California - Managing Corn Under Drought Conditions

- With California under a drought state of emergency, corn growers may have limited water for irrigation purposes.\(^1\)
- Furrow irrigation efficiency can be improved by shortening field lengths, or by using alternate furrow irrigation, furrow torpedoes, or surge irrigation.
- Conservation tillage and corn product selection are other important ways to conserve soil moisture.

Corn Water Use and Irrigation

Corn water use, or evapotranspiration (ET), represents soil evaporation (E) and plant transpiration (T).\(^2\) Water is lost to the atmosphere through evaporation from the soil and plant surfaces, and from plant transpiration through small openings on leaves. When the corn crop is at full canopy, ET is about 0.3 inches per day (Table 1). Corn grown in the Central Valley of California uses from 25 to 29 inches of water (or between 2 and 2.5 acre feet) due to ET, depending on the location, planting date, and relative maturity of the corn product.\(^3\)

Almost all of the corn grown in California is surface irrigated, mostly by furrow irrigation. The frequency and the amount of irrigation depends on the growth stage of the corn, prevailing weather conditions (temperature, wind, humidity), and water holding capacity of the soil. Soil texture is the main factor determining the soil water holding capacity. Heavier soil, such as a clay loam, will have a higher water holding capacity than sandier soil, such as a sandy loam. Most of the root mass of a corn plant is in the top 3 feet of soil, which is considered the effective rooting depth for irrigation purposes.

Deficit Irrigation of Corn

Deficit irrigation is the application of water below the ET requirements of corn.\(^4\) Corn biomass can be reduced with deficit irrigation, and any loss in biomass can result in silage yield reduction. Water stress from deficit irrigation also affects the corn harvest index (HI), or the proportion of grain in the plant’s total above ground biomass. Although overall grain yield will decline as biomass declines, effective deficit irrigation management can allow corn water stress to be managed so that HI does not decline. However, the HI can decline if corn is severely stressed. The amount of stress that corn can withstand before the HI is impacted depends on the soils water holding capacity and ET demand.

The least damaging time for corn to be under water stress is during the vegetative stage up to 2 weeks prior to silking. Stress during the vegetative period will have the least impact on grain yield. However, stress during this period can result in shorter corn, and delay corn entering into the reproductive period of growth. Also, delaying the first irrigation is not recommended, because this can have a negative impact on corn growth and grain yield.

### Table 1. Estimated corn evapotranspiration (ET) and yield loss per stress day during various stages of growth.

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>ET* (inches per day)</th>
<th>Average % Yield loss per day of stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 4 leaf</td>
<td>0.06</td>
<td>—</td>
</tr>
<tr>
<td>4 to 8 leaf</td>
<td>0.10</td>
<td>—</td>
</tr>
<tr>
<td>8 to 12 leaf</td>
<td>0.18</td>
<td>—</td>
</tr>
<tr>
<td>12 to 16 leaf</td>
<td>0.21</td>
<td>3.0</td>
</tr>
<tr>
<td>16 leaf to VT</td>
<td>0.33</td>
<td>3.2</td>
</tr>
<tr>
<td>Silking (R1)</td>
<td>0.33</td>
<td>6.8</td>
</tr>
<tr>
<td>Blister (R2)</td>
<td>0.33</td>
<td>4.2</td>
</tr>
<tr>
<td>Milk (R3)</td>
<td>0.26</td>
<td>4.2</td>
</tr>
<tr>
<td>Dough (R4)</td>
<td>0.26</td>
<td>4.0</td>
</tr>
<tr>
<td>Dent (R5)</td>
<td>0.26</td>
<td>3.0</td>
</tr>
<tr>
<td>Maturity (R6)</td>
<td>0.23</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Rhoads and Bennett (1990) and Shaw (1988).
* Under severe conditions, ET can increase by 50% above normal.

The next least damaging time for water stress to corn is later in the season during grain fill. However, this can result in smaller kernels, and increased stalk rot which could lead to lodging and harvest losses.

The most important time to avoid water stress on corn is the 2 weeks prior to silking through the 2 weeks after silking. Stress during silking can reduce grain yield by 3 to 8% per day, with an average of 6.8% (Table 1). Water stress during this time can delay silking, reduce pollination, and lead to kernel abortion.

Deficit irrigation is not the best management strategy because it can be difficult to implement with surface irrigation methods. Surface irrigation methods (furrow and border flood) are generally inefficient due to
over-irrigation and poor application uniformity. Deep percolation of water below the root zone and tail water run-off can occur. Excessive field lengths is a main cause of irrigation inefficiency. A certain quantity of water is required to advance irrigation water to the end of a field. With long field lengths, this minimum amount of water often exceeds the amount needed to refill the crop’s root zone. For example, at maximum corn crop canopy when ET is about 0.3 inches per day, the crop requires about 3 inches of water every 10 days to refill the effective rooting depth. However, surface irrigation systems can require 4 to 6 inches of water just to move the water to the end of the field. Surface irrigation application amounts can be even higher (6 to 9 inches) for pre-irrigation and irrigations following cultivation. In soils with a water holding capacity of 1 inch of water per foot (loamy sand), these amounts would wet to a depth of 4 to 9 feet, which is beyond the effective rooting depth needed for irrigation purposes.

**Improving Furrow Irrigation Efficiency**

Improving the efficiency of furrow irrigation systems is a strategy to limit the amount of applied water needed for corn production.

**Shorten Irrigated Field Lengths** - This management strategy can provide the most improvement in irrigation efficiency and uniformity. Shortening the field length can reduce the time needed for irrigation water to reach the end of the field. This can improve distribution uniformity and reduce deep percolation of water. With less time required to reach the end of the field, applied irrigation amounts can be reduced by up to 55%. Added expenses of new pipelines and roads are required, and a tail water recovery system would be needed to re-use runoff water.

**Alternate Furrow Irrigation** - This management strategy can help to reduce subsurface drainage and runoff. The amount of applied water can be reduced by 30% using this approach compared to supplying irrigation water to every row.

However, soils that are prone to crack across the bed may not be suitable to this approach.

**Furrow Torpedoes** - These are heavy, tube shaped blocks that are pulled along furrows to smooth the surface, allowing the water to run more quickly to the end of the field (Figure 1).

**Surge Irrigation** - This management strategy allows water to run a certain distance down the furrow, and then the irrigation is switched to a new set of furrows. The water in the first set of furrows can drain while the alternate set of furrows is being irrigated. The water is switched back and forth between the sets until it reaches the end of the field. This can result in lower infiltration and reduced water application by irrigating over an already wetted furrow.

**Other Forms of Irrigation as Possible Solutions**

Sprinkler and drip irrigation are other more efficient means of irrigating. There are a number of center pivot irrigation systems operational in western Fresno county. Drip irrigation can be successful, but requires monitoring because salt accumulation can reduce water quality and placement. These systems can apply smaller amounts of water, with more uniformity, when the corn needs it.

**Conservation Tillage**

Conservation tillage helps to retain moisture in the soil, making it more available to plants. Water evaporation can be reduced if the soil is covered with a mulch.

**Corn Product Selection**

Corn products with more favorable drought tolerance ratings should be chosen. New Genuity® Droughtgard® Hybrids combine top performing genetics with superior drought-tolerance characteristics, including the only drought-tolerant biotech trait for corn. Also, planting shorter maturity corn products can reduce the amount of irrigation needed.

For additional information, please contact your DEKALB® Brands Seed Representative.

**Sources:**


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