Phosphorus and Zinc Fertilization Beneficial Management Practices for Corn in Manitoba

Crop Rotation and Strip-Tillage Preliminary Results

Magda Rogalsky*, Don Flaten, Yvonne Lawley, Mario Tenuta, John Heard
Background
Corn Production in Manitoba, Canada

- Grain corn acreage steadily increasing
- In 2015 grain corn was ranked 7th among “Top 10 acreage crops in MB” (Yield Manitoba, 2016)
- Northern fringes of the Northern Great Plains, short growing season and cold soils at planting
Crop Rotation Study

Fertilization strategies for corn grown after canola vs. soybeans

- P?
- Zn?
Rotation Study: Background

- Canola is non-mycorrhizal, so AMF population drops
- Corn is highly dependent on mycorrhizal fungi (AMF)
- Therefore, corn on canola stubble is prone to P perhaps Zn deficiency (Ontario & BC studies)
- Starter fertilizer P and Zn may help to offset this problem

MAP 30 kg $P_2O_5$ ha$^{-1}$  
No P Check  
P deficiency symptoms at V3
## Rotation Study: Site Information

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Planting Date</th>
<th>Harvest Date</th>
<th>Olsen-P (ppm)</th>
<th>DTPA-Zn (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 Sites</td>
<td>Carman, MB</td>
<td>May 25</td>
<td>Oct. 15</td>
<td>19</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>Stephenfield, MB</td>
<td>May 26</td>
<td>Oct. 14</td>
<td>6</td>
<td>0.82</td>
</tr>
<tr>
<td>2016 Sites</td>
<td>Carman, MB</td>
<td>May 12</td>
<td>Oct. 05*</td>
<td>9</td>
<td>1.91</td>
</tr>
<tr>
<td></td>
<td>Portage la Prairie, MB</td>
<td>May 16</td>
<td>Oct. 06</td>
<td>12</td>
<td>1.81</td>
</tr>
</tbody>
</table>

* Carman 2016 site was hand harvested due to wind damage and green snap.

**Corn Hybrid: DKC 26-28RIB (2150 CHU)**
Rotation Study: 2 Previous Crops Treatments

Canola

Soybean
# Rotation Study: 5 Fertilizer Treatments

(kg ha\(^{-1}\), sidebanded 5 cm by 2.5 cm at planting)

## CONTROL

1. No P Check

## MAP (11-52-0) + AS (21-0-0-24)

2. 30 P\(_2\)O\(_5\) 0 Zn 7.5 S

3. 60 P\(_2\)O\(_5\) 0 Zn 15 S

## MicroEssentials SZ (12-40-0-10S-1Zn)

4. 30 P\(_2\)O\(_5\) 0.75 Zn 7.5 S

5. 60 P\(_2\)O\(_5\) 1.50 Zn 15 S

[MicroEssentials SZ Image](http://www.microessentials.com/#fusion-process)
Rotation Study: Preliminary Results

Collected at V4

Corn Early Season Biomass
2015 - 2016

Effect  \( Pr > F \)

- fertilizer: <.0001
- crop: 0.0383
- crop*fertilizer: 0.0025
- site-year: <.0001
- siteyear*fertilizer: <.0001

Alpha = 0.05

<table>
<thead>
<tr>
<th>Effect</th>
<th>( Pr &gt; F )</th>
</tr>
</thead>
<tbody>
<tr>
<td>fertilizer</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>crop</td>
<td>0.0383</td>
</tr>
<tr>
<td>crop*fertilizer</td>
<td>0.0025</td>
</tr>
<tr>
<td>site-year</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>siteyear*fertilizer</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Biomass (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>No P Check</td>
<td>200</td>
</tr>
<tr>
<td>30 kg P2O5/ha MAP</td>
<td>AB</td>
</tr>
<tr>
<td>60 kg P2O5/ha MAP</td>
<td>A</td>
</tr>
<tr>
<td>30 kg P2O5/ha MESZn</td>
<td>A</td>
</tr>
<tr>
<td>60 kg P2O5/ha MESZn</td>
<td>A</td>
</tr>
</tbody>
</table>

Canola

85 – 110%

Soybean

30 – 38%
Rotation Study: Preliminary Results

Silking differences as compared to control plots

<table>
<thead>
<tr>
<th>Site-year</th>
<th>Maturity Advance (days)</th>
<th>Fertilizer and Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carman 2015</td>
<td>+2 to 3</td>
<td>All fertilizer treatments, corn on canola</td>
</tr>
<tr>
<td>Stephenfield 2015</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Carman 2016</td>
<td>+2 to 7</td>
<td>All fertilizer treatments, regardless of crop</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>fertilizer</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>crop</td>
<td>0.0003</td>
</tr>
<tr>
<td>crop*fertilizer</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>siteyr</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>siteyr*fertilizer</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>siteyr*crop</td>
<td>0.0217</td>
</tr>
<tr>
<td>siteyr<em>crop</em>fertilizer</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

Alpha=0.05
Rotation Study: Preliminary Results

Recorded at harvest

Grain Moisture at Harvest
2015 - 2016

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>fertilizer</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>crop*fertilizer</td>
<td>0.0002</td>
</tr>
<tr>
<td>siteyear</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>siteyear*fertilizer</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Alpha = 0.05

Moisture (%)

- Canola
  - No P Check
  - 30 kg P2O5/ha MAP
  - 60 kg P2O5/ha MAP
  - 30 kg P2O5/ha MESZn
  - 60 kg P2O5/ha MESZn

- Soybean
  - No P Check
  - 30 kg P2O5/ha MAP
  - 60 kg P2O5/ha MAP
  - 30 kg P2O5/ha MESZn
  - 60 kg P2O5/ha MESZn

2 – 3%
Rotation Study: Preliminary Results

Adjusted to 15.5%

Corn Grain Yield Response to Previous Crop
2015 - 2016

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canola</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Soybean</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

7421 kg ha\(^{-1}\) 8%

Effect Pr > F
- fertilizer 0.0017
- crop 0.0415
- siteyear <.0001
- siteyear*crop 0.0139

Alpha = 0.05

March 06, 2017
Soils and Crops 2017 SK
Flaten & Rogalsky: Preliminary Results
Rotation Study: Preliminary Results

Adjusted to 15.5%

Corn Grain Yield Response to Starter Fertilizer
2015 - 2016

- No P Check
- 30 kg P2O5/ha MAP
- 60 kg P2O5/ha MAP
- 30 kg P2O5/ha MESZn
- 60 kg P2O5/ha MESZn

Yield (kg ha⁻¹)

7421 kg ha⁻¹

10%

Effect

Pr > F

fertilizer 0.0017

crop 0.0415

siteyear <.0001

siteyear*crop 0.0139

Alpha = 0.05
Rotation Study: Summary

Early season significant increase in early season biomass with all starter P treatments especially in corn following canola.

Maturity at 2 out of 3 site-years we saw advanced maturity for starter compared to control, greater maturity response in corn on canola.

Dry Down all starter P treatments significantly reduced kernel moisture at harvest by 2 – 3% in corn on canola only.

Grain yield 10% increase in yield with high rate of MAP only compared to the control, regardless of preceding crop.
University of Manitoba - Manitoba Corn Growers Association
Corn Agronomy Project

Tillage Study

Fertilization strategies for corn planted in strip tillage vs. conventional tillage

P?
Tillage Study: Background

Strip till:
- reduces risk of erosion
- provides opportunity to preplant band P
- may provide a warmer or cooler seed bed zone vs. conventional tillage
- cool soil may aggravate P deficiencies

Application of starter P may:
- accelerate early-season crop development
- decrease grain moisture
- increase grain yield

P deficiency symptoms at V3 in striptill

60 kg P$_2$O$_5$ ha$^{-1}$ MAP
Spring Sideband

No P Check
## Tillage Study: Site Information

<table>
<thead>
<tr>
<th></th>
<th>Planting Date</th>
<th>Harvest Date</th>
<th>Olsen-P (ppm)</th>
<th>Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2015 Sites</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carman, MB</td>
<td>May 25</td>
<td>Oct. 16</td>
<td>8</td>
<td>Wheat</td>
</tr>
<tr>
<td>Portage la Prairie, MB</td>
<td>May 26</td>
<td>Oct. 19</td>
<td>11</td>
<td>Barley</td>
</tr>
<tr>
<td><strong>2016 Sites</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carman, MB</td>
<td>May 12</td>
<td>Oct. 5*</td>
<td>5</td>
<td>Wheat</td>
</tr>
<tr>
<td>Portage la Prairie, MB</td>
<td>May 16</td>
<td>Oct. 6*</td>
<td>14</td>
<td>Wheat</td>
</tr>
</tbody>
</table>

*Carman 2016 site was hand harvested due to wind damage and green snap.
*Portage 2016 sites was hand harvested due to hail and black bird damage.

**Corn Hybrid: DKC 26-28RIB (2150 CHU)**
Tillage Study: 2 Previous Tillage Treatments
Tillage Study: 5 Fertilizer Treatments
(kg ha\(^{-1}\), spring (5 cm by 2.5 cm) and fall application (10 - 13 cm))

CONTROL

1. No P Check

MAP (11-52-0) Only

2. 30 P\(_2\)O\(_5\) SPRING SB
3. 60 P\(_2\)O\(_5\) SPRING SB
4. 30 P\(_2\)O\(_5\) FALL DB
5. 60 P\(_2\)O\(_5\) FALL DB

JD 1755
4-row, Yetter Strip Till Unit
8” (20 cm) wide strips on 30” (76 cm) centers
4.5’ (10-13 cm) deep band

JD 1755
4-row unit with sideband fertilizer capability (5 cm beside and 2.5 cm below the seedrow)
Tillage Study: Preliminary Results
Collected at V4
Corn Early Season Biomass (V4) 2015 - 2016

Carman 2015

- Biomass (kg ha⁻¹)
- Varieties: No P Check, 30 kg P2O5/ha MAP, 60 kg P2O5/ha MAP
- Tillage: Conventional, Striptill

Carman 2016

- Biomass (kg ha⁻¹)
- Varieties: No P Check, 30 kg P2O5/ha MAP, 60 kg P2O5/ha MAP
- Tillage: Conventional, Striptill

Statistical Analysis:

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Site*Year</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Site<em>Year</em>Fertilizer</td>
<td>0.0005</td>
</tr>
<tr>
<td>Site<em>Year</em>Tillage</td>
<td>0.046</td>
</tr>
<tr>
<td>Site<em>Year</em>Tillage*Fertilizer</td>
<td>0.0177</td>
</tr>
</tbody>
</table>

Alpha = 0.05

March 06, 2017
Soils and Crops 2017 SK
Flaten & Rogalsky: Preliminary Results
Tillage Study: Preliminary Results

Silking differences as compared to control plots

<table>
<thead>
<tr>
<th>Site-year</th>
<th>Maturity Advance (days)</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carman 2015</td>
<td>+2</td>
<td>All fertilizer treatments</td>
</tr>
<tr>
<td>Portage la Prairie 2015</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Carman 2016</td>
<td>+3 to 4</td>
<td>Both rates of spring side-banded MAP</td>
</tr>
<tr>
<td>Portage la Prairie 2016</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>fertilizer</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>siteyear</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>siteyear*fertilizer</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Alpha = 0.05

60 kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1} MAP Spring Sideband
CONTROL No P Check
60 kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1} MAP Spring Sideband
No P Check
Tillage Study: Preliminary Results
Recorded at harvest

Grain Moisture at Harvest
2015 - 2016

March 06, 2017
Soils and Crops 2017 SK
Flaten & Rogalsky: Preliminary Results

Carman 2015
Portage 2015
Carman 2016
Portage 2016

Effect | Pr > F
-------|---------
fertilizer | <.0001
siteyear | <.0001
siteyear*fertilizer | 0.0126

Alpha = 0.05

2%
1-2%
Tillage Study: Preliminary Results

Adjusted to 15.5%

Corn Grain Yield Response to P
2015 - 2016

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (kg ha$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No P Check</td>
<td>9146</td>
</tr>
<tr>
<td>30 kg P2O5/ha MAP</td>
<td>5% increase</td>
</tr>
<tr>
<td>60 kg P2O5/ha MAP</td>
<td></td>
</tr>
<tr>
<td>30 kg P2O5/ha MAP</td>
<td></td>
</tr>
<tr>
<td>60 kg P2O5/ha MAP</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>fertilizer</td>
<td>0.0002</td>
</tr>
<tr>
<td>siteyear</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Alpha = 0.05
Early season at Carman in 2015 and 2016 spring side-banded MAP increased early season biomass, relative to the controls.

Maturity advanced maturity at Carman in 2015 and 2016 with banded MAP compared to control, regardless of tillage system.

Dry Down banded MAP significantly reduced kernel moisture at harvest by 1 – 2% at Carman and Portage in 2016.

Grain yield 5% yield increase with spring side-banded MAP compared to the control and fall banded MAP, regardless of tillage.
Tillage Study: Summary

76 - 103%  2 - 4 days  1 - 2%  5%

Good News...
Corn planted in strip till yielded as well as corn planted in conventional till and had similar grain moisture.
Acknowledgments

Manitoba Corn Growers Association
Canada-Manitoba GF2 Program
Western Grains Research Foundation
Agrium
Mosaic
MAFRD (J.Heard)
Canada-Manitoba CDC (C.Cavers)
Plateau Sands Farm (C.Dyck)
University of Manitoba (G.Bardella, I.Vaisman, E. Wallace, G.Bartley, A.Iverson, J.Dunn, F.Zvomuya)
Richardson Pioneer (B.Hellegards)
Western Economic Diversification Canada
Contact Information

Email: magdalena.rogalsky@umanitoba.ca

Twitter: @umrog