IMPLICATIONS OF CANOLA CROPPING ON NITROGEN CYCLING IN SOIL

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Canola: A rotational break crop

Benefits:
- 20% wheat yield bump
- Disease suppression

Fig. 3. Effect of increasing N availability (N1 to N5) at Dirmaseer on the grain yield of wheat following wheat (○) and canola (□) in phase I (absence of seedling root disease; open symbols) and phase 2 (in the presence of root disease; closed symbols). Vertical lines represent LSD for previous crop×N interactions.

Kirkegaard et al., 1997
Canola root architecture

More soil water and N extracted from soil than wheat after wheat.
Potential shifts in nutrient management:

### Canola Nitrogen (N) Use

<table>
<thead>
<tr>
<th></th>
<th>Canola</th>
<th>Soft white wheat (9% protein)</th>
<th>Dark northern spring wheat (14% protein)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uptake</strong> by the plant</td>
<td>5.8</td>
<td>2.3 (1.35 lb/bushel)</td>
<td>3.2 (1.8 lb/bushel)</td>
</tr>
<tr>
<td><strong>Removal</strong> in the seed</td>
<td>3.4</td>
<td>1.6 (1.0 lb/bushel)</td>
<td>2.5 (1.5 lb/bushel)</td>
</tr>
<tr>
<td><strong>Difference</strong> (left in field)</td>
<td>2.4</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Recommendation</strong>*</td>
<td>5 to 11</td>
<td>4.5 (2.7 lb/bushel)</td>
<td>6.0 (3.6 lb/bushel)</td>
</tr>
</tbody>
</table>

*from various university fertilizer guides for canola and WSU guides for wheat
Potential shifts in nutrient management

<table>
<thead>
<tr>
<th>Test</th>
<th>Garbanzos</th>
<th>Lentils</th>
<th>Peas</th>
<th>Spring canola</th>
<th>Soft white spring wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bray 1 (ppm)</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>0-20</td>
<td>60</td>
<td>50</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>20-30</td>
<td>40</td>
<td>30</td>
<td>40</td>
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<td>40</td>
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<tr>
<td>30-40</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>&gt;40</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>K test ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-50</td>
<td>90</td>
<td>70</td>
<td>80</td>
<td>80</td>
<td>80*</td>
</tr>
<tr>
<td>50-75</td>
<td>60</td>
<td>40</td>
<td>60</td>
<td>60</td>
<td>60</td>
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<tr>
<td>&gt;75</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>SO₄-S (ppm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-10</td>
<td>20</td>
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<td>25</td>
<td>20</td>
</tr>
<tr>
<td>&gt;10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Boron</td>
<td></td>
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<td></td>
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<tr>
<td>&lt;0.5 ppm</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1-1.5</td>
<td>NA</td>
</tr>
<tr>
<td>Molybdenum</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed treatment</td>
<td>1</td>
<td>0.50</td>
<td>0.50</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

* 0-35 ppm of K test; Source: Various fertilizer guides by Mahler and Guy, University of Idaho Extension
Root Apex NH$_3$ Toxicity

Canola

Wheat

Pan, 2013
N dynamics following canola…..
Crop residues and N dynamics

- Alfalfa shoots
- Mature canola leaves
- Mature canola leaves
- Maize straw

Trinsoutrot et al., 2000
N cycling in cropping sequence with canola

(Time)

(Short-run < 1 year)

(Turnover of canola residue after more than 1 year)

(Long-run > 1 year)

(Engstrom, 2010; Lupwayi et al., 2006, Sieling et al., 2006, Sieling et al., 1999, Soon and Arshad, 2004; Jensen et al., 1997; Lupwayi et al., 2006; Trinsoutrot et al., 2000ab, Singh et al., 2006)
... N-sequestration???

(Lupwayi et al., 2006)

Net N immobilization

Release then stabilization

Release then stabilization

Net N immobilization
N partitioning (McClellan Maaz, 2014)

Mean separation by Tukey HSD, n = 4
N dynamics

Net mineralization (mg N g⁻¹ added C)

Week

19:1 pea vs other residues, p < 0.001
C:N ratio < 60:1 vs C:N ratio > 60:1, p < 0.05
Predicting N release

N tie up correlated with:
• Water extractable N
• Dissolved organic N
• Soluble N
• Total N

Not C:N ratio
How to predict N tied-up during residue decomposition?

Relationship between extent of N mineralization and C:N ratio

\[ y = 71.7 - 3.38x \quad R^2 = 0.979 \]
## Predicted differences in net N immobilization

<table>
<thead>
<tr>
<th>Citation</th>
<th>Crop</th>
<th>Residue (kg ha(^{-1}))</th>
<th>%N</th>
<th>%C</th>
<th>Predicted N debit (kg N ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lupwayi et al., 2004</td>
<td>canola</td>
<td>2900</td>
<td>0.66</td>
<td>43.9</td>
<td>16.1</td>
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<td></td>
<td>pea</td>
<td>2290</td>
<td>0.95</td>
<td>42.1</td>
<td>10.1</td>
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<td></td>
<td>wheat</td>
<td>1620</td>
<td>0.61</td>
<td>45.4</td>
<td>9.6</td>
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<tr>
<td>Soon and Arshad, 2002</td>
<td>canola</td>
<td>2300</td>
<td>0.70</td>
<td>49.7</td>
<td>14.1</td>
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<tr>
<td></td>
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<td>5830</td>
<td>0.71</td>
<td>46.9</td>
<td>33.5</td>
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<tr>
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<td>4750</td>
<td>0.50</td>
<td>48.5</td>
<td>32.0</td>
</tr>
<tr>
<td>Malhi and Lemke, 2007</td>
<td>canola</td>
<td>3290</td>
<td>0.59</td>
<td>47.5</td>
<td>20.6</td>
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<td>4340</td>
<td>0.72</td>
<td>38.8</td>
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<td>4230</td>
<td>0.40</td>
<td>42.0</td>
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<td>5339</td>
<td>0.55</td>
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<td>7426</td>
<td>1.02</td>
<td>44.2</td>
<td>32.4</td>
</tr>
</tbody>
</table>

*Calculated from \( y = -7.6652 \times %N + 17.711 \)
Conclusions

• All residue types resulted in initial N immobilization

• Extent of N immobilization was related to N partitioning into fiber fractions

• Interaction between quantity and quality of N fractions in crop residues affects soil N cycling
Questions