Effect of Tillage and N Fertilizer Rate on Sugar Beet Production

2011 General Meeting
American Society of Sugar Beet Technologists
Albuquerque, New Mexico

David Tarkalson and Dave Bjorneberg
USDA - Agricultural Research Service
Northwest Irrigation & Soils Research Lab
Kimberly, Idaho

Amber Moore
University of Idaho
• Roundup Ready sugar beet seed.
• Strip tillage becomes an option.
  – Reduced tillage costs.
• How will sugar beet produce under strip tillage systems?
• Is N management different in a strip tillage system compared to conventional tillage systems?
  – Different residue management.

Why Do This Research
• 3-year study (2008-2010)
  – Data from 2008 and 2010 used in analysis

• Tillage System (Spring and Fall)
  – Strip Tillage
  – Moldboard Plow
  – Chisel Plow

• N Rate (Supply)
  – \( \approx 0, 50, 100, 150, 200 \text{ lbs applied N/acre} + \text{Residual inorganic N in soil.} \)

• Experimental Design
  – Split plot design
<table>
<thead>
<tr>
<th>Tillage System</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip Tillage</td>
<td>Strip Tillage</td>
<td>Moldboard Plow</td>
</tr>
<tr>
<td>Moldboard Plow</td>
<td>Moldboard Plow</td>
<td>Roller Harrow Bed</td>
</tr>
<tr>
<td>Chisel Plow</td>
<td>Offset Disk</td>
<td>Chisel Plow Tandem Disk Bed</td>
</tr>
</tbody>
</table>

2008 Tillage System Descriptions
2010 Tillage System Descriptions

<table>
<thead>
<tr>
<th>Tillage System</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip Tillage</td>
<td></td>
<td>Strip Tillage</td>
</tr>
<tr>
<td>Moldboard Plow</td>
<td>Moldboard Plow</td>
<td>Roller Harrow, Harrow Bed</td>
</tr>
<tr>
<td>Chisel Plow</td>
<td>Offset Disk, Plow</td>
<td>Tandem Disk, Disk, Bed</td>
</tr>
</tbody>
</table>

Tandem Disk
• **Soil Samples**
  – From each tillage system prior to planting and fertilization
  – 2008 – 0-1 and 1-2 ft. – Root restricting layer at \( \approx 20 \) inches. = 93 lbs N/acre
  – 2009 - 0-1, 1-2, and 2-3 ft. = 60 lbs N/acre

• **Planting Dates**
  – 2008 – April 25
  – 2010 - April 27

• **N Fertilization**
  – 2008 – April 25 (after planting); surface UAN with Agrotain
  – 2010 – June 2 (2 to 3 leaf stage); UAN banded between rows.
  – Fertilizer was irrigated into the soil shortly after application.

• **Glyphosate was applied as needed and according to the label to control weeds**

• **Irrigation was applied 2 to 3 times/week to match estimated crop water requirements** (Kimberly-Penman Reference Evapotranspiration Model)

**Materials and Methods**
• Beet harvest
  – Mid October
  – 2 rows × 30 ft.
  – 2 sample locations per plot
    • rows 2-3 and 6-7 (center 2 rows of each 4 row planting pass)
• Beet harvest cont.
  – Root Yield (tons/acre)
  – Sugar analysis
    • 2 – eight beet samples sent to tare lab
  – Total N analysis
    • 1 – eight beet sample

Methods Cont.
Harvest Stand
Inorganic N Supply (Fertilizer N + Inorganic Soil N) (lbs N/acre)

Yields

Root Yield (tons/acre)

Sucrose Yield (lbs/acre)

N Fertilizer Rate (lbs N/acre)

Strip Tillage
Moldboard Plow
Chisel Plow
Root Yield

Inorganic N Supply (Fertilizer N + Soil N) (lbs N/acre)

Root Yield (tons/acre)
Estimated Recoverable Sucrose

Sucrose
17.7%
16.4%
2008

Sucrose
17.7%
16.4%
2010
• Calculated Net Return from applying N fertilizer
  - $ return associated with applying a given amount of N fertilizer
  - = Gross return of beets with N fertilizer applied – Gross return of beets with no N fertilizer applied – N fertilizer cost
    - Calculated for every 1 lb increase in N as predicted using the regression model
  - N Supply corresponding to maximum $ return = EONS

• N Fertilizer Price
  - $0.60, $0.90, and $1.20/lb N fertilizer

• Sugar Return
  - Base price = $45/ton at 17.0% sugar
  - Adjusted from base price = ± $0.33/ton for every ± 0.1% sugar
Economic N Rate (Supply)
<table>
<thead>
<tr>
<th>Year</th>
<th>N Fert. Price ($/lb N)</th>
<th>EONR-fertilizer (lbs/acre)</th>
<th>EONS-total supply (lbs/acre)</th>
<th>Yield at EONR</th>
<th>RTN at EONR ($/acre)</th>
<th>Nr (lbs N/ton beets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>0.60</td>
<td>94</td>
<td>187</td>
<td>33.2</td>
<td>98</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>0.90</td>
<td>80</td>
<td>173</td>
<td>33.0</td>
<td>72</td>
<td>5.2</td>
</tr>
<tr>
<td></td>
<td>1.20</td>
<td>67</td>
<td>160</td>
<td>32.7</td>
<td>50</td>
<td>4.9</td>
</tr>
<tr>
<td>2008</td>
<td>0.60</td>
<td>156</td>
<td>216</td>
<td>36.0</td>
<td>406</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>0.90</td>
<td>147</td>
<td>207</td>
<td>35.9</td>
<td>360</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>1.20</td>
<td>138</td>
<td>198</td>
<td>35.7</td>
<td>317</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**Historical Nr:**
Recent: 8 lbs N/ton beets
Past: 11 lbs N/ton beets
Brei Nitrate

Inorganic N Supply (Fertilizer N + Soil N) (lbs N/acre)

Brei Nitrate

2008

2010
• Strip tillage had similar production factors compared to conventional moldboard plow system.
• Chisel plow had reduced harvest stands and trends for lower yields compared strip tillage and moldboard plow.
• N requirement per ton of beets lower than historic 8 lbs N/ton beets.
• N Mineralization in soil still the great unknown.

Conclusions
Thank You!

Questions?