Irrigation Scheduling Principles: Tools for Dry Times

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Climate change seems to be a fact of life. Whether or not it is due to global warming, parts of the world, including Ontario, have just come through two very warm, dry years with little likelihood of significant change in the near future. With the pressures of urbanization and demand on water in general, athletic fields share with society a prospect of a drier future. Many high schools no longer activate their irrigation systems. Keys to survival will include optimizing your irrigation decisions and keeping careful records of when, why, and how much irrigation water you are using. Whether you use a state-of-the-art computer assisted irrigation system, guns or raintrains or back-of-the-envelope calculations on a bowling green, a few basic principles of irrigation scheduling will give you a good grounding to help you develop and implement a successful water use plan.

Water and Turfgrass Function

Turfgrasses are irrigated in summer in cool-season regions for a number of reasons, some having to do with the health and biology of the turf, and some with the function of the turf. The grass plants need water for most of their active metabolism and growth, taking up nutrients in solution from the soil and transpiring water in the course of photosynthesis. Turf managers need grass which is not dormant, tolerant to stresses such as traffic, and actively growing to maintain a playable surface and recover from injury – all of which requires water. Water is also important in the proper function of most management material such as fertilizers and pesticides.

Irrigation Decision-Making

In practice, the decision to irrigate will take into account all of the reasons why turf needs water. The basic requirement will be to replace the water used by the plant and lost to the atmosphere in the course of its metabolism, referred to as evapotranspiration or ET. At the same time, the soil reservoir of water can be replenished so that water is maintained "in the bank." Turf which is stressed or recovering from damage may need extra irrigation. Syringing to control high temperatures or remove leaf wetness is an additional use of irrigation. Many management chemicals will also need to be watered in.

Input Data and Decision Tools

The turf manager has a number of important sources of information to assist in irrigation scheduling. The better and more complete the information at your fingertips, the more successful your irrigation program will be. The first category is information about the water requirements for the different turf species being managed (creeping bentgrass vs. annual bluegrass vs. Kentucky bluegrass vs. fine fescues vs. fall fescues, etc.) as well as the effects of management regimes (fertility, height of cut) and season. This is probably the most difficult information to come up with precise values for, although rough estimates in mm of water per day are available for different species and they can be corrected, again very roughly, for management and season.

The second category is weather information, including insolation (sunlight), temperature, wind, relative humidity and precipitation. Records of past weather, current conditions and forecasts are all important in an irrigation program.

The third category of information is vital – records of your irrigation system. This includes not only how much water has been applied (preferably in terms of mm or inches rather than minutes) and when, but also an idea of how evenly your system delivers water to the turf.

The fourth category, good information about the rootzones that your turf is growing in, is one which is sometimes overlooked, but which is particularly important if you are scheduling irrigation on a water budget system. Soil texture, organic matter content, soil and root system depth, soil hydraulics and drainage will all affect how much water is available to the turf and how quickly a water deficit may develop.

The final special category of information is all the little peculiarities of your turf which lead to the need for "custom" irrigation. If localized dry spots or hydrophobic areas have developed due to underwatering or wet areas are present due to a spring or seep, you will need to fine tune your irrigation program to compensate.

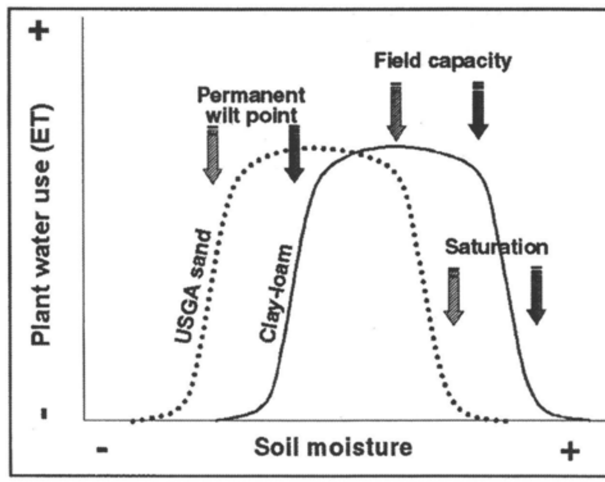


Figure 1. Relation between soil moisture and plant water use for two typical soils.

Irrigation Scheduling Approaches

There are two approaches which are commonly taken to irrigation scheduling. They have some similarities and some important differences.

Water deficit scheduling. As the name suggests, this approach to irrigation primarily aims to deal with the deficit that turfgrass water use has produced, that is to replace the ET losses that have occurred. It relies heavily on estimates of the water use of the turf (mm/day) corrected for management, weather, time of year, etc. There are

TABLE 1

Typical water balance features of two turf rootzones.

1) USGA rootzone: 95% sand, 2% clay
   Saturation: 35% (water by volume)
   Field Capacity: 22%
   Permanent wilt point: 9%
   Available water: 13%
   In 30 cm of rootzone, 3.9 cm of available water.

2) Sandy loam soil: 50% sand, 15% clay
   Saturation: 45% (water by volume)
   Field Capacity: 23%
   Permanent wilt point: 11%
   Available water: 12%
   In 30 cm of rootzone, 3.6 cm of available water.

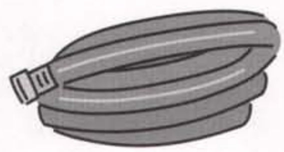
a number of very sophisticated computer models of ET which are used by some computer assisted irrigation systems and which integrate weather data with irrigation records to schedule applications to replace ET losses. Because this type of scheduling doesn't directly factor in the reservoir of water in the soil, it may lead to a tendency to overwater.

Water budget scheduling. This approach to irrigation scheduling is similar to water deficit systems in that the estimation of ET losses is calculated in the same way. However, the soil water is measured or estimated and the aim of the irrigation schedule in this type of system is not to replace ET losses directly, but to keep the soil water at an appropriate level.

Essentially the soil water is treated as a bank balance, with withdrawals (turf water use, evaporation, drainage) and deposits (irrigation, precipitation) recorded and irrigation applied to keep an appropriate balance at all times in the soil. Understanding the characteristics of the soil is critical to this approach. Figure 1 shows the relationship between soil water status and plant activity (ET) for two soil types. Regardless of the soil type, there is a water content level (saturation) when all soil pores are full of water. At this point, roots are shut down due to lack of oxygen and eventually the plant will die.

A normal soil will drain water until only capillary pores retain water, at which point the soil is at field capacity. Field capacity varies widely from soil to soil. Plant activity and water use is high and fairly uniform at water levels from field capacity down to the point at which the water that remains in the soil is too tightly bound to be available to the roots (permanent wilting point). The wilting point also varies widely from soil to soil – below the wilting point the plant will begin to shut down and, unless water is added, will eventually enter dormancy or die.

The trick to water budget scheduling is to be able to determine where the turf is on the scale between field capacity and wilting point, and at what point to irrigate back up to field capacity. Table 1 illustrates two typical turf rootzones and their characteristics in terms of water content at critical points.



With the pressure of urbanization and demand on water in general, athletic fields share with society a prospect of a drier future.

We have been doing some research into water budget scheduling at the GTI. The typical budgeting is a day to day process as illustrated in Table 2. ET is estimated by a simple model from weather data and rainfall and irrigation inputs are recorded. The first experiments set the threshold to irrigate when soil water fell halfway between wilting point and field capacity. The budgeting approach was applied to several types of turf (creeping bentgrass greens, Kentucky bluegrass sports turf) on different rootzones.

A few interesting points have emerged:

TABLE 2

Typical water budget calculations.

Soil water Day 0	15 mm
Deposits	
Irrigation	0
Rainfall	6 mm
Withdrawals	
ET	8 mm
Drainage	0
Runoff	0
Balance Day 1	13 mm

Irrigation to field capacity (30 mm) will require 17 mm of water.

- Water budget irrigation can significantly decrease the amount of water used to maintain some types of turf (by as much as 25% in Kentucky bluegrass sports turf in our simple experiment).
- We still need to improve our ability to identify the permanent wilting point, especially for lower maintenance turf – the bluegrass continued to grow without drought stress and the soil retained moisture long after the model predicted.
- Water budget irrigation needs to be used with care on sand rootzones on athletic fields. Because there is a tendency to underwater, the rootzone dries down more between irrigation cycles and localized dry spot may develop or worsen.

This research is ongoing. The future definitely holds a prospect of ever more careful use of irrigation water. The key to successful and responsible irrigation will be complete data and records about the components of the system (soil, turf, weather, irrigation) and an understanding of the principles of irrigation scheduling. ♦

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