Scheduling Irrigation for Corn

- Irrigation scheduling is a sustainable approach to the efficient use of water for crop production.
- ET-based irrigation scheduling uses cumulative daily crop ET along with water inputs from irrigation and precipitation to estimate soil water content; irrigation is applied when soil water content thresholds are reached.
- Soil moisture sensors can be placed at differing depths in the crop root zone to provide a direct measure of changes in soil water content for determining when irrigation is needed.

Fundamentals - The Soil Water and ET-Based Paradigm

Irrigation scheduling is a planning, measuring, and decision making process for determining when irrigation should be applied and how much to apply. Irrigation scheduling involves tracking water withdrawals and water inputs in order to monitor soil water content. Irrigation is applied when the soil water content reaches a threshold. Water withdrawals are determined from weather-based estimates of crop water use (ET) and/or direct measurements of changes in soil water. Water inputs account for stored soil moisture plus irrigation and precipitation.

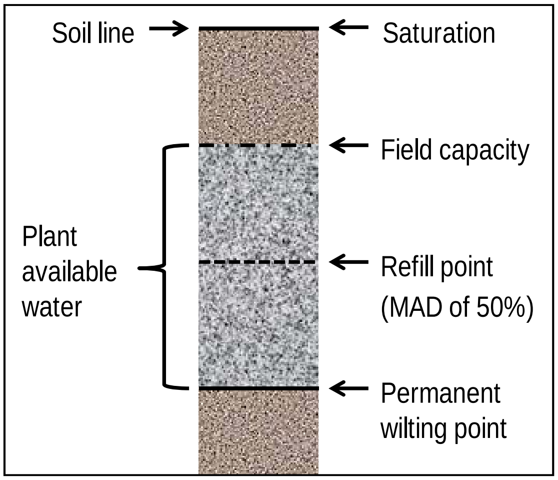

Figure 1. Soil water content.

When to Apply

Soil moisture levels are used to determine when irrigation should be applied. The rate of water loss from ET and inputs from precipitation will affect soil moisture levels. Ideally, irrigation is applied before the soil water content drops below the MAD.

Soil moisture is tracked using daily crop ET estimates and/or soil moisture measurements from soil sensors or probes. Many tools are available for estimating soil moisture and daily crop ET, ranging from filling in a spreadsheet to using sophisticated web-based applications that have access to soil databases and weather networks. Daily crop ET estimates are made in relation to local weather conditions and crop developmental stage. Soil moisture sensors placed throughout the crop root zone can provide the farmer with a direct measure of changes in soil water content.

The following terms are important to understand in any irrigation scheduling discussion:

- *Evapotranspiration (ET)* refers to the loss of water through evaporation (E) from the soil and transpiration (T). *Transpiration* is the movement of water from the soil, through the plant, and back out into the atmosphere.
- *Field capacity* is the water content of a soil that has been saturated by rainfall or irrigation and allowed to drain by gravity.
- *Permanent wilting point* is the soil water content at which the soil particles have a stronger affinity for the water and the crop cannot remove any more moisture from the soil.
- *Plant available water* is the water held by the soil between field capacity and the permanent wilting point. The amount of plant available water differs greatly by soil texture.
- *Maximum allowable depletion (MAD)* also known as *management allowed depletion* is the soil water level at which plant stress (and potential yield losses) will occur. This is the threshold that indicates when irrigation should be applied. The MAD will vary by crop species and crop developmental stage.

How Much to Apply

The amount of water to apply in an irrigation will depend on the:

- Crop rooting depth, which is related to plant growth stage (Table 1). Irrigation should be targeted to the depth of the crop roots. Irrigation in excess of the crop root depth may not be utilized by the plants and could be wasted.
- Water holding capacity of the soil, which is related to soil type (Table 2). Irrigation that exceeds the water holding capacity of the soil may be lost to deep percolation and/or runoff.
- Efficiency of the irrigation system, which is the percent of the total output that makes its way to the root zone where plants can absorb it versus loss to evaporation, deep percolation, and runoff.

Scheduling Irrigation for Corn

By using these three variables (crop rooting depth, water holding capacity, and irrigation efficiency) farmers can calculate the maximum amount of water to apply at one time if the soil moisture level is depleted.

Using ET Estimates and the MAD to Determine When to Irrigate

How to determine the MAD. Corn is capable of using 50% of the available water stored in the soil before plant stress begins.[1] Information on the root depth of the crop (Table 1), the water holding capacity of the soil (Table 2), and the efficiency of the irrigation system can be used to determine how many inches of water must be depleted to reach a MAD of 50%.

- For corn at silking, the rooting depth is approximately 3 feet.[1]
- At 3 feet, a sandy loam soil has a plant available water holding capacity of 4.2 inches (1.4 in water/ft soil depth x 3.0 ft root depth).
- Corn can use only 50% of that capacity before stress will begin, so the MAD would be 2.1 inches of water (4.2 in x 0.5).

In order to prevent crop stress, irrigation will need to be applied before the corn crop has used 2.1 inches of water.

How to use daily ET estimates to determine when soil water will reach the MAD. As shown above, with a MAD of 50%, the corn crop has an allowance of 2.1 inches of stored soil water at field capacity.

- If the ET rate is 0.32 inches per day, there should be ample stored soil water for approximately 6.5 days (2.1 in ÷ 0.32 in/day).

Consider the efficiency of the irrigation system. If the irrigation equipment has 80% efficiency and a farmer wants to apply 2.1 inches of water, only 1.7 inches of the irrigation water will go to the plants (2.1 in of water x 0.8).

- Accounting for the loss of water due to the inefficiency of the irrigation system, 2.6 inches of irrigation would need to be applied to bring the field back to capacity (2.1 in of water needed for plants ÷ 0.8).
- If rain is in the forecast, a farmer would not necessarily need to apply the full amount of irrigation needed to bring the water content of the soil back to field capacity. In most regions, with the exception of some of the more extreme arid and semi-arid climates, leaving room in the soil profile for a precipitation event is a wise way to save money on irrigation costs.

Table 1. Average root depth of corn at various growth stages

Stage of corn development	Assumed root depth (ft)*
12-leaf	2.0
Early tassel (16-leaf)	2.5
Silking	3.0
Blister	3.5
Beginning dent	4.0

*Root development may be restricted to a depth less than that shown due to compaction or limiting layers.

Table 2. Water holding capacity of different soil types

Soil textural classification	Water storage capacity (inches/foot)
Fine sand	1.0
Loamy sand	1.1
Sandy loam	1.4
Silty clay or clay	1.6
Fine sandy loam, silty clay loam, or clay loam	1.8
Sandy clay loam	2.0
Loam, very fine sandy loam, or silt loam topsoil; Silty clay loam or silty clay subsoil	2.0
Loam, very fine sandy loam, or silt loam topsoil; medium textured subsoil	2.5

Table modified from Yonts, C.D. et al. 2008. Predicting the last irrigation of the season. NebGuide G1871. University of Nebraska-Lincoln Extension.

ET values are dependent on climate and vary from location to location. Always obtain ET estimates from local sources for greatest accuracy. Follow recommendations from your local Extension service or technical representative for local conditions.

Sources:

[1] Rhoads, F.M. and Yonts, C.D. 2013. Irrigation scheduling for corn-why and how. NCH-20. *In* National Corn Handbook. University of Wisconsin Extension.

Kranz, W.L., Irmak, S., van Donk, S.J., Yonts, C.D., and Martin, D.L. 2008. Irrigation management for corn. NebGuide G1850. University of Nebraska-Lincoln Extension.

Andales, A.A. and Chávez, J.L. 2011. ET-based irrigation scheduling. Proceedings of the 2011 CPIC. Burlington, Colorado, Feb 22-23.

For additional agronomic information, please contact your local seed representative.