Irrigation Scheduling for Soybean

- Irrigation scheduling helps manage the timing and quantity of irrigation necessary to maximize yield potential and water efficiency.
- In order to maintain soybean yield potential, adequate moisture is critical between pod development and seed fill.
- When considering soybean irrigation scheduling, crop water use, stored soil moisture, weather conditions, and soil water holding capacity should all be taken into account.

Background
Applying irrigation can increase soybean yield potential, especially on low-moisture soils and during dry conditions. A soybean crop can yield around 2 to 4 bu/acre per 1 inch of water consumed. A soybean crop generally requires 20 to 25 inches of water throughout the season to attain yield potential. The exact quantity of irrigation needed depends on soil type, soil moisture, and rainfall.

In some regions, reductions in well capacity, increased water pumping costs, and water use restrictions have encouraged soybean growers to maximize management of natural precipitation, stored soil moisture, and irrigation. Effective irrigation management balances economics with yield potential. Humid regions can be more susceptible to overwatering when water is applied regularly. To reduce the chances of overwatering, irrigation should be applied only when soil moisture levels and soybean growth stage warrant application.

Irrigation Scheduling
Determining when to irrigate involves more than responding to visual signs of crop stress. Irrigation scheduling is a planning, measuring, and decision-making process to help growers decide how much water to apply and when to apply it. Decisions may be based on crop water stress, weather-based estimates of crop water use, soil moisture content, or a combination of these. To effectively use weather-based crop water use estimates, growers need to estimate how much soil moisture is available for plant uptake and how much moisture is being used by the crop in a given day.

There are several methods that may be used to help estimate soil moisture. The simplest way is to take a soil sample from the root zone and place in your hand. If the soil can form a hand-rolled ball, then the soil moisture is sufficient. It is important to take samples throughout the field, as some areas may dry out faster and require earlier irrigation. A more accurate way to measure soil moisture is to use multiple soil moisture sensors throughout the field. Approximately 70% of plant roots are within the top half of plant root depth. This results in about 70% of soil water use also occurring in the top half of plant root depth. Calibrating and then placing sensors within the root zone can provide precise measurements of soil moisture and useful information for irrigation scheduling.

The most widely used form of irrigation scheduling is based on crop water use, soil water evaporation, and how these two processes can be used to determine irrigation needs. Evapotranspiration (ET) is used to describe the loss of moisture through evaporation (E) from the soil and transpiration (T) through the plant. Transpiration is the movement of water from the soil to plant roots, through stems and leaves, and back into the atmosphere. Several factors including crop selection, growth stage, relative maturity, weather conditions, soil water holding capacity, and tillage method affect ET and should be considered when determining irrigation needs. Some important irrigation terms are as follows:

- **Field capacity.** Soil water content when saturated by rain or irrigation and allowed to drain by gravity.
- **Permanent wilting point.** Soil water content at which the crop cannot remove any more moisture from the soil.
- **Plant available water.** Water held by the soil between field capacity and the permanent wilting point. Plant available water differs greatly by soil texture.
- **Maximum allowable depletion (MAD).** Soil water level at which plant stress and potential yield loss will occur. The MAD indicates when irrigation should be applied, and fluctuates by crop developmental stage.

Soybean Irrigation Timing and Quantity
Soybean plants can endure some water stress early in the growing season without large effects on yield potential. However, consistent reduction of soil moisture throughout the soil profile may become difficult to counteract as soils may not contain enough water for soybean plants later in the season. Irrigation should be applied prior to soil water content dropping below the MAD. Soil moisture may be monitored by using daily crop ET estimates and/or soil moisture measurements from soil moisture sensors. Growers may use any of the options available to help estimate soil moisture and track daily crop ET including spreadsheets and advanced web-based programs with access to soil and weather databases. Daily crop ET estimates are made in relation to local weather conditions and crop developmental stage.
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Table 1. General soybean growth and water use.

<table>
<thead>
<tr>
<th>Crop Development</th>
<th>Water Use (inch/day)</th>
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</thead>
<tbody>
<tr>
<td>Germination and seedling</td>
<td>0.05-0.10</td>
</tr>
<tr>
<td>Rapid vegetative growth</td>
<td>0.10-0.20</td>
</tr>
<tr>
<td>Flowering to pod fill (full canopy)</td>
<td>0.20-0.30</td>
</tr>
<tr>
<td>Maturity to harvest</td>
<td>0.05-0.20</td>
</tr>
</tbody>
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**Vegetative growth stages.** Soybean plants tolerate some water stress during vegetative growth stages, but require adequate moisture during reproductive growth stages to help maximize yield potential. Irrigation is generally not recommended for soybean plants during the vegetative growth stages unless soil moisture is extremely low. Too much water early in the season can result in excessive vegetative growth, delayed flowering, and lodging. Limiting early season irrigation encourages soybean plants to develop deep root systems that can help increase access to water deeper in the soil profile. In areas with adequate soil moisture, the MAD for soybean during vegetative growth stages should be no larger than 70%, or 30% of available water remaining.

**Reproductive growth stages.** Soybean plants are most sensitive to water stress during pod development (R3) and seed fill (R5). Water stress during these stages can greatly limit yield potential by reductions in seed size and seed number per pod. If water application is necessary during flowering (R1–R2), as in exceptionally dry or sandy soils, it is especially important to make sure enough water is supplied during seed fill. This is because water application during flowering can result in an increase in the number of seeds produced. If the water required to fill the additional seeds is not applied, seed size can be reduced, possibly resulting in greater yield penalties than soybean plants that did not receive water during flowering. Throughout soybean reproductive growth stages, the MAD should not exceed 50%.

To help determine when and how much to irrigate, growers may use a spreadsheet, like the checkbook method, or employ a web-based program to help keep track of ET and soil moisture. All of these methods account for water deposited into the soil and water withdrawn from the soil. Locally obtained data for daily crop water use combined with precipitation and irrigation are recorded on a water balance table from which soil moisture balance can be calculated.

Irrigation scheduling computer programs are readily available and can be easier to use. The programs work similarly to the checkbook method, but may automatically input local data and complete calculations for the user, reducing time entering data and error. Irrigation scheduling programs may be easier to use than tensiometers alone, and can forecast possible irrigation needs 14 days ahead, making irrigation management decisions timely and efficient. Although the idea of irrigation scheduling appears straightforward, it can be complicated in application. This should not deter growers, as water efficiency may become increasingly important for a profitable crop. Irrigation scheduling resources can be found at local county extension offices.

**Terminating Irrigation**

Determining when to stop irrigating soybean plants can impact yield potential. Discontinuing irrigation before physiological maturity can result in reduced yield potential. Many universities recommend to apply the final irrigation at the start of the beginning maturity (R7) growth stage with a soil moisture near 60% capacity. However, in sandy soils, final irrigation application may be delayed well into the R7 growth stage. Additional information about soybean growth stages and terminating irrigation may be found at www.aganytime.com.

**Sources**


For additional agronomic information, please contact your local seed representative. Individual results may vary, and performance may vary from location to location and from year to year. Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Individual results may vary, and performance may vary from location to location and from year to year. Always read and follow pesticide label directions. All other trademarks are the property of their respective owners. ©2016 Monsanto Company. 150316123501 033115MEC