Optimizing Fertilizer Applications on Sugar Beet

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Objectives

- Discuss sugar beet nutrient use;
- Describe fertilizer recommendations and how each component of can be optimized to stretch fertilizer dollars;
- Discuss results of N fertilizer trials.
Introduction

- Sugar beet is the highest value crop grown in Wyoming and is regionally economically important;
- Also the most resource-intensive crop, requiring large amounts of water, fertilizers, and pesticides;
- Until recently, high value dwarfed input costs, and producers had little incentive to conserve, but high fertilizer prices have changed that;
- There is evidence that fertilizer rates can be reduced without sacrificing profits;
- Requires careful nutrient management, which starts with understanding crop nutrient use and the factors that impact it;
- Begins with annual soil testing.
Fertilizer requirements

- Wyoming soil tests usually indicate needs for supplemental nitrogen, phosphorus, and often sulfur;
- N is most limiting to growth and yield:
  - Most common, plant available form is nitrate (NO$_3^-$), which is very soluble and volatile;
- P as phosphate (P$_2$O$_5$) is less soluble but is rapidly tied up in soil minerals;
- S is often applied as ammonium sulfate;
- Placement near the seed is important for rapid uptake and minimal loss.
Sugar beet nutrition

- Sugar beets convert energy from the sun into sugar so need to close their canopy rapidly to intercept maximum sunlight;
- This requires abundant fertility, especially nitrogen, early in the season;
- But N uptake later in the season forms impurities and promotes vegetative growth at the expense of root growth.
Sugar beet nutrition

- Challenge is to provide abundant nutrition early but limit access later;
  - Beets have limited lateral root development;
  - Growth starts slow in cool spring temperatures;

- Irrigation can provide excellent control for nutrient management because NO3 is soluble and moves with water;

- But over irrigation with over fertilization carries excess N below the early season roots, possibly making it available as roots extend downward later in the season.
Sugar beet nutrition

- Application at soil-test-based rates combined with careful water management would limit access to deep, late season N;
  - Sprinkler or surge irrigation improves control

- This may reduce early season growth somewhat but should increase quality and reduce fertilizer costs.
Nitrate movement

2007 PREC “all preplant” plot:
- Late June
- Mid August
- October 2 (harvest)
Basis for sugar beet recommendations

Required for growth:

- Nitrogen: 9 lbs per ton;
- Phosphorus: 3 lbs per ton;
- Potassium: 9 lbs per ton;
- So 20 tons per acre requires:
  - 180 tons of N per acre
  - 60 tons of P per acre
  - 180 tons of K per acre

- Recommendations use total required minus RSN, nutrients from decomposing organic matter, and other credits from legumes, manure applications, etc.
Components of reliable fertilizer recommendations

1. Analysis of representative soil samples at a reliable lab;
2. Realistic yield goals;
3. Residual soil nutrients;
4. Soil organic matter;
5. Irrigation water management;
6. Cropping history;
Representative soil sample

- Bulk by one-foot depth increments down to three feet or deeper:
  - Mix samples from 15-20 points with like soils and management and subsample;
  - More is better, especially where fertilizers have been banded.
  - Dry samples thoroughly ASAP, but don’t oven dry.
  - Each year for N and P, every 3-4 years for other nutrients, pH, and organic matter.

- [http://ces.uwyo.edu/PUBS/MP 6.3.pdf](http://ces.uwyo.edu/PUBS/MP 6.3.pdf)
Realistic yield goals

- Use average yields for particular fields, not maximum or record yield:
  - Long-term average in Wyoming = 21 T/ac

- Yield goals set too high result in excess fertilizer that wastes money and can degrade quality.
Average Sugarbeet Yield, 1998-2006

<table>
<thead>
<tr>
<th>Region</th>
<th>Tons per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bighorn</td>
<td>20.9</td>
</tr>
<tr>
<td>Fremont</td>
<td>21.0</td>
</tr>
<tr>
<td>Park</td>
<td>21.9</td>
</tr>
<tr>
<td>Washakie</td>
<td>21.7</td>
</tr>
<tr>
<td>Goshen</td>
<td>18.5</td>
</tr>
<tr>
<td>Laramie</td>
<td>18.2</td>
</tr>
<tr>
<td>Platte</td>
<td>17.8</td>
</tr>
<tr>
<td>NW</td>
<td>21.4</td>
</tr>
<tr>
<td>SE</td>
<td>18.0</td>
</tr>
<tr>
<td>Wyoming</td>
<td>20.9</td>
</tr>
</tbody>
</table>

[http://www.montana.edu/extensionecon/software/S.W.%20Fertilizer%20Economics-Dryland.swf](http://www.montana.edu/extensionecon/software/S.W.%20Fertilizer%20Economics-Dryland.swf)
Residual soil nutrients

- Available nutrients left in the soil after the previous crop;
- Impacted by:
  - Yield & management of previous crop;
  - Weather: SOM mineralization, leaching;
- N and P can be lost:
  - Measure as close to planting as possible;
  - Don’t apply excess;
- Should be measured by a lab for best recommendations.
Organic matter

- Crop residues & humus;
- Store of time-release nutrients;
- UWyo soil lab assumes 20 lbs of N per year for each 1% SOM;
- Many other attributes:
  - Increases water- and nutrient-holding capacity;
  - Improves tilth;
  - Dark color;
- Can be increased or decreased by management.
Increasing SOM

- Whole cropping system soil management:
- Manure applications to other crops in rotation: much N becomes available late in the season so not good on sugar beets but good on crops where high protein is desired;
- Green manure crops: Planted after barley, for instance, and then plowed down in fall;
- Legumes in rotation increase beet yields;
- Reduced tillage.
Tillage

- Tillage speeds loss of SOM;
- Renewed interest in strip till with high fuel costs and RR beet varieties;
- Long-term study in Montana shows reduced fuel and labor costs;
- Beets grow faster early on than slower, turn yellow sooner, and have higher sucrose content with similar yields;
  - Banded N separate from residue is more available to growing plants, which use it up;
  - Later immobilization may limit access to N;
  - Conserves SOM: will eventually reduce fertilizer needs.
Fertilizer placement

- Important for early access with limited lateral root development;
- Options include broadcast, knife banded, and point injected;
- Broadcast & incorporation of urea is common, but losses can be large because of poor early season access;
- Banding liquid provides better placement and can save an operation;
- Knife banding liquid UAN known to reduce losses and increase availability, but takes more horsepower;
- In research at PREC point injection performed better than knife banding with less disturbance and fuel.
Irrigation water management

- Irrigation enables precise nutrient management because dissolved fertilizers move where the water moves;
- Early on, shallow irrigation prevents losses through leaching: Most fertilizer used up before roots, and irrigation, extend deeper into soil;
- Recommend irrigation water management plan based on soil intake and water holding capacity:
  - Sprinklers provide most control over nutrient movement;
  - Surge irrigation, at least in early-season applications, much better than standard furrow.
Nitrogen from legumes and manure

<table>
<thead>
<tr>
<th>Manure</th>
<th>Typical Dry Matter</th>
<th>Lbs N / ac credit</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>50%</td>
<td></td>
<td>100-140</td>
<td>50-70</td>
<td>0</td>
</tr>
<tr>
<td>Dairy</td>
<td>20%</td>
<td></td>
<td>60-100</td>
<td>30-50</td>
<td>0</td>
</tr>
<tr>
<td>Poultry litter</td>
<td>75%</td>
<td></td>
<td>0-60</td>
<td>0-30</td>
<td>0</td>
</tr>
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The N and moisture content of manure is variable: have it tested in a lab for accurate credit.
N credit from irrigation water

- Have NO3 content of irrigation water tested at lab;
- Each ppm NO3 = 2.7 lbs N per acft of water;
- Sugar beets can use about 22 inches, or 1.1 acft of water per season;
- ppm NO3 in water x acft of water use = Lbs N / acre;
- This can change through the season, so having several samples tested can support better estimates.
N source, rate, and placement study

Products:
- **Urea**: standard dry N form (46% N);
- **UAN**: standard liquid N form (32% N);
- **Agrium ESN**: coated, slow release urea;
- **Simplot NSN**: coated, slow release urea;
- **Agro-Culture NRG**: liquid slow release;
- **Georgia Pacific Nfusion**: slow release, mix 80/20 with UAN.
Treatments

- **RATES:**
  - UW N recommendation: 150 lb/ac;
  - Standard application at PREC: 220 lb/ac;

- **TIMING:**
  - All preplant;
  - Split: half preplant/half with UAN sidedress;

- **PLACEMENT:**
  - Broadcast vs injection of liquid products;
  - Wet row vs dry row injection.
Results

- Currently in second year of study comparing five N products, two rates, and injection vs broadcast;
- First-year results: variability larger than treatments differences
- Yields from injected liquids higher than broadcast;
- And lower, “soil test” rates more economical.
Summary

- Optimizing returns from fertilizer requires
  - Knowledge from soil testing;
  - Realistic yield goals;
  - Building soil organic matter;
  - Tillage and fertilizer placement advances;
  - Careful water management;
  - Remembering what happened last year.

- Preliminary data suggest placement is important and soil test rates are more profitable than traditional higher rates.