Field Pea Input Optimization

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Background

• Many agronomic studies have been conducted on one aspect of field pea production
• The effect on yield when many agronomic factors are combined is unknown
• It is unknown what factors may affect yield more than others
Previous Field Pea Research

1) Seeding rate
2) Seed treatment
3) Inoculant
4) Starter fertilizer
5) Foliar fungicide
Seeding Rate

- Seed weight declined as pea density increased.
- Estimated optimum seeding rate for yield was 108 seeds/m² (80 plants/m²).
- Yield increases were small at seeding rates >50 plants/m².
- Yield was reduced with seeding rates <50 plants/m².

Seeding Rate and Weed Control

- Increasing stand density reduced weed populations
- Growth habit didn’t affect number of weeds
- Field pea yield increased with increasing seeding rate to a rate between 50-100 seeds/m²

Inoculants

• Rhizobium inoculation can increase field pea seed yield and improve yield stability
• Previous research has found granular inoculant to be more effective than seed applied inoculants
Granular inoculant resulted in 17, 50 and 56% higher pea seed yield than peat, liquid or the uninoculated check, respectively.

<table>
<thead>
<tr>
<th>Inoculant formulation</th>
<th>Biomass (kg ha(^{-1}))</th>
<th>Seed yield (kg ha(^{-1}))</th>
<th>Harvest index</th>
<th>Seed protein (g kg(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granular</td>
<td>4190</td>
<td>4850</td>
<td>0.37</td>
<td>194</td>
</tr>
<tr>
<td>Peat powder</td>
<td>3810</td>
<td>4150</td>
<td>0.35</td>
<td>176</td>
</tr>
<tr>
<td>Liquid</td>
<td>3800</td>
<td>3230</td>
<td>0.33</td>
<td>170</td>
</tr>
<tr>
<td>Uninoculated</td>
<td>3740</td>
<td>3110</td>
<td>0.32</td>
<td>168</td>
</tr>
<tr>
<td>SE</td>
<td>67</td>
<td>68</td>
<td>0.02</td>
<td>2</td>
</tr>
</tbody>
</table>

Orthogonal contrasts

- Inoc vs. No inoc: NS
- Soil vs. Seed: ** NS
- Peat vs. Liquid: NS

\(^{a}\)Biomass dry matter at flatpod stage of pea growth.

* Significant at the 0.05 level of probability; ** Significant at the 0.01 level of probability; NS, not significant.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Inoculant</th>
<th>Formulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No inoculant</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Nodulator XL</td>
<td>Granular</td>
</tr>
<tr>
<td>3</td>
<td>Nodulator XL</td>
<td>Liquid</td>
</tr>
<tr>
<td>4</td>
<td>Nodulator XL</td>
<td>Peat</td>
</tr>
<tr>
<td>5</td>
<td>Cell-Tech</td>
<td>Granular</td>
</tr>
<tr>
<td>6</td>
<td>Cell-Tech</td>
<td>Liquid</td>
</tr>
<tr>
<td>7</td>
<td>Cell-Tech</td>
<td>Peat</td>
</tr>
<tr>
<td>8</td>
<td>TagTeam</td>
<td>Granular</td>
</tr>
<tr>
<td>9</td>
<td>TagTeam</td>
<td>Liquid</td>
</tr>
<tr>
<td>10</td>
<td>TagTeam</td>
<td>Peat</td>
</tr>
<tr>
<td>11</td>
<td>Optimize</td>
<td>Granular</td>
</tr>
<tr>
<td>12</td>
<td>PulseSignal II</td>
<td>Liquid</td>
</tr>
<tr>
<td>13</td>
<td>No inoculant + 60 lb/ac N</td>
<td>-</td>
</tr>
</tbody>
</table>
Methods

• 3 sites: Melfort, Swift Current, Scott
• Variables measured:
  - Biomass
  - Nodulation
  - Yield
## Results – Swift Current

<table>
<thead>
<tr>
<th>Orthogonal Contrasts</th>
<th>Yield (kg/ha)</th>
<th>Biomass (kg/ha)</th>
<th>Nodulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td>177</td>
<td>4103</td>
<td>9.8</td>
</tr>
<tr>
<td>Liquid</td>
<td>1886</td>
<td>4393</td>
<td>11.6</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>NS</td>
<td>NS</td>
<td>**</td>
</tr>
<tr>
<td>Check</td>
<td>1777</td>
<td>4103</td>
<td>9.8</td>
</tr>
<tr>
<td>Granular</td>
<td>1890</td>
<td>4399</td>
<td>11.4</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>NS</td>
<td>NS</td>
<td>**</td>
</tr>
</tbody>
</table>

** Significance at P <0.01; NS, not significant at P <0.05.

Nodulation Rating:
11-13 = effective nodulation
7-10 = nodulation less effective
1-6 = generally unsatisfactory nodulation
Starter Nitrogen Fertilizer

- Fertilizer N is known to have a negative effect on nodulation and $N_2$ fixation of legumes
- Small starter doses of fertilizer N can be beneficial to plant development, nodulation and $N_2$ fixation
- Research trials have found varying responses to starter N fertilizer
• Starter N improved pea yield in 24% of 58 trials conducted in Alberta (avg. yield increase = 9%)
• Greater benefit to starter N when spring soil test N was less than 18 lb/ac (average yield increase = 11%)

General Recommendations

**Seeding rate:** target 75 plants/m²

**Seed treatment:** recommended when spring conditions favour disease development or when inoculum levels are high

**Inoculant:** granular more effective than liquid or peat

**Starter fertilizer:** may provide a benefit with very low soil N levels

**Foliar fungicide:** recommended when conditions favour disease development
Field Pea Input Study

Objectives:

1) To determine which agronomic practices contribute most to field pea seed yield

2) To determine which combinations of agronomic practices produce the highest pea yield in different areas of Saskatchewan and provide the best economic return for producers
Materials and Methods

• Compare ‘full’ input package with ‘empty’ input package

• 4 sites: Melfort, Swift Current, Indian Head, Scott

• 3 year study (2012, 2013, 2014)
## Treatments

<table>
<thead>
<tr>
<th></th>
<th>Empty</th>
<th>Full</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td>CDC Meadow</td>
<td>CDC Meadow</td>
</tr>
<tr>
<td>Seeding rate</td>
<td>60 seeds/m²</td>
<td>120 seed/m²</td>
</tr>
<tr>
<td>Seed treatment</td>
<td>None</td>
<td>Apron Maxx RTA</td>
</tr>
<tr>
<td>Inoculant</td>
<td>Liquid</td>
<td>Granular</td>
</tr>
<tr>
<td>Starter fertilizer</td>
<td>None</td>
<td>30 lb/ac 46-0-0</td>
</tr>
<tr>
<td>Fungicide</td>
<td>None</td>
<td>2 applications (Headline EC + Priaxor DS)</td>
</tr>
</tbody>
</table>
Treatment List

1) Empty package
2) Full package
3) E + ST
4) E + SR
5) E + GI
6) E + Fz
7) E + Fn
8) E + ST + SR
9) E + ST + GI
10) E + Fz + GI
11) E + Fz + SR
12) E + SR + Fn
13) E + Fz + Fn
14) E + GI + Fn
15) E + ST + Fn
16) E + ST + Fz
17) E + SR + GI
18) E + ST + SR + GI + Fn
19) E + SR + GI + Fn
20) E + ST + GI + Fn
21) E + ST + SR + GI
22) E + ST + SR + Fn

ST – seed treatment
Fz – starter fertilizer
SR – seeding rate
Fn – foliar fungicide
GI – granular inoculant
Preliminary Results – 1st year of study
Yield - Scott

Kg ha\(^{-1}\)
Scott – Actual yield increase or decrease

Kg ha\(^{-1}\)

<table>
<thead>
<tr>
<th></th>
<th>E+ST</th>
<th>E+SR</th>
<th>E+GI</th>
<th>E+Fz</th>
<th>E+Fn</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>1268</td>
<td>902</td>
<td>573</td>
<td>392</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Addition
Scott – Actual yield increase or decrease

Removal

<table>
<thead>
<tr>
<th>Component</th>
<th>Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>-365 Kg/ha</td>
</tr>
<tr>
<td>F - Fz</td>
<td>-634 Kg/ha</td>
</tr>
<tr>
<td>F - Fz - ST</td>
<td>-918 Kg/ha</td>
</tr>
<tr>
<td>F - Fz - SR</td>
<td>-1378 Kg/ha</td>
</tr>
<tr>
<td>F - Fz - Fn</td>
<td>-1862 Kg/ha</td>
</tr>
</tbody>
</table>

Addition

<table>
<thead>
<tr>
<th>Component</th>
<th>Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>1268 Kg/ha</td>
</tr>
<tr>
<td>E + ST</td>
<td>902 Kg/ha</td>
</tr>
<tr>
<td>E + SR</td>
<td>573 Kg/ha</td>
</tr>
<tr>
<td>E + Fz</td>
<td>392 Kg/ha</td>
</tr>
</tbody>
</table>
Yield – Swift Current

![Yield graph showing various treatments and their corresponding yields in kg ha⁻¹.](image-url)
Seeding rate, granular inoculant and fungicide had the greatest impact on yield

<table>
<thead>
<tr>
<th></th>
<th>Scott</th>
<th>Indian Head</th>
<th>Melfort</th>
<th>Swift Current</th>
<th>All Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed treatment</td>
<td>(-34)</td>
<td>(-92)</td>
<td>68</td>
<td>(-117)</td>
<td>42</td>
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<tr>
<td>Seeding rate</td>
<td>1268</td>
<td>4</td>
<td>598</td>
<td>506</td>
<td>604</td>
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<tr>
<td>Granular inoculant</td>
<td>902</td>
<td>73</td>
<td>357</td>
<td>33</td>
<td>364</td>
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<td>Starter fertilizer</td>
<td>573</td>
<td>52</td>
<td>191</td>
<td>-70</td>
<td>195</td>
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<tr>
<td>Fungicide</td>
<td>392</td>
<td>845</td>
<td>1134</td>
<td>-8</td>
<td>1004</td>
</tr>
</tbody>
</table>
Crop Inputs generally interact in a sequentially additive manner, provided there are no limiting factors.

“The largest net response comes when there are no limiting factors and the magnitude of the response will increase as more limiting factors are corrected. The attained yield is greater than of the individual parts (inputs) because the various parts interact to multiply the values of the others.”

Input Effects on Pea Yield

2157 kg/ha

3012 kg/ha
Input Effects on Pea Yield

Yield increase (kg/ha) over empty:
- Seed treatment: 42
- Seeding rate: 604
- Granular inoculant: 364
- Starter N: 194
- Fungicide: 1004
Input Effects on Pea Yield

Predicted yield increase = 2.44 x empty
Actual yield increase = 1.4 x empty
Actual vs predicted = 1.4/2.44 = 0.58
Antagonism between inputs?

Predicted

Actual

E+ST+SR+GI+Fn

Kg ha⁻¹

Fn
Fz
GI
SR
ST
Empty
Protein – Swift Current

Starter Fertilizer
Summary

• More research needs to be conducted on effects of combining field pea inputs
• 2012 results show increased seeding rate and fungicide application are the individual inputs contributing the most to field pea production
• Yield of the full input package not as high as predicted – more site years needed
What’s Next?

• In-depth look into the interactions between inputs
• More site years of data will allow us to further investigate how inputs interact
• Economic analysis
Acknowledgements