some water-holding capacity, and it provides some cushioning effect. The surface is usually better for play while the grass is developing a suitable cushion. It is important that not too much organic matter be used. If more than about 20 percent, by volume, of organic matter is used, then playing surfaces tend to footprint and are not sufficiently firm.

What does soil contribute to the mixture? If we discount the value of soil as a nutrient supplier and accept the premise that we are dealing essentially with a hydroponic type of nutrient supply, then the only contribution of soil is physical. In this case, the soil contributes more small pores to the mixture. It generally causes a decline in permeability and an increase in the water retention capacity of the soil.

Two other factors have an effect on the water and air relationships in the soil. One is the condition of the surface of the green and the ability of water and air to infiltrate the soil. Permeability and infiltration are terms that are sometimes used interchangeably, but the phenomena they describe are quite different. Permeability is the term applied to the ability of the soil to permit the flow of water under saturated conditions. Infiltration applies to the ability of water to enter the soil. Greens with a good soil mixture with adequate permeability may not behave properly if topdressing or some other treatment has created an impermeable crust at the surface. Fortunately, it is usually within the capability of the golf course superintendent to correct a faulty situation that exists near the surface. It is much more difficult to correct faulty permeability, which is usually considered to involve the entire soil profile.

The other factor is layering. A layer near the surface may be extremely detrimental to the growth of putting green turf. Layers placed deeper in the profile may be helpful in that they may be used to enhance the water-holding capacity of the rootzone medium. The textural barrier formed when a sandy soil is

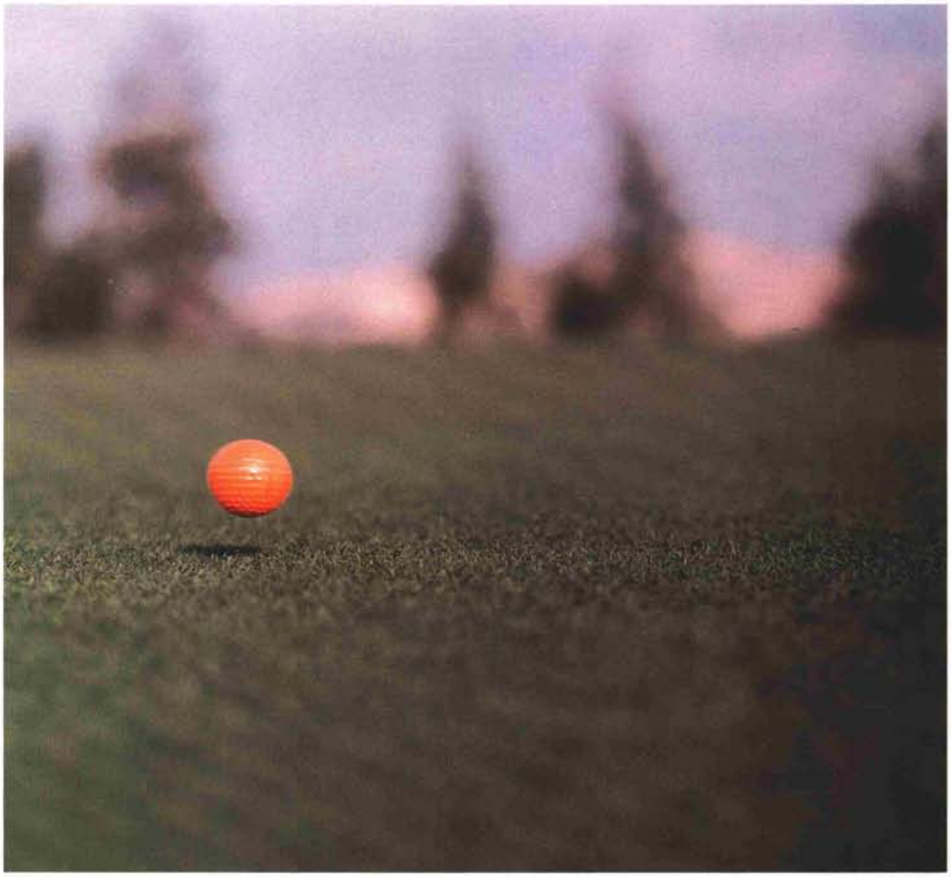
Tines drift out of falling sand.



placed over a gravel layer allows the use of a sand and organic matter mixture that would hold too little water if the barrier were absent. The perched water table provides a reservoir of available water, which would drain to a deeper region of the soil, out of reach of the roots if the mixture extended deeper.

IN SUMMARY, there has been a revolution in our thinking with respect to soil mixture for putting greens. The emphasis must be upon the matter of pore space and its effect upon the water and air relationships within the rootzone. Much research is needed in the area of sand particle sizes, amounts and quality of organic matter, and upon layers of different composition within the rootzone.

It may be possible to produce a mixture that contains optimal attributes for putting greens, but such a mixture would not likely be economically feasible. Through measurement of the physical characteristics of a rootzone mixture, it is now possible to compound a growth medium that works reasonably well through the use of materials that are available at a reasonable cost.



Airborne! Topdressing may be needed.

Particle size variability can be great in sands.

Organic matter. A small but important component of modern soil mixes.