IRRIGATION SCHEDULING FOR TURF SITES

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Irrigation scheduling is the process of determining if a turf site needs to be watered, and if the turf needs water, how much water should be applied. Turf managers make irrigation scheduling decisions nearly every day during the growing season. Unfortunately, turf managers often make irrigation scheduling decisions without a clear water management goal in mind or a clear understanding of irrigation principles and irrigation scheduling. This article will discuss water management goals, turf irrigation principles, and one method of irrigation scheduling.

Water management goals for most turf managers include the production of a high quality turf, prudent use of water resources, and on golf courses and sports fields watering to minimize potential for soil compaction. A high quality turf is dense, uniform, green, and actively growing. In addition, this turf should provide good playability and wear tolerance on golf courses and athletic fields. Prudent use of water resources conserves water, saves on pumping costs, and minimizes interference with users of turf sites. Soil compaction is a major concern on golf courses and sports turf. Soil is most prone to compaction at a water content at or near field capacity (all gravitational water has drained from the soil). Soil compaction can be minimized by timing irrigations so the soil water content is not near field capacity prior to periods of intense use and not maintaining soil water content at field capacity on a continual basis. These water management goals can be met by practicing proper irrigation principles and irrigation scheduling.

Water deeply and infrequently is the standard irrigation principle given to turf managers by university turf specialists. While the advice to water deeply and infrequently is given often, few turf specialists take the time to fully explain their advice. The first thing to keep in mind when trying to follow the principle of watering deeply and infrequently is to remember that deeply and infrequently is a relative term and not an absolute edict. Deep and infrequent irrigation will vary from turf site to turf site depending on the conditions at a given location. To fully understand the concept of deep and infrequent irrigation each component of this phrase needs to be examined individually.

Deep irrigation means water applied at each irrigation should percolate through the soil to a depth of approximately 1 inch below the bottom of the rootzone. Therefore, deep irrigation is based on the rooting depth of the desired species. For instance, if a Kentucky bluegrass turf had an effective rooting depth of 5 inches, enough water should be applied so the water will percolate to a depth of 6 inches. The recommendation to apply water to a depth of 1 inch below the bottom of the rootzone is made for two reasons. The first reason is that water uptake only occurs where the roots are growing. Once water passes below the bottom of the rootzone the water is essentially lost to the turf plant and is not helping the turf grow. The second reason to water to a depth of 1 inch below the bottom of the rootzone is to encourage deeper rooting. By continually watering so the water percolates slightly below the bottom of the rootzone the root system of the turf will grow downward in search of water. So even though a small amount of water is lost to the turf, irrigating so water penetrates 1 inch below the bottom of the rootzone will help produce a healthy turf.

Rooting depth of a turf plant depends on many factors including grass species and cultivar, season of the year, weather, management practices, soil conditions, and traffic. The bottom line is that rooting depth is not static, rooting depth changes throughout the year. This means that irrigation programs should change throughout the year as turfgrass rooting depth changes. For example, in spring, creeping bentgrass on a putting green with a rooting depth of 4 inches should receive enough water at each application so the water percolates 5 inches deep. The same creeping bentgrass on the putting green may only have roots 2 inches deep in the middle of summer. To irrigate deeply in this case, enough water should be applied so the water percolates to a depth of 3 inches or 1 inch below the bottom of the rootzone.

The only way to determine rooting depth is to examine the root system and measure how far the roots extend in the soil. A soil probe works very well for this purpose. Several soil cores should be removed and examined on each turf site to accurately determine rooting depth.

A soil probe is also a useful tool to determine how deeply water will percolate in soil following irrigation. Run the irrigation system a known amount of time and simultaneously catch water in a series of catch cans to determine how many inches of water were applied. Allow the water to percolate through the soil for several hours. Then go out and remove many cores of soil from the turf site and measure how deeply water has percolated into the soil. After making these measurements, adjustments can be made in irrigation run times so the appropriate amount of water will be applied so water will penetrate 1 inch below the bottom of the rootzone.

Infrequent irrigation of a turf stand means only irrigate when the turf begins to show signs of water stress. By waiting to irrigate until the turf shows signs of water stress, the turf will have used all the water that is available to it. This helps develop a more stress tolerant turf, minimizes soil compaction, and reduces overwatering. Frequency of irrigation is based on turfgrass water use rate, water holding capacity of soil, and rooting depth.

Turfgrass water use rate is primarily controlled by weather conditions. Air temperature, relative humidity, duration and intensity of sunlight (solar radiation), and wind speed govern the rate of water use by turfgrass plants. As air temperature increases, relative humidity decreases, amount of solar radiation increases, and wind speed increases turfgrass water use rate increases. During spring and fall when turf water use rates are low, turf sites may only need to be irrigated every 7 to 10 days. In the summer when turf water use rates are high the same turf may need to be irrigated every 2 or 3 days. In both cases the turf manager is watering infrequently if the turf is allowed to use all available water before being irrigated again.

Turfgrass species and cultivar, and management practices play a lesser role compared to weather in influencing water use by turf. Proper species selection in certain areas of the country will have a significant impact on turfgrass water use rate but not to the extent of weather. Turf management practices may influence water use rate by up to 10%.

Water holding capacity of soil helps determine how frequently a turf will need to be irrigated. Sandy soils have less plant available water than a loam soil or a clay soil. This necessitates that turf growing on sandy soils be irrigated more frequently than turf growing on loam or clay soils. A turf manager can still follow the principle of irrigating infrequently by only irrigating turf growing on a sandy soil when the turf shows signs of water stress. In the summer months when the water use rate is high, turf growing on a sandy soil may need to be irrigated every 1 or 2 days. In this case, the turf is utilizing all the available water every 1 or 2 days. The turf manager is watering to meet the needs of the turf plant and is watering infrequently based on the conditions at that particular site.

The final factor determining how frequently a turf site should be irrigated is rooting depth. Since water uptake only occurs where roots are growing, it stands to reason that a turf with a root system 8 inches deep has access to more water in the soil profile than a turf with a root system 4 inches deep. A turf stand with a deep root system will need to be irrigated less frequently than a turf stand with a shallow root system. In both cases though, irrigation should only occur when the turf has used all available water in the soil profile and is beginning to show signs of water stress. Any practice a turf manager can implement to develop a deeper root system will allow for a longer interval between irrigations.

The most commonly used irrigation scheduling technique, other than visual observation of the turf, is based on evapotranspiration. Evapotranspiration (ET) is the loss of water due to evaporation from leaf surfaces and soil, and transpiration of water by turfgrass plants. Transpiration is the process by which plants cool themselves. Water taken up from soil passes through the roots, up the stem, and into the turf leaves. In the leaves water is converted from a liquid to a vapor. The vapor then passes out through the stomata into the atmosphere. Heat that has built up in the leaves is dissipated when water is converted from a liquid to a vapor. Over 90% of the water taken up by a turfgrass plant is used for transpiration. By measuring evapotranspiration it becomes possible to determine how much water the turf is using.

Evapotranspiration is measured using either a Class A evaporation pan or by collecting weather data and using the Penman equation to calculate ET. Both methods work well in determining ET. However, the amount of ET measured with a Class A weather pan is not equal to the amount of ET determined using weather data and the Penman equation. On golf courses with a computer controlled irrigation system it is common to have a weather station to collect the necessary weather data and calculate ET using the Penman equation.

Water loss determined by ET overestimates actual water use by turf. The following equation has been developed to relate measured ET to turf ET:

$$ET_{(p)} \times k_c = ET_{(turf)} \qquad \text{(Eq. 1)}$$

where $ET_{(p)}$ is potential evapotranspiration determined from a Class A weather pan or Penman equation, k_c is a crop coefficient or adjustment factor, and $ET_{(turf)}$ is the evapotranspiration of the turf.

Crop coefficients (k_c) vary due to turfgrass species and method used to determine ET. Listed below are crop coefficients for several turfgrass species:

Crop coefficients.

Turfgrass species	Class A weather pan	Penman equation
Kentucky bluegrass	0.7 - 0.8	0.85 - 1.0
Perennial ryegrass	0.65 - 0.75	0.8 - 1.0
Tall fescue	0.6 - 0.7	0.75 - 0.85
Bermudagrass	0.55 - 0.65	0.7 - 0.8

When selecting a crop coefficient to use to estimate turfgrass water use be certain to know the method being used to determine $ET_{(p)}$.

The following example illustrates how to estimate $ET_{(turf)}$ using evapotranspiration data:

Turf species:	Kentucky bluegrass
Method of measuring $ET_{(p)}$:	Penman equation
Crop coefficient (k_c):	0.9
$ET_{(p)}$:	0.4 inches

$$ET_{(p)} \times k_c = ET_{(turf)}$$

$$0.4 \text{ inches} \times 0.9 = 0.36 \text{ inches}$$

In this example it was determined that the Kentucky bluegrass turf used 0.36 inches of water on that particular day. The turf manager knows how much water must be added through irrigation to replace water lost by the turf. It is possible to keep a running total of $ET_{(turf)}$ each day so a turf manager knows how much water to irrigate with at the end of several days.

By keeping water management goals firmly in mind, practicing deep and infrequent irrigation, and scheduling irrigation using evapotranspiration data, a turf manager can produce high quality turf without overwatering.