Production Response of Sugar Beet Breeding Lines to Deficit Irrigation

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Northwest Irrigation & Soils Research Lab
Kimberly, Idaho
“Crop Production Down Due to Drought”
“Severe winter drought threatens crop production in China”
“U.S. farmers hit hard by drought”
“Russian drought devours world wheat supplies”
“World Running Short on Water”
“North Platte NRD Seeking Input on Proposed Changes to Allocations”
“The pending scramble for water”
“Idaho fighting another Snake River water war”

Headlines: Crop Production, Drought, Irrigation Water Demands
• There are limited breeding efforts to improve drought tolerance.

• Research shows significant sugar beet genotype diversity for tolerance to drought.

Sugar Beet Drought Research
Background
• Objective: Screen KWS Breeding Lines and a Commercial Line for Drought Tolerance Using a Line Source Sprinkler System

• Conducted a 3-year study (2008, 2009, 2010)
• 6 KWS breeding lines, 1 commercial cultivar line.
  – Selected and provided by KWS
• 6 irrigation levels.
  – Based on a percent of predicted crop seasonal ET (based on the Kimberly-Penman Reference Evapotranspiration Model)
  – Approximately 125%, 100%, 75%, 50%, 25% of ET, and rain-fed.
    • Varied year to year based on variability of sprinkler application pattern and wind.
    • Crop ET summed daily and replaced with irrigation based on treatment irrigation percentages 2 to 3 times a week.
2010 Cumulative Irrigation and Precipitation

Cumulative CWR
- 119%
- 101%
- 67%
- 37%
- 14%
- 8%

Date (2010): Jun, Jul, Aug, Sep, Oct

Cumulative Water (in)
**Design**

- Line source system used.
- Irrigation treatments set relative to line source.
- Breeding line treatments were randomized within irrigation treatments.
- 4 Replications.
- Each Plot is 4 rows wide by 36 ft long

### Experimental Design and Protocol

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• Entire study emergence irrigation:
  – 2008 – 2.4 inches
  – 2009 – 2.2 inches
  – 2010 – 2.8 inches
• Daily crop water use logged (based on the Kimberly-Penman Reference Evapotranspiration Model) and line source irrigations started after estimated 100% emergence.
• Stand hand thinned to an in-row plant spacing of 4 inches at about the 2-leaf stage.
• Beets harvested in October.
  – 2 center rows – 30ft (60 ft of row).
  – Yield (tons/acre)
  – Sugar analysis

• 2 – eight beet samples for sugar and impurity analysis

Experimental Design and Protocol
Water Input vs. Recoverable Sugar
• Linear regression analysis for deficit irrigation treatments.
  – rain-fed – ≈75% ET.
  – Intercept and slope comparisons.
• Non-Linear regression used to compare maximum yields.
  – Spherical Model.
  – All irrigation levels.

Statistical Analysis
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<tr>
<td><strong>Sucrose Yield</strong></td>
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<tr>
<td>Rain-Fed</td>
<td>1,430 – 5,450</td>
<td>3,480-10,090</td>
<td>980-4,450</td>
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<tr>
<td>≈100% ET</td>
<td>6,520-14,460</td>
<td>8,479 – 13,300</td>
<td>9,100-15,440</td>
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<td><strong>Root Yield</strong></td>
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<tr>
<td>Rain-Fed</td>
<td>6.4-26.7</td>
<td>12.4-34.6</td>
<td>5.1-16.3</td>
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<td>≈100% ET</td>
<td>24.3-44.1</td>
<td>29.5-45.6</td>
<td>32.5-48.4</td>
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**Root Yield and Recoverable Sugar Ranges**
All Line Slope Average = 420 lbs sucrose/acre/inch water

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**Water Input vs. Recoverable Sugar**
Water Input vs. Recoverable Sugar
Intercept dif. = 2,200 lbs/acre

**Water Input vs. Recoverable Sugar**

The graph shows the relationship between growing season precipitation plus irrigation (in) and sucrose yield (tons/acre). The data is presented for the year 2008.

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Water Input vs. Recoverable Sugar
Water Input vs. Recoverable Sugar
Intercept dif. = 3,100 lbs sucrose/acre
Slope dif. = 200 lbs sucrose/acre/inch water
All Line Slope Average = 270 lbs sucrose/acre/inch water

Water Input vs. Recoverable Sugar
Water Input vs. Recoverable Sugar
Water Input vs. Recoverable Sugar
Intercept dif. = 1,600 lbs sucrose/acre

All Line Slope Average = 440 lbs sucrose/acre/inch water

Water Input vs. Recoverable Sugar

USDA Agricultural Research Service
Northwest Irrigation and Soils Research Laboratory
Water Input vs. Recoverable Sugar
• Genetic differences in the production of lines under deficit water conditions.
• Response rate of lines to water inputs under deficit water conditions can differ.
  – E.g. Line 5. – High comparative sucrose and root yield under low water inputs; low comparative sucrose and root yield under higher and optimum water inputs.
• Yield potential differences exist between lines.

Summary
Questions?