When and how much should I irrigate?

Gary Zoubek
&
Brandy VanDeWalle
Extension Educators
York & Fillmore Counties
(PREP REQUIRED AHEAD OF TIME)
- Show youth three potted plants (healthy, flooded, drought) Try to not let youth see soil conditions.
- What are the differences between these plants?
- What types of conditions do you think were present for each type of plant?
- What can we learn from these three plants?
  (Plants require a certain amount of water to thrive.)
Lesson Objectives:
Define and understand basic irrigation terminology.
Become familiar with problems associated with under or over-irrigating crops.
Understand & demonstrate how to use irrigation equipment for effective (corn and soybean) irrigation management.
Why did irrigation first start? (supplement the crop with needed water so it wouldn’t die)

What is the economic impact irrigation has on Nebraska?
(The University of Nebraska’s Bureau of Business Research conducted an Economic Impact Study* in 2003, a drought year, to determine the impact of irrigated agriculture on Nebraska’s economy. The actual net total economic impact was computed as more than $4.5 billion; adjusted to $3.6 billion for normal precipitation conditions.)

How do most producers decide when to irrigate?

What tools are they using to decide when to irrigate? Do you think those are pretty accurate?

Let’s define some key irrigation terms to first understand how and what irrigation does.

**Irrigation**, (defined by Britannica) is the artificial supply of water to land, to maintain or increase yields of food crops, a critical element of modern agriculture. Irrigation can compensate for the naturally variable rate and volume of rain.
Irrigation

“The artificial supply of water to land, to maintain or increase yields of food crops, a critical element of modern agriculture. Irrigation can compensate for the naturally variable rate and volume of rain”

(Britannica, 2010)

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Proper irrigation management is required to maintain adequate soil moisture in the crop root zone for healthy plant growth and optimum yield. The objective of irrigation management is to establish proper timing and amount of irrigation for greatest effectiveness. It also reduces the potential for runoff and reduces soil erosion and pesticide movement into the surface and groundwater.
In order to understand irrigation management, there are two important concepts to understand in regards to crops: 1) Crop Water Use, also called Evapotranspiration and 2) Soil Water Status.
Crop Water Use (Evapotranspiration) The evapotranspiration (ET) process is a key variable in many disciplines including, irrigation management, crop growth, hydrologic cycle, plant physiology, soil-plant-water-atmosphere relationships, microclimate and surface interactions, and drainage studies.

ET can be defined in a broad definition as the combined process of both evaporation from soil and plant surfaces and transpiration from plant canopies through the stomates to the atmosphere.

In the ET process, water is transferred from the soil and plant surfaces into the atmosphere in the form of water vapor.

Crop ET can be measured directly using advanced techniques. However, in practice, the most commonly used method of estimating the ET rate for a specific crop requires first calculating reference ET and then applying the proper crop coefficients to estimate actual crop ET.
Crop Water Use = Evapotranspiration (ET)

\[ T = 70-80\% \]

\[ E = 20-30\% \]

ET = Evaporation + Transpiration
When the crop is small, almost all ET is EVAPORATION
When the crop fully shades the ground, 90 - 98% of ET is TRANSPARATION.
What affects a crop’s ET?

Weather data:
- Solar Radiation
- Air Temperature
- Relative Humidity
- Wind Speed

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Soil water status is an indication of the amount of water present in the soil profile and can be described in two ways: 1. Soil water content and 2. Soil water potential. Soil water potential determines availability of water to plants is a direct indication of the energy required for plants to obtain water from the soil.
The soil water balance slide shows that several factors are involved in determining how much water the crop has to use and when more irrigation is needed. Soil water monitoring gives the irrigator the net effect of all of the factors so they can directly determine how long until irrigation is needed and how much water the soil will hold. Knowing how much water is in the root zone is also critical in determining when to stop irrigating for the season.
As water is removed from the soil, the remaining water molecules are bonded to soil particles and to other water molecules, and are not readily and easily removed from the soil by plants. Matric potential indicates the energy that must be available in the plants to extract water from the soil. In general, more clay content in a soil, the greater the water content at any given matric potential.
In order to measure a crop’s ET, an atmometer or ETgage can be used.
Actual crop water use = $E_T r \times K_{cr}$

From ETgage

From ETgage NebGuide
Crop ET can be measured directly using advanced techniques. However, in practice, the most commonly used method of estimating the ET rate for a specific crop requires first calculating reference ET and then applying the proper crop coefficients to estimate actual crop ET.
Crop Water Use by Growth Stage – Soybeans

Soybean Growth Stages
V1: Cotyledon leaves with cotyledons leaves esked
V2: 1st node containing trifoliates leaf fully expanded
V3: 3rd node containing trifoliates leaf fully expanded
R1: At least one flower on any node.
R2: 5 leaf nodes after V3 using the framework nodes.
R3: Seed 1.5 inch long in a pod of the upper half nodes.
R5: Full Mature, one fourth leaf on main stem.

Weekly ET Change in Inches

<table>
<thead>
<tr>
<th>Crop Stage</th>
<th>0.00</th>
<th>0.11</th>
<th>0.22</th>
<th>0.33</th>
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<th>0.88</th>
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<tbody>
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<tr>
<td>V2 Soybeans</td>
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<td>0.80</td>
<td>0.85</td>
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<tr>
<td>V3 Soybeans</td>
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<td>R5 Soybeans</td>
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<td>Full Soybeans</td>
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</table>

Note: The data is provided by the USDA-NRCS. Please consult with your local Cooperative Extension Service for local ET values.
Example

Corn is at **12-leaf growth stage** and the water level in the ETG (with a No. 54 canvas cover) sight tube decreased **1.30 inches** during the 7-day period since the last irrigation. Determine the actual crop ET (ETc), net irrigation requirement (NIR), and the gross irrigation requirement (GIR) if irrigation is applied with a center pivot with an application efficiency of **85%** (AE = 0.85). Rainfall = 0.

\[\text{ETr} = 1.30 \text{ inches} \text{ (reference ET from the ETG)}\]

\[\text{Kc} = 0.88 \text{ (from table for 12-leaf stage)}\]

\[
\text{ETc} = \text{ETr} \times \text{Kc} \\
\text{ETc} = 1.30 \text{ inches} \times 0.88 = 1.1 \text{ inches}
\]

\[
\text{NIR} = \text{ETc} - \text{Rainfall} \\
\text{NIR} = 1.1 \text{ inches} - 0 = 1.1 \text{ inches}
\]

\[
\text{GIR} = \frac{\text{NIR}}{\text{IE}} \\
\text{GIR} = \frac{1.1 \text{ inches}}{0.85} = 1.3
\]

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Different locations... best location is open area above the crop canopy!
More information on how to use an ETgage for irrigation management

Using Modified Atmometers (ETgage) for Irrigation Management

Soni Ernak, José O. Perez, and Berrel L. Martin
Extension Water Resources/Irrigation Engineers

This NebGuide describes the atmometer (evapotranspiration gage) and explains how it can be used for irrigation scheduling. Examples are provided to show how information collected with an atmometer can be used to estimate crop water use for corn and soybean.

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Soil Water Monitoring

Key to applying the optimum amount of irrigation
For effective irrigation, must know water applied
**Watermark sensors** are used to measure soil moisture to determine irrigation timing and amount. One of the simple, economical, durable, and accurate sensors to monitor soil water status is the Watermark Granular Matrix sensor.
Installed in the row

1, 2, 3 feet deep
# Irrigation trigger levels for different soil types

Table 1. Depletion (inches) in available water versus soil moisture potential and suggested range of irrigation trigger point for different soil textures.

<table>
<thead>
<tr>
<th>Soil moisture potential (kPa)</th>
<th>Silty clay loam</th>
<th>Clay loam</th>
<th>Silty loam</th>
<th>Clay loam</th>
<th>Silt loam</th>
<th>Clay loam</th>
<th>Available water holding capacity (inches)</th>
<th>Fine sand loam</th>
<th>Medium loam</th>
<th>Fine sand loam</th>
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</table>

*Note: Trigger points were calculated with the assumption of no surface evaporation. The trigger points are calculated based on the 25% depletion of the total soil water holding capacity per foot of soil layer. The trigger points should be verified checked against the crop appearance in the actual field conditions during the season. Trigger points should be the average of the first 2 feet of moisture prior to crop reproductive stage and 2 feet of moisture reaches the reproductive stage. However, for the sandy soils, the average of top 2 inches should be used as a trigger point at all times.*
Table 1.
Depletion (in ft) in available water versus soil matric potential and suggested range of irrigation trigger point for different soil textures.

<table>
<thead>
<tr>
<th>Soil matric potential (kPa)</th>
<th>Silty clay loam topsoil, Silty clay loam subsoil (Sharpsburg)</th>
<th>Silt loam topsoil, Clay loam subsoil (Keith)</th>
<th>Upland silt loam topsoil, Silty clay loam subsoil (Hastings, Crete, Holdrege)</th>
<th>Bottom land silt loam (Walsh, Hall)</th>
<th>Fine sandy loam</th>
<th>Sandy loam</th>
<th>Loamy sand (O’Neill)</th>
<th>Fine sand (Valentine)</th>
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</tbody>
</table>

Water holding capacity (in ft) | 1.8-2.0 | 1.8-2.0 | 2.20 | 2.00 | 1.80 | 1.40 | 1.10 | 1.00

(*) The trigger points were calculated with the assumption of no sensor malfunction. The trigger points were calculated based on the 35% depletion of the total soil water holding capacity per foot of soil layer. The sensor readings and the trigger points should be verified checked against the crop appearance in the actual field conditions during the season. Trigger point should be the average of first 2 feet of sensors prior to crop reproductive stages and 3 feet once crop reaches the reproductive stage. However, for the sandy soils, the average of top 2 sensors should be used as a trigger point at all times.

(N/A) Not available.
Which soil depth to consider for irrigation management?

**Corn:**
- Average of top 2 ft until tassel
- Average of top 3 ft after tassel

**Soybeans:**
- No irrigation before R3 stage. Average of top 3 ft thereafter.

*Trigger irrigation when the average matric potential is between 90 and 100 kPa for both crops grown in silt-loam soils.*

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Example: change in soil water status
Example: change in soil water status
Example: change in soil water status
More information on how to use Watermark sensors for irrigation management?

Watermark Granular Matrix Sensor to Measure Soil Matric Potential for Irrigation Management

Stunt Irwaali, Irrigation and Water Resources Engineer; Jose O. Paez, Irrigation Engineer; David E. Bininger, Hydrologist and Irrigation Engineer; William L. Kuzma, Irrigation Specialist; Derrell L. Martin, Irrigation and Water Resources Engineer; Gary L. Zoselheit, Extension Educator; Jennifer M. Jones, Extension Educator; Brandon Soto-Duvalle, Extension Educator; Andrew P. Christiansen, Extension Educator; Dan Leisinger, Water Conservationist; Upper Big Blue NDR

University of Nebraska–Lincoln
Ask youth if too much of a good thing can happen, whether its that they eat too much of a healthy food. i.e. apple, etc. (Everything needs to be in balance; think back to the demonstration at the beginning of lesson with over water, underwater, etc. plants) The impact of excess water on crop growth and yield is influenced by crop type, soil characteristics, duration of excess water or flooding, initial soil water and nitrogen status of the soil before flooding, crop stage, air temperature, etc. What happens to crops that receive excess water? (they will “drown” out b/c they need oxygen to survive) Adopting proper irrigation management strategies can reduce negative impacts of over-irrigation and provide a balance between the crop water requirements and available water. Over-irrigation leads to water loss, increases energy use for pumping, causes leaching of nitrogen and other micronutrients and wastes time.
Plants need O2 also!!!
Research conducted in 2006 and 2007 at the University of Nebraska South Central Agricultural Laboratory near Clay Center by Dr. Suat Irmak included corn plots irrigated at 50%, 75%, 100% and 125% of actual crop water use or evapotranspiration. In both years, the over irrigated fields (125%) yield less than the optimum or fully irrigated field (100%).

Yields were:
50% - 194 bu/acre
75% - 213 bu/acre
100% - 217 bu/acre
125% - 205 bu/acre
To achieve proper irrigation management...

**Nebraska Ag Water Mgmt Demonstration Network**

- To transfer high quality research-based information to farmers’ fields
- Implement tools to address and enhance crop water use efficiency and energy savings.

University of Nebraska–Lincoln
Started in 2005 with UNL Extension and UBBNRD, spread to Little Blue NRD and others across the state. NRCS has served as a great supporter and provided grants to expand the network. Producers and crop consultants make this program work! Producers have been very great to work with as they have provided input and helped us improve the workings of the network.
NAWMDN Website

http://water.unl.edu/cropswater/nawmdn
UNL Water
Your natural resource for reliable water information.

NAWMDN - Enabling producers to use water and energy resources efficiently.

Contact: Gary Zodzak, Extension Educator, York County

The Nebraska Agricultural Water Management Demonstration Network (NAWMDN), ETgage project is one part of a system for testing cutting-edge technologies and creating a network with growers, UNL, Entomology, NDSU, WDC, crop consultants, and other interested partners, that will enable the adoption of water and energy conservation practices.

What is an ETgage?

ETgages (ETgage) are designed to simulate evapotranspiration (ET) from a plant canopy in a way that agrees with a plant’s resistance to ET. The ETgage is a tool that can be used to meet ET rates and the information can be utilized for irrigation management. The simplicity of use and interpretation of the ETgage data, as well as the economics involved, makes it easy for farmers to adopt and use ETgage for efficient water use and irrigation needs. For more information please see the "Using ETgage Data for Irrigation Management" Extension publication.

ETgage data information

For participating producers, consultants, and personnel and Extension Educators across Nebraska and outlying states ETgage information is located at the ETgage data page and map on our county. If you are looking for the data from your area, simply go to the NEOWADE data page and check your county. You will then see a Google map that will show the ETgage data contact.
UNL Water
Your natural resource for reliable water information.

Weekly ETgage Site Data
Use this interactive ETgage map to access weekly information provided by growers, consultants, NRD staff and Extension Educators. To view the data, click on the county you’d like to view the data from. You will then see a Google™ Map view of the county that has the ETgage sites marked as balloons, simply click on the balloon near your location. You will then go to a page that includes the weekly ETgage change along with weekly rainfall amounts. The ETgage change along with your crop’s stage of growth can be used to estimate your crop’s water use.
Each year we have been working on this project, we sent surveys to producers to get their input. Most of the surveys returned from 2006 and those coming in from 2007 have been very favorable. We also have meetings throughout the growing season and at the end of the year for support and ideas, hence the development of quick charts and other materials received.
The NAWMDN has expanded State-wide this year with over 120 cooperators. This is twice the amount of cooperators from last year. Last year producers that responded indicated that they reduced irrigation applications by 2-3" per acre as a results of the new technologies. Preliminary survey results (N=12) indicate an average water savings of 2.5 inches. We anticipate more surveys after harvest. One producer in the LBNRD reported "Those moisture sensors have paid for themselves about ten times over for one pivot". 2008 Survey data is being tabulated.
What overall impact has the NAWMDN had on you?

- I've learned from it! Confident that this technology is helpful.
- More focused on reducing water use on growing crops.
- Makes you more aware of the need to schedule irrigation based upon facts vs. a gut feel to irrigate.

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Now you should....
Define and understand basic irrigation terminology.
Become familiar with problems associated with under or over-irrigating crops.
Understand & demonstrate how to use irrigation equipment for effective (corn and soybean) irrigation management.

**Summary (Closure) – Conclusion to the Problem:**
What is the importance of irrigation in Nebraska and when should I irrigate?

**Review:**
What is a definition of irrigation management?
Why is it important to irrigate efficiently and how can you be effective?
Define and understand basic irrigation terminology.
What are problems associated with under or over-irrigating crop?
What are two tools used to irrigate crops/soybeans?
Ask youth to answer.... When and how much should they irrigate?
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