TURFGRASS IRRIGATION AND WATER CONSERVATION

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Water is the most abundant compound on earth. Unfortunately, less than 1% of the earths entire water supply is suitable for agricultural, industrial, or residential use at any one time so that the overall availability of water is limited. Presently, it is projected over the next 30 years that the amount of water needed for agricultural, industrial and residential uses in the United States will double to triple while the supply of potable (i.e., drinkable) water, which is already in short supply in some locations, will remain unchanged or decline slightly due to insufficient groundwater recharge or environmental pollution. A pattern which has become apparent over the past decade as a result of several regionalized droughts is that when municipalities are faced with impending water shortages, restrictions are usually first placed on the irrigation of turf and landscape ornamentals. As industrial and human consumptive needs for potable water grow it is likely that restrictions will be placed on turfgrass irrigation irrespective of the occurrence of droughts in the future. Additionally, water costs, which already account for a substantial portion of the maintenance budgets of some metropolitan parks and golf courses, will no doubt, increase in the future as the competition for potable water increases.

Whether for economic or judicial reasons, the days in which a turfgrass manager can indiscriminately irrigate to sustain lush growth are rapidly coming to a close. Today's turfgrass manager is being forced to strike a balance between sustaining turfgrass growth while reducing turfgrass irrigation. Reducing the amount of water that needs to be applied to a lawn area over the course of the growing season can be accomplished by: 1) maximizing the efficiency with which water enters the turfgrass root zone or, 2) by reducing turfgrass water use.

WHEN SHOULD I IRRIGATE?

Two central questions related to irrigation scheduling are: (1) When should I irrigate? and, (2) how much water should I apply when I do irrigate? The answer to both these questions is dependent on the soil texture in which the turfgrass roots are growing. The amount of water which a soil can hold for plant use is called available water. When most of the available water within the root zone of a plant is removed the plant begins wilt because the roots are unable to supply water to the above ground portions of the plant fast enough to keep up with water loss from the leaves. Most cool season turfgrass species have few roots that penetrate below a depth of about one foot. Therefore, in order to forestall wilting, cool season turfgrasses, such as Kentucky bluegrass and perennial ryegrass, should be watered just before most of the available soil moisture has been depleted in the top foot of soil. The amount of available water held by various soil textural types is listed below.

Inches of available water per foot of soil*

soil texture	available water
sand	0.4 - 1.0
sandy loam	0.9 - 1.3
loam	1.3 - 2.0
silt loam	2.0 - 2.1
clay loam	1.8 - 2.1
clay	1.8 - 1.9

*Table adapted from M. A. Harivandi, 1984, California Turfgrass Culture.

A good rule of thumb to use to prevent turfgrass wilting is to irrigate when about 50% of the available water has been removed from the root zone. If values which fall in the middle of the ranges given above are used for each soil texture it can be seen that a sandy loam soil, for example, should be irrigated when about one half inch (0.5 to 0.6 inch) of water has been removed from the soil. For a clay loam soil, irrigation should be delayed until about one inch of water has been lost from the soil.

But how many days does it take for a soil to lose one half or one inch of water? This is dependent on a number of atmospheric factors, namely, solar radiation (i.e., sunlight), relative humidity, air temperature, and the presence of wind. Very complex equations have been developed which can predict the amount of water that is lost from a soil when the soil is completely covered with grass for a wide range of atmospheric conditions. Fortunately, for us, these equations are really not needed to determine the amount of water lost from a turfgrass root zone each day. Researchers have found that the amount of water lost from an open pan of water during most summer days is slightly greater than the amount of water lost from a turfgrass root zone when the turf is well supplied with water (i.e., the root zone has greater than 50% available soil moisture).

The type of pan used to estimate daily water loss is called a U.S. Weather Bureau Class A Evaporation Pan. If you are working with a large turfgrass area, such as on a golf course, it is a good idea to buy one of these pans and use it to determine the amount of water that is lost from soil each day. When the cumulative pan evaporation total since your last irrigation reaches 50% of the available water supply for your soil textural type, it is time to irrigate. If a pan is not available, daily pan evaporation amounts can often be obtained from local weather station data. Often, pan evaporation for the preceding day is listed in the weather section of the local newspaper.

Unless rainfall occurs in the time between irrigations the amount of water which should be applied to the soil at each irrigation should be the same as the cumulative pan evaporation loss since the last irrigation. When rainfall does occur, subtract the amount of rainfall on that day from your pan evaporation amount for the same day. This calculation is summarize below:

daily soil water loss = daily pan evaporation − daily rainfall amount.

Depending on the region of the country in which the turf is grown turf root zone soil water loss in the summer will typically range from 70 to 90% of actual pan water loss. Few irrigation systems are able to apply water at rates of efficiency exceeding 90%. Applying an amount of water that is commensurate with the amount that is lost from a class A pan will insure that all water loss from the soil is replaced with little over application of water.

In instances where it is not possible to obtain pan evaporation data a good visual indicator of imminent turfgrass wilting is the failure of footprints to disappear when walking over turf. This isn't always a good indicator because whether the footprint remains or not often depends on the current weather conditions and the time of the day the person walks on the turf. The biggest problem with this approach is that it doesn't tell us how much water should be applied to the soil.

IRRIGATING TO MAXIMIZE WATER APPLICATION EFFICIENCY

Maximizing irrigation efficiency centers on one basic principal; irrigate in a manner which results in as much water as possible ending up in the turfgrass root zone. Water that comes out of a sprinkler head does one of five things: (1) it evaporates into the atmosphere prior to reaching the ground, (2) it reaches the ground but then runs off the soil surface (3) it collects or ponds on the soil surface and then evaporates back into atmosphere, (4) it infiltrates into the soil moving into the root zone or, (5) it infiltrates into the soil but moves below the root zone. In order to maximize irrigation efficiency, soil surface ponding, runoff, water movement below the root zone and evaporative losses all must be reduced to their lowest possible levels.

MINIMIZING RUNOFF AND SURFACE PONDING

The rate at which water enters the soil is called the infiltration rate of the soil. The primary cause of ponding and surface runoff is applying water at a rate which exceeds the infiltration rate of the soil. In general, coarse textured soils (i.e., soils with a high percentage of sand) have infiltration rates which are high enough to insure that runoff and ponding are usually not a problem unless the site is located on a steep slope or in a depression were water can rapidly accumulate. Fine textured soils, however, (i.e., those with a moderate to high percentage of silt and clay) often have infiltration rates that are below the water application rates of most sprinkler systems. On such soils, the water that needs to be replaced should not be applied all at once, but should be applied by alternatively turning the sprinkler heads on and off for short time periods several times in succession. The amount of time the sprinkler heads should remain on is most easily determined by observing the amount of time that is required for runoff or ponding to occur. The time a sprinkler head should remain off before applying more water should be at least as long as the time the sprinkler head was actively delivering water.

Turfgrass areas that have a thick layer of thatch, are compaction prone, or develop a water repellent surface layer typically having low soil infiltration rates. Hence, the water application efficiency in these areas is usually quite low due to runoff or evaporation. Fortunately, cultural practices have been developed that can improve soil infiltration when one or more of these conditions develops. When excessive traffic creates a dense soil layer at or near the soil surface, the infiltration rate of this soil is reduced. It can be increased by periodically removing cores from the soil using a device called a core cultivator. Similarly, the presence of a thick thatch layer may indicate that water entry into the soil is restricted. By running a vertical tine or flail type power mower over the turf and removing the dead or decaying plant material from the soil surface the thatch layer can be destroyed. Core cultivation following thatch removal will increase the infiltration rate of the soil. Soils that develop a water repellent layer at or near the surface are called hydrophobic soils. Hydrophobic soils are usually restricted to sandy soils such as golf course greens. The exact reason for the formation of the water repellent layer is not understood. The application of surfactants (i.e., wetting agents) have been shown to dramatically improve the infiltration rate of hydrophobic soils.

REDUCING WATER MOVEMENT BELOW THE ROOT ZONE.

Water will move below the root zone only when more water enters the soil than was lost from the soil since the last irrigation. It has already been stated that the amount of water lost from a soil fully covered with turf is slightly less than the amount of water that evaporates from a U.S. Weather Bureau Class A Evaporation Pan. As long as no more water is applied at each irrigation than the amount of water lost from one of these pans, little water will move below the root zone.

MINIMIZING EVAPORATIVE LOSSES.

Sprinkler evaporative loss is primarily dependent on the size of the water droplet emitted from the sprinkler head. Smaller size droplets evaporate more easily than large size droplets so that sprinkler heads which emit smaller size water droplets lose more water to evaporation that sprinkler heads which emit larger water droplets. Water droplet size is controlled by the operating pressure of the sprinkler system and the size of the nozzle orifice on the sprinkler head. Consult an irrigation design manual for more detailed information on this subject.

Three atmospheric factors also influence the amount of water that evaporates either as a droplet or as water residing on foliage or the soil surface. These factors are wind speed, relative humidity and solar radiation. High wind speeds, low relative humidity and high solar radiation increase water evaporation. Relative humidity is typically highest when the air temperature drops to its low for the day. This usually occurs just before sunrise. For this reason, this is the best time of day to irrigate. Sometimes it is not desirable to irrigate around sunrise because of early morning traffic on the turf. In such instances, in arid climates the turf should be watered shortly after sunset. This will allow sufficient time for the water to infiltrate into the soil while taking advantage of the fact that the relatively humidity is higher after sunset than during the late morning and afternoon hours. In the humid temperate climates of the Mid–West and Eastern portions of United States night time irrigation promotes a favorable environment for the outbreak and spread of many common turfgrass diseases. In these regions night time irrigation should be avoided.

Windy conditions promote droplet and still water evaporation. However, of greater concern is the effect of wind on the water distribution pattern of a sprinkler head. In areas where a predictable wind develops during a certain time of the day, no irrigation should take place at this time. Alternatively, irrigation should be scheduled so that water is applied when wind speed is usually at its lowest.

REDUCING TURFGRASS WATER USE

The amount of water a turfgrass plant uses is influenced by the total surface area of the plant. Increasing the leaf surface area increases the area from which water is lost from the plant. A key strategy to reduce turfgrass water use is to minimize the leaf area of the turfgrass plant without adversely affecting root growth. This can be achieved by keeping a regular mowing schedule which does not allow turfgrass leaf growth to become excessive at any time. This can be accomplished by following the 1/3 rule of mowing. This rule simply states that you should mow a lawn area whenever the grass reaches 1.5 times the height at which you normally mow. For example, if a lawn is normally cut at a mower height of 2.0 inches, the lawn should be mowed when it grows to a height of 3.0 inches.

Turfgrass leaf surface area and the depth of root penetration are intimately interrelated. Carbohydrates needed to sustain root growth are produced in plant leaves. If the surface area of the leaves is reduced too much in an attempt to save water by lowering the mowing height of the grass below the suggested minimum height for the species, root soil penetration will be reduced when this practice is sustained for a extended period of time. Deep root penetration is a desirable turfgrass attribute because it increases the volume of soil from which the plant extracts water. If the depth of penetration of a turfgrass root zone is reduced by 50% (from 1 foot to 6 inches for example) by mowing the turf too low, the time between irrigations to prevent wilting will also be cut in half. In order to increase the probability that natural rainfall will provide as much of the water needs for the turf as possible, it is desirable to keep the time between irrigations as long as possible.

A practice which promotes excessive turfgrass leaf area is applying too much nitrogen to the turf. In order to encourage low turfgrass water use do not apply nitrogen in amounts that promote rapid growth. Also, excessive leaf growth brought on by excessive nitrogen fertilization causes storage carbohydrates to be preferentially utilized to create new leaf tissue rather than new root tissue. This will cause a decline in the production of new roots and will reduce the depth of penetration of the root zone. A good rule of thumb is to not exceed a nitrogen application rate of 0.3 pound of water soluble nitrogen per month for cool season turfgrasses.