Low Commodity Prices and Fertilizer Management – Where do we go from here?

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Fertilizing Corn in Minnesota

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In Minnesota, corn is grown on more acres than any other crop. Nationally, Minnesota ranks among the top five states in corn production. Average corn yields have improved steadily over the past several decades. While general fertilizer use contributed substantially to yield increases in the past, total fertilizer management which optimizes nutrient efficiency will be needed to increase future production and profitability.

philosophy/approach for determining N rate guidelines for corn.

Because of technology improvements in corn production practices such as weed and pest control, expected yield is not as important a factor in determining N rate as it has been in the past. Soil productivity has become a better indicator of N need. A majority of Minnesota soils are highly productive and have generally produced maximum economic corn yield with
MRTN Statistics: MN Database

• Last Update in 2011 (data from 1990-2010)
  – C-C Sites: 61
  – C-Sb Sites: 48

• Proposed Update: 2016
  – C-SB Sites: (1990-2016) 83
  – C-C Sites (1996-2016) 60
  – C-C EONR values are relatively low during the 1990

• We cannot throw out all of the data without hurting the integrity of the database, but we probably could get rid of some of the early years.
<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Sites</th>
<th>Average EONR(0.10) (lb N/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1995</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>2000</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>2005</td>
<td>8</td>
<td>150</td>
</tr>
<tr>
<td>2010</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>2015</td>
<td>12</td>
<td>250</td>
</tr>
</tbody>
</table>
Corn – Soybean (0.10 ratio)

- Frequency of Economic Optimum N Rate

Corn – Corn (0.10 ratio)

- Frequency of Economic Optimum N Rate

Relationship Between Economic Optimum N and Yield
CNRC - Comments

• Corn N Rate Calculator website was updated in 2016 and has a different link
  – http://cnrc.agron.iastate.edu/

• The output I have shared can be found on the website

• I have taken over updating the site
  – Goal is to be more consistent with updates
    • i.e. – yearly update
Table 1. Guidelines for use of nitrogen fertilizer for corn grown following corn or soybean when supplemental irrigation is not used.

<table>
<thead>
<tr>
<th>N price/Crop value ratio</th>
<th>Corn/Corn MRTN</th>
<th>Acceptable range</th>
<th>Soybean/Corn MRTN</th>
<th>Acceptable range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>180</td>
<td>160 to 200</td>
<td>140</td>
<td>125 to 160</td>
</tr>
<tr>
<td>0.10</td>
<td>155</td>
<td>145 to 170</td>
<td>120</td>
<td>105 to 130</td>
</tr>
<tr>
<td>0.15</td>
<td>150</td>
<td>140 to 155</td>
<td>105</td>
<td>95 to 115</td>
</tr>
<tr>
<td>0.20</td>
<td>140</td>
<td>130 to 150</td>
<td>95</td>
<td>85 to 105</td>
</tr>
</tbody>
</table>
2015 – N Prediction Methods Study

Stewart, MN Sb-C
- Nicollet Cl
- 96 day RM planted 4/25
- 5.5 GPA 10-34-0
- 22” rows
- 32 lb N @ 2’
- Applied 40 lb of N as a base rate before side-dress

Waseca, MN C-C
- Webster Cl
- 101 day RM planted 5/1
- 2.5 GPA 10-34-0
- 30” rows
- 38 lb N @ 2’
- Applied 45 lb of N as a base rate before side-dress

Methods Used
1. Soil tests – 2’ pre-plant and 1’ PSNT
2. Active sensors – SPAD @ V5, V10, and R2; Crop Circle @ V5 and V10
3. Multispectral images @ V5, V10, and R2
4. Crop models
Crop Models – Side-dress application
40-45lb N Pre-Plant, 200 bu/ac yield goal

### Stewart, MN Sb-C: 40lb N

<table>
<thead>
<tr>
<th>Model</th>
<th>Stage</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>V5</td>
<td>-59 (99)</td>
</tr>
<tr>
<td></td>
<td>V10</td>
<td>-62 (102)</td>
</tr>
<tr>
<td>B</td>
<td>V5</td>
<td>-70 (110)</td>
</tr>
<tr>
<td></td>
<td>V10</td>
<td>-35 (75)</td>
</tr>
</tbody>
</table>

### Waseca, MN C-C: 45lb N

<table>
<thead>
<tr>
<th>Model</th>
<th>Stage</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>V5</td>
<td>-55 (90)</td>
</tr>
<tr>
<td></td>
<td>V10</td>
<td>-54 (89)</td>
</tr>
<tr>
<td>B</td>
<td>V5</td>
<td>-115 (160)</td>
</tr>
<tr>
<td></td>
<td>V10</td>
<td>-105 (150)</td>
</tr>
</tbody>
</table>

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**Average of Yield:**

![Graph showing yield over time for Stewart and Waseca locations with stages V5 and V10.]
Nitrogen Models: Good or Bad

• All models require a return to a yield goal system
• The most difficult factor to predict is N mineralization
  – I think most models overestimate this
• Some of our N loss pathways are underestimated – denitrification
• Soil parameters need to be measured in field
  – SURGO data is not the best information to use
• There is a reasonable end to when we should be looking to side-dress N ~ V10 no later
  – Beyond that should be considered a rescue treatment
• Yield goal is dynamic and is affected throughout the year
Final Points on N Guidelines

• Significant changes were made when N crediting for corn following alfalfa
• Irrigated corn has different suggested N rates than what was shown in the presentation
• The suggested N rates for marginal soils was left out of this update
  – There was no evidence of a difference in N need
• The MRTN based system will still be suggested for use in Minnesota
• z.umn.edu/nutrientmgmt
Phosphorus and Potassium

• The primary changes were made to the expected yield levels
• The guidelines are still mostly based on sufficiency values and not on a build + maintenance
  – Suggestions will be conservative for medium to high soil test levels
• Removal of P and K in grain was included in the update
What is the meaning of low P?

• Think of your soil test as a probability function
• Soils which test low in P or K should have a low potential to supply required nutrients
• Currently it is easier to generate this data for P than for K

Table 8. Corn grain yield response to applied P fertilizer based on soil test category.

<table>
<thead>
<tr>
<th>BRAY-P1 OR OLESEN SOIL TEST P CATEGORY</th>
<th>EXPECTED TIME P FERTILIZER WILL INCREASE CORN GRAIN YIELD</th>
<th>EXPECTED YIELD WITHOUT P FERTILIZER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>Low</td>
<td>83</td>
<td>90</td>
</tr>
<tr>
<td>Medium</td>
<td>27</td>
<td>98</td>
</tr>
<tr>
<td>High</td>
<td>13</td>
<td>99</td>
</tr>
<tr>
<td>Very High</td>
<td>7</td>
<td>99</td>
</tr>
</tbody>
</table>
Fertilizer Strategies

**Sufficiency**
- Apply based on crop needs
- Lower rates of P particularly near the critical level
- More diligent soil sampling
- Maximize economic return to P
- May not achieve the maximum yield each year

**Build and Maintain**
- Maximize yield potential
- Apply P based on a strategy related to crop removal
- Soil sampling is a monitoring tool
- Less return per lb of P applied near the critical level
- Build rates vary by soil

*Soil Fertility*
Critical Soil Test P Levels

Critical soil test P level at selected relative corn grain yield levels

<table>
<thead>
<tr>
<th>Soil Test</th>
<th>95%</th>
<th>98%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bray-P1</td>
<td>10</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Olsen</td>
<td>9</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Mehlich-3</td>
<td>14</td>
<td>19</td>
<td>19</td>
</tr>
</tbody>
</table>

Critical soil test P level at selected relative soybean grain yield levels

<table>
<thead>
<tr>
<th>Soil Test</th>
<th>95%</th>
<th>98%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bray-P1</td>
<td>12</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Olsen</td>
<td>8</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

Critical level is typically defined as the soil test at 95% relative yield
Nutrient Removal Values
Updated through 2015

Corn
• P: n=7806
• K: n=4958
• Removal in lbs/bu
  – P$_2$O$_5$ – 0.28
  – K$_2$O – 0.19

Soybean
• P: n=5071
• K: n=4427
• Removal in lbs/bu
  – P$_2$O$_5$ – 0.69
  – K$_2$O – 1.09

• Values are generated from sites where responses to P or K may or may not have occurred
• Values are median values for removal
  • Actual values may be +/- 10%
  • Mean and median for the dataset are similar

Soil Fertility
## Build and Maintain Strategies

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Soil Test Change when applying P or K based on crop removal</th>
<th>Annual P or K application required to Maintain Soil Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>------ppm yr⁻¹-----</td>
<td>--lb P₂O₅ ac⁻¹ yr⁻¹------</td>
</tr>
<tr>
<td>Phosphorus</td>
<td></td>
<td><strong>Lamberton</strong></td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Morris</strong></td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Saint Charles</strong></td>
<td>1.0</td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
<td><strong>Delavan</strong></td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Lamberton</strong></td>
<td>7.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Morris</strong></td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Saint Charles</strong></td>
<td>1.0</td>
</tr>
</tbody>
</table>

### Phosphorus Values
- Lamberton: 2.4 ppm yr⁻¹, 14.3 lb P₂O₅ ac⁻¹ yr⁻¹
- Morris: 0.9 ppm yr⁻¹, 14.3 lb P₂O₅ ac⁻¹ yr⁻¹
- Saint Charles: 1.0 ppm yr⁻¹, 25.0 lb P₂O₅ ac⁻¹ yr⁻¹

### Potassium Values
- Delavan: 12.0 ppm, 7.9 lb K₂O ac⁻¹ yr⁻¹
- Lamberton: 7.9 ppm, 12.0 lb K₂O ac⁻¹ yr⁻¹
- Morris: 9.3 ppm, 9.3 lb K₂O ac⁻¹ yr⁻¹
- Saint Charles: 1.0 ppm, 25.0 lb K₂O ac⁻¹ yr⁻¹

### Regression Lines
- **Lamberton, MN**
  - Net P Applied (lbs P2O5/ac) vs. Change in Bray P Test (ppm)
  - $y = 0.08x + 16.85$
  - $R^2 = 0.73$

- **Morris, MN**
  - Net P Applied (lbs P2O5/ac) vs. Change in Olsen P Test (ppm)
  - $y = 0.04x + 6.05$
  - $R^2 = 0.81$

- **St Charles, MN**
  - Net P Applied (lbs P2O5/ac) vs. Change in Bray P Test (ppm)
  - $y = 0.04x + 7.23$
  - $R^2 = 0.64$

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**Soil Test**

- **Lamberton**
  - 14.3 ppm
- **Morris**
  - 14.3 ppm
- **Saint Charles**
  - 25.0 ppm

---

**Fertilizer Application**

- **Bray P-1**
  - Lamberton: 14.3 lb/acre
  - Morris: 14.3 lb/acre
  - Saint Charles: 25.0 lb/acre

- **Olsen P**
  - Lamberton: 25.0 lb/acre
  - Morris: 25.0 lb/acre
  - Saint Charles: 50.0 lb/acre

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**Driven to Discover**
Key Points on Build + Maintain

• Exact maintenance is likely not required to maintain soil test values
  – Question – if crop removal is not used will mining of the soil occur?
  – If any P fertilizer is applied drawdown of soil P is slow
• Exact Removal will likely increase soil test P
• Concentration of P in the grain is a moving target so using an average value may apply more or less than removal depending on the hybrid/variety
• Better to build slowly over time
## PKS Study Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Bray P1-P</th>
<th>NH₄OAC-K</th>
<th>SOM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>YR 1</td>
<td>YR3</td>
<td>YR5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Est.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Red Wing</td>
<td>2011</td>
<td>SiL</td>
<td>34</td>
<td>29</td>
</tr>
<tr>
<td>Rochester</td>
<td></td>
<td>L</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>Becker</td>
<td>2012</td>
<td>LS</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Lamberton</td>
<td></td>
<td>L</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

YR3 & YR5 data represents the average value for the control (No P, K, or S). Colors represent expected response to applied fertilizer: blue – low, green – moderate, red - high.
## Net Return over the Rotation

### Table: Nutrient Rate

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Rate</th>
<th>2 yr</th>
<th>4 yr</th>
<th>6 yr</th>
<th>Total</th>
<th>2 yr</th>
<th>4 yr</th>
<th>6 yr</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus</td>
<td>120</td>
<td>0.0</td>
<td>-48.0</td>
<td>80.0</td>
<td>32</td>
<td>-48.0</td>
<td>-96.0</td>
<td>-8.0</td>
<td>-152</td>
</tr>
<tr>
<td>200</td>
<td>-44.0</td>
<td>47.0</td>
<td>56.0</td>
<td>59</td>
<td>-80.0</td>
<td>-60.0</td>
<td>-11.0</td>
<td>-151</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>-84.0</td>
<td>30.0</td>
<td>16.0</td>
<td>-38</td>
<td>-120.0</td>
<td>-100.0</td>
<td>-51.0</td>
<td>-271</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>100</td>
<td>-4.0</td>
<td>31.0</td>
<td>96.0</td>
<td>123</td>
<td>-40.0</td>
<td>-50.0</td>
<td>4.0</td>
<td>-86</td>
</tr>
<tr>
<td>Sulfur</td>
<td>25</td>
<td>15.5</td>
<td>148.0</td>
<td>180.5</td>
<td>344</td>
<td>-12.5</td>
<td>59.0</td>
<td>73.0</td>
<td>119.5</td>
</tr>
</tbody>
</table>

- **P** rates are in lb P$_2$O$_5$/ac - 0.40/lb
- **K** rates are in lb K$_2$O/ac – $0.40/lb
- **S** - $0.50/lb  Corn $4/bu  Beans $10/bu
- Applied P and K rate may not be the “optimum rate” for each site
- Application cost is not factored into net return
## Net Return over the Rotation

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Rate</th>
<th>2 yr</th>
<th>4 yr</th>
<th>6 yr**</th>
<th>Total</th>
<th>2 yr</th>
<th>4 yr</th>
<th>6 yr**</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus</td>
<td>120</td>
<td>-16.0</td>
<td>58.0</td>
<td>108</td>
<td>150</td>
<td>-48.0</td>
<td>58.0</td>
<td>40.0</td>
<td>50</td>
</tr>
<tr>
<td>Potassium</td>
<td>100</td>
<td>-84.0</td>
<td>-40.0</td>
<td>-40.0</td>
<td>-164</td>
<td>-40.0</td>
<td>40.0</td>
<td>4.0</td>
<td>4</td>
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<tr>
<td></td>
<td>200</td>
<td>-144.0</td>
<td>-80.0</td>
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<td>-304</td>
<td>-80.0</td>
<td>0.0</td>
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<td>-116</td>
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<td>-120.0</td>
<td>-120.0</td>
<td>-464</td>
<td>-120.0</td>
<td>-40.0</td>
<td>-76.0</td>
<td>-236</td>
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<tr>
<td>Sulfur</td>
<td>25</td>
<td>-12.5</td>
<td>-12.5</td>
<td>-12.5</td>
<td>-37.5</td>
<td>15.5</td>
<td>-12.5</td>
<td>-12.5</td>
<td>-9.5</td>
</tr>
</tbody>
</table>

- P rates are in lb P$_2$O$_5$/ac - 0.40/lb
- K rates are in lb K$_2$O/ac – $0.40/lb
- S - $0.50/lb  Corn $4/bu  Beans $10/bu
- Applied P and K rate may not be the “optimum rate” for each site
- Application cost is not factored into net return

"only 2016 corn data included"
What is the most economical Rate of P For a 2-year rotation?

<table>
<thead>
<tr>
<th>Block</th>
<th>EOPR -lb P₂O₅/ac-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamberton</td>
<td>1 42</td>
</tr>
<tr>
<td>Morris</td>
<td>2 27</td>
</tr>
<tr>
<td>Saint</td>
<td>1 50</td>
</tr>
<tr>
<td>Charles</td>
<td>2 87</td>
</tr>
</tbody>
</table>

$4 Corn  
$10 Soybean  
$0.40/lb P₂O₅

- Beginning soil test P was low for all blocks except for Morris B1 which was medium
- Soil pH: Lamberton 5.4; Morris 8.0; St Charles 6.3
- Values were averaged over 8 years of data
- EOPR – economic optimum P rate
2-Year Summary –
Corn Response to P based on STP Class
Average of 12 locations

Grain yield (bu ac⁻¹)

- P  + P  - P  + P  - P  + P  - P  + P

LOW MEDIUM HIGH V.HIGH

c a b a ab ab ab

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2016 Corn Response to P applied based on P applied in 2015 - Average of 6 locations

Grain yield (bu ac⁻¹)

- P  + P  - P  + P  - P  + P  - P  + P

LOW  MEDIUM  HIGH  V.HIGH

- P  + P  - P  + P  - P  + P  - P  + P

Soil Fertility

2016 Corn Response to P applied based on P applied in 2015 - Average of 6 locations

Grain yield (bu ac⁻¹)

- P  + P  - P  + P  - P  + P  - P  + P

LOW  MEDIUM  HIGH  V.HIGH

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Economics of P Fertilization

• It is difficult to evaluate economics of a maintenance type strategy
  – In the short term it costs more
  – In the long term???
• Data indicates a sufficiency type approach would be more profitable
  – How long can that approach be maintained?
  – Soil sampling needs to be increased
• How do low-input, starter only strategies fit
Starter Response 2012-2015

1) Response to starter across soil test P classes only when broadcast P was applied
   • Response to 2.5 GPA
2) Response to broadcast P, but only when soil P was less than 15 ppm olsen

Why did starter increase yield regardless of STP class but broadcast P did not?
Low Input Strategy-Summary

- Increased early growth DOES NOT indicate where an increase in yield will occur
- Yield response is still dictated by soil test of the soil where the treatment is applied
- Starter should supplement the entire fertility program
- 2.5-5 Gallons of 10-34-0 is a good option
- Applying more than 5 GPA 10-34-0 is risky and there is no economic benefit
- Decreased grain moisture is a possibility but target fields where grain moisture content at harvest will be >20%
  - Do not band a rate that provides more $P_2O_5$ than the crop needs factoring in all amounts of P applied.
What is the most economical Rate of K For a 2-year rotation?

- **Delavan Block 1**
  - K Cost
  - Gross Return
  - Net Return

- **Lamberton Block 1**
  - K Cost
  - Gross Return
  - Net Return

- **Morris Block 1**
  - K Cost
  - Gross Return
  - Net Return

| Block | EOKR -lb K₂O/ac-
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Delavan</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Lamberton</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Morris</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

- Beginning soil test K was High for all blocks except for Lamberton B1 which was medium
- Values were averaged over 8 years of data
- EOKR – economic optimum K rate

$4 Corn
$10 Soybean
$0.40/lb K₂O
P&K: Where do we go from here?

• Suggested rates in the new publication should result in a slow build of P and K for low soil tests – then what do you do?
• There is no overwhelming evidence to economically justify maintaining high-very high soil test
  – More economically justified to apply maintenance for medium-high soil tests
• Is there a future for reductions in P or K application when banding?
• I would strongly caution against using yield maps from the previous crop to generate fertilizer maps
  – How accurate is your yield monitor?
• Can starter fertilizer be incorporated and maintain high yield
Sulfur Guideline Changes

- New guidelines assume a sulfate source is being used.
- Application of elemental S is risky if being applied to a S deficient situation.
- No reason to exceed a rate of 25 lbs S/ac.

Table 12. Broadcast Sulfate-Sulfur guidelines for corn grown in Minnesota

<table>
<thead>
<tr>
<th>Soil Organic Matter Concentration</th>
<th>0-6” Soil Organic Matter Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop Rotation</td>
<td>lb S/acre as SO₄-S</td>
</tr>
<tr>
<td>Soybean/Corn</td>
<td>0-2%</td>
</tr>
<tr>
<td>Corn/Corn</td>
<td>2-4%</td>
</tr>
<tr>
<td>Sandy Soils</td>
<td>4%+</td>
</tr>
</tbody>
</table>

- Soybean/Corn: 10-25 10-15 0*
- Corn/Corn: 10-25 10-15 5-10**
- Sandy Soils: 25 25-25 15-25

*Research data suggest that a rate of 10 lbs of sulfate S may be warranted when corn follows soybean on poorly drained calcareous soils.
**A low rate of S is suggested when corn follows corn and SOM is 4% or greater. A rate of 10-15 lbs of S is suggested for corn following corn on reduced tillage in the presence of high levels of surface residue.
Sulfur Guideline Footnotes

• We are suggesting a set rate of S being applied for corn on corn in high residue situations

• Sulfur research projects are underway:
  – Comparing application methods of liquid ATS
    • Thiosulfate is a source of sulfate and elemental S
  – Fall versus spring rate and source on poorly drained soils with organic matter % >4.0
  – Timing and source in SE Minnesota

• Sulfur mineralization is affected by year

• Sulfur can carry over in medium and fine textured soils
## Chelated Zinc With 10-34-0 - Corn

<table>
<thead>
<tr>
<th>Site</th>
<th>Control</th>
<th>10-34-0</th>
<th>10-34-0 + Zn</th>
<th>ST – Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>--------</td>
<td>---------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>bushels/ac</td>
<td></td>
<td>---ppm---</td>
<td></td>
</tr>
<tr>
<td>Murdock ’12</td>
<td>194</td>
<td>192</td>
<td>192</td>
<td>2.8</td>
</tr>
<tr>
<td>Waseca ’12</td>
<td>188</td>
<td>189</td>
<td>200**</td>
<td>1.4</td>
</tr>
<tr>
<td>St Charles ’13</td>
<td>204</td>
<td>198</td>
<td>197</td>
<td>1.7</td>
</tr>
<tr>
<td>Willmar ’13</td>
<td>159b</td>
<td>173a</td>
<td>172a</td>
<td>1.0</td>
</tr>
<tr>
<td>Prinsburg ’14</td>
<td>200</td>
<td>209</td>
<td>204</td>
<td>2.6</td>
</tr>
<tr>
<td>Stewart ’14</td>
<td>162</td>
<td>167</td>
<td>162</td>
<td>1.3</td>
</tr>
<tr>
<td>Becker ’15</td>
<td>179</td>
<td>192</td>
<td>184</td>
<td>1.1</td>
</tr>
<tr>
<td>Lamberton ’15</td>
<td>214</td>
<td>213</td>
<td>212</td>
<td>0.6</td>
</tr>
<tr>
<td>Becker ’16</td>
<td>228</td>
<td>234</td>
<td>228</td>
<td>1.8</td>
</tr>
<tr>
<td>Lamberton ’16</td>
<td>201</td>
<td>201</td>
<td>201</td>
<td>0.5</td>
</tr>
</tbody>
</table>

- 2.5-6 gpa + 1 qt/ac (10% fully chelated zinc with citric acid/EDTA)
- **Indicates a potential response to Zn. Individual plot yield was highly variable for the treatment (min 168 and max 228), no response for treatment with Zn only.
Take Home Message on Zn

• Rate and critical soil test level (0.75ppm) seem to still hold – better response when <0.5ppm

• We have not seen hard evidence that Zinc deficiencies in corn are occurring in situations not traditionally responsive to Zn
  – Likely will not benefit a starter program for high Zn soils

• The current research on Zn-chelates do not overwhelmingly support application in starter to all acres

• Recommendation – Target low testing field areas with broadcast zinc for the highest return
Thank You
Questions?

SW&C Field Crew
Cooperators and Consultants

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AFREC
Appalachian Fertilizer Research & Education Council

Minnesota Corn Growers Association

MN Soybean Research & Promotion Council