Effects of Deficit Water Supply on Sugarbeet: Summary of ARS Research

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Drought

IT’S NOTHING TO BE AFRAID OF... IT’S CALLED RAIN...
Irrigation supply shortages become a major concern
Crop ET (Water Requirement) – Annual Averages (inches)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Nampa</th>
<th>Twin Falls</th>
<th>Aberdeen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa (Mean)</td>
<td>41.3</td>
<td>39.0</td>
<td>37.0</td>
</tr>
<tr>
<td>Spring Grain</td>
<td>26.8</td>
<td>23.2</td>
<td>23.7</td>
</tr>
<tr>
<td><strong>Sugar Beets</strong></td>
<td><strong>33.8</strong></td>
<td><strong>30.4</strong></td>
<td><strong>28.7</strong></td>
</tr>
<tr>
<td>Potatoes</td>
<td>27.4</td>
<td>25.2</td>
<td>24.7</td>
</tr>
<tr>
<td>Dry Beans</td>
<td>20.6</td>
<td>17.8</td>
<td>--</td>
</tr>
<tr>
<td>Field Corn</td>
<td>26.6</td>
<td>25.0</td>
<td>24.8</td>
</tr>
</tbody>
</table>
Data Set Summary

- 3 studies
- 6 years (2008-2013)
- 7 site years
- 8 sugarbeet varieties
- 44 crop ET variations
  - 14% - 124% of crop ET based on Kimberly-Penman ET model.
  - Crop ET water supplied by precip.+ irrigation (Treatments applied evenly over entire season).
  - Soil water was not accounted for
  - Average ET = 32.1 in.
Data Set Summary Cont.

- Treatments all replicated 4 times
- 550 data points (plots)
- Silt loam soil
- 68 - 150 feet of row in harvest areas
- All beets in harvested area weighed
- 50-100 lbs beet samples sent to Tare Lab for sugar and quality analysis
- Root yield and Estimated Recoverable Sucrose (ERS) determined
Data Normalization

- Done on a site by site basis
- Yield/Maximum Yield
- Adjusting measured values (yield, % sugar, etc.) on different scales to a common scale.
- Allows comparison of data from one study to another.
  - Different Years
  - Different Locations
  - Different Varieties
Normalized Root Yield, % of Maximum

Crop ET (% of precipitation and irrigation vs. Normalized Root Yield)
Normalized ERS Yield, % of Maximum
Normalized ERS Yield, % of Maximum

\[ r^2 = 0.78 \]
Normalized ERS Yield, % of Maximum

Crop ET (%, precipitation and irrigation)

Normalized ERS Yield

93

63
Water Reductions Relative to 100% Crop ET (32in) to Achieve Same ERS Yield

<table>
<thead>
<tr>
<th>% Crop ET</th>
<th>Water Reduction (in)</th>
<th>Water Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>12</td>
<td>37</td>
</tr>
<tr>
<td>70</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>75</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>80</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>85</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>90</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>95</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>
Sugar content versus Crop ET

$\text{Normalized Root Sugar Content}$ vs $\text{Crop ET (\%)}$

$r^2 = 0.31$
Brei Nitrate versus Crop ET

Diagram showing the relationship between Crop ET (%) and Normalized Brei Nitrate.
Summary

- Compared to “full irrigation”:
  - Reducing water inputs by approximately 37% (12 in) did not affect ERS yields.
  - Over irrigating by 20% (6 in) did not reduce ERS yields.
- Understanding soil water storage/availability status is important to understand potential effects on yields.
  - Under full irrigation soil water often does not change significantly, but under deficit conditions it becomes an important source.
  - “Rainy Day Fund”
Thank You

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Effects of Deficit Irrigation on Sugarbeet Production

- Deficit Irrigation scenarios:
  - Reduced allocation of irrigation all season or until water is gone
  - Full irrigation allocation as long as water lasts (cutoff or reduced)
Tarkalson, ARS Study 2011 and 2012

Full – 100% crop ET

Deficit 1 Even Stress- 65% ET

Deficit 1 Late Stress- 100%/55% (6/29) - 65% ET

Deficit 2 Even Stress - 42% ET

Deficit 2 Late Stress- 100%/25% (6/29) – 42% ET
<table>
<thead>
<tr>
<th>Crop ET</th>
<th>Crop ET Reduction (33 in)</th>
<th>Mean Root Yield Reduction</th>
<th>Mean ERS Reduction</th>
<th>Net Value to Grower Reduction ($0.14/lbs Sugar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>in</td>
<td>%</td>
<td>tons/acre</td>
<td>%</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>95</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>5</td>
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<td>10</td>
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<td>50</td>
<td>16</td>
<td>30</td>
<td>11</td>
<td>32</td>
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<td>40</td>
<td>20</td>
<td>40</td>
<td>15</td>
<td>42</td>
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Tarkalson, ARS Study 2011 and 2012

At planting soil held 1.4 inches of AW/ft = 5.6 inches in 4 ft.

At FC the soil could have held 2 in/ft = 8 inches in 4 ft.

With no stress until 50% of AW, this means that at FC the soil would have 4 extra inches

5.6 in – 4 in = 1.6
4 in – 1.6 in = 2.4 inches less.

RY – extra 3.1 tons
ERS – extra 790 lbs/acre
ERS Yield (lbs/acre)

Tarkalson, ARS Study 2011 and 2012

Full – 100% crop ET

Deficit 1 Even Stress - 65% ET

Deficit 1 Late Stress - 100%/55% (6/29) - 65% ET

Deficit 2 Even Stress - 42% ET

Deficit 2 Late Stress - 100%/25% (6/29) – 42% ET
**Carter et al.**

**Soil:** Silt loam

**Irrigation:** Furrow

Both treatments irrigated at 100% ET until 8/1.

**August 1 cutoff treatments**

1977-68% ET (based on irrigation + precipitation)

1978 - 75% ET (based on irrigation + precipitation)

Furrow irrigation likely filled entire profile with water prior to cutoff: Assume 4 ft rooting depth, 2 in/ft = 8 in available water, no stress until 50% used so 4 in available before any stress,

Total Soil Water Difference (Beg – End)

Difference in Total Soil Water (in)

0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8

2013 Data – ARS-Kimberly

Soil: Silt loam

Irrigation: Linear Move

Average data from deficit irrigation treatments (25%, 50%, and 75% ET)

Irrigation treatments imposed over whole season.
Summary

- At equivalent crop ET levels, sugarbeet handle deficit water supply similar when receiving reduced water all season vs full water early with a reduction or cutoff later in season.
- Understanding soil water storage is important to understand the effects of deficit water supply on sugarbeet.
- Under full irrigation soil water often does not change, but under deficit conditions it becomes an important source.
- Irrigation water supply scenarios will dictate how water resources will be allocated to deal with irrigation supply shortages.
Thank You

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