Canola Soil Fertility Management

Northeast Montana Pulse Plot Tour, June 30, 2017
Valley County Extension

by Clain Jones, Soil Fertility Specialist (clainj@montana.edu 994-6076) and Kathrin Olson-Rutz, Research Associate

Image by Sophia Flikkema
Why am I giving a CANOLA talk in a PULSE workshop?

• I’ve presented on pulse fertility at this Pulse Plot tour before
• Planned canola acreage increased this year
• Nutrient management of canola is quite distinct from both small grains and pulses
• Shel asked me to 😊
Question for you:
Why are there relatively few acres of canola in MT?
Objectives

We will discuss the following:
1. General soil preferences
2. How canola needs differ from small grain
3. Nutrient considerations for canola in rotation
4. Soil fertility management using the right rate, source, timing and placement
Optimum soil conditions for canola

1. Soils with adequate infiltration and aeration
2. Low to moderate sodium and salt content (up to 6 mmhos/cm before yields decline) = similar to small grains, far more tolerant than pulses
3. Minimal tillage, continuous and high diversity rotations to keep residue on surface preventing crusting, and interrupt disease cycles
Goal of soil fertility management

Synchronize nutrient supply (amount and timing) from soil and fertilizer, with plant nutrient demand. However there are:

Sources of variation
- Cultivars
- Soil variability
- Soil & tissue testing methods and labs
- Rate of nutrient supply from fertilizer & SOM
- Weather

Additional unknowns
- Fertilizer use efficiency
- Nutrients lost to water, air and soil erosion
Use the 5 R’s to aim for the best results

5 R’s of fertilizer management

1. Rotation
2. Rate
3. Source
4. Timing
5. Placement
Soil nutrient considerations for crop rotations that include canola

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>Can be provided by a legume</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>Canola and alfalfa are good P scavengers, deplete P for next crop</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Canola leaves behind high K residue</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>Canola is a good scavenger, depletes S for next crop</td>
</tr>
<tr>
<td>Other</td>
<td>Canola can reduce P, copper (Cu) and zinc (Zn) uptake by subsequent mycorrhizal crops (e.g., flax, legumes, small grains to a lesser extent)</td>
</tr>
</tbody>
</table>
Canola relative yields after other crops  
Based on research at Mandan, ND, average over 4 rotations  

<table>
<thead>
<tr>
<th>Residue</th>
<th>SW, Barley</th>
<th>Pea, Lentil</th>
<th>Canola</th>
<th>Sunflower, Safflower</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW, Barley</td>
<td>1.00</td>
<td>1.19</td>
<td>1.09</td>
<td>1.81</td>
</tr>
<tr>
<td>Pea, Lentil</td>
<td>1.02</td>
<td>1.00</td>
<td>1.16</td>
<td>2.04</td>
</tr>
<tr>
<td>Canola</td>
<td>0.99</td>
<td>1.00</td>
<td>1.00</td>
<td>1.67</td>
</tr>
<tr>
<td>Sunflower, Safflower</td>
<td>0.95</td>
<td>0.99</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Average</td>
<td>0.96</td>
<td>1.05</td>
<td>1.04</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Adapted from Tanaka et al., 2005 and 2007, by K. McVay
Questions?

On to tools to determine fertilizer needs and deficiencies
Start with a realistic yield goal

- Use MSU’s NARC variety trials ([http://agresearch.montana.edu/narc/varietytestingreports/variety_testing_reports_by_year.html](http://agresearch.montana.edu/narc/varietytestingreports/variety_testing_reports_by_year.html)), or successful local producers’ experience
- Past yields indicate future performance
- Having ability for in-season N application allows conservative yield estimate for pre-plant rate
- Then look up how much is needed to produce a bushel of seed:
  (soil + in-season organic matter decomposition + fertilizer)
How much fertilizer is removed by canola plant and a bushel of canola seed?

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>K₂O</th>
<th>P₂O₅</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total uptake</td>
<td>0.9-1.2</td>
<td>4.1-4.2</td>
<td>0.9-1.2</td>
<td>2.7-2.9</td>
</tr>
<tr>
<td>In seed</td>
<td>0.2-0.4</td>
<td>0.5-0.6</td>
<td>0.7-1.2</td>
<td>1.5-1.9</td>
</tr>
<tr>
<td>MSU Fert Guideline lb N/bu</td>
<td>~ 3.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canola Council of Canada lb N/bu</td>
<td>2.9-3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Next step: soil testing

- Help calculate fertilizer rates
- ID nutrient deficiency or imbalance
- Save on fertilizer cost
- Decrease environmental risks
- Take to 2 ft depth for N and S, 6” for P and K
- Consider sampling N to 3 ft if didn’t reach yield goal on previous crop or two
Ideally soil test in spring; fall soil tests can lead to over or under-fertilized fields.

- High N crop residue and/or high O.M.
- High N on shallow or coarse soil

Over winter

- Mineralization
- High Precip
- Under fertilized
  - N leaching
    (or $N_2$ gas losses?)

Under fertilized

Compare fall with spring a few times to see patterns of loss or gain for given pastures/rotation.
Variable rate N application (Zone or site specific farming)

- At this time economic advantage is inconsistent (and hard to study)
- Is best to divide field into zones of low, med, high productivity
- NDSU has bulletin series on Zone farming SF1176 series at www.ag.ndsu.edu/publications

Image adapted from IPNI 2012
Tissue tests and optical sensors

**Tissue sufficiency:** levels are published, but too much variation in cultivars, plant growth stage, time of day to make reliable nutrient management decisions based solely on tissue testing.

**Optical sensors:** the technology is here, the correlations between sensor readings and N fertilization recommendations not yet for MT.
Plant symptoms – once symptoms appear, yield may already be compromised.

**Boron**

R. Karamanos

**Nitrogen**

GRDC Canola Guide

**Phosphorus**

IPNI, El Gharous

**Potassium**

IPNI, Roberts

**Sulfur**

Gov. W. Aust., T. Potter

R. Karamanos
Questions?

On to *calculating fertilizer rates*
N rate adjustments

• Stubble: small grains stubble high carbon to N (C:N). Adjust fertilizer N up or down?
  10 lb N/1000 lb stubble up to 40 lb N

• Fallow: assume ½ of stubble has decomposed over previous year when adjusting

• SOM: 15 – 20 lb N credit per % >2%

• After legume rotation: Adjust fert up or down?
  Legumes credit (add) N

<table>
<thead>
<tr>
<th>Crop</th>
<th>N credit (lb N/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse grain 1-2 x</td>
<td>~10</td>
</tr>
<tr>
<td>Pulse grain ≥ 3 x</td>
<td>~20</td>
</tr>
<tr>
<td>Pulse cover 1-2 x</td>
<td>20-30</td>
</tr>
<tr>
<td>Pulse cover ≥ 3 x</td>
<td>30-50</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>40</td>
</tr>
</tbody>
</table>
Example N rate calculations depending on previous crop

<table>
<thead>
<tr>
<th></th>
<th>Spring wheat</th>
<th>Grain pulse grown 1x</th>
<th>Legume cover crop grown 1x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canola yield goal (bu/ac)</td>
<td>18</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Total soil N recommended (bu/ac x 3.25 lb/bu)</td>
<td>58</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>Spring soil N (lb/ac)</td>
<td>20</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>N credit (lb/ac)</td>
<td>0</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Fertilizer N (lb/ac)</td>
<td>38</td>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>
Canola can only respond to N if S is not limiting; S helps most when N is sufficient.

Open pollinated variety, N and S broadcast and incorporated just prior to seeding. Malhi et al., 2007

N:S of 7:1 only helpful if both are deficient, otherwise irrelevant.

(Karamanos et al., 2007)
S for canola

- Base S rate on field history, crop appearance, response to test strips, tissue & soil testing.
- S varies greatly across a field – but if <20 lb S/acre (to 2 ft. depth) then likely limiting
- 18-20 lb S broadcast at seeding or 9 lb S/acre w/seed (BEWARE – very sensitive to seed placed fertilizer)
- 0.5 lb S/bu yield potential as 8-0-0-9, 21-0-0-24, or 12-0-0-26 (amm thiosulfate) as an in-season rescue through rosette (Janzen and Bettany, 1984)
P and K guidelines depend on soil test levels and do not vary with yield potential

Banded P and K fertilizer guidelines

<table>
<thead>
<tr>
<th>Olsen P (ppm)</th>
<th>P$_2$O$_5$ (lb/acre)</th>
<th>K (ppm)</th>
<th>K$_2$O (lb/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>45</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>8</td>
<td>35</td>
<td>100</td>
<td>35</td>
</tr>
<tr>
<td>12</td>
<td>30</td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>16</td>
<td>25</td>
<td>200</td>
<td>25</td>
</tr>
<tr>
<td>&gt;16</td>
<td>0.9 lb P$_2$O$_5$/bu or 10 lb/ac w/seed</td>
<td>250</td>
<td>20</td>
</tr>
<tr>
<td>&gt;250</td>
<td></td>
<td>&gt; 250</td>
<td>0.5 lb K$_2$O/bu</td>
</tr>
</tbody>
</table>

More if surface broadcast, especially at low soil levels
Application rates depend on source, placement and timing (coming later)
Can soil fertility affect canola maturity?

- Starter P important for an early start
- Excess N slows maturity, especially in dry years or with delayed seeding
- Sufficient S needed before elongation stage for earlier maturity, insufficient S extends flowering period

(Janzen & Bettany, 1984, greenhouse study)
Questions?

On to Source
N source

Select readily available N, e.g., urea (46-0-0) vs. 28-0-0 or 32-0-0 based on:

- $/lb N
- ease of application
- leaf burn potential
- seed-placed safety
- potential leaching or volatilization loss to the air

<table>
<thead>
<tr>
<th>Source*</th>
<th>POTENTIAL loss compared to urea</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN, CAN, AS</td>
<td>less</td>
</tr>
<tr>
<td>UAN</td>
<td>less</td>
</tr>
<tr>
<td>+NBPT (Agrotaïn, ContaiN, Arborite Ag)</td>
<td>less</td>
</tr>
<tr>
<td>+nitrification inhibitor (Nserve, Instinct)</td>
<td>≈</td>
</tr>
<tr>
<td>Combo (SuperU)</td>
<td>less</td>
</tr>
<tr>
<td>Polymer coated (ESN)</td>
<td>less</td>
</tr>
<tr>
<td>Slow release (Nitamin)</td>
<td>≈</td>
</tr>
</tbody>
</table>

* Examples given do not imply endorsement

Other N sources

- Polymer coated
- Legumes

- Polymer coated are safer seed-placed than urea
- PCU release is too slow in cool, dry conditions to provide enough N early on – consider blending
### S source and timing to benefit seed yield

<table>
<thead>
<tr>
<th></th>
<th>2-plus years prior</th>
<th>Prior crop</th>
<th>Fall</th>
<th>Spring, before or at seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfate – on soil surface or incorporated</td>
<td>😞</td>
<td>😐</td>
<td>😐</td>
<td>😊</td>
</tr>
<tr>
<td>Elemental-S incorporated</td>
<td>😊</td>
<td>😐</td>
<td>😞</td>
<td>😞</td>
</tr>
<tr>
<td>Rapid release elemental-S</td>
<td>😞</td>
<td>😐</td>
<td>😊</td>
<td>😞</td>
</tr>
</tbody>
</table>

- 😊 ideal
- 😐 not ideal but may benefit yield
- 😞 not recommended
P source

• MAP vs DAP (11-52-0 vs. 18-46-0) base on: $/lb P_2O_5, ease of application, seed-placed safety

• Specialty P: inconsistent results, higher safe seed-row rates, simplifies application and saves time

• Specialized bacteria/amendments: may increase nutrient availability, inconsistent yield response. Use on-farm strip trials and common sense to evaluate.

Phosphorus source for seed row placement

- **MAP** < 5-20 lb P$_2$O$_5$/acre seed placed
- **DAP** use CAUTION = toxic to seedlings
- **Liquids** – equally potent as MAP, but close proximity of band to seed = higher risk to seed (Grenkow et al., 2013).

- **Coated specialty P** – 2x safe seed placed rate, unsure on ability to provide needed P (Qian and Schoenau, 2010; Grenkow et al., 2013, SK)
Questions?

On to *Timing and Placement*
Application timing – depends on source. Fertilizer needs to become ‘plant available’ but not be lost from system.

**N**: Ideally split application, 50 to 65% of N at seeding, remainder adjusted to current production potential by 5- to 6-leaf stage.

**S**: Rescue broadcast or foliar up to early flowering, followed by rain/irrigation. Foliar after 5\(^{th}\) leaf emergence to minimize leaf burn.

**P and K**: before or at seeding
Placement: N

- side or pre-plant band >2” deep prior to packing
- early-spring broadcast with incorporation
- if seeder can’t place N deep, consider NBPT (e.g., Agrotain®)
- 28-0-0, 32-0-0 better subsurface than surface band

Dick, Nebo, Holzapfel, Tenuta, unpub data courtesy Karamanos
Placement: P and K

**P**: critical close to seedling roots in first 2-6 weeks

- Especially in cool or dry soil even if Olsen P > 16 ppm, 10-15 lb P$_2$O$_5$/acre seed placed or side band
- If more P required – sub-surface side band next to seed, broadcast incorporate before seeding, build with prior crop

**K**: seed-placed K$_2$O + N not > 10 lb/acre (4 lb/acre in sandy soils) affects ability to seed-place P, since 10 lb P$_2$O$_5$ as 11-52-0 = 2 lb N

Ex: If 8 lb K$_2$O/acre seed-placed, only allows 10 lb P$_2$O$_5$/acre as 11-52-0 seed-placed. More important P close to the seed than K close to seed
Seed-placed guidelines

Seed row safe rates depend on source and seed bed conditions

- heavy clay soil >> coarse
- high SOM >> low SOM
- high moisture >> dry soils
- low pH >> high pH

Equipment

Use wide openers, or put fertilizer in knife and seed in fertilizer slot

Use SDSU/IPNI online safe seed-placed rate calculator

Nyborg & Henning 1969, AB and SK
Micronutrients

• A combination of deficiency symptoms, soil testing, and tissue testing may be best approach at identifying deficiencies. This is NOT an exact science.
• Micronutrient deficiencies are exception, not rule
• Cool wet conditions cause deficiency – likely disappear when weather warms
• Too much of some micros can hurt yield more than not enough
• The main challenge is even distribution of a very small quantity – consider foliar options, but likely can’t apply enough to correct severe deficiencies
Relative response to micronutrients

<table>
<thead>
<tr>
<th>Response to micronutrient (Karamanos 2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
</tr>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

Routine application is NOT suggested, focus on N and seeding rate before other amendments (Harker & Harman, 2017, AB, SK)

Best test is field test strips and measured yield response

“Micronutrients should be used when there is an economic benefit to the farmer, ......” – R. Karamanos
Summary

- Use soil tests
- Ensure nutrients are available before stem elongation
- Adjust N in-season to reflect the growing season
- Need adequate S to ensure N response
- Low rates of seed-placed P and S promote a healthy start
- Select appropriate timing & placement for given fertilizer source
- Beware of seed-placed fertilizer toxicity
- Consider pulse crop rotation before canola
For more information and this presentation see MSU Soil Fertility Website
http://landresources.montana.edu/soilfertility/

*Soil Nutrient Management for Canola* (EB0224) – under ‘Extension publications’

**Canola: Nitrogen & Sulfur Management** and **Canola: P, K, & Micronutrient Management** – both under ‘Soil Scoop’

Canola Council of Canada *Canola Encyclopedia*
http://www.canolacouncil.org/canola-encyclopedia/

Safe seed-placed fertilizer rate calculator: SDSU and IPNI
Online Fertilizer Damage Tool
http://seed-damage-calculator.herokuapp.com/
QUESTIONS?

Image by K. Olson-Rutz