Managing for Moisture Stress in Turf

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Many golf courses do not have the luxury of "wall-to-wall" irrigation. Roughs in particular are dependent on rainfall, a growth factor whose predictability remains as elusive as the Loch Ness monster. Managing these areas so as to minimize the effects of drought on the turf is the subject of this article.

Getting the most out of rainfall in terms of maintenance of turf quality involves some fairly simple principles. These principles become obvious when we examine the plant water budget shown below:

Transpiration = Rainfall - Runoff
- Evaporation - Percolation
+ Soil storage

In this budget, rainfall is our input, and our objective is to maximize the portion of the rainfall that is available for turfgrass use in the form of transpiration. To do this, we need to attempt to minimize rainfall losses. These include any means whereby the water does not become available for turfgrass use. The rainfall loss pathways include runoff, evaporation from soil and plant surfaces, and percolation of the water beyond the rootzone of the turfgrass. Of these three avenues of rainfall loss, one that is manageable is runoff.

Runoff of rainwater occurs whenever the rate of rainfall exceeds the infiltration rate of the soil. At the onset of rain, water initially moves very quickly into soil because the dry soil exerts a wicking action on the water. This lasts only until the soil surface is wet. Thereafter, the rate at which water infiltrates is determined primarily by the numbers and sizes of soil pores that are open to the soil surface. Rapid infiltration of rainwater requires the presence of large pores. To emphasize this fact, let's contrast the rate at which water can enter soil via an earthworm channel vs. a relatively large soil pore with a diameter of 0.5 mm. A typical earthworm channel will conduct water at approximately 100,000 times the rate of this large soil pore.

Relative to agricultural land, turf typically has high water infiltration rates. However, soil compaction can easily render turf areas less permeable than cultivated soils. The reason for this is that soil compaction is basically a process in which larger pores are compressed into many smaller pores. This increases the moisture holding capacity of the soil but at the expense of reduced infiltration and increased runoff loss of rainfall. The net result is less total water being available for the turfgrass. Therefore, the first management practice that needs to be implemented to manage moisture stress in nonirrigated turf is to alleviate soil compaction. Heavily trafficked areas should be core aerified at least once a year—preferably more than once. In fact, any area where runoff commonly occurs is a candidate for periodic aerification.

The second management practice that needs attention is N fertilization. Contrary to popular opinion, fertilization with moderate rates of N delays the onset of drought-induced dormancy in turfgrass. Applying 2 to 3 lb N/M/ season to Kentucky bluegrass ensures good stand density, favors deeper rooting and provides for faster recovery from drought. Improved turf density increases water infiltration by slowing down the velocity of runoff water, thereby allowing more time for infiltration to take place. Deeper rooting reduces the amount of rainfall lost via percolation beyond the rootzone as well as increasing the total amount of water available to the grass. At moderate N rates, all of these favorable results can be achieved without significant increases in turfgrass evapotranspiration rates.

So far our attention has focused on increasing the amount of rainwater available to the turfgrass. Now we need to ask if anything can be done to reduce turfgrass water use rates. The answer is yes. Research has shown that consistently mowing a grass such as Kentucky bluegrass at a moderate height of 2 to 2 1/2 inches every 3 to 5 days reduces water use rates by as much as 25%, as compared to mowing at greater heights at intervals of 10 days or so. The reason for this is that more frequent mowing at moderate heights reduces air turbulence within the grass canopy. Rather, air flows smoothly across the level surface of recently-mown grass. A higher relative humidity is maintained within the grass canopy and this reduces evapotranspiration rates. The argument that higher cutting heights have the favorable effect of keeping down soil temperatures and increasing turfgrass survival rates during drought is not valid once the height of cut exceeds 2 inches.

In the event of drought so prolonged the turfgrass dormancy occurs regardless of the management practices followed, concern must then turn to grass survival per se. When this happens, you have to be prepared to take emergency measures. Thermal death of Kentucky bluegrass growing points begins when surface soil temperatures approach 105°F. Complete kill occurs at 117°F to 120°F. Once soil has dried out and water is no longer present to serve as a heat sink, surface soil temperatures of 110°F or more can arise on clear days even at air temperatures as low as 90°F. The only practical way to save the turfgrass under these conditions is to moisten the top inch or two of soil by applying about 0.2 inch of water every 5 to 7 days.

Careful monitoring of surface soil temperature will tell you when more water needs to be applied. The place and time to check soil temperatures is 2 to 3 pm on south-facing slopes. These sites are where thermal death of the turfgrass will first occur and are, therefore, the most critical areas.

What this small amount of water does is serve as a sink for radiant energy so that soil temperatures are moderated and large amounts of heat are dissipated as it evaporates. Such small amounts of water will not induce the turfgrass to break dormancy. This is crucial because more than a single dormancy/recovery cycle per season can result in significant thinning of turf.

When, despite your best efforts, turf is lost to drought and renovation becomes necessary, choice of replacement grass species and/or variety merits careful thought. Water use rates among cool-season grasses vary to the extent that there are significant differences in drought tolerance.

Drought tolerance ratings generally follow the sequence tall fescue > hard fescue > red fescue > Kentucky bluegrass > perennial ryegrass. In going from perennial ryegrass to tall fescue, the reduction in water use is typically in the range of 20 to 30%. The exact amount depends on the varieties that are compared.

Varietal drought tolerance studies have been most extensive for Kentucky bluegrass. Among the older varieties, Adelphi, Touchdown, Newport, and Baron reportedly have lower evapotranspiration rates than do Merion, Sydsport, Birka, Majestic, and Nugget. Recently reported Illinois ratings for drought tolerance indicate that Unique, Opal, and SR 2000 have high drought tolerance, while Miracle, Kenblue, Nublue, and Liberty have low tolerance.