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COMPACTION OF TURF SOILS — SOME CAUSES AND EFFECTS

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Compaction of turf soils is a condition which has existed for as many years as turf areas have been walked on and driven over.

What is a compacted soil? It is a soil whose particles have been fitted together so closely that the openings or pores which remain between them are of such a size, shape and arrangement that the plumbing, ventilation and heating systems within the soil are out of order. It is within this system of pores, as they occur in the soil, that both water and air are held and through which the soil is warmed or cooled. Soils, as they consist of many different sizes and shapes of particles as well as clusters of particles (called soil aggregates), also have a great many pores of different sizes and shapes.

There are two general types of pores in soils, the large or non-capillary pores and the small or capillary pores. The larger pores serve as drainage conduits. It is through these pores that most of the water enters the soil, and any excess which the smaller capillary pores cannot hold is drained into the substratum. As these pores are unable to hold water against gravity, they not only make up the overflow system of the soil but also serve as air chambers through which the soil "breathes."

One of the characteristic features of many compacted soils is the way in which the particles assume a flat, platy shape, and are layered together much as bricks are laid in a wall. In this layering, the particles often overlap each other as do shingles on a roof. The pores between these particles not only are small but also offset from one another due to this peculiar particle arrangement. Both air and water movement through these flat, horizontal pores often is very slow. A loose, porous soil has a preponderance of the larger, rounded particles between which there is more likely to be a much more ideal assortment of pores. The larger pores tend to be more or less connected into a pattern of continuous passageways into the substratum. The differences in the physical characteristics of a soil in good and poor structure is illustrated in Figure 1.

Where does compaction occur in turf soils? Water-tight layers, of course, occur everywhere within the soil. Many turf areas are underlain by heavy, natur-

FIGURE 1

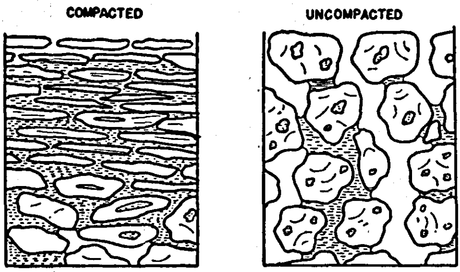
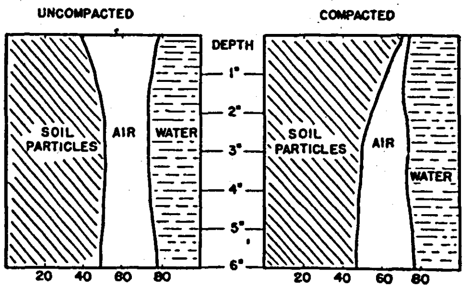


FIGURE 2



PERCENT OF TOTAL VOLUME OF SOIL OCCUPIED BY SOLID PARTICLES, AIR AND WATER

ally compact subsoils, in which tile drains are placed to remove some of the excess moisture in the soil above them. In a great many naturally well-drained turf soils, compaction occurs right at the surface. In many respects, this is the worst place for this condition to exist in the soil. The different proportions of a surface soil occupied by solid particles, air and water (Figure 2) furnish a means of illustrating the location and the effects of compaction in a typical turf soil.

How does one measure or determine whether or not a particular piece of turf soil is compact? Numerous techniques have been proposed for measuring soil compaction. Penetrometers of either the impact or steady load type have been used extensively by turf specialists. Another method of measuring compaction is to determine the permeability of the soil to water and air. The effects of compaction on the rate of water intake, in percent of 1½ inches per rainfall lost as runoff and percent non-capillary porosity, under a Kentucky bluegrass sod are shown in Table 1.

What are some of the causes of compaction in turf soils? Most compaction takes place as a result of mechanical pressure on the soil, such as trampling and wheel traffic, and to some extent rolling.

Under what conditions does compaction take place? Soils become highly vulnerable to compaction when, for some reason or other, the soil is left bare of any surface cover; when the resistance of the soil to compaction is low; and when the moisture content of the soil is such as to permit maximum compactibility.

When does most compaction take place and how long does it take? Experimental results reveal that most compaction takes place during the spring and early summer. The surface permeability of the soil, however, can be decreased materially by only one trampling when the soil is near its maximum water-holding capacity.

TABLE 1. EFFECT OF SOIL COMPACTION ON INFILTRATION, RUNOFF AND NON-CAPILLARY POROSITY
Kentucky Bluegrass Sod

Compaction by Trampling	*Infiltration Rate Ins. per hour*	*Runoff % Rainfall*	*Non-Capillary Porosity - 0.1" surface layer %*
Heavy	.35	76	6.1
Moderate	.67	52	19.2
None	1.50+	0	33.1

TABLE 2. EFFECT OF SOIL TEXTURE ON INFILTRATION, RUNOFF AND NON-CAPILLARY POROSITY UNDER HEAVY COMPACTION IN BLUEGRASS SOD

Soil type	*Infiltration Ins. per hr.*	*Runoff % Rainfall*	*Non-capillary porosity 0-1" surface layer %*
Hagerstown Clay loam	.81	36	9.4
Morrison sandy loam	.83	41	9.5

TABLE 3. EFFECT OF QUALITY AND AMOUNT OF SURFACE COVER ON INFILTRATION, RUNOFF AND SOIL POROSITY UNDER HEAVY TRAMPLING.
Bluegrass sod.

% of surface covered on fertilization	Infiltration rate ins. per hour	runoff %	Non-capillary porosity 0-1" surface layer %
55% unfertilized	.24	88	6.1
85% fertilized	.72	42	9.4

TABLE 4. EFFECT OF FERTILIZATION OF KENTUCKY BLUEGRASS ON SOIL ORGANIC MATTER CONTENT, AGGREGATION AND NON-CAPILLARY POROSITY

Fertilization per 1,000 sq. ft.	Organic matter %	Aggregation %	Non-capillary porosity %
5 lbs. nitrate of soda	2.48	23.6	13.3
25 lbs. 10-10-10	2.79	25.5	17.6
50 lbs. 10-10-10	3.22	27.6	21.2

Simply by walking over the moderately compacted sod plots included in Table 1, their infiltration rate was reduced from .67 to .46 inch per hour; runoff was increased from 52 to 67 percent; and the non-capillary porosity of the first inch of surface soil was reduced from 19.2 to 8.6 percent—all in a matter of a few minutes.

What effect does texture have on the compactibility of the soil? Two heavily compacted Kentucky bluegrass sods on a clay loam and on a sandy loam soil were selected for the purpose of determining whether, with the same amount of trampling, sandiness was any real protection against compaction. No differences in permeability, runoff or non-capillary porosity were obtained, as shown in Table 2.

The question naturally arises as to what can be done to prevent, to minimize the effect of, or to correct compaction as it exists in soils under turf. It has been found that the cushioning action which a dense high-quality sod has on the compactibility of the soil is quite important, as shown in Table 3.

Another Reason Why Compaction is a Problem

Photo by O. J. Noer

The use of this and bigger motorized caddie carts does not help to relieve soil compaction on golf courses. On the cart, from left, are Mr. Mitchell, professional at the River Crest Country Club, Fort Worth; Fred V. Grau, Director of the USGA Green Section, and Frank Goldthwaite, of Fort Worth, Tex.

One of the simplest ways of providing for proper growth of turf is, of course, to provide the grass plants with sufficient nutrient elements by adequate fertilization. In Table 4 are shown the effects of different fertilization of a Kentucky bluegrass sod on the accumulation of organic matter which is so important in the aggregation of soils, and the loosening effect of stimulated root activity in the first two inches of surface soil as reflected by an increase in non-capillary porosity.

Specialized implements such as the Aerifier, Terferator, and others are now being used for puncturing compacted surface layers in turf soils. These machines, in removing plugs of soil from turf areas, actually create a system of large or non-capillary pores by which moisture, fertilizer and seed can be taken into the soil. They also provide a breathing system through which air can escape during rainfall or irrigation and through which fresh air can enter the soil later. The rapid intake and movement of water and air are recognized generally as prime necessities in compacted soils. The widespread use of these mechanical devices in opening up or in aerating compacted surface layers would indicate that results are being obtained in terms of better turf.

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OBSERVATION OF NEMATODES IN YELLOW TUFT OF BENTGRASS

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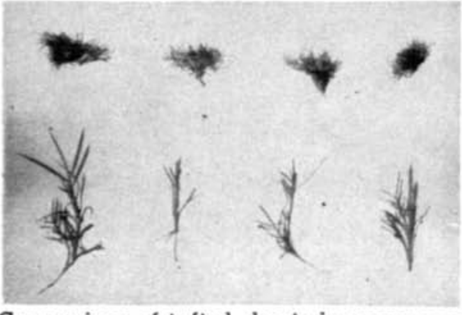
Yellow tuft in bentgrass occurs as small circles in the turf ¼ to 1 inch in diameter. A close examination discloses that the tufts are formed by many small shoots arising from a node on the stolons of bentgrass. The majority of these shoots will contain a number of fine leaves, many of which are yellow and some of which may be dead. The yellow color may persist indefinitely or may be present only a few months until the advent of more favorable growing conditions, after which the normal green color reappears. This condition is apparent mostly in the fall or early spring but may persist throughout the year. Although this disease may occur on other grasses, it is most common on bentgrass turf. Similar conditions have been reported on Bermuda grass in Florida and in South Africa. Fig. 1 shows a comparison of tufted shoots with normal shoots of bentgrass.

FIGURE 1



Comparison of tufted shoots in upper row with normal shoots in lower

Historical

Yellow tuft was first described by R. A. Oakley[1] in 1924. In this account he stated: "A close examination shows the small tufts or rosettes which cause the mottling or spotting to be made up of young grass plants produced on the stems of the older plants. Botanically the tufts or rosettes are proliferations from the older turf. So far as can be ascertained, they are not due to any fungus disease or to any insect or nematode". This investigator tried to alleviate the condition by applications of ammonium sulfate, ammonium phosphate, and iron salts but did not obtain any noticeable results.

[1] Oakley, R. A. MOTTLED CONDITION OF BENT TURF. Bulletin of the Green Section of the U. S. Golf Association, Vol. IV, No. 11, p. 259, Nov. 1924.