Feasibility of a New Granular Rapid Release Elemental S (RRES) 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.
- 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.
- 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 (Table 1).
- 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.

Table 1. Effect of gypsum, elemental S and other sulphate-S fertilizers on increase in yield (kg ha^{-1})of canola seed or grass forage DMY

Experiment	Year	Yield increase (kg ha^{-1})		
		ES	Gypsum	K_2SO_4
Grass (DMY)	**Yr 1**	357	1696	2401
(15 kg S ha^{-1})	**Yr 2**	195	1256	722
Alberta	**Yr 3**	1533	4646	4271
		ES - Spring	**ES - Fall**	**Sulphate-S**
Canola seed	**Yr 1**	6	45	851
(20 kg S ha^{-1})	**Yr 2**	94	572	783
Tisdale, SK	**Yr 3**	196	349	363
	Yr 4	268	590	1068
Canola seed	**Yr 1**	6	602	2087
(15 kg S ha^{-1})	**Yr 2**	677	1405	1191
Porcupine plain,	**Yr 3**	274	498	803
SK	**Yr 5**	891	1114	1444

- In our other experiments with spring applied S in 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 (Table 2).
- 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.

Table 2. Effect of elemental S formulation and sulphate-S fertilizer on increase in seed yield (kg ha^{-1}) of canola

Treatment	Seed yield increase (kg ha^{-1})			
	Porcupine Plain		Canwood	Legal, AB
	2000	2001	2001	2000
ES-90 Granular	0	127	1296	299
Biosul-ES90 Granular	143	256	1518	75
Biosul-ES50 Suspension	784	593	1710	637
Sulphate-S	861	581	1788	430

- Research was completed recently to determine the feasibility of a new granular rapid release elemental S (RRES [micronized ES] - from Sulvaris Inc., Calgary, Alberta, now called Vitasul) fertilizer in preventing S deficiency in canola using relatively a low yielding cultivar (Figures 1, 2, 3 and 4).

Figure 1. Alternative Nutrients Sources Study 2009

Treatments with commercial fertilizer applied

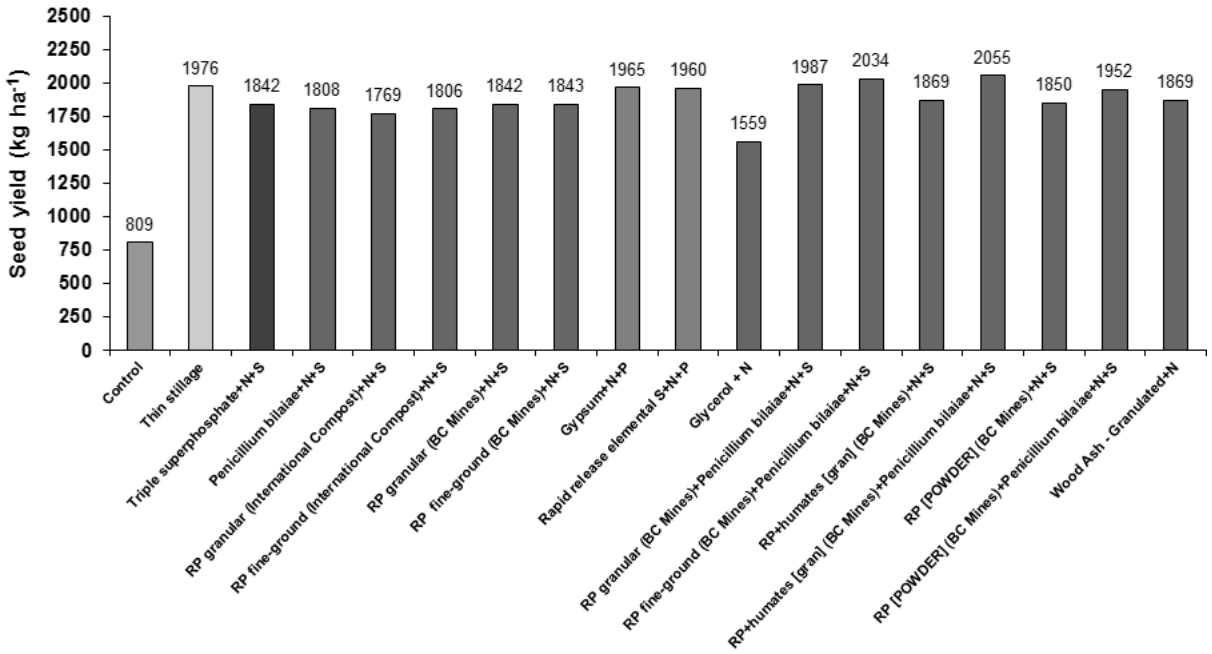


Figure 2. Alternative Nutrients Sources Study 2010

Treatments with commercial fertilizer applied

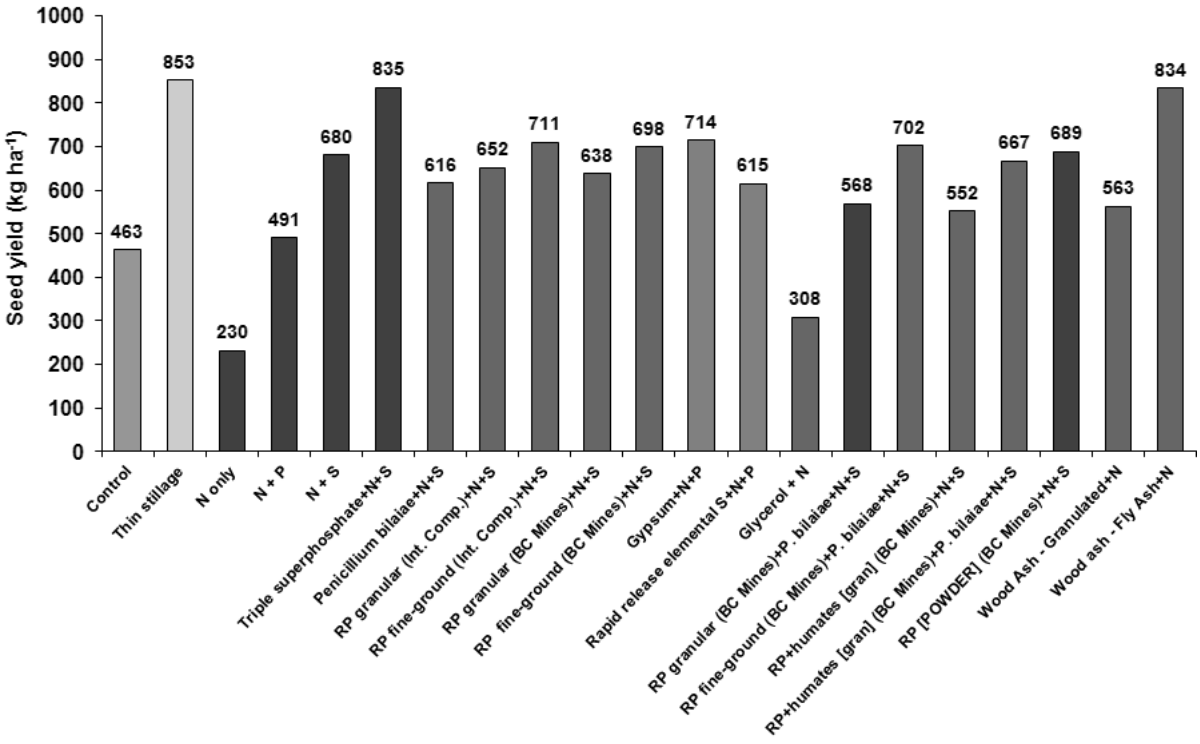


Figure 3. Alternative Nutrients Sources Study 2011

Treatments with commercial fertilizer applied

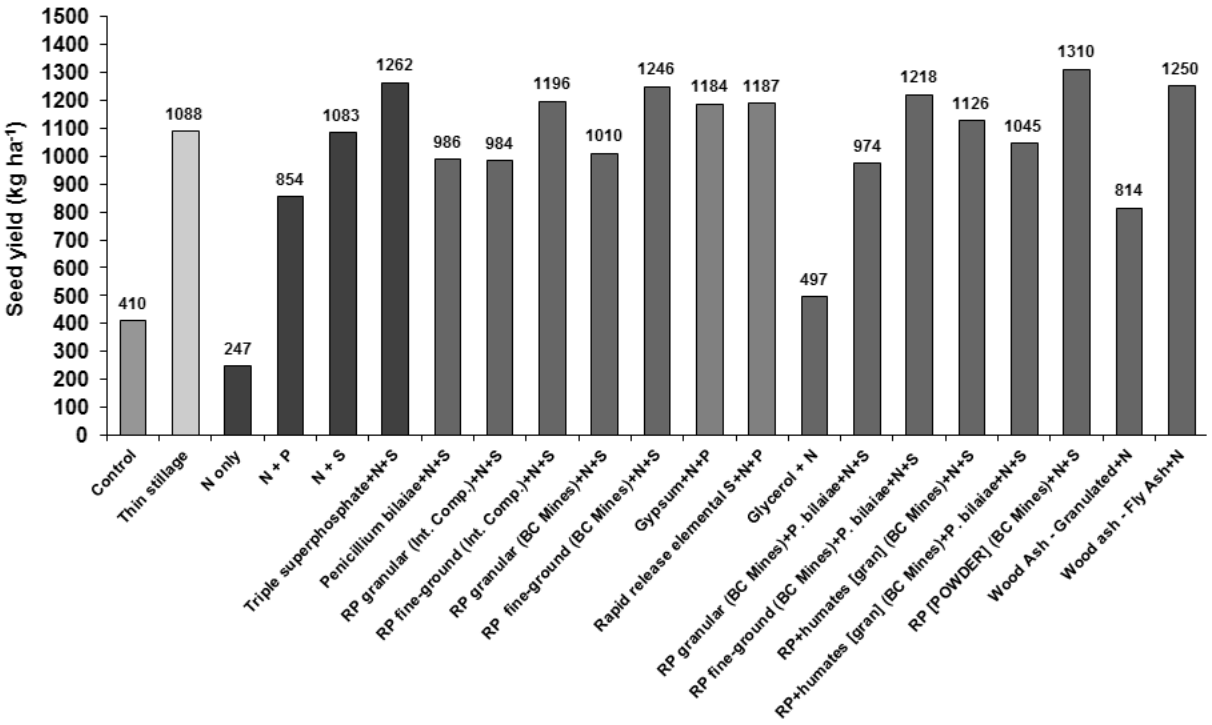
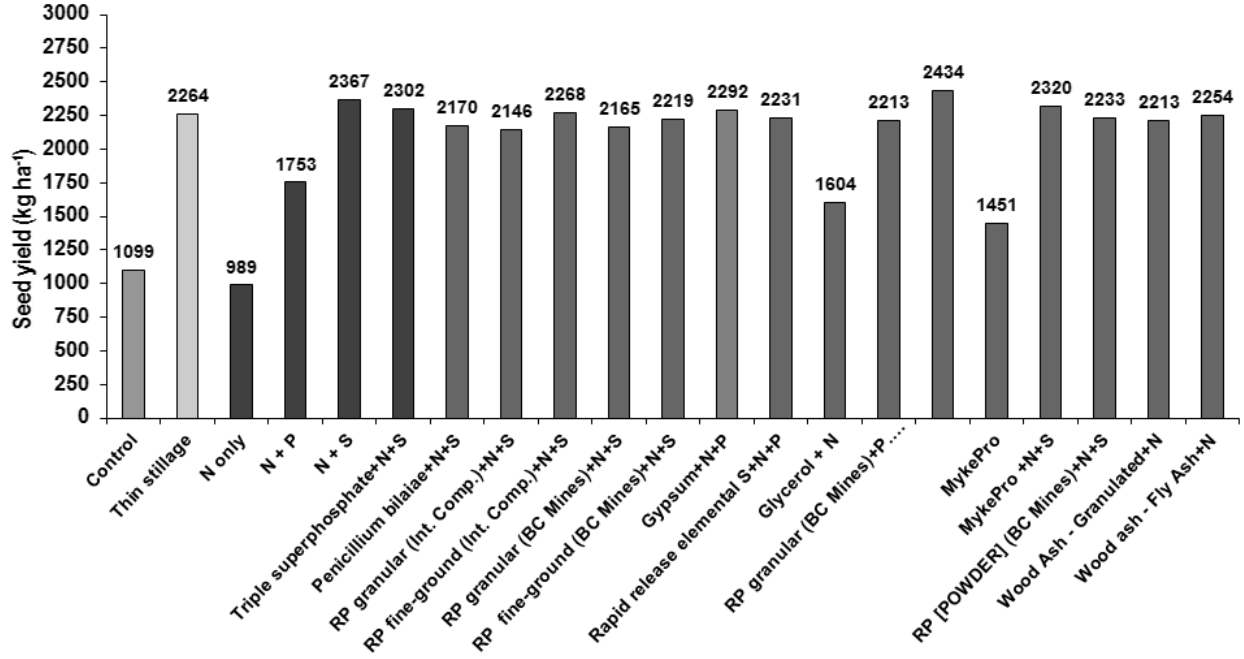


Figure 4. Alternative Nutrients Sources Study 2012

Treatments with commercial fertilizer applied



Objective

The objective of this study is to determine the relative effectiveness of a new granular rapid release elemental S (RRES – now 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

- A field experiment was established in autumn 2010 on a Gray Luvisol (TypicHaplocryalf) 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.
- 11 treatments included two granular S sources (rapid release elemental S [RRES] and potassium sulphate, applied at 20 kg S ha^{-1}) and five application time/placement method combinations (broadcast in fall, broadcast in spring pre-tillage, broadcast in spring pre-emergence, side-banded in spring and seedrow-placed in spring), plus a zero-S control.

***Treatments*:**

1. Control (no S fertilizer)
2. RRES Broadcast Fall
3. RRES Broadcast Spring Pre-Till
4. RRES Broadcast Spring Pre-Emergence
5. RRES Spring Sideband
6. RRES 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^{-1}.

Blanket application of 120 kg N, 30 kg P and 20 kg K/ha.

Summary of Results

- Growing season precipitation was below average (especially in 2011, much above average (very wet) in 2012 and near average (well distributed) in 2013.
- There was a significant seed yield response of canola to applied S in all 3 years (Figures 5, 6 and 7). Compared to zero-S control, seed yield increased considerably with all sulphate-S treatments. Seed yield also increased significantly with all RRES treatments but less than sulphate-S. The seed yield responses to applied S varied with S source and application time-placement combination in different years.
- On the average of 3 years, spring broadcast-incorporated sulphate-S produced significantly greater seed yield than other sulphate-S treatments (which were essentially similar) (Figure 8).On the average of 3 years, fall broadcast RRES or spring broadcast pre-emergence RRES produced greater seed yield than other RRES treatments.
- Oil concentration in canola seed increased with sulphate-S in all 3 years, and increased with RRES in 2012 and 2013 (Figures 9, 10 and 11).
- 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 (data not shown).

Conclusions

- Our findings indicated optimum/high consistent seed yield of canola with sulphate-S, applied as broadcast-incorporated into soil in spring prior to seeding.
- Findings also suggested 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 obtained with spring broadcast/incorporated sulphate-S teatment.
- As far as I know, itasul 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).

- However, our results/findings are based on one site/soil, so there is a need of further future research to test this ES product 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.

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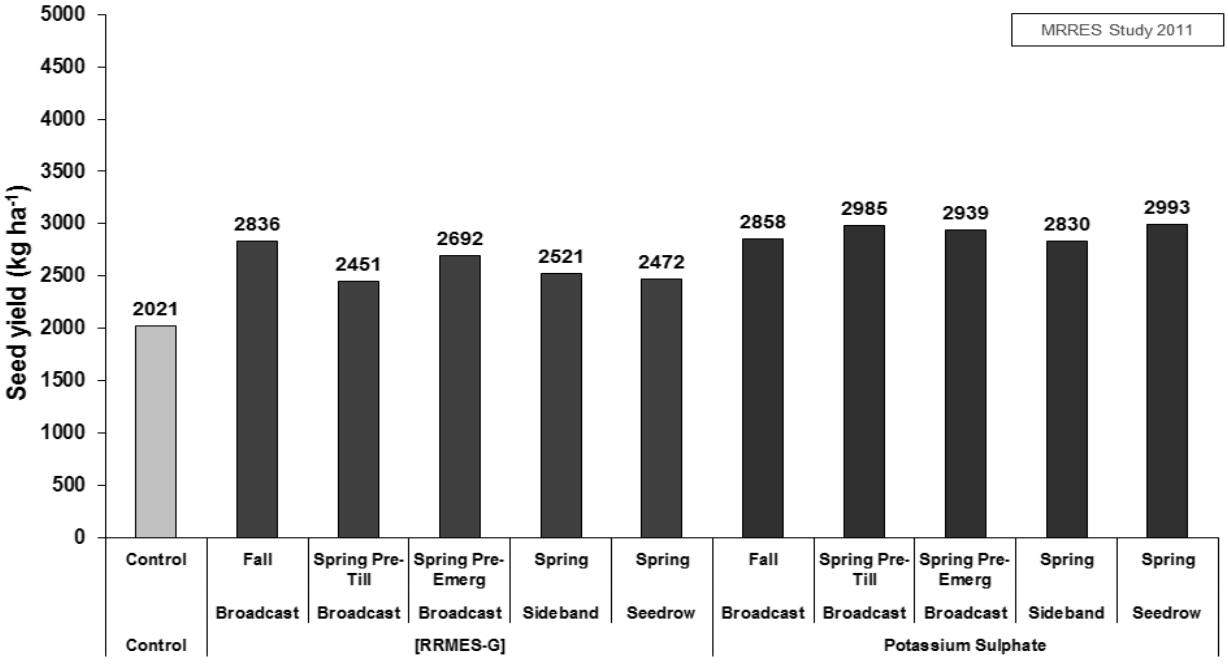

Figure 5.Seed yield of canola with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2011 on a S-deficient soil at Star City, Saskatchewan ($LSD_{0.05}$ = 425).

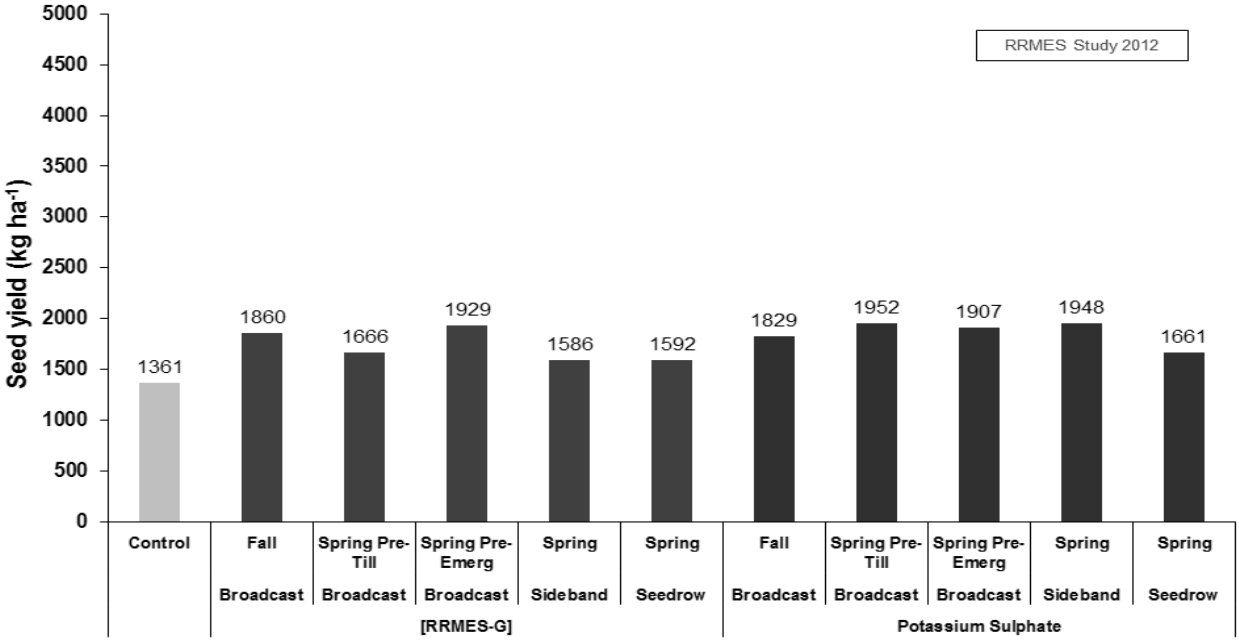

Figure 6. Seed yield of canola with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2012 on a S-deficient soil at Star City, Saskatchewan ($LSD_{0.05}$ = 228).

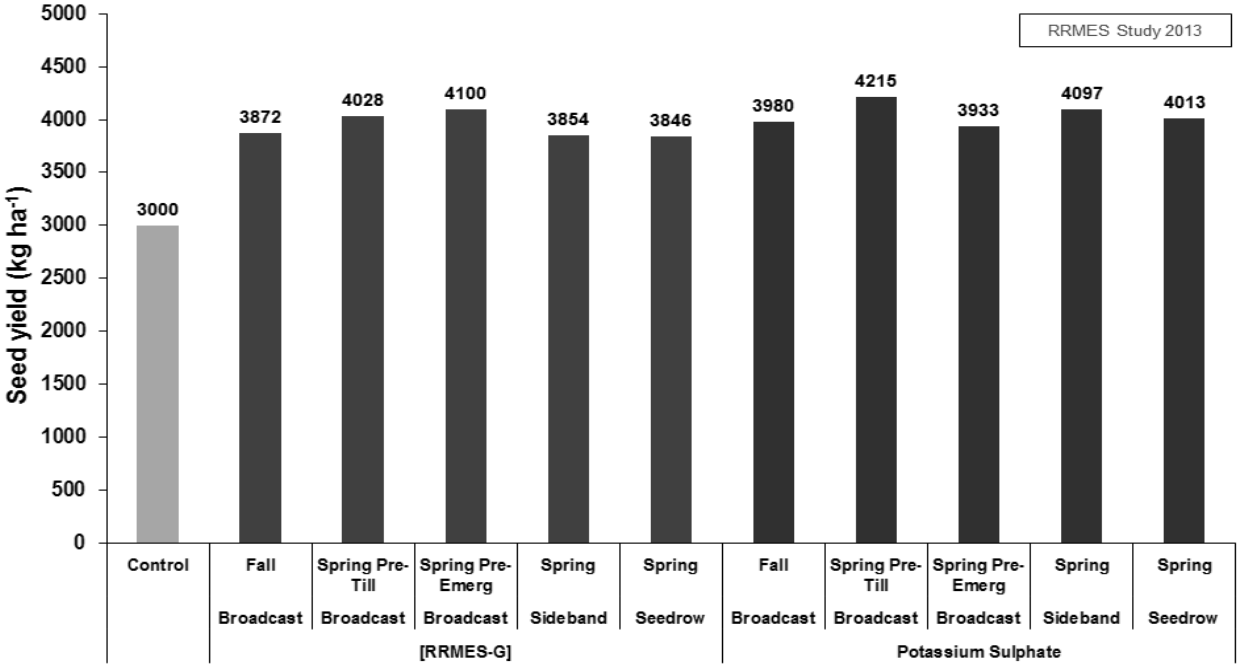

Figure 7. Seed yield of canola with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2013 on a S-deficient soil at Star City, Saskatchewan ($LSD_{0.05}$ = 337).

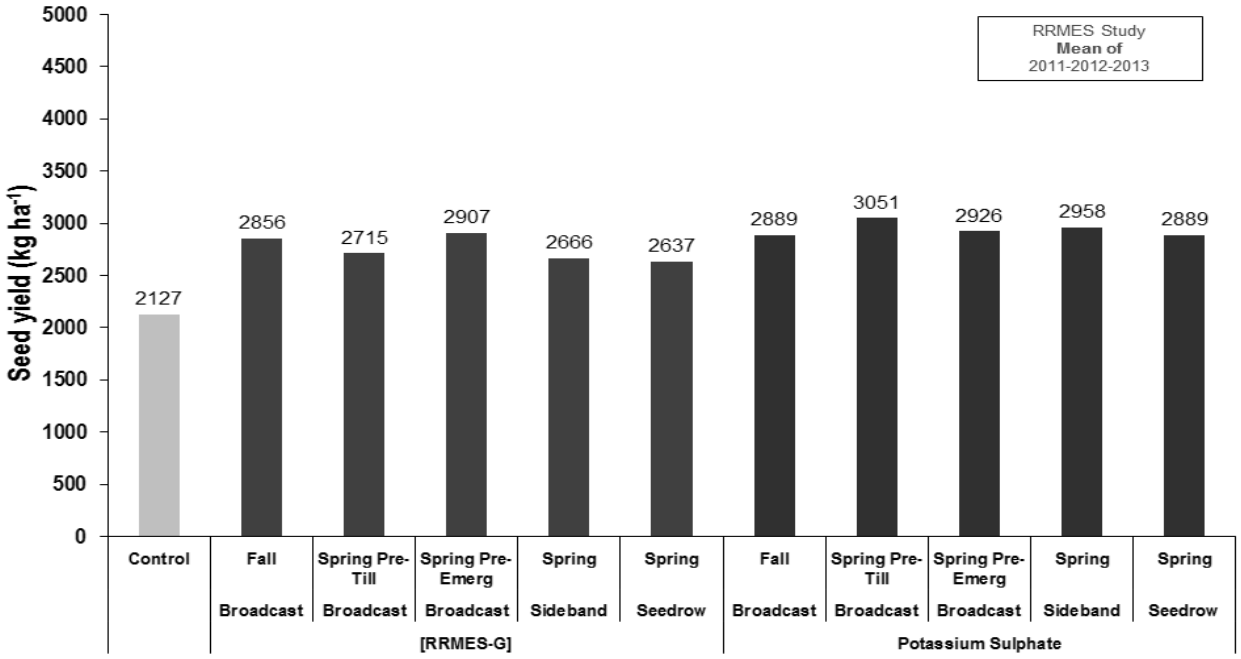

Figure 8. Mean seed yield of canola (average of 3 years) with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method on a S-deficient soil at Star City, SK, ($LSD_{0.05}$ = 207).

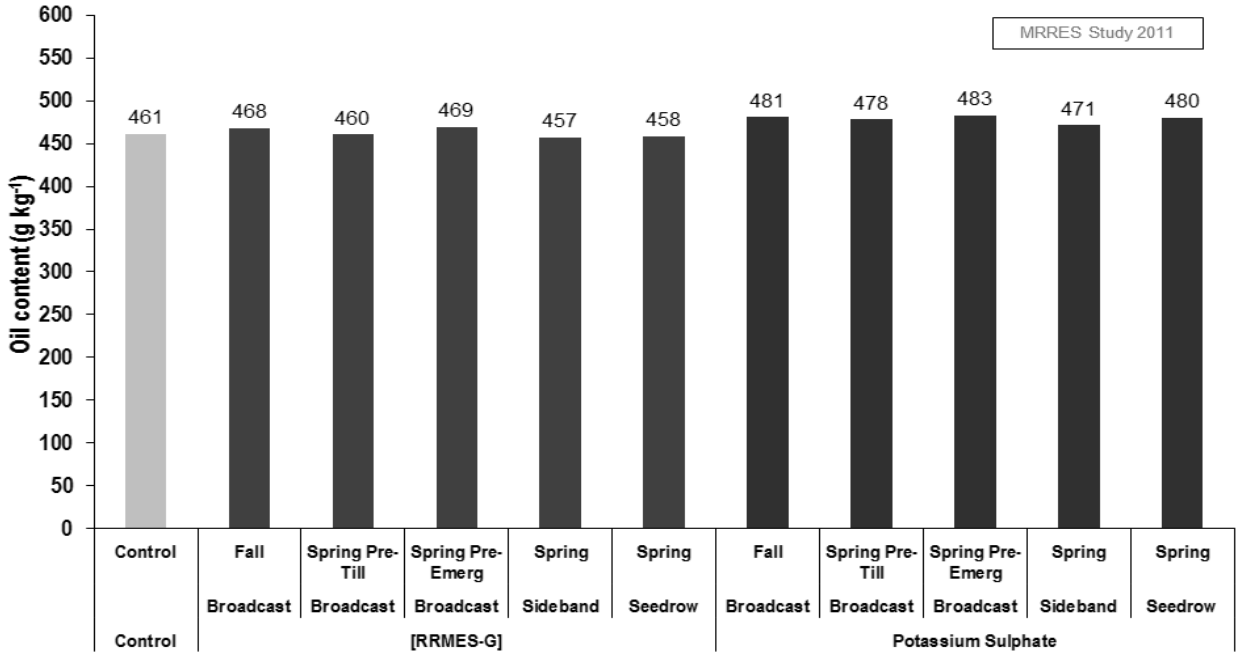

Figure 9.Oil concentration in canola seed with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2011 on a S-deficient soil at Star City, Saskatchewan (LSD0.05 = 12).

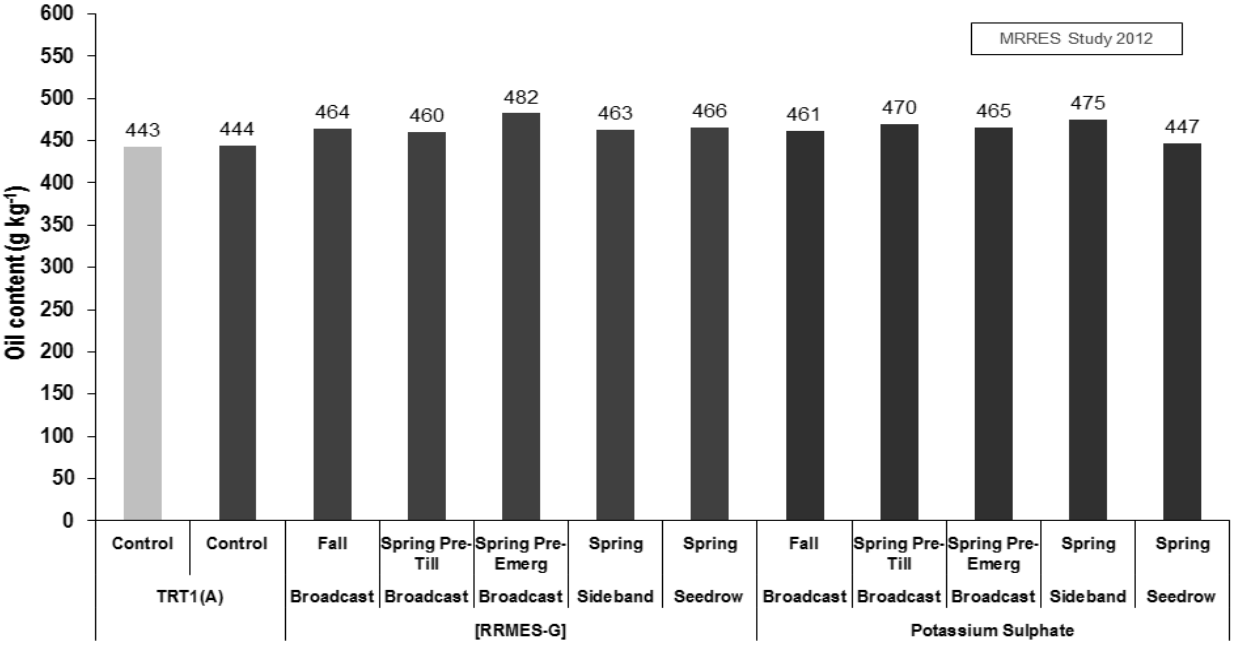

Figure 10.Oil concentration in canola seed with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2012 on a S-deficient soil at Star City, Saskatchewan (LSD0.05 = 16).

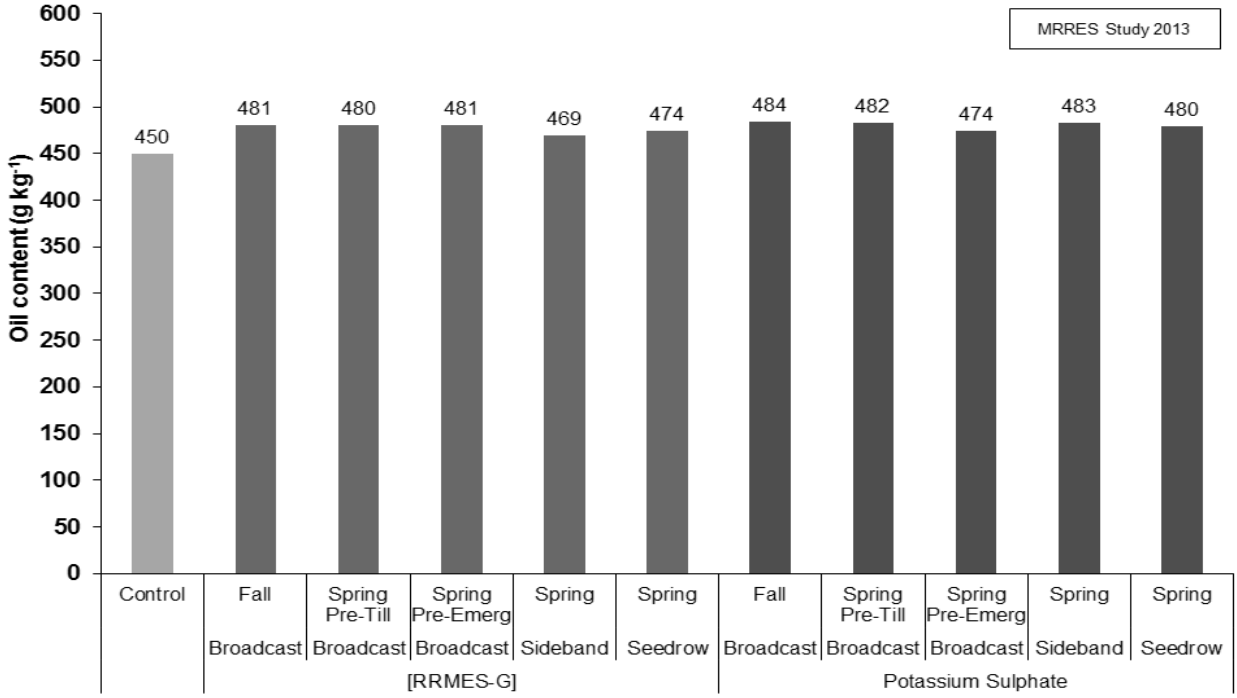

Figure 11.Oil concentration in canola seed with rapid release elemental S (RRES) and sulphate-S fertilizers applied with various combinations of application time and placement method in 2013 on a S-deficient soil at Star City, Saskatchewan (LSD0.05 = 9).