How Soils Affect Water Usage

J. R. Watson, V.P., Agronomist
The Toro Company, Minneapolis

Water is essential for plant growth and plant activity. It is involved either directly or indirectly in all phases of the care and management of turfgrass. Water is necessary for germination, for cellular development, for tissue growth, for food manufacture (photosynthesis), for temperature control and resistance to pressure. It acts both as a solvent and as a carrier of plant food materials. Nutrients dissolved in the soil by water are taken in through the roots and then carried to all parts of the grass plant in water. The food manufactured in the leaves also is distributed through the plant body in water.

Soil affects watering practices because it is the reservoir from which the plant obtains the water needed to sustain its growth and development. Thus, effective and efficient water usage on golf courses demands a knowledge of the basic physical and chemical soil properties and how these relate to water absorption, storage and drainage as well as the frequency, rate and manner in which water must be applied to turfgrass. Further all such basic information must be correlated with the requirements for color, play or use, adjusted to fit the existing or planned irrigation facilities, and modified to suit the level or standard of maintenance at which the golf course is being kept or maintained.

Golf course soils, as for any turfgrass site, must provide support for the turfgrass, provide a firm uniform footing for the player, serve as a storehouse for nutrients, supply oxygen by providing for exchange of soil and atmospheric gases and act as a reservoir for the water used by the turfgrass plants.

The texture (size of soil particle), structure (arrangement of soil particles) and porosity (percentages of soil volume not occupied by solid particles) of a soil are the basic physical factors which control the movement of water into the soil (infiltration), through the soil (percolation) and out of the soil (drainage).

Texture, structure and porosity, along with organic matter content, determine the water-holding or reservoir capacity, control the air-water relationships and drainage characteristics of the soil. All directly affect watering practices and hence impact directly on water usage.

The intake of water is through the roots, actually through root hairs as they are the organs through which water is taken into the plant system. Hence, the depth of rooting, the extent to which a given root system occupies the soil, the age of the roots and the supply or number of root hairs all affect the depth to which the soil should be wet. The volume of soil that is occupied by active roots represents the soil reservoir for that plant. When high evapotranspiration (ET) rates occur the need for water is great and the reservoir may have to be replenished frequently, especially if the root system is shallow and the soil sandy.

For example, if the need for moisture is 0.25 inches daily, as the case may be during the heat of summer, the soil must supply to the plant, 0.25 inches of water between irrigations. Soils that are otherwise very good for putting greens may hold only 0.5 to 0.75 inches per cubic foot. This would be an adequate amount of water for one to two days if all of it were available to the plant. For this to be the case, the roots must

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extend through (permeate) the entire volume of soil to a depth of 12 inches. If the roots are only three to four inches, obviously the soil may have to be replenished more frequently — irrigated daily or even twice daily. With a limited root system or one that does not fully occupy the volume of soil; the soil must possess the characteristics necessary to move the needed amount of water at a rate rapidly enough to permit its uptake by the root. Generally, plant water needs can be satisfied if enough supplemental water is applied to replenish that portion of the available water in the root zone which has been used since the last irrigation. Some authorities indicate that water should be added when approximately 50% of the available soil water has been exhausted. Thus, if the roots fully occupy the soil to a depth of six inches and the soil holds one inch per cubic foot, the ET rate is 0.25 inches per day, the green must be watered daily, since 50% of the potentially available water will have been used in that period of time.

Enough water should be applied to ensure that the entire root zone will be wetted. Too, on natural soils, as opposed to those modified for intensive use (golf greens and bowling greens), sufficient water should be applied to bring about contact with sub-soil moisture. Continuous contact between the upper and lower levels of moisture will avoid development of a dry layer through which roots cannot penetrate.

Under arid or semi-arid conditions, or any location where salts may have, or will accumulate, water must be added in quantities greater than is actually required to satisfy the water needs of the grass or to replenish the soil reservoir. This is necessary to ensure periodic "flushing" of the soil to remove the salt accumulations.

Application of too much water at one time (misuse) is serious when the soil is poorly drained and the excess cannot be removed within a reasonable period of time. Such a situation is more critical in saline or salty areas or when saline water is being used. When such conditions obtain, water usage must be modified.

Soils have little direct affect on plant usage of water. Plant use of water is a solar driven phenomenon. The water evaporated and transpired as a result of this solar energy is approximately equal to that required to meet the plant's need. This relationship must be clearly understood to make efficient use of this vital, and dwindling resource.

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Measuring Roots' Muscle Power

As plant roots grow toward water and nutrients, they exert pressures of up to 150 pounds per square inch, often splitting granite boulders and upheaving sidewalks and streets in the process. U.S. Department of Agriculture scientists are studying root pressure and growth in order to breed plants that can better penetrate compacted or dry soils. For these studies, the scientists invented special research tools, including a miniature pressure gauge less than five-millionths of an inch in diameter to record pressure inside individual root cells, and sensitive rulers to measure root growth — often less than one thirty-second of an inch per hour. These tools have allowed detection in growing root tips of minute pressure changes caused by the plant's response to its environment, and give scientists some indication of the roots' muscle power.

Pictures from the Inverness C.C. Meeting held in April