Feasibility of a New Granular Rapid Release Elemental S (RRES – Now Called Vitasul) Fertilizer in Preventing S Deficiency in Canola on a S-deficient Soil

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Rationale

• **Canola** is the **major cash crop** in the Parkland region. Being a **high protein** oilseed crop, it has **high requirements** for S.

• As S is **immobile** in plants, deficiency of S at any growth stage can cause a **considerable reduction** in seed yield.
S Deficient

Good supply of sulphate-S
Rationale

• In order to prevent seed yield loss due to S deficiency, a constant supply of available S to canola plants is thus needed throughout the growing season.

• Sulphate is the only form of S which is available to plants.

• There are a wide variety of commercial fertilizers that contain elemental S (ES), which may cost less per unit of S than sulphate-S fertilizers.

• However, the effectiveness of these fertilizers depends on how quickly the ES is oxidized in soil to plant-available sulphate.
Rationale (cont’d)

• In our previous research, granular ES fertilizers were found **not effective** in the first year of application, and also were not **consistently** as effective as sulphate-S fertilizers in improving seed yield of canola on S-deficient soils, **even after multiple** annual applications, particularly when applied in spring.

• **Fall-applied** elemental S usually produced **greater** seed yield than **spring-applied** elemental S, most likely because of dispersion of elemental S particles in soil and its **subsequent oxidation** to sulphate-S.
Effect of gypsum, elemental S and other sulphate-S fertilizers on increase in yield (kg ha\textsuperscript{-1}) of canola seed or grass forage DMY

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Year</th>
<th>Yield increase (kg ha\textsuperscript{-1})</th>
<th>ES - Spring</th>
<th>ES - Fall</th>
<th>Sulphate-S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ES</td>
<td>Gypsum</td>
<td>K\textsubscript{2}SO\textsubscript{4}</td>
</tr>
<tr>
<td>Grass (DMY)</td>
<td>Yr 1</td>
<td>357</td>
<td>6</td>
<td>45</td>
<td>851</td>
</tr>
<tr>
<td>Alberta</td>
<td>Yr 2</td>
<td>195</td>
<td>94</td>
<td>572</td>
<td>783</td>
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<tr>
<td></td>
<td>Yr 3</td>
<td>1533</td>
<td>196</td>
<td>349</td>
<td>363</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>268</td>
<td>590</td>
<td>1068</td>
</tr>
<tr>
<td>Canola seed</td>
<td>Yr 1</td>
<td>6</td>
<td>6</td>
<td>602</td>
<td>2087</td>
</tr>
<tr>
<td>(20 kg S ha\textsuperscript{-1})</td>
<td>Yr 2</td>
<td>677</td>
<td>677</td>
<td>1405</td>
<td>1191</td>
</tr>
<tr>
<td>Tisdale, SK</td>
<td>Yr 3</td>
<td>274</td>
<td>274</td>
<td>498</td>
<td>803</td>
</tr>
<tr>
<td></td>
<td>Yr 4</td>
<td>891</td>
<td>891</td>
<td>1114</td>
<td>1444</td>
</tr>
<tr>
<td>Canola seed</td>
<td>Yr 1</td>
<td>6</td>
<td>6</td>
<td>602</td>
<td>2087</td>
</tr>
<tr>
<td>(15 kg S ha\textsuperscript{-1})</td>
<td>Yr 2</td>
<td>677</td>
<td>677</td>
<td>1405</td>
<td>1191</td>
</tr>
<tr>
<td>Porcupine plain, SK</td>
<td>Yr 3</td>
<td>274</td>
<td>274</td>
<td>498</td>
<td>803</td>
</tr>
<tr>
<td></td>
<td>Yr 5</td>
<td>891</td>
<td>891</td>
<td>1114</td>
<td>1444</td>
</tr>
</tbody>
</table>
Rationale (cont’d)

• In our other experiments with spring applied S on S-deficient soils, the S deficiency in canola was prevented by broadcast/spread surface-application of elemental S fertilizers that contained S particles in suspension or powder formulation producing seed yield comparable to sulphate-S fertilizer.

• Dispersion of elemental S particles from granular elemental S fertilizers in soil to enhance microbial oxidation of elemental S particles to sulphate-S in soil was considered as the major problem for lack of effectiveness of granular elemental S fertilizers.
Effect of elemental S formulation and sulphate-S fertilizer on increase in seed yield (kg ha⁻¹) of canola

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seed yield increase (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Porcupine Plain</td>
</tr>
<tr>
<td>ES-90 Granular</td>
<td>0</td>
</tr>
<tr>
<td>Biosul-ES90 Granular</td>
<td>143</td>
</tr>
<tr>
<td>Biosul-ES50 Suspension</td>
<td>784</td>
</tr>
<tr>
<td>Sulphate-S</td>
<td>861</td>
</tr>
</tbody>
</table>
Rationale (cont’d)

• Further research was completed recently to determine the feasibility of a new granular rapid release elemental S (RRES [micronized ES] - now called Vitasul - from Sulvaris Inc., Calgary, Alberta) fertilizer in preventing S deficiency in canola using relatively lower yielding cultivar to simulate organic crop production.
Granular Sulphur Fertilizer

Sulvaris Technology: Extremely small ES particles (average <10 micron) pelleted into water dispersable granules, to create extremely large surface area in soil resulting in much faster microbial oxidation.

Guaranteed Analysis: 0-0-0-90S

Physical Properties:
SGN 280 – 310 (2.8 – 3.1 mm)
Uniformity Index > 60
Crushing Strength > 2.7 kg (6 lb) per granule
Bulk Density 0.882 g/cm³ (55 lb/ft³)
Disintegration Rate in Water* (300 Seconds) > 90%
Coated to reduce dust

The first Vitasul production facility is being built in Western Canada.

- Production forecasted to begin in 4th Q 2014.
- Facility will have nameplate capacity of 217,000 metric tonnes per year.
- Facility will be co-located with Keyera Energy’s Strachan Gas Plant near Rocky Mountain House, Alberta.
Alternative Nutrients Sources Study 2011

Treatments with commercial fertilizer applied

Seed yield (kg ha\(^{-1}\))

- Control
- Thin stillage
- N only
- N + P
- N + S
- Triple superphosphate+N+S
- Penicillium biliae+N+S
- RP granular (Int. Comp.)+N+S
- RP fine-ground (Int. Comp.)+N+S
- RP granular (BC Mines)+N+S
- RP fine-ground (BC Mines)+N+S
- Gypsum+N+S
- Rapid release elemental S+N+S
- Glycerol+N
- RP granular (BC Mines)+P. biliae+N+S
- RP fine-ground (BC Mines)+P. biliae+N+S
- Rapid release [gran] (BC Mines)+N+S
- RP [gran] (BC Mines)+P. biliae+N+S
- RP POWDER (BC Mines)+N+S
- Wood Ash - Granulated+N
- Wood ash - Fly Ash+N

Quantity:
- 410
- 1088
- 854
- 1083
- 986
- 984
- 1196
- 1010
- 1246
- 1184
- 1187
- 814
- 1218
- 1126
- 1045
- 1310
- 1250
Alternative Nutrients Sources Study 2012

Treatments with commercial fertilizer applied

Seed yield (kg ha\(^{-1}\))
Objective of a New 3-Year Study

• Previous study with RRES/Vitasul was conducted using relatively lower seed yielding canola.

• The objective of this NEW 3-year study (from 2011 to 2013) was to determine the relative effectiveness of a new granular rapid release elemental S (RRES – Called Vitasul) fertilizer and sulphate-S fertilizer on seed yield, straw yield, oil and protein content in seed, and N and S uptake of canola (under high yield situation using hybrid canola) on a S-deficient Gray Luvisol loam soil near Star City, Saskatchewan.
**Materials and Methods**

- Feld experiment was established in **fall 2010** on a Gray Luvisol (Typic Haplocryalf) loam soil at Star City, Saskatchewan.

- **Soil test** sulphate-S– 4.5 mg S/kg in 0-15 cm, 2.3 mg S/kg in 15-30 cm and 1.6 mg S/kg in 30-60 cm soil.

- Soil at this site has shown **severe S deficiency** in canola in all previous years, and significant increase in forage yield of timothy from S application.
Materials and Methods

- 11 treatments included:

  - Two granular S sources (rapid release elemental S [RRES/Vitasul] and potassium sulphate, applied at 20 kg S/ha);

  - Five application time/placement method combinations:
    - Broadcast in fall - surface-broadcast in fall and then incorporated into soil in spring prior to seeding,
    - Broadcast in spring pre-tillage - surface-broadcast and incorporated into soil in spring prior to seeding,
    - Broadcast in spring pre-emergence - surface-broadcast in spring after seeding but prior to crop emergence,
    - Sidebanded in spring at seeding, and
    - Seedrow-placed in spring at seeding;

  - Plus a zero-S control.
Materials and Methods (cont’d)

Treatments:
1. Control (no S fertilizer)
2. RRES/Vitasul Broadcast Fall
3. RRES/Vitasul Broadcast Spring Pre-Till
4. RRES/Vitasul Broadcast Spring Pre-Emergence
5. RRES/Vitasul Spring Sideband
6. RRES/Vitasul Spring Seedrow-Placed
7. Potassium Sulphate Broadcast Fall
8. Potassium Sulphate Broadcast Spring Pre-Till
9. Potassium Sulphate Broadcast Spring Pre-Emergence
10. Potassium Sulphate Spring Sideband
11. Potassium Sulphate Spring Seedrow-Placed

Note: In treatments 2-11, S was applied at 20 kg S/ha.
Blanket application of 120 kg N, 30 kg P and 20 kg K/ha.
Seed yield of canola with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2011 on a S-deficient soil at Star City, Saskatchewan (LSD$_{0.05} = 425$).
Seed yield of canola with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2012 on a S-deficient soil at Star City, Saskatchewan (LSD$_{0.05}$ = 228).
Seed yield of canola with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2013 on a S-deficient soil at Star City, Saskatchewan (LSD$_{0.05} = 337$).
Summary of 3-Year Average Results

• Compared to zero-S control, seed yield also increased significantly with all RRES/Vitasul treatments in all 3 years.

• On the average of 3 years, spring broadcast-incorporated sulphate-S tended to produce greater (significant in 2 of 4 cases) seed yield than other sulphate-S treatments (which were essentially similar).

• On the average of 3 years, fall broadcast RRES/Vitasul or spring broadcast pre-emergence RRES/Vitasul produced greater (significant in 2 of 3 cases) seed yield than other RRES treatments, but seed yield was still slightly lower (although not significant) than the highest yield obtained with spring broadcast-incorporated sulphate-S treatment.
Mean seed yield of canola (average of 3 years) with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method on a S-deficient soil at Star City, SK, (LSD$_{0.05}$ = 207).
Summary of Other Results

- Oil concentration in canola seed increased with sulphate-S in all 3 years, and it increased with RRES/Vitasul in 2012 and 2013.

- There was no effect of any S source on protein concentration in canola seed.

- Response trends of total N uptake, total S uptake, PFP, SUE and % recovery of applied S were usually similar to seed yield.
Conclusions

• Our findings indicated optimum/highest consistent seed yield of canola with sulphate-S, applied as broadcast-incorporated into soil in spring prior to seeding.

• Findings also suggested the potential of fall broadcast RRES/Vitasul or spring broadcast pre-emergence RRES/Vitasul in preventing S deficiency in hybrid canola, but seed yield was still slightly lower (although not significant) than the highest seed yield that obtained with spring broadcast/incorporated sulphate-S.
Conclusions/Cont’d

• As far as I know, Vitasul is probably the first granular ES fertilizer, which has shown potential to prevent S deficiency in hybrid canola in the first year of application, even when applied in spring, producing 3-year average seed yield 94-95% of the best/highest seed yield obtained with sulphate-S.

• ES fertilizers are usually less expensive and are expected to cost less per unit of S compared to sulphate-S. So, it is possible that RRES/Vitasul may result in better economic returns/farm income, plus any environmental benefits (by minimizing leaching of sulphate-S, which may occur on coarse-textured/sandy soils under wet soil conditions after sporadic heavy rains in spring or early growing season).
Conclusions/Cont’d

• However, our results/findings are based on one site/soil, so there is a need of further future research to test this ES product (Vitasul) for its efficacy under varied soil types, climatic and crop growing conditions.

• For producers - who are planning to use this ES fertilizer/Vitasul on their farms, they should try it on a small scale (for their own satisfaction) and find out if Vitasul is working/effective under their particular soil, crop and farm/climatic situations/conditions.
Acknowledgements

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