Corn Irrigation Scheduling

Scheduling Irrigation for Corn

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 to monitor soil water content. Irrigation is applied when soil water content reaches a threshold before plants are stressed. Water withdrawals are determined from weather-based estimates of crop water use and/or direct measurements of changes in soil water. Water inputs are applied with consideration for stored soil moisture plus irrigation and precipitation.

The following terms are important to understand 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 of the atmosphere.
- **Saturation** is the water content of a soil filled with water.[1]
- **Field capacity** is the water content of a soil that has been saturated by rainfall or irrigation and then 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.

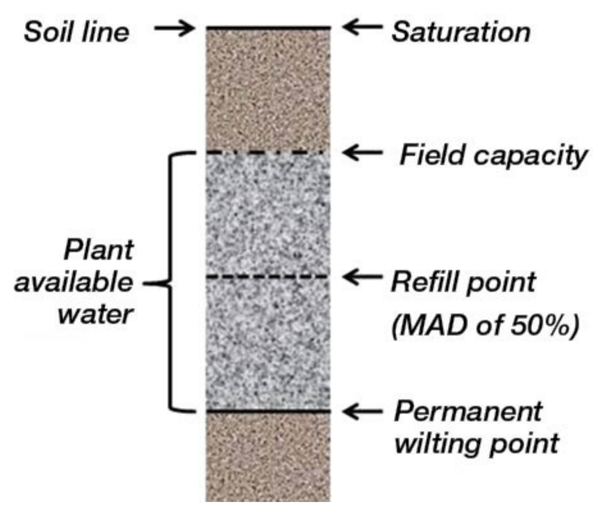

Figure 1. Soil water content. Adapted from Utah State University Extension.

- **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.

When to Apply

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

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. Actual ET can vary with higher-than-normal ET on hot windy days and lower-than-normal ET on cool cloudy days. Soil moisture sensors placed throughout the crop root zone can provide the farmer with a direct measure of changes in soil water content. Soil probes can be used with the feel method to estimate soil moisture in each foot of soil depth.

For more information on corn water use by growth stage see the article Corn Water Use and Irrigation Timing.

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 that penetrates beyond 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 (Table 3).

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

Using Evapotranspiration (ET) Estimates and the Maximum Allowable Depletion (MAD) to Determine When to Irrigate

How to determine the Maximum Allowable Depletion (MAD). Corn can use 50% of the available water stored in the soil before plant stress begins.[2] 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 (Table 3) can be used to determine how many inches of water must be depleted to reach a MAD of 50%. For the example below we will determine the MAD for corn at silking in a sandy loam soil.

- For corn at silking, the rooting depth is approximately three feet.[2]
- At three feet, a sandy loam soil has a plant available water holding capacity of 4.2 inches (1.4 inches of water per foot of 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 inches x 50%).
- To prevent crop stress, irrigation will need to be applied before the corn crop has used 2.1 inches of water.

Table 1. Average root depth of corn at various growth stages[2]

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.

How to use daily ET estimates to determine when soil water will reach the MAD.

- In the above example, with a MAD of 50%, the silking corn crop has an allowance of 2.1 inches of stored soil water at field capacity in sandy loam soil.
- If the ET rate is 0.32 inches per day, there should be ample stored soil water for approximately 6.5 days (2.1 inches ÷ 0.32 inches per day).

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 representatives.

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 find sandy loam, or silt loam topsoil; silty clay loam or silty clay subsoil	2.0
Loam, very find 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.

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Consider the efficiency of the irrigation system.

- See Table 3 for efficiency of various irrigation systems. For this example, we will assume the irrigation system has 80% efficiency and 2.1 inches of water is available to the corn crop when field capacity is reached. If the farmer applied 2.1 inches of water, only 1.7 inches of the irrigation water will go to the plants. (2.1 inches of water x 80%).
- 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 inches of water needed for plants ÷ 80%).
- 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. This depends on the regional climate. In regions, with more extreme arid and semi-arid climates where rain is unlikely, it may be best to fill the soil to field capacity. In other regions, leaving room in the soil profile for a precipitation event is a wise way to save money on irrigation costs.

Table 3. Potential application efficiencies (AE) for well-designed and well-managed irrigation systems[3]

Irrigation system		Potential AE (%)
Sprinkler irrigation systems	LEPA (low-energy precision application)	80-90
	Linear move	75-85
	Center pivot	75-85
	Travelling gun	65-75
Surface irrigation systems	Furrow (conventional)	45-65
	Furrow (surge)	55-75
	Furrow (with tailwater reuse)	60-80
Microirrigation systems	Bubbler (low head)	80-90
	Microspray	85-90
	Subsurface drip	>95
	Surface drip	85-95

Sources

[1] Peterson, J. M., Christiansen, A.P., Dierberger, B.S., Ferguson, R.B., Frank, K.D., Hay, P.C., Hergert, G.W., Lewis, D.T., Jones, A.J, et al. 1999. Soils. Plant & Soil Sciences eLibrary. University of Nebraska Cooperative Extension Institute of Agriculture and Natural Resources. https://passel2.unl.edu/view/lesson/0cff7943f577/10.

[2] 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.

[3] Irmak, S., Odhiambo, L.O., Kranz, W.lL., and Eisenhauer, D.E. 2011. Irrigation efficiency and uniformity and crop water use efficiency. Publication EC732. University of Nebraska-Lincoln 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.

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Legal Statements

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.