Soybean Response to Potassium Fertility and Fertilizer in Manitoba

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Background

Objectives & Methodology

Research Objectives:
1. Determine the frequency of soybean yield response to K fertilizer additions across a range of soil test K levels and soil types
2. Assess the effectiveness of different combinations of potash rates and placements, for increasing soybean seed yield
3. Investigate the capacity for MB soils to retain added K in non-exchangeable forms, which may not be available for crop uptake

Methodology: SMALL PLOT TRIALS
- 7 site years were established, over two field seasons (2017 & 2018), in commercial fields with STK levels ranging from 49 – 117 ppm
- 3m x 8m plots were planted with a John Deere 1755 4-row precision planter, at 30” spacing
- Measurements included:
  - Spring NH4OAc STK
  - PRS* probe K supply rates
  - Midseason tissue K concentration and uptake
  - Seed yield, K concentration, oil, and protein content

Methodology: ON-FARM TRIALS
- 20 site years were established over two field seasons (2017 & 2018) in commercial fields with STK values ranging from 52–235 ppm
- In cooperation with MB Pulse and Soybean Growers
- Replicated strip trials with one treatment at each location
- Measurements included:
  - Spring NH4OAc STK
  - Midseason paired soil & plant tissue samples
  - Seed yield and K concentration from midseason sampling points
  - Seed yield for whole strips

Results

Table 1. Current K recommendations for MB soybean production (MB Soil Fertility Guide)

<table>
<thead>
<tr>
<th>Ammonium Acetate STK level</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;100 ppm</td>
<td>No additional K</td>
</tr>
<tr>
<td>50 – 75 ppm</td>
<td>30 lb K2O/ac broadcast &amp; incorporated</td>
</tr>
<tr>
<td>&lt;25 ppm</td>
<td>60 lb K2O/ac broadcast &amp; incorporated</td>
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</tbody>
</table>

Table 2. Combinations of spring applied potash rates and placements for small plot trials

<table>
<thead>
<tr>
<th>Placement</th>
<th>Rate (lb K2O/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sidebanded</td>
<td>30</td>
</tr>
<tr>
<td>Broadcast &amp; Incorporated</td>
<td>60</td>
</tr>
<tr>
<td>Banded</td>
<td>120</td>
</tr>
</tbody>
</table>

Figure 1. Harvested acres of major MB crops

Current K fertility recommendations for MB soybean production are…
- based on very limited historical data (two site years harvested in early 1980s)
- the same K fertility recommendations for spring wheat and canola production
- lower than what is currently recommended in ND, MN and Ontario

Table 3. 2017 On-farm trial statistically significant yield responses

<table>
<thead>
<tr>
<th>Trial</th>
<th>NH4OAc STK</th>
<th>Trt yield/Control yield</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin Borders</td>
<td>155 ppm</td>
<td>47.5 / 45.3</td>
<td>0.0235</td>
</tr>
<tr>
<td>Portage la Prairie</td>
<td>76 ppm</td>
<td>41.7 / 36.8</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Figure 2. Annual K2O removal in MB

Figure 3. Expected relationship between relative yield and NH4OAc STK based on current soil test recommendations

Figure 4. 2017 On-farm trial relative yield and NH4OAc STK levels

Figure 5. 2017/18 small plot trial relative yield and dry soil NH4OAc STK for 132 kg K2O/ac broadcast & incorporated (left) and 66 kg K2O/ac sidebanded (right)

Figure 6. 2017/18 small plot trial relative yield and moist soil NH4OAc STK for 132 lb K2O/ac broadcast & incorporated (left) and 66 lb K2O/ac sidebanded (right)

Figure 7. Difference in yield between soybean with and without 120 lb K2O/ac, and barley with and without 120 lb K2O/ac across three site years

Conclusions and Discussion

Frequency of yield response to fertilizer K:
- 2017 On-farm trials: 4 of 14 sites responded statistically significantly to K addition (two positive responses, two negative responses)
- No agronomically significant relationship between ammonium acetate STK level and relative yield in the on-farm (or small plot) trials

Effectiveness of K fertilizer rate & placement:
- 2017/18 Small plot trials: no statistically significant yield response to any treatment in any site year
- Optimum rate & placement of K fertilizer not determined, due to lack of yield response to K fertilizer

Challenges for measuring response to K fertilizer rate & placement:
1. Moisture was a yield limiting factor, with lower than average rainfall in 2017 & 2018
2. Lack of moisture prevented achieving maximum yield, demand for K may not have been as great
3. Variability within the sites (pictured left)
4. NH4OAc STK was not a reliable indicator for K response, or selection of K responsive sites

Under the growing conditions in these field trials (i.e., with the variability within sites and lack of moisture), the NH4OAc test was not well correlated with K response
- Under different conditions, the test could prove more reliable as an indicator of K response

Next Steps

Questions:
- Are soybeans able to access more soil K than other crops?
- Are our soils releasing significantly more K over the growing season than we anticipate with our NH4OAc spring soil test?
- Is there yield loss in K deficient patches, and if so, what is the extent of that loss?
- How do we make K recommendations if the response is unpredictable?

Additional Measurements to be Further Investigated:
- Midseason plant tissue K from on-farm and small plot trials
- Soybean/soybean K responsiveness comparison study (tissue K and yield data)
- Plant Root Simulator* probe K supply rate data
- Chemistry study: fertilizer K distribution among soil K pools

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Manitoba Pulse and Soybean Growers, Western Grains Research Foundation, Nutrien/Agrium, Monsanto-Dekalb, Western Ag Labs, University of Manitoba, University of Manitoba Graduate Fellowship, Manitoba Graduate Scholarship

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Figure 8. Variability of K deficiency symptoms at Long Plain, 2018