Optimizing returns from your fertilizer investment—broadcast, banding, fertigation and source

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Goals today

• Review mobility of plant nutrients
• Discuss potential nitrogen (N) and phosphorus (P) losses
• Show data on the effects of N placement and source on sugarbeet sucrose yield and rotation crop yield and quality
• Show results on effects of P placement
There are 14 mineral nutrients that have been found to be essential for growth of most plants:

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Micronutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>Boron (B)</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>Chloride (Cl)</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Copper (Cu)</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>Iron (Fe)</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>Manganese (Mn)</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Molybdenum (Mo)</td>
</tr>
<tr>
<td></td>
<td>Nickel (Ni)</td>
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<tr>
<td></td>
<td>Zinc (Zn)</td>
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</tbody>
</table>

The macronutrients are simply needed in larger amounts by the plant than the micronutrients.

Nutrient deficiencies of the bolded nutrients have been observed in Montana.
### Mobility in soil of selected nutrients

<table>
<thead>
<tr>
<th>Mobile (and soluble)</th>
<th>Relatively immobile</th>
<th>Very immobile (and insoluble)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (as nitrate) Sulfur Boron Chloride</td>
<td>Potassium</td>
<td>Phosphorus Copper Iron Manganese Zinc</td>
</tr>
</tbody>
</table>

Why important? Can affect optimum fertilizer placement
So how do I optimize my return on my fertilizer investment?

• Optimize yield and quality
• Reduce fertilizer losses
Nitrogen Cycle

You will increase your ROI by decreasing these losses.
Fertilizer Placement Methods

- Broadcast
- Broadcast/Incorporated
- Banded
- Injected (ex: spoke)
- Fertigation/Foliar
Effect of N placement on sugarbeet sucrose yield in Wyoming

Powell, WY
Stevens et al. 2007

Sugarcane Yield (lb/acre)

---|---|---
No added N | a | a | a
Bcast-inc | b | b | b
Point-inj | c | c | c
Kn-band | c | c | c

WHY?

PI was 3” to side of seed and 3” below surface

N Fertilizer Placement and Year
Effect of placement method on economic return in Wyoming

![Bar chart showing the return over fertilizer and haul costs for different placement methods: Bcast-inc, Point-inj, and Kn-band. The graph indicates that Point-inj has the highest return, followed by Bcast-inc, and then Kn-band. The data source is Van Tassell et al. (1996).]
Effect of 28-0-0 placement on sucrose yield in Wyoming (2007)

Sucrose Yield (lb/acre)

Wyoming Norton 2007

N Fertilizer Timing and Placement

Pre-plnt 40 lb/ac  Pre-plnt 150 lb/ac  Split 150 lb/ac
Effect of Placement on Spring Wheat Yield – Weed Free

Spring wheat grain yield (bu/ac)

- No N
- Surface Broadcast
- Banded
- Point Inject

Lethbridge, AB
Blackshaw et al. (2004)

4 in. deep, every other row

1998
1999
Effect of N Placement on Spring Wheat Yield - With Wild Oats

Why the difference from weed-free?
Enhanced Efficiency Fertilizers

• Two major types:
  slow release (ex: ESN, NSN, NRG)
  urease inhibitors (ex: Agrotain)

• Should you consider using them?
  Yes: on warm season, irrigated crops
  Maybe: on cool season crops

Downside-N release often occurs too late to match N uptake and could decrease sucrose content or increase malt barley protein

Upside-can apply ~2 – 4x as much slow release product as urea directly with small grain seeds
Effect of N source (pre-plant broadcast) on sucrose yield in Wyoming (150 lb N/ac)

Norton, 2007
Effect of N source using a split application on sucrose yield in Wyoming (150 lb N/ac)

Norton, 2007
Effect of ESN and urea on irrigated spring wheat grain yield

Parma, 2007

Wheat Yield (bu/A)

control
all urea
all ESN
1/2 ESN
2/3 ESN
all ESN
120 urea pp 60hd

N Rate (lb/A)
0
120
180

Brad Brown (2008)
Effect of N source applied with the seed on spring wheat yield

![Graph showing the effect of N source on spring wheat yield](image)

- urea
- urease inhibitor
- polymer coated

Grain Yield (bu/acre)

Application Rate (lb N/acre)

Saskatchewan

Data from Mahli et al. 2003
Foliar Application/Fertigation

• Some N can be absorbed through leaves

• However, most foliar applied N ends up being washed off and taken up by roots:
  - Only 8-11% of foliar applied liquid urea was taken up by leaves, whereas 37-67% of soil-applied N was taken up by plant in same study (Rawluk et al., 2000).

• Risk of burn if > ~ 20 lb N/ac (crop dependent). Yield losses at higher rates (40-60 lb N/ac).
Questions on Nitrogen?
Phosphorus
Movement of P is largely through erosion/runoff, NOT leaching. Why?

P binds strongly to soil
Banding vs Broadcast Phosphorus

Banding P is much more effective than banding N, because P is much more immobile in the soil.

Figure 7. The advantages of P banding are greatest when STP levels are very low (VL) to low (L). From Randall and Hoeft (1988).
Effect of P banding depth on winter wheat grain yield

McConnell et al. 1996
Effect of P banding depth on small grains

![Diagram showing the effect of P banding depth on small grains. The diagram illustrates the depth (in.) and distance from the seed row (in.) for the crown, seed, primary root, first seminal pair, and fertilizer band. The soil surface is marked at the top.]
QUESTIONS?
Conclusions

• Banding or injecting N often produces higher crop yields and lower weed density.
• Fertigation and foliar application allow for in-season N application, but do not result in much foliar uptake.
• Enhanced efficiency fertilizers (EEFs) have not produced consistently higher yields but more research is needed.
• More EEF can be placed with the seed than conventional fertilizer, possibly saving a fertilizer pass and fuel costs.
• Phosphorus should be banded near the seed to optimize yields especially if soil test is < ~12 ppm.
For additional information

• Soil Fertility Website:
  
  http://landresources.montana.edu/soilfertility

QUESTIONS?