Influence of Phosphorus and Potassium Rates in a Multi-year Spring Wheat-Soybean Crop Rotation

Prairie Grains Conference
December 12th, 2019

University of Minnesota
Long Term Rotation Trials in Field Crops

• More challenges with site selection and methodologies compared to single year trials
• Must have strong project cooperation and coordination
• Project concept discussed for several years
• Project partners: AFREC, MN Wheat Growers, Soybean Growers, U of MN and farmer cooperators
Research Objectives

• To establish long term crop rotation trials (4 year minimum) in wheat and soybeans
• Conduct small plot replicated research to determine the influence of elevated level of P and K on wheat and soybean growth, development, yield and seed quality
• Partner with the MN Wheat Growers, OFN to determine if current P and K recommendations provide adequate fertility in a high yield wheat-soybean crop rotation
Project Will Incorporate Both Small Replicated and Large On-Farm Trials

Small Plot Replicated Research

Large On-Farm Trials
USDA District 10 - NW MN

- 11 Counties area in NW MN
- Soybean acres
  - 2007 = 1,106,000
  - 2017 = 1,813,000
- Soybean Yields (bu/ac)
  - 2007 = 35.7
  - 2017 = 34.1
- Wheat Yields (bu/ac)
  - 2007 = 50.4
  - 2017 = 65.8
NW MN Soils

What do we know?

- Glacial Lake Agassiz is the origin of area soils
- Reduced nutrient uptake by plant roots in cold soils
- High pH soils limit nutrient uptake
- A 50 bu bean crop removes: 40# P2O5 & 70# K2O, and 80 bu wheat 50 # P and 30# K
- 7-30-30 going backwards. ‘Mining’ of the soil to supply P&K

Law of the Minimum
% Soil Samples with Soil pH greater than 7.3

Fall 2017 samples (0-6” samples)
% Soil Samples with Phosphorus less than 10 ppm

Fall 2017 samples
(0-6” samples)
(Olsen P test)
% Soil Samples with Potassium less than 150 ppm

Fall 2017 samples (0-6” samples)
Project Specifics

• Crop rotation: wheat-soybean-wheat-soybean
• Manage wheat for 80 and soybeans for 50 bu/ac
• Trial design: RCB with 4 replications
• Soil samples collected in spring prior to planting in 2019 and after harvest in years 2-4
• Tissue samples collected at early tillering in wheat and early bloom in soybeans
• Early season crop vigor, yield and grain quality
Project Specifics - Continued

• Soil samples at two depths (0-6 & 6-24) in year 1&4, and one depth (0-6) in years 2&3
• Complete analysis in year 1&4 and P&K in year 2&3
• Relative chlorophyll meter index readings mid-season and plant height at maturity
• Soil and plant tissue analysis will help determine if elevated P&K levels are causing an interaction with other plant nutrients (e.g. P & Zn, K & Ca, N, Mg)
Project Teams

U of MN Small Plot Research
- Dr. Nancy Ehlke
- Mr. Donn Vellekson
- Dr. Dave Grafstrom
- Summer intern/s

MN Wheat OFRN
- Lauren Proulx
- Missy Geiszler
- Summer Intern/s
2019 P&K Trial Locations

• 2 On-Farm
• 2 Small Plot

Image credit: http://www.minnnesota-map.org/road-map.htm
Magnusson Research Farm
Small Plot and On-Farm Trials - 2019

Small Plot Replicated Trials
- Established 2 sites in 2019
- 15 treatments + Untreated = 16
- P source 11-52-0 & 0-46-0
- K source 0-0-60
- Rates: 20, 40, 60, 80 & 100 units of each product and combination
- Product applied in the spring of first year and after harvest in year 2-4

On-Farm Research Trials
- Established 2 sites in 2019
- MN Wheat Growers OFRN
- Two treatments:
  - Farmer Practice (FP)
  - FP plus 50 units additional P & K
- Fertilizer treatments applied in the spring of year one and will have 50 additional units after harvest in years 2-4
Rainfall and Temperatures - May to August

Percent of Normal Rainfall
(2019-05-01 - 2019-08-31)
North Dakota Agricultural Weather Network (NDAWN)

Departure from Normal Daily Average Air Temperature
(2019-05-01 - 2019-08-31)
North Dakota Agricultural Weather Network (NDAWN)
Total Rainfall and Departure from Average

Monthly Rainfall

- May
- June
- July
- August
- Sept

Average vs. 2019 comparisons for each month.

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Background Soil Test Information

Small Plot Wheat Trial
- Soil test 0-6 inch
- OM - 2.8%
- PH - 8.2
- Nitrates - 9 #/ac
- P (Olsen) - 6 ppm
- K - 154 ppm
- S - 14 #/ac
- Soluble salts 0.23

Small Plot Soybean Trial
- Soil test 0-6 inch
- OM - 2.8%
- PH - 7.8
- Nitrates - NA
- P (Olsen) - 23 ppm
- K - 166 ppm
- S - 34 #/ac
- Soluble salts 0.4
Small Plot Trial Methods

Wheat Trial
- Nitrogen (urea) applied PPI, a total of @ 160 #/ac for all plots
- P&K treatments were applied by hand to the entire 6’x15’plot
- 11-52-0 was P source, nitrogen subtracted to equalize N rate
- Linkert wheat seeded @ 120 #/ac on 5/11/19
- BMP used for weed, disease and insect control
- Plots harvested on 9/2/19

Soybean Trial
- Asgrow AG005X8 seeded at 225,000 seeds/ac (181,000) final plant population on 5/17/19
- P&K treatments were applied by hand to the entire 6’x15’plot
- 0-46-0 was P source
- BMP used for weed, disease and insect control
- Plots harvested on 10/31/19
## Small Plot Wheat and Soybean Trial Summary - 2019

### Wheat

<table>
<thead>
<tr>
<th>P &amp; K</th>
<th>Bu/Acre</th>
<th>Wt./Bu</th>
<th>Protein³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20-0</td>
<td>85.0</td>
<td>60.3</td>
<td>15.3</td>
</tr>
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<td>0-40-0</td>
<td>86.3</td>
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<td>15.3</td>
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<td>0-60-0</td>
<td>87.3</td>
<td>60.2</td>
<td>15.1</td>
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<tr>
<td>0-80-0</td>
<td>85.3</td>
<td>60.3</td>
<td>15.1</td>
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<td>0-100-0</td>
<td>92.8</td>
<td>60.2</td>
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<tr>
<td>0-0-20</td>
<td>81.3</td>
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<td>0-0-80</td>
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<td>0-0-100</td>
<td>82.5</td>
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<tr>
<td>0-20-20</td>
<td>89.0</td>
<td>60.1</td>
<td>15.3</td>
</tr>
<tr>
<td>0-40-40</td>
<td>86.5</td>
<td>60.1</td>
<td>15.2</td>
</tr>
<tr>
<td>0-60-60</td>
<td>85.3</td>
<td>60.2</td>
<td>15.1</td>
</tr>
<tr>
<td>0-80-80</td>
<td>77.5</td>
<td>60.0</td>
<td>15.3</td>
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<td>15.3</td>
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</tbody>
</table>

**LSD @5% level**

<table>
<thead>
<tr>
<th></th>
<th>8.6</th>
<th>0.3</th>
<th>0.2</th>
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**LSD @10% level**

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<tr>
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<th>7.2</th>
<th>0.2</th>
<th>0.2</th>
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</table>

**CV(%)**

|                           | 7.2 | 0.3 | 1.1 |

### Soybean

<table>
<thead>
<tr>
<th></th>
<th>Bu/Acre</th>
<th>Wt./Bu</th>
<th>Protein³</th>
<th>Oil³</th>
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<tbody>
<tr>
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<td>65.3</td>
<td>57.4</td>
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<tr>
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<td>62.0</td>
<td>57.5</td>
<td>37.1</td>
<td>20.4</td>
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<tr>
<td>0-60-0</td>
<td>61.5</td>
<td>57.2</td>
<td>37.4</td>
<td>20.5</td>
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<tr>
<td>0-80-0</td>
<td>61.0</td>
<td>57.5</td>
<td>36.9</td>
<td>19.6</td>
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<td>0-100-0</td>
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<td>57.3</td>
<td>37.0</td>
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<td>37.0</td>
<td>20.4</td>
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<td>67.5</td>
<td>57.5</td>
<td>36.9</td>
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<tr>
<td>0-0-80</td>
<td>61.5</td>
<td>57.5</td>
<td>37.0</td>
<td>20.0</td>
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<tr>
<td>0-0-100</td>
<td>68.0</td>
<td>57.4</td>
<td>37.0</td>
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<td>57.3</td>
<td>37.4</td>
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<tr>
<td>0-0-0</td>
<td>61.7</td>
<td>57.3</td>
<td>36.9</td>
<td>19.9</td>
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</tbody>
</table>

**LSD @5% level**

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<thead>
<tr>
<th></th>
<th>7.7(ns)</th>
<th>0.4</th>
<th>NS</th>
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</table>

**LSD @10% level**

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<tr>
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<th>6.4</th>
<th>0.3</th>
<th>0.8</th>
</tr>
</thead>
</table>

**CV(%)**

<table>
<thead>
<tr>
<th></th>
<th>8.5</th>
<th>0.5</th>
<th>1.8</th>
</tr>
</thead>
</table>

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Wheat Yield Influenced by P Rate

![Bar graph showing wheat yield influenced by P rate. The x-axis represents P rate levels (0-0-0, 0-20-0, 0-40-0, 0-60-0, 0-80-0, 0-100-0) and the y-axis represents yield in Bu/acre. The graph indicates an increase in yield as the P rate increases.]
Wheat Protein Influenced by K Rate
Soybean Yield Influenced by K Rate

Yield (bu/ac)
Large On-Farm Trial - Methods

**Wheat Trial**
- Location: Baudette
- Plot size 70’ by length of field
- WB 9590 seeded on 5/15/19
- 2.9% OM
- P - 7 ppm
- K - 109 ppm
- Trial harvested on 9/8/19

**Soybean Trial**
- Location: Elbow Lake
- Plot size 70’ by length of field
- LG C1000RX
- 4.7% OM
- P - 13 ppm
- K - 171 ppm
- Trial harvested on 10/26/19
### Large Plot Trial Results - 2019

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No treatment differences</td>
<td>• No treatment differences</td>
</tr>
<tr>
<td>• FP - Wheat yield = 90.3 bu/ac</td>
<td>• FP Soybean yield 53.9 bu/ac</td>
</tr>
<tr>
<td>• Elevated P&amp;K = 90.8 bu/ac</td>
<td>• Elevated P&amp;K = 55.8 bu/ac</td>
</tr>
<tr>
<td>• FP - Protein = 11.5%</td>
<td>• FP Test wt = 57.3 #/bu</td>
</tr>
<tr>
<td>• Elevated P&amp;K = 11.1%</td>
<td>• Elevated P&amp;K = 57.6 #/bu</td>
</tr>
<tr>
<td>• FP - Test wt = 59.4 #/bu</td>
<td></td>
</tr>
<tr>
<td>• Elevated P&amp;K = 59 #/bu</td>
<td></td>
</tr>
</tbody>
</table>
First Year Summary – 2019

• Two small plot and two on-farm trials initiated
• Goal is to add 3-5 on-farm trial locations in 2020
• On-farm soybean trial: No treatment differences
• On-farm wheat: No treatment differences (over 90 bu/ac)
• Small plot wheat: A trend for increased wheat yield with as P rate increased. Wheat protein increased with higher level of K
• Small plot soybean: No treatment differences (over 60 bu/ac)
2019 P&K Trial Locations

- 2 On-Farm
- 2 Small Plot
Questions