SOIL COMPACTION

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(Continued)

The conditions which arise from compaction present an unhealthy environment for the grass plant. Air and water movement into and through the soil is limited. Grass vigor is reduced and root systems become shallow. Weeds which tolerate compaction may soon persist. Movement of fertilizers and other chemicals into the soil is reduced, and bacterial activity, which is necessary for release of nutrients held in organic form, is decreased. Not only is a compacted soil bad for the grass, but it is also unfavorable from the player standpoint. A hard playing surface exists. A softer, resilient playing surface is appreciated by all players, especially the golfer trying to hold a shot on a green and the 17-pound halfback about to be dropped by several 250-pound linemen.

Compaction seems to be unavoidable on intensively used areas. Therefore, it is necessary to use some form or forms of prevention and remedy. Methods of prevention, or perhaps better called "minimization", and remedies are available and are strongly recommended by the respective sponsors. Specifications for putting green soils and laboratory evaluation of the same are now available. Various physical conditioning materials now on the market are recommended for use in soil mixtures in order to improve air and water relationships. It seems that for a clearer understanding of the potential of these methods and materials they must be subjected to further testing and evaluation by our state and federal experiment stations. Penn State research workers have undertaken an intensive field study of various mixes of soil, sand, peat, and other soil modifying materials. Their results should be enlightening.

Remedies for compacted turf fall into two groups: (1) complete renovation and (2) adoption of an aerification program. Complete renovation is the alternative when the situation gets well out of hand. The separation of prevention and remedy may be difficult in a program or regular aerification. The idea is to prevent a serious condition from developing by treating a not-so-serious condition. The choice of equipment for aerification is a topic in itself and will not be discussed now.

To repeat a previous statement, keep off wet areas if at all possible. This is a preventative method which costs nothing and is available to all.

The use of wetting agents on compacted areas has helped to overcome the problem of decreased infiltration and water movement in the soil.

II. *Relation of Soil Porosity to Compaction*

Soil porosity is the precentage of the total soil volume which is not occupied by solid particles. In dry soil, the pores are filled with air, whereas in moist soils they contain both air and water. The amount of smaller pores, termed capillary pores, will largely determine the moisture content and the larger or non-capillary pores will largely determine air content.

The average soil has a porosity of about 50%. Sands are usually less, and clays and organic soils are usually higher than this figure. The distribution of pore size, is more important than the total porosity. The ideal situation is to have the total pore space equally divided between capillary and non-capillary pores. If capillary pore are abundant the moisture holding capacity of the soil fill be high; however, water and air movement may be inhibited due to lack of adequate non-capillary pores. The reverse situation may produce excessive drainage and aeratoin at the expense of adequate moisture-holding capacity.

When a soil is compacted, there is a decrease in total pore space due to the particles being packed closer together. The fact of major importance is that the effect of compaction on non-capillary porosity is much more severe than on capillary porosity.

III. *Porosity and Aeration*

Air content and movement in soils is dependent on the amount of non-capillary pore space, and when soils are compacted aeration may be limiting in the root zone. Many observations about plant behavior are attributed to poor aeration, but without adequate justification. There is little experimental evidence to prove or disprove the major factor affecting plant growth in compacted soil. There is ample evidence showing the need of oxygen in the root zone. Oxygen deficiency in compacted soil may be the major cause of poor growth. Carbon dioxide toxicity and mechanical resistance to root penetration are other possibilities as factors influencing growth in compacted soils.

In the evaluation of soil aeration we can measure

both concentration and deffusion of oxygen. Concentration gives no indication of the volume of gas, but only the percentage in the soil air. Oxygen diffusion measurements indicate the oxygen supplying capabilities of a soil and are better for evaluating soil aeration. The factor of importance is how fast oxygen can diffuse into the area where it is needed by the plant roots.

The solubility of air in water is such that 100 cc of *water* will disolve 1.7 cc of air including 0.6 *cc of oxygen*. A water saturated soil will contain considerably less oxygen than one having both air and water in the pores. Not only is the content of oxygen affected by the water and air levels, but the diffusion is likewise decreased by the presence of water. The diffusion of oxygen in water is about 1/10,000 as great as in air. Compacted and flooded soils possess characteristics which will greatly decrease the amount of oxygen reaching the plant roots. There are several other factors besides water content which will effect the oxygen supply for the roots. An increase in temperature increases the consumption of oxygen by micro-organisms and roots so that more oxygen is needed. However, an increase in temperature decreases the solubility of

oxygen in water and increases the viscosity of air, both of which would result in less oxygen reaching the plant roots. As salt concentration increase, the solubility of oxygen in water decreases. This could be a factor in heavily fertilized soils. These are some of the arguments for oxygen as a limiting factor in compacted soil.

Various methods of measuring oxygen concentration and diffusion are available, and it seems that for a better understanding of the compaction problem we must now work in tht lines of (1) correlation of oxygen measurements with plant growth and (2) determination of critical levels of oxygen for plant growth. Investigations concerning mechanical impedence and CO2 toxicity as limiting factors for root growth are also needed.

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