Crop Response to Seed-Row Placed Sulfur Fertilizers

T. King[1], J. Schoenau[1], H. Ahmed[1], R. Hangs[1], S.S. Malhi[2] and R. Urton[1]

[1]Department of Soil Science, 51 Campus Drive, University of Saskatchewan, Saskatoon, SK, CANADA S7N 5A8. [2]Agriculture & Agrifood Canada (AAFC), Melfort, SK, CANADA S0E 1A0.

Introduction

- Sulfur (S) fertilizers may be applied to wheat, canola and yellow pea crops in the seed-row at the time of seeding. S fertilizers available to growers on the Canadian Prairies include soluble sulfate forms (ammonium sulfate and potassium sulfate); partially soluble forms (calcium sulfate or 'gypsum'); insoluble forms that undergo oxidation (elemental S); and liquid ammonium thiosulfate (ATS) that forms sulfate and elemental S upon application to soil.
- Such fertilizers may be applied in the seed-row at the time of seeding in the spring as a starter nutrient source. Depending on fertilizer S form, rate and crop, there is a limit to how much can be safely placed in the seed-row.

Study Objectives

- To evaluate the crop response in yield and plant S uptake to different S fertilizer forms added in the seed-row over two growing seasons.

Materials and Methods

- **Study Sites:**

  1) Brown Chernozem; Ardill Association loam near Central Butte, SK.

  2) Gray Luvisol; Waitville Association loam near Star City, SK.

  Cropping history of the two sites was typical, with fields well managed and having history of fertilizer use. Soil available S was considered marginal while soil available P was marginal to sufficient.

- **Seeding and Fertilization:**

  Plots (3.0 m X 1.0 m) were seeded at a row spacing of 25 cm (Fig. 1) to: HRS wheat (Waskeda), canola (Liberty Link-150) and yellow peas (Meadow).

  S and P (as P_2O_5, 11-52-0, MAP) fertilizer treatments were applied in the seed-row during seeding (Table 1).

  Treatments were replicated 4 times for each crop.

  Prior to seeding, wheat and canola plots were broadcast fertilized with 100 kg N ha^{-1} as urea.

- **Plant Sampling:**

  1.0 m row-length crop samples (Fig. 2) were harvested in each treatment.

Fig. 1. Single-row seeding and fertilizer application.

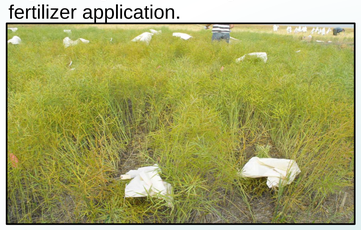

Fig. 2. 1.0 m row-length canola samples.

Table 1. Treatments and application rates.

Treatments	Application Rates		
	N‡	S	P_2O_5§
		(kg ha^{-1})	
Control (N only)	100		
Control (N + P only)	100		20
Ammonium sulfate (12-0-0-24)	100	20	
Ammonium thiosulfate (15-0-0-26)†	100	20	
Gypsum (Ca=23%; S=16%)	100	20	
Potassium sulfate (0-0-50-17)	100	20	
Elemental sulfur (0-0-0-90)	100	20	
Ammonium sulfate + P	100	20	20
Ammonium thiosulfate + P	100	20	20
Gypsum + P	100	20	20
Potassium sulfate + P	100	20	20
Elemental S + P	100	20	20

†Ammonium thiosulfate added as 12-0-0-26 in 2013, 15-0-0-20 in 2014.

‡N broadcast as urea (46-0-0) to wheat and canola crops pre-seed. No urea broadcast pre-seed to yellow pea crop.

§P added as P_2O_5 equivalent using 11-52-0 (monoammonium phosphate).

Table 2. Sulfur uptake in wheat, canola and yellow pea in Brown Chernozem and Gray Luvisol soils.

Treatments	WHEAT				CANOLA				YELLOW PEA			
	Brown Chernozem	Gray Luvisol	Brown Chernozem	Gray Luvisol	Brown Chernozem	Gray Luvisol	Brown Chernozem	Gray Luvisol	Brown Chernozem	Gray Luvisol	Brown Chernozem	Gray Luvisol
	Total S Uptake (kg ha^{-1})											
	2013		2014		2013		2014		2013		2014	
Control (N only)	14.5 ab	16.2 bc	15.6 bc	11.7 a	24.0 a	22.0 a	45.2 bc	15.5 c	10.8 a	15.8 a	9.8 ab	9.7 ab
Control (N + P only)	14.8 ab	15.6 bc	15.3 c	10.4 a	28.3 a	21.6 a	58.6 abc	12.8 c	12.3 a	12.5 a	13.9 ab	7.1 b
Ammonium sulfate	17.6 ab	15.3 bc	19.6 abc	14.3 a	27.8 a	32.8 a	65.6 ab	20.6 bc	10.3 a	18.3 a	13.0 ab	13.9 a
Ammonium thiosulfate	16.7 ab	14.3 c	22.5 a	15.6 a	27.9 a	27.3 a	58.3 abc	22.9 abc	15.1 a	19.7 a	14.5 a	10.2 ab
Gypsum	18.4 ab	21.1 ab	17.7 abc	13.8 a	26.3 a	41.6 a	47.8 bc	23.5 abc	14.3 a	17.3 a	9.0 b	8.2 ab
Potassium sulfate	23.9 a	23.9 a	19.5 abc	13.8 a	25.7 a	41.1 a	38.3 c	18.3 c	11.0 a	9.4 a	9.8 ab	6.2 b
Elemental sulfur	15.6 ab	17.1 bc	21.7 ab	13.6 a	22.1 a	36.9 a	61.1 abc	19.5 c	10.8 a	20.1 a	11.6 ab	9.4 ab
Ammonium sulfate + P	14.6 ab	16.8 bc	16.9 abc	12.9 a	27.4 a	28.0 a	58.8 abc	34.0 a	15.0 a	18.0 a	14.2 a	8.3 ab
Ammonium thiosulfate + P	12.8 b	15.7 bc	17.3 abc	11.7 a	23.0 a	39.4 a	58.7 abc	32.6 ab	12.9 a	21.4 a	10.9 ab	10.3 ab
Gypsum + P	17.1 ab	20.0 abc	17.6 abc	12.5 a	29.2 a	37.5 a	71.4 a	21.9 abc	12.7 a	16.6 a	12.7 ab	11.1 ab
Potassium sulfate + P	12.0 b	15.9 bc	16.6 abc	12.8 a	22.7 a	27.3 a	56.9 abc	14.1 c	8.4 a	15.3 a	12.4 ab	9.1 ab
Elemental S + P	16.5 ab	15.5 bc	14.3 c	13.3 a	29.4 a	19.6 a	51.6 abc	14.6 c	9.6 a	15.9 a	11.4 ab	11.3 ab
P × S Fertlizer effect												
P Value ($P \leq 0.05$)	0.038	<0.0001	0.581	0.989	0.953	0.046	0.570	0.103	0.479	0.078	0.808	0.775
F Value	2.18	5.33	0.76	0.11	0.38	2.13	0.78	2.00	0.99	1.89	0.45	0.50
SEM††	2.091	1.495	2.19	1.98	4.486	5.957	8.07	4.28	2.469	2.964	1.80	2.25

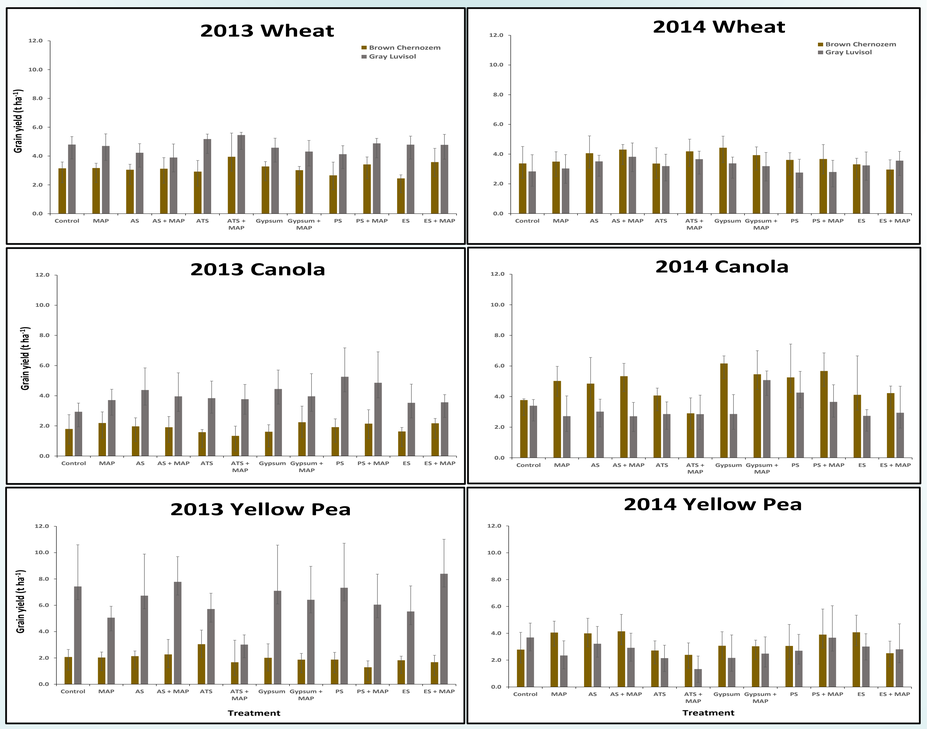

Fig. 3. Wheat, canola and yellow pea grain yield (t ha^{-1}) harvested at: Brown Chernozem (Central Butte) and Gray Luvisol (Star City) sites in fall 2013 and fall 2014. Error bars denote standard error of the treatment means with N=48 and n = 4. (MAP = Monoammonium Phosphate; AS = Ammonium Sulfate; ATS = Ammonium Thiosulfate; PS = Potassium Sulfate and ES = Elemental Sulfur).

Results and Discussion

- Addition of sulfate and ATS increased S uptake in wheat, canola and pea, at Brown Chernozem and Gray Luvisol sites in 2013 (Table 2).
- S uptake in canola at Brown Chernozem site for all treatments in 2014 was greater than 2013, reflecting better growing conditions and grain yields in 2014, compared to 2013.
- Calcium sulfate (gypsum) plus MAP, and potassium sulfate plus MAP added to canola at Gray Luvisol site in both years increased yields (Fig. 3).
- The addition of MAP fertilizer did not significantly affect wheat, canola and yellow pea grain yields, consistent with adequate soil available P at sites (Fig. 3).
- Addition of ATS + MAP in seed row reduced germination and emergence of canola and pea at both sites in 2013 and 2014, owing to problems in separation between liquid fertilizer and seed.
- Limited response of wheat to addition of S fertilizers at Brown Chernozem and Gray Luvisol sites in both years of the study suggests that of the three crops evaluated, wheat is least responsive to S fertilization.
- Subsoil reserves of sulfate in the Brown Chernozem soil likely contributed to lack of response of any crop to added S fertilizer in 2013, while high moisture conditions in 2014 resulted in response to S, despite the presence of sulfate at depth.

Conclusions

- Thiosulfate and sulfate sources, especially calcium sulfate (gypsum), applied in the seed-row at 20 kg S ha^{-1} were generally effective in enhancing S uptake and yield of canola in these marginally S deficient soils.
- Responses to seed-placed S fertilizer depend on S fertilizer form, crop, growing conditions, soil S status and factors affecting seed safety.

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