Water, Roots, and Turfgrass

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Research at the Guelph Turfgrass Institute with regard to water use by turfgrass suggests some new ideas about effective turfgrass rooting.

In the classic study "The Underground Organs of Herbage Grasses" by Arthur Troughton of the Welsh Plant Breeding Station, it is reported that the roots of bluegrass or bentgrass mowed at five cm seldom are found below 45 to 60 cm. Any reduction in the mowing height or increase in the frequency of irrigation tends to reduce the depth of rooting. Furthermore, he reports many studies have shown that the root system of grasses is concentrated in the 0 to 10 cm depth. Therefore it would be expected that after a heavy rain or irrigation, the soil would dry out more rapidly at the surface where the concentration of roots are than at lower depths.

This was not found to be the case in studies conducted on the U.S.G.A. designed research green at the GTI. Special moisture measuring devices were inserted at several depths in the sand root zone of the green to allow the moisture content to be measured at hourly and daily periods for 10 days following an irrigation which saturated the sand to the degree the tile lines were flowing. Laboratory measurements had indicated that the sand would stop draining when the retention tension on the water reached 20 mbars and moisture stress would be observed at a tension of 40 mbars.

An example of results obtained in 1996 and 1997 is illustrated in the adjacent figure. The first point to observe is that the free drainage of water had approached the 20 mbar point within 1.5 hours of turning off the irrigation system. Thus air return into the pore space is rapid in this sand system. Wilting was observed at Day 7 when the moisture content fell below the 40 mbar point.

The more significant point is that the water was withdrawn uniformly over the full 30 cm depth of the root zone from the first day onward. The uniformity of withdrawal continued for a 10 day period during which there was no rain or further irrigation. No significant drying of the surface 10 cm before the lower depths occurred as would be expected due to the greater concentration of roots in that zone.

Examination of the root zone indicated that there were roots over the full 30 cm of the root zone. It could be argued that the fewer roots were very efficient in water withdrawal, but this is highly unlikely. The more plausible explanation is that the capillary flow of water in the sand is rapid enough to transmit water to the zone where the majority of roots are located to satisfy the daily water requirements of the grass.

It is known that the nutrients required by the grass—nitrogen, phosphorus, potassium, etc.—must be dissolved in water prior to uptake by the grass. It therefore follows that the nutrients will also be moving upward with capillary flow of water from the lower depths where there are few roots to satisfy the requirements of the grass. Nitrate nitrogen, which can become an environmental hazard if it leaches to the ground water, must, therefore, also be extracted from the root zone in a uniform fashion.

Irrigation at frequent periods may be an erroneous practice. Allowing the profile to dry down to the level of incipient moisture stress may enhance the withdrawal, not only of water stored in the soil, but also of nitrates which may have been leached by frequent irrigation.

More recent studies on construction site soils (that is sites where the bulldozer has destroyed the normal soil profile) have indicated that water is being withdrawn from depths greater than expected on the basis of where the concentration of roots are located. Irrigation scheduling based on a water budget procedure indicated moisture stress was not observed when 100% of the available water stored in the upper 15 cm had been consumed. It was only when the water storage in 30 cm of soil was considered that moisture stress was observable when the available water was used.

These studies indicate water movement by capillary flow to roots is an important part of water use by grass. While the root system may be relatively shallow, the zone of water withdrawal is much greater. Irrigation scheduling procedures which recognize this fact are needed to make water and nutrient use more efficient. ♦