TDR AS MEANS OF MEASURING WATER USE BY TURF

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Plant growth and quality are directly controlled by the soil water status and environmental conditions. Inadequate and irregular rainfall may result in soil water deficits and cause moisture stress in plants when the rate of water loss exceeds the rate of water uptake.

The main water inputs or sources of soil moisture are rain, snow, dew and irrigation. Excess soil moisture is usually leached below the root zone into ground water. Surface runoff occurs when the rainfall or irrigation rate is greater than the infiltration rate. Soil water is lost to the atmosphere by plant exudates or a evapotranspiration which is a combination of evaporation and transpiration.

The soil moisture status is usually expressed on a percent basis by weight (gravimetric soil moisture content) or by volume (volumetric soil moisture content, VMC). Soil moisture is partitioned into free or gravitational water, capillary water and hygroscopic water based on the degree of tenacity of the water to the soil particles. Capillary water is available to plants. Free water is also available but drains very rapidly. When all the free water has drained the soil is said to be at field capacity. The percent water at field capacity varies from soil to soil ranging from 3 percent in sandy soils to over 30 percent in heavy clay soils. For any given time period,

The soil moisture content = Soil moisture (at Start) + Precipitation − Evapotranspiration − Runoff

Water is a constituent of protoplasm, a raw material for building up carbohydrates, a solvent and catalyst for various metabolic processes, a medium for the transport of nutrients and carbohydrates within the plant. Water is required for germination, it has a skeletal function and helps in cooling the turfgrass plant.

Turfgrass plants adsorb water from the soil primarily the roots hairs. The water and nutrients are translocated from the root hairs to the cortex and eventually to the leaves. About 97–99 percent of the water absorbed is lost to the atmosphere through transpiration. The rest is used to meet the growth requirements of the plant. The water use rate by plants is thus the sum of the water needed for turfgrass growth and the quantity lost through transpiration.

Climatic and plant factors affect the water use efficiency of the of turfgrass plants. Rainfall intensity and frequency, temperature, light duration, wind speed and relative humidity affect the vapor pressure deficit of the atmosphere which is driving force for transpiration.

Plant factors such as root density and length determine the volume of soil water that can be exploited for transpiration. Transpiration occurs primarily through the stomata and to some extent through the cuticle. The thickness of the cuticle also reduces cuticular transpiration. Stomatal distribution and behavior, different metabolic pathways, leaf size, structure and arrangement are other examples of plant factors the affect stomatal transpiration rates.

Cultural practices in turf cultivation have a tremendous impact on water use. Mowing height and frequency also affect the evapotranspiration. High nitrogen rates promote succulent growth and increase evapotranspiration. On the other hand, potassium is usually promoted as a nutrient that reduces transpiration.

Irrigation is an important input in fine turf management whose economic and environmental significance is greater today than ever before. The competing and increasing demand for good quality water accelerate the contamination and depletion of our water resources. The efficient management of water and the improvement of the water use efficiency by plants are major challenges for the turf industry.

Efficient water use strategies can be divided into two main groups: management or cultural factors and plant factors. Cultural practices in turf cultivation have a tremendous impact on water use. High rates of nitrogen promote succulent growth and increases evapotranspiration. On the other hand, potassium has been promoted as an important element that enhances drought tolerance and resistance by reducing transpiration via osmoregulation.

Economic irrigation scheduling requires the determination of the potential evapotranspiration, (PET) the soil moisture status and the physiological age which are indices of the crop water requirement. Modifications of the Penman equation are used to indirectly estimate ET. Of the direct methods, the most widely used include: the weighed lysimeters, the evaporation pan, gamma attenuation technique, tensiometers and the neutron probe. Time Domain reflectometry has been used to monitor volumetric soil moisture on a daily basis. It could be adapted to measure soil moisture continuously over the critical summer months.

A conservative approach to water management is to watch for signs of stress before applying irrigation. Some people use timers to schedule irrigation. Both methods have their shortcomings: the latter may lead to excess soil moisture particularly when irrigation scheduling coincides with or is followed by rainfall with various consequences. The former subjects plants to cycles of stress and recovery and frequently results in loss of plant quality.

A method of irrigation scheduling that is site specific, rapid, accurate, affordable, safer, economical and dependable is most desirable in the turf industry. Time domain reflectometry save time, energy and money, and would lead to more efficient use of our water resources and reduce the potential for leaching of pesticides and fertilizers into ground water if properly used in irrigation scheduling.

Time domain reflectometry was used to monitor the volumetric soil moisture content last summer at the Hancock Turf Research Center. The effect of three irrigation treatments; Field capacity, 0.2 inch every other day and water at stress only were evaluated in terms of total water use. Annual bluegrass and Creeping bentgrass were the two species used in the study. Soil probes were installed at 0–5, 5–10, 10–15 and 15–25 cm depths. TDR readings were taken and soil volumetric moisture content and irrigation needs computed daily.

There were 18 days of rainfall within a period of about sixty days during which data was collected. The maximum rainfall recorded was 1.69 inches. The longest dry down period was 11 days. The stress treatment received no irrigation through out the experiment because rainfall coincided with the irrigation scheduling. The field capacity treatment received a total of 196 minutes or 3.27 inches of irrigation while the 2/10 an inch every other was irrigated for a total of 162 minutes (2.7 inch).

Water use was not significantly different by species. The volumetric soil moisture content varied by irrigation treatment and by depth. The volumetric soil moisture content was significantly different between the stress treatment and the other two treatments during the dry down periods. Differences between the field capacity treatment and the 0.2 inch every other day were occasional significant but not on all days.

In all the irrigation treatments the maximum VMC was in the 0–5 cm layer except during the dry down periods. The top layer also showed the greatest variation in volumetric soil moisture during the course of the experiment. The dynamic nature of this layer can be attributed to the high density of functional roots absorbing the moisture. The high organic matter content and its vulnerability to fluctuations in atmospheric conditions such as rainfall, wind speed, radiation, temperature and relative humidity.

In the field capacity treatment, the top layer, (0–5 cm depth) had the highest volumetric soil moisture content for all days. The VMC for the other layers were in the order 5–10 > 10–15 > 15–25. The sequence of soil moisture by depth was similar for 0.2 inches every other day and the field capacity treatments. But the 5–10, 10–15, and 15–25 depths were much more clustered than in the field capacity treatment. These three layers have similar soil texture and hence similar soil moisture retention capacity.

The stress treatment showed the same general pattern during periods following rainfall. During the dry down period periods however, the different depths tend to have about the same VMC initially. At the peak of the dry period, a complete reversal of the soil moisture pattern by depth was observed: 15–25 > 10–15 > 5–10 > and 0–5. On the last day of this dry down period there was a yellowish brown discoloration delineating the stress treatment from the field capacity and 0.2 inch every other day treatments. The discoloration disappeared the following morning following 1.04 inches of rainfall. The VMC pattern was again completely reversed. The above discussion shows that TDR can be used to monitor soil moisture on a daily basis or continuously. Such information can be used to determine irrigation rate and frequency. The efficient use of water for irrigation purposes will help maintain turf quality and reduce the potential for leaching agricultural chemicals into groundwater.