Soil Factors and Their Control

IN THE preceding chapter of this series, we discussed "Soil as a Medium for Growth and a Source of Plant Food". Successful turf culture and maintenance requires not only a thorough understanding of the physical constituents and proper classification of soils but, of equal importance, a sound knowledge of auxiliary soil factors and their control. Moisture; drainage; mineral plant food elements; soil reaction; beneficial soil organisms and how they work—these factors offer an interesting and constructive study.

AMPLE MOISTURE: Water exists in the soil as hygroscopic moisture, gravitational and capillary water.

The moisture which condenses on the surface of a dry soil when exposed to the air is hygroscopic water. It never exceeds several percent and is held so tenaciously that it is unavailable to plants.

Gravitational water is the surplus water free to move downward by gravity. If retained by the soil it fills the voids and thus deprives the roots of needed air. Where natural drainage is inadequate, one of the first essentials to turf production is rapid removal of gravitational water by artificial drainage.

The water held around the individual and compound soil granules as a film is capillary water. The surface on the outside of the film acts as an elastic covering or skin, and is responsible for its movement. When water is removed by roots, or by evaporation, the stretched skin pulls water from adjacent areas until the strains become equalized.

Area of internal soil surface determines capacity to retain and ability to release water to the roots. Soils made up of small sized particles contain the largest area of internal surface, so they have the largest water-holding capacity. Loams and clay generally retain two to three times more water than the coarser sands.

Water is taken by roots most readily when the films are thick. Intake decreases as the films become thinner, and finally ceases although the soil may still contain capillary water. Plants then begin to wilt. Because of the smaller area of internal surface, less water is required on sandy soils to produce a thick film than on the heavier soils with more extensive surfaces.

The effect of drought appears first on sandy soil because of its low water-holding capacity. Yet light showers, wholly inadequate on heavy soil, often produce startling recovery on sands, because less water is required to produce thick films.

The diminishing supply of available water in the surface soil is partially replenished by movement of capillary water. Movement is most rapid in sands; heavy soil moves water to greater heights but rate is often so slow that plants may perish before sufficient water is brought up from below.

ADEQUATE DRAINAGE: Excess water beyond that required to produce films is of no value. It reduces soil air, retards early warming of the soil in the spring; may cause severe injury during the winter or during hot humid summer weather.

Surface as well as subsoil drainage is important. Depressions and pockets which hold water should be avoided, and if soils are heavy and compact tile drainage is needed. Seepage water along hillside slopes may cause damage in spring or fall. A line of tile placed at right angles to the slope will intercept the seeping water and prevent damage. After placing the tile the trench should be backfilled with pea gravel or cinders to within eight inches of the surface, otherwise water will pass directly over the tile and lead to the erroneous conclusion that tiling is ineffective.

ABUNDANT MINERAL PLANT FOOD ELEMENTS: Soils usually contain an abundance of all the elements needed by plants, but may be deficient in one or more of these: nitrogen, phosphorus and potassium. Sometimes these three are referred to as ammonia, phosphoric acid, and potash, respectively. Occasionally on very acid soils, calcium deficiency occurs and in some instances, particularly along the Atlantic Coast, magnesium also. Need for the rare elements is most likely on sandy soils of the Coastal Plains Section and on calcareous, alkaline soils.

Since nitrogen occurs in the organic matter, dark colored soils contain more nitrogen than those of light color. However, the humus of dark soils may be so resistant to further decay that nitrogen need may be acute. Phosporus and potassium exist in the mineral fraction; and are most abundant in the finer silt and clay separates. In general, sands may be deficient in all three elements; the heavier soils are usually high in potassium, may need phosphorus and almost always require nitrogen.

In order for soil nutrients to enter the plant, they must be present in the soil water in soluble forms. At any one time the soil solution never contains a sufficient quantity of soluble nutrients to satisfy plant requirements for an entire season. Hence a fertile soil is one which rapidly replenishes the soil solution when plant demands are heavy.

According to the present concept, essential plant food elements exist in the soil as dissolved salts, as easily soluble compounds and as difficultly soluble substances. Because the soil solution is very weak, the amount of readily soluble material, not quantity of soluble salts, determines ability of soil to supply essential nutrients. Hence most of the new rapid chemical soil tests attempt to measure the easily soluble, rather than the water soluble elements.

SOIL REACTION: Soils may be acid, neutral, or alkaline in reaction. In humid regions, soils tend to become acid due to the leaching effects of rain.

Present practice is to express reaction in terms of its pH equivalent. By this method the figure 7 represents neutrality; lower figures denote increasing acidity; figures above 7 represent increasing alkalinity. Most plants grow best in a pH range of 6 to 8. Grasses exhibit marked differences in their ability to withstand acidity. Bents and fescues continue normal growth in soils too acid to support blue grass. In fact this may account for the predominance of these grasses in some districts where acid soils prevail. For Kentucky blue grass, readings below pH 6 must be looked upon with suspicion, but the limit for fescue and bent is lower, probably close to pH 5.5.

Besides its direct effect on plant growth, reaction affects physcial soil condition, activity of soil organisms, and availability of plant food elements.

With strongly acid heavy soils, extreme acidity reduces water-holding capacity and adversely affects its physical condition. Acid clay does not form aggregates. The use of lime increases water-holding capacity and improves the soil by promoting beneficial granulation.

The activity of desirable soil organisms is curtailed as acidity increases.

Acid soils may be low in available phosphorus, and even added soluble phosphate may become fixed in relatively unavailable form. This type of fixation is not likely to occur when soil reaction is pH 6.2, or more. Extreme alkalinity may render iron, manganese, and other so-called basic elements unavailable. Hence, for all practical purposes, soils near neutrality are probably best, although reasonable acidity may be an advantage to discourage clover and weeds.

BENEFICIAL SOIL ORGANISMS: A fertile soil teems with vast numbers of minute microscopic organisms, especially bacteria, but fungi, algae, and other forms are also present. They are the scavengers of the soil, being responsible for the decay of applied plant or animal residues. During decay complex organic forms of nitrogen are converted into ammonia first, then nitrites, and finally into nitrates. Other essential nutrients are released also. The carbon dioxide formed during decomposition augments that excreted by the roots and aids in the solution of insoluble soil minerals.

The conditions favoring maximum activity of soil organisms are: a supply of decomposable organic matter; temperatures favorable for growth; desirable soil reaction; and the presence of needed nutrients. In general these same conditions are required by growing plants.

ABSENCE OF TOXIC SUBSTANCES: Occasonally grass growth is inhibited by the presence of toxic substances. The use of bordeaux to control fungus disease, or the excessive application of corrosive sublimate, or soluble fertilizers, may check growth or kill the grass. In water-logged soil the products of bacterial decay may prove toxic. If the soil is well aerated and kept in good physical condition, there is little danger of toxic conditions developing, unless harmful materials are actually added.

(To be continued)

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