SOIL AND TURF RELATIONSHIPS
PART II

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You will recall that in the last issue of the USGA JOURNAL *we gave a number of mechanical analyses of putting green soils. There was not enough space to print the discussion and conclusions so, much as we regret breaking the article, we are presenting the discussion of the analyses in this issue.*

Volume weight was higher in the "poor" greens in 80 per cent of the cases studied. In the 20 per cent where volume weight of the "poor" greens was lower than in the "good" greens, other factors were known to be important.

Porosity was lower in the "poor" greens in 80 per cent of the cases studied. The 20 per cent where porosity was higher in the "poor" greens represented the same courses where the volume weight relationships were reversed.

A desirable soil from the standpoint of turf production and maintenance necessarily entails the existence in the soil of an air-and-water regime suitable for the growing grasses. These conditions can be described in terms of pore-space distribution. They are controlled by the proportion of gravel, sand, silt and clay in the soil, the kind of minerals forming these particles, the amount and type of organic matter and the distribution and position of these particles.

Individual particles are bound into aggregates of visible shapes by the finer particles and by organic matter. The pockets of fine pores inside each aggregate act as water reservoirs, and the larger channels surrounding each aggregate drain surplus water and facilitate soil aeration. This structural design is essential for a continuous supply of water and a continual replacement of the carbon dioxide which the roots give to the soil.

Soil porosity is defined as the percentage of the soil volume which is not occupied by solid particles. It is calculated from the real and apparent specific gravity according to the formula. Percent pore space:

$$\frac{1 - \text{Apparent specific gravity}}{\text{Real specific gravity}} \times 100$$

(Apparent specific gravity: weight of a given volume of soil in its natural structure).

(Real specific gravity: weight per unit volume of solid particles. Average—2.65)

The total porosity of soils varies in the neighborhood of 50 per cent. Gravelly and sandy soils have lower total porosities; clays and organic soils have higher. It is not the total porosity, but the relative proportion of the small pores (capillary) to the large pores (noncapillary) that is responsible for the physical properties. For example, clays possess a large number of small pores which contribute to a high water-holding capacity and slow permeability. Sands, on the other hand, have a small number of large pores which are responsible for a low water-holding capacity and rapid drainage.

One objective of these studies was, if possible, to determine within limits the desirable proportions of the different sized soil fractions. It is obvious from the analyses presented that sweeping conclusions cannot be drawn. It is further recognized that other measurements must be made and many more samples must be studied to render the data statistically significant. It is believed that the publication of the data at this time is important to call attention to the very wide variations in the physical make-up of soils on which it is

desired to produce turf that has uniform playing qualities. Obviously, it is virtually impossible to produce uniform playing qualities on the greens studied.

We believe that these studies draw attention to the importance of building and maintaining a high sand content and a low clay content to avoid insofar as possible the detrimental effects of compaction. Putting-green turf is in use every day during the season, regardless of the moisture content of the soil. Golf players are not agronomists, and they are entitled to the use of the facilities for which they pay.

Until further studies are made, we are not in a position to draw definite conclusions, but we would suggest that, in the construction of new greens, or in the rebuilding of old ones, the total sand content be developed to 50 to 65 per cent and the clay content be held below 15 per cent. If the gravel content is developed at about 5 per cent, there would be about 25 per cent of silt in the mixture. Organic matter may be added according to the local needs as established by good practice under intelligent management. From 15 per cent to 20 per cent of the volume of the surface four to six inches of soil may be organic materials.

This study is incomplete because it does not differentiate between the types of clay, which are known and which impart vastly different qualities to the soils in which they are found. Neither were the chemical characteristics of these soils studied, which might have revealed important differences where physical differences were slight.

It can be said that greater density, represented by volume weight, is an important factor because it appears to be associated with compaction. It is hoped that improved techniques will be developed to measure compaction.

The rate of water percolation was not studied, which could be an important measurement associated with quality of soils as related to plant growth.

Layering was represented in 22 samples. Any abrupt break in structural design of a soil impairs water movement and affects the supply of water which reaches the roots. All layered greens showed a marked local concentration of roots, much of it at shallow depths.

Attempts to correct originally poor physical soil conditions by topdressing with a sandy loam are evident in most samples. Evidence is strong that this is a relatively ineffective procedure. Deep cultivation to mix the various layers and to provide vertical planes for water and air movement represents a more logical approach. Suitable machinery to accomplish this has been developed. In some cases complete rebuilding may be the only satisfactory solution.

No apologies are made for the incompleteness of the studies presented. They are published in the hope that they may guide others to research which will be more nearly complete and from which more nearly definite recommendations can be drawn. Lack of funds has necessitated abandonment of this important project under the plan originally conceived.

The goal is to develop information for building a synthetic soil which will permit the free entrance and percolation of water, permit the nutrient elements to permeate to the lower levels to promote deep, healthy root systems and permit the continuous use and traffic abuse of the turf areas regardless of climate conditions, without deterioration of the turf. Information of this type will have value far beyond the putting greens on golf courses.

RADIOACTIVITY TESTS

The following quotation is from Daily Summary, November 30, 1948, published by the U. S. Department of Agriculture:

"Experiments with certain low level radioactive materials conducted during the 1948 crop year in 14 States and with 18 crops so far have not shown any beneficial effect upon either crop growth or quality. The detailed results of these comprehensive tests will be announced at an early date."