EFFECTS OF SEED-PLACED SULFUR FORMS ON WHEAT, CANOLA AND PEA YIELDS IN SASKATCHEWAN SOILS

Tom King[1], Jeff J. Schoenau[1], Ryan Hangs[1], S. S. Malhi[2] and Ron Urton[1]

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

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Introduction

- *Sulfur fertilizers are important for not only canola, but also sometimes recommended for cereal and pulse crops.*
- ***Sulfur sources include:***
  - *soluble forms (Ammonium Sulfate, Potassium Sulfate)*
  - *slightly soluble forms (Calcium Sulfate [Gypsum])*
  - *insoluble forms (Elemental Sulfur)*
  - *liquid forms (Ammonium Thiosulfate)*
- ***Is there an advantage of using one or more of the S fertilizer forms in conjunction with phosphorus fertilizer in cereal, oilseed and legume crops in different Saskatchewan soils?***

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STUDY OBJECTIVE

- *To examine the effects that* ***different forms of sulfur fertilizers****,* ***with and without the addition of phosphorus fertilizer****, have on wheat, canola and pea yield in:* ***Brown Chernozem, Gray Luvisol and Gray-Black Chernozem soils*** *in Saskatchewan.*

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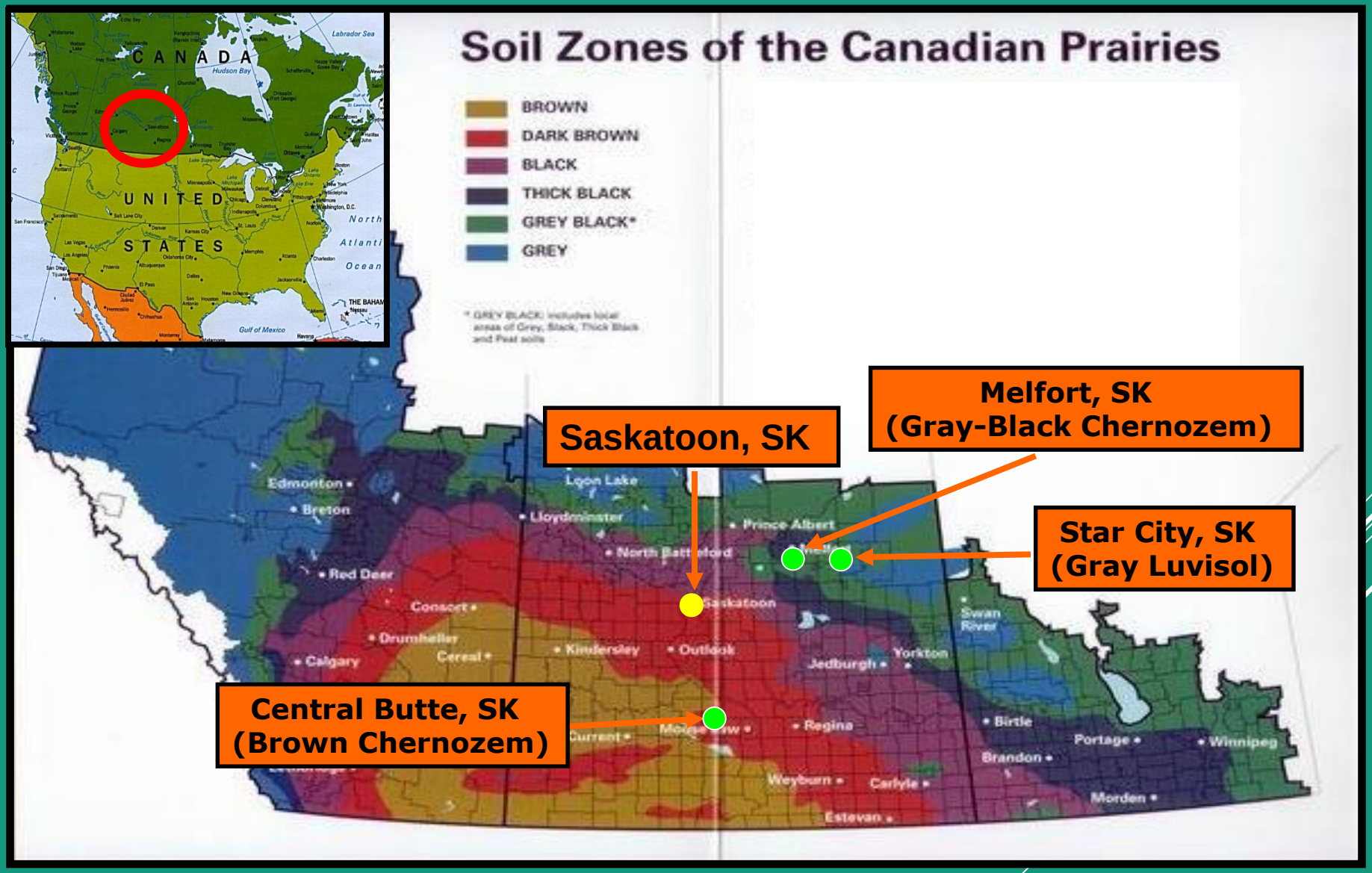
STUDY LOCATIONS



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(Henry's Handbook of Soil and Water, 2003)

STUDY METHODOLOGY

- Study set up as a randomized complete block design (RCBD), complete with 4 replicate blocks for each of the 3 crops at 3 sites in Saskatchewan.
- 3 Crops: Cereal: Hard Red Spring Wheat (Waskada HRSW)
  Oilseed: Canola (Liberty Link 150)
  Legume: Yellow Pea (Meadow)
- Plot Size: 3 metre X 1 metre
- Plots seeded & seed-row fertilizer placement using a single row seeder.
- Row Spacing: 25 cm
- Seedbed utilization (SBU) = ~ 5%
- Harvest samples: 1.0 metre row length

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STUDY METHODOLOGY

Treatments	Fertilizer Rates (kg ha^{-1})		
	Sulfur	Phosphorus[†]	Nitrogen[‡]
Urea	0	0	100
Urea+Monoammonium Phosphate (MAP)	0	20	100
Ammonium Sulfate	20	0	100
Ammonium Sulfate + MAP	20	20	100
Ammonium Thiosulfate	20	0	100
Ammonium Thiosulfate + MAP	20	20	100
Gypsum	20	0	100
Gypsum + MAP	20	20	100
Potassium Sulfate	20	0	100
Potassium Sulfate + MAP	20	20	100
Elemental Sulfur	20	0	100
Elemental Sulfur + MAP	20	20	100

[†]Phosphorus fertilizer added as P_2O_5 equivalent. Phosphorus fertilizer applied as monoammonium phosphate (MAP: 12-51-0).

[‡]Nitrogen fertilizer applied as urea (46-0-0). Sulfur and/or phosphorus fertilizer containing N is taken into account to maintain a 100 kg N ha^{-1} rate. No N fertilizer (other than the N contained in sulfur and/or phosphorus fertilizer) was added to the pea crop.

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2014 STUDY RESULTS

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SOIL TEST EXTRACTABLE P AND S SPRING 2014

	P		S	
	-----kg ha^{-1} (0-15 cm)-------			
Central Butte (Brown Chernozem)†	17	48‡	37	11
Star City (Gray Luvisol)	13	50	43	20
Melfort (Gray-Black Chernozem)	42	59	32	14

†Sulfates present in sub-soil (30-60 cm) at Central Butte (Brown Chernozem) site.

‡Values in red indicate spring 2013 soil extractable P and S

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2014 Wheat Grain Yield

Treatments	Central Butte Brown Chernozem	Star City Gray Luvisol	Melfort Gray-Black Chernozem
	----------(kg ha^{-1})----------		
Urea	3373[†]	2323	4130
Urea+Monoammonium Phosphate (MAP)	3494	3501	4581
Ammonium Sulfate	4659	3511	3778
Ammonium Sulfate + MAP	4304	3822	4477
Ammonium Thiosulfate	3366	3196	3720
Ammonium Thiosulfate + MAP	4188	3658	3726
Gypsum	4431	3377	3617
Gypsum + MAP	3888	3192	4201
Potassium Sulfate	3611	3088	3616
Potassium Sulfate + MAP	4175	2796	3848
Elemental Sulfur	3311	3639	4004
Elemental Sulfur + MAP	2963	3562	4229
	Pr > F	**Pr > F**	**Pr > F**
Crop	0.0005	0.1730	0.0247
Treatment	<0.0001	0.1620	<0.0001
Crop*Treatment	<0.0001	<0.0001	0.0001

[†]Least significant difference at $P \leq 0.10$

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2014 Wheat Crop Summary

- At Brown Chernozem (Central Butte) ammonium sulfate and gypsum produced highest yields.
- Addition of MAP to S fertilizers slightly boosted wheat yields at Gray-Black Chernozem (Melfort) site.
- No significant response of wheat grain yield to S fertilizers at Gray Luvisol or Gray-Black Chernozem sites.

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2014 Canola Grain Yield

Treatments	Central Butte Brown Chernozem	Star City Gray Luvisol	Melfort Gray-Black Chernozem
	(kg ha^{-1})		
Urea	3773[†]	3402	5576
Urea+Monoammonium Phosphate (MAP)	5021	3308	3957
Ammonium Sulfate	4093	2646	3888
Ammonium Sulfate + MAP	5332	2714	4974
Ammonium Thiosulfate	4071	3164	4168
Ammonium Thiosulfate + MAP	2452	2258	3254
Gypsum	6192	3266	4424
Gypsum + MAP	6119	5076	5421
Potassium Sulfate	4186	3635	7819
Potassium Sulfate + MAP	5672	3154	3945
Elemental Sulfur	5298	2725	3744
Elemental Sulfur + MAP	4226	3735	4763
	Pr > F	**Pr > F**	**Pr > F**
Crop	0.0005	0.1730	0.0247
Treatment	<0.0001	0.1620	<0.0001
Crop*Treatment	<0.0001	<0.0001	0.0001

[†]Least significant difference at $P \leq 0.10$

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2014 Canola Crop Summary

- In Brown Chernozem soil, calcium sulfate (gypsum) (± MAP) *produced significant canola yield response.*
- At Gray Luvisol site, addition of calcium sulfate + MAP *increased canola yields.*
- For Gray-Black Chernozem site, *potassium sulfate had highest yield.* Gypsum + MAP had similar high yields.
- Some issues with injury for seed-placed AS, ATS and MAP at Gray and Gray-Black sites.

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2014 Yellow Pea Grain Yield

Treatments	Central Butte Brown Chernozem	Star City Gray Luvisol	Melfort Gray-Black Chernozem
	(kg ha^{-1})		
Control (No Urea)	3436[†]	3278	5237
Monoammonium Phosphate (MAP)	4478	2893	7268
Ammonium Sulfate	3995	3857	3761
Ammonium Sulfate + MAP	4146	3225	3755
Ammonium Thiosulfate	3023	2665	2633
Ammonium Thiosulfate + MAP	1995	1481	1620
Gypsum	3070	2988	2569
Gypsum + MAP	3034	2002	3131
Potassium Sulfate	3815	2701	4904
Potassium Sulfate + MAP	3055	2752	5791
Elemental Sulfur	4665	3009	4937
Elemental Sulfur + MAP	2968	2019	4814
	Pr > F	**Pr > F**	**Pr > F**
Crop	0.0005	0.1730	0.0247
Treatment	<0.0001	0.1620	<0.0001
Crop*Treatment	<0.0001	<0.0001	0.0001

[†]Least significant difference at $P \leq 0.10$

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2014 Pea Crop Summary

- No significant positive yield responses of pea to S fertilizer.
- ATS treatment (with MAP) <u>significantly decreased pea grain yield.</u>
  - 20 kg P_2O_5/ha plus 20 kg S/ha in seed-row may have caused injury especially with the low SBU (~ %5).
- At Brown and Gray-Black Chernozem sites, positive yield responses to MAP.

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General Conclusions

- Calcium sulfate (gypsum) and potassium sulfate were *effective fertilizer S sources in the seed-row for crops* evaluated. Suitable alternative to ammonium sulfate.
- Elemental S produced some positive yield responses, especially in wheat.
- Of the three crops, *canola most consistent in response to added S*. Peas showed no positive response.
- Addition of ATS, especially in combination with MAP *placed in seed row in contact with seed impaired canola and especially pea crop germination and growth* at all three Saskatchewan sites.
- Better response to P fertilizer application at Brown Chernozem and Gray Luvisol sites due to lower residual soil available phosphorus.

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