Influence of formulation of elemental S fertilizer on yield, quality and S uptake of canola seed

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BACKGROUND

- Plants use only the sulphate form of S.
- Now, there are many commercial fertilizers that contain S in elemental form and effectiveness of these fertilizers depends on the rate at which S is oxidized to sulphate-S in soil for plant uptake.
- Rate of S oxidation in elemental S fertilizers to plant available sulphate-S depends on factors that affect microbial activity such as soil moisture, temperature, aeration and size of fertilizer granules.
- Deficiency of S in canola can be readily or effectively prevented or eliminated by applying sulphate-S fertilizers.
- In a number of field studies, canola has been found to produce lower seed yield with elemental S fertilizers than with sulphate-S fertilizers on S-deficient soils, particularly in the first year of application and especially with spring application at seeding time.
- In most of the previous studies, granular elemental S and sulphate-S fertilizers were used.
- There is little information on the influence of formulation of elemental S on seed yield and S uptake of canola in the Parkland region of western Canada, where canola is a major cash crop and many agricultural soils are deficient or potentially deficient in plant-available S for optimum seed yield.

OBJECTIVE

- The objective of this study was to determine the influence of formulation of elemental S fertilizers on yield, oil, protein and S concentration, S uptake, percent recovery of applied S and N uptake in seed of canola grown on S-deficient soils.

MATERIALS AND METHODS

- Three field experiments were conducted on S-deficient Gray and Dark Gray Luvisol soils (Typic Cryoboralf) in Saskatchewan and Alberta in 2000 and 2001.
- Experiment 1 was conducted in 2000 and 2001, and same treatment was imposed on a given plot in both years. Experiment 2 was carried out in 2000 near Legal, Alberta.

- In Experiments 1 and 2, treatments included five elemental S fertilizers (ES-99 granular, ES-95 granular, ES-90 granular, Biosul-90 granular, and Biosul-50 suspension), a sulphate-S fertilizer (potassium sulphate) and a zero-S control.
- Experiment 3 was conducted near Canwood, Saskatchewan, and had eight elemental S fertilizers (ES-99 granular, ES-95 granular, ES-90 granular, Biosul-90 granular, Biosul-50 suspension, Lab fine ES-99.5 powder, ES Settle-47 powder and ES SPB571-85.8 powder), a granular fertilizer containing 21.7 % elemental S and 18.7% sulphate-S (Agrium Plus), a granular fertilizer blend of ES-90 and ammonium sulphate (1:1), a sulphate-S fertilizer (ammonium sulphate) and a zero-S control.
- ES-99 granular and ES Settle-47 powder were obtained from Shell Global Solution, ES-95 granular from Fernz SulFer Inc., ES-90 granular from Tiger Industries, Biosul-90 granular and Biosul-50 suspension from New Paradigms, ES SPB571-85.8 powder from Alberta Research Council, and Agrium Plus from Agrium.
- Each treatment was replicated four times in a randomized complete block design. All plots received a blanket annual application of N, P and K fertilizers 3-5 days prior to seeding in spring, and were tilled once to incorporate the fertilizers into the soil.
- Crop canola (*Brassica napus* L. cv. A4573 at Porcupine Plain, and cv. Invigor 2663 at Legal and Canwood) was seeded in mid to late May at a seed rate of 9 kg ha^{-1}.
- The S fertilizers were surface-broadcast or sprayed at 15 and 30 kg S ha^{-1} rates within 2-3 days after sowing in spring.
- Data were recorded on yield, concentration of oil, protein and S, and uptake of S and N in seed.

RESULTS

- Canola plants in the zero-S treatment showed S deficiency in the growing season, and seed yield increased with sulphate-S fertilizer by 21.8, 1.4, and 3.6 times in Experiment 1, 2, and 3, respectively.
- There was little effect of S fertilizer on protein concentration in seed. Biosul-50 suspension in all experiments and powder forms of elemental S fertilizers, used only in Experiment 3, were almost as effective as sulphate-S fertilizers.
- In all experiments, granular elemental S fertilizers had no or only very small effect on seed yield, S uptake, % recovery of applied S, N uptake, oil concentration, S concentration and protein concentration of canola seed in first year of application.
- In second year of Experiment 1, granular elemental S fertilizers tended to increase seed yield, S uptake, N uptake, oil concentration, and S concentration of canola seed, but none of them produced seed yield or improved other parameters of canola seed comparable to the sulphate-S and elemental S powder or suspension fertilizers.

CONCLUSIONS

- Seed yield, N uptake and S uptake of canola seed were very low in the absence of S fertilization on S-deficient soils.
- There was a marked increase in seed yield, N uptake and S uptake with granular sulphate-S and suspension or powder elemental S fertilizers.
- Increase in seed yield, N uptake and S uptake with increasing rate of S application was dependent on the severity of S deficiency.
- Granular elemental S fertilizers were not effective in correcting S deficiency in canola in the first year of application.
- Even after two annual applications in Experiment 1, seed yield, N uptake, S uptake, % recovery of applied S and oil concentration in canola seed on S-deficient soils were much less with granular elemental S fertilizers compared to the sulphate-S fertilizers indicating that granular elemental S fertilizers corrected S deficiency partially only.
- Seed yield, N uptake, S uptake and % recovery of applied S in canola seed with surface application of suspension and powder formulations of elemental S fertilizers were similar to sulphate-S fertilizer, and were more than granular S elemental S fertilizers.
- The findings demonstrate that on S-deficient soils granular elemental S fertilizers are less effective in increasing seed yield and quality of canola than sulphate-S fertilizer, but S deficiency in canola can be prevented by broadcast/spread surface-application of elemental S fertilizers that contain 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 S fertilizers.

ACKNOWLEDGEMENTS

- The authors thank New Paradigm (Gas Processing), Calgary, Alberta for financial assistance, and Z. Zhang, D. Leach, K. Fidyk and K. Falk-Hemstad for technical help.

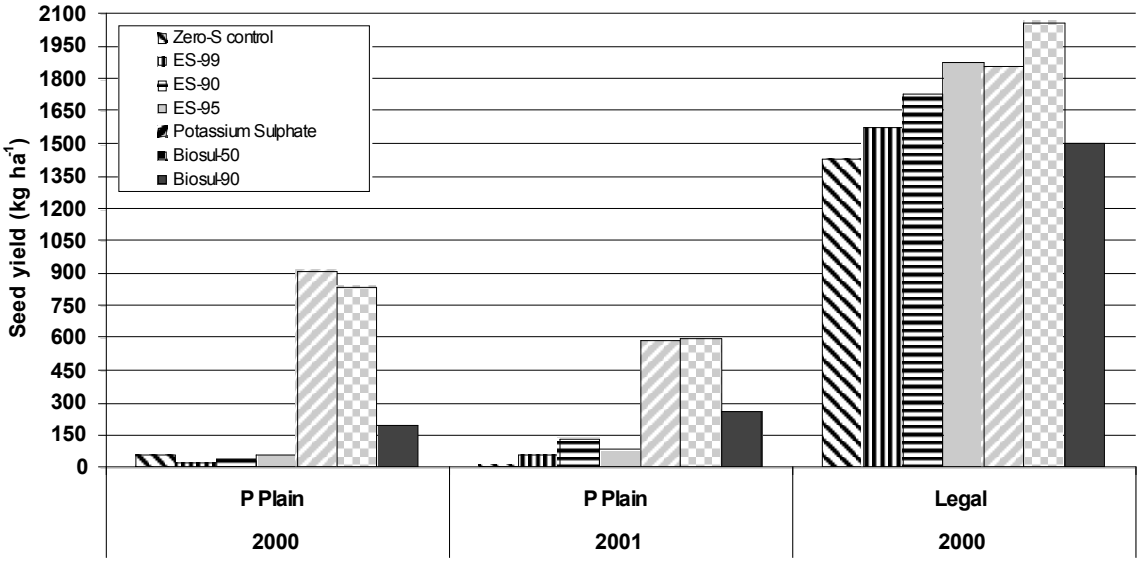

Figure 1. Seed yield of canola from various S fertilizers applied at two rates (15 and 30 kg S ha^{-1}) at Porcupine Plain (Experiment 1) and Legal (Experiment 2) in 2000 (averaged across the two S rates).

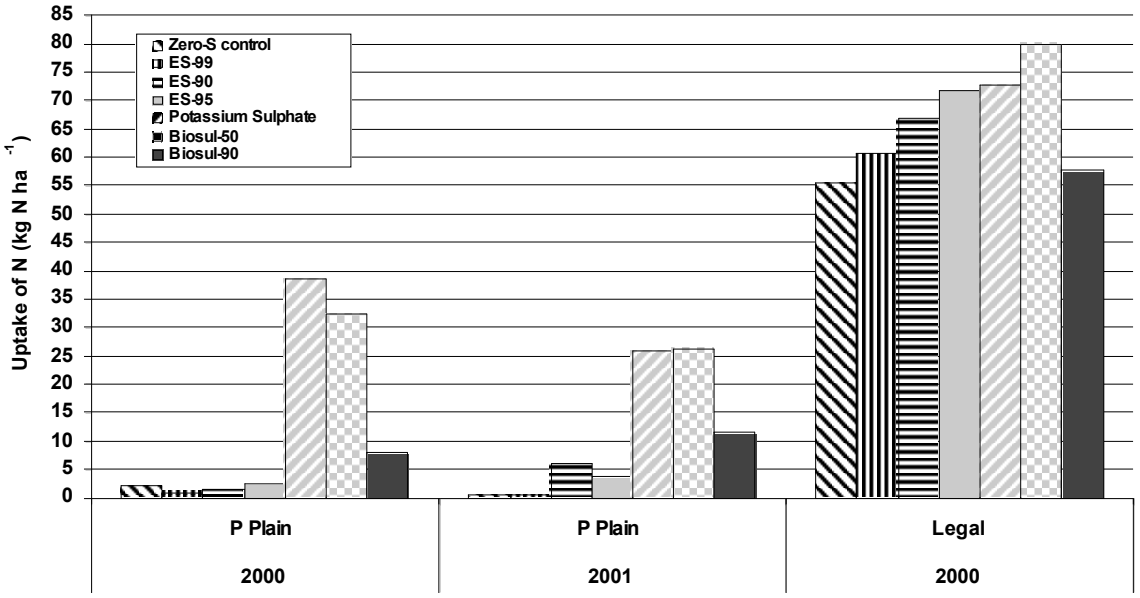

Figure 2. Nitrogen uptake in canola seed from various S fertilizers applied at two rates (15 and 30 kg S ha^{-1}) at Porcupine Plain (Experiment 1) and Legal (Experiment 2) in 2000 (averaged across the two S rates).

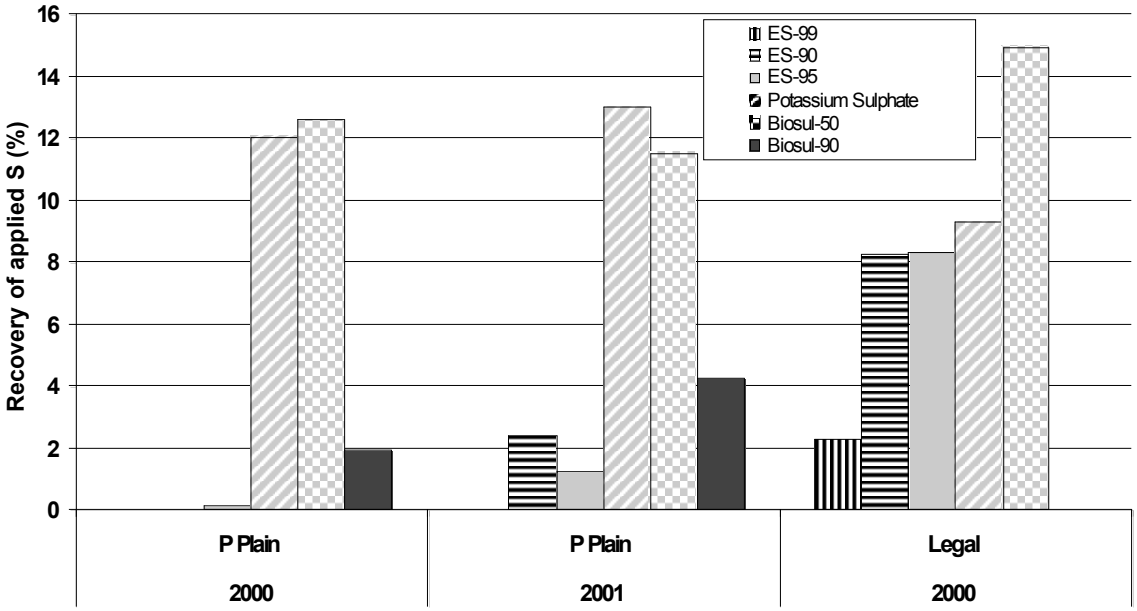

Figure 3. Recovery of applied S fertilizer in canola seed from various S fertilizers applied at two rates (15 and 30 kg S ha^{-1}) at Porcupine Plain (Experiment 1) and Legal (Experiment 2) in 2000 (averaged across the two S rates).

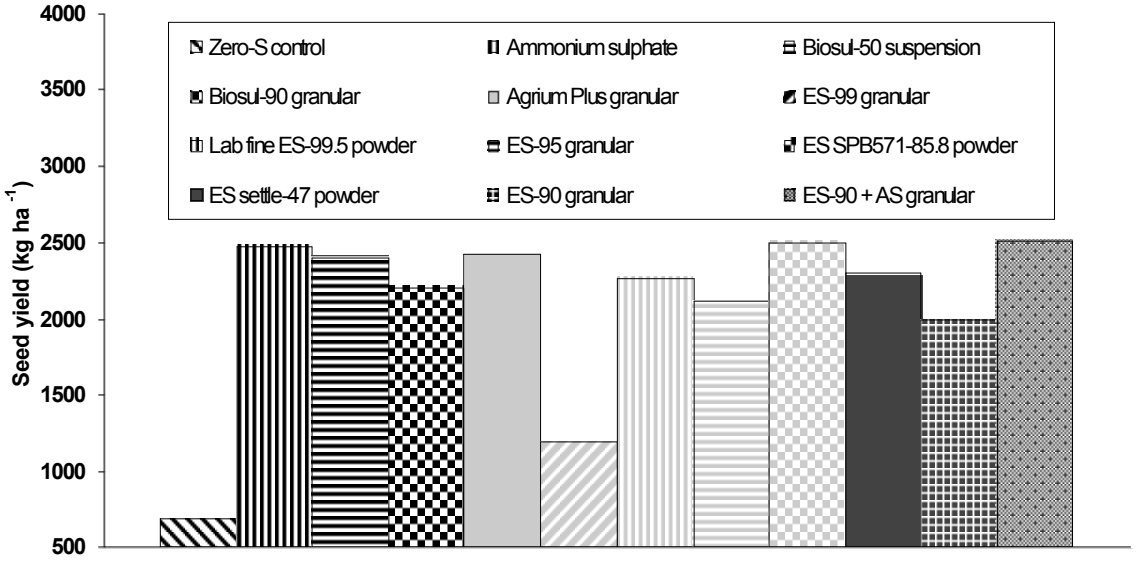

Figure 4. Seed yield of canola from various S fertilizers applied at two rates (15 and 30 kg S ha^{-1}) at Canwood (Experiment 3) in Northwestern Saskatchewan in 2001 (averaged across the two S rates).

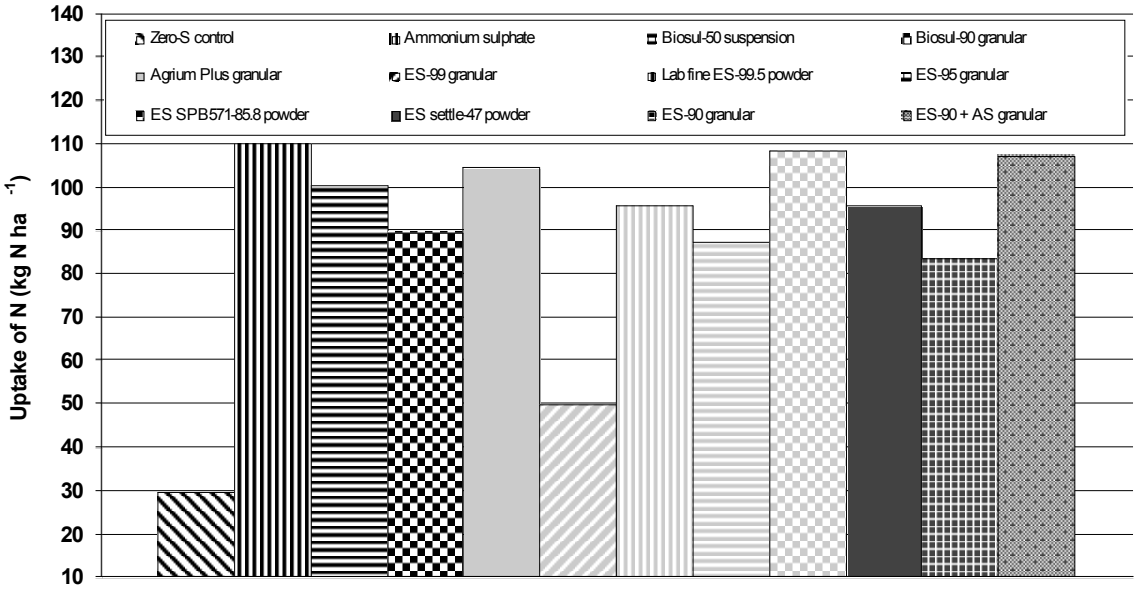

Figure 5. Nitrogen uptake in canola seed from various S fertilizers applied at two rates (15 and 30 kg S ha^{-1}) at Canwood (Experiment 3) in Northwestern Saskatchewan in 2001 (averaged across the two S rates).

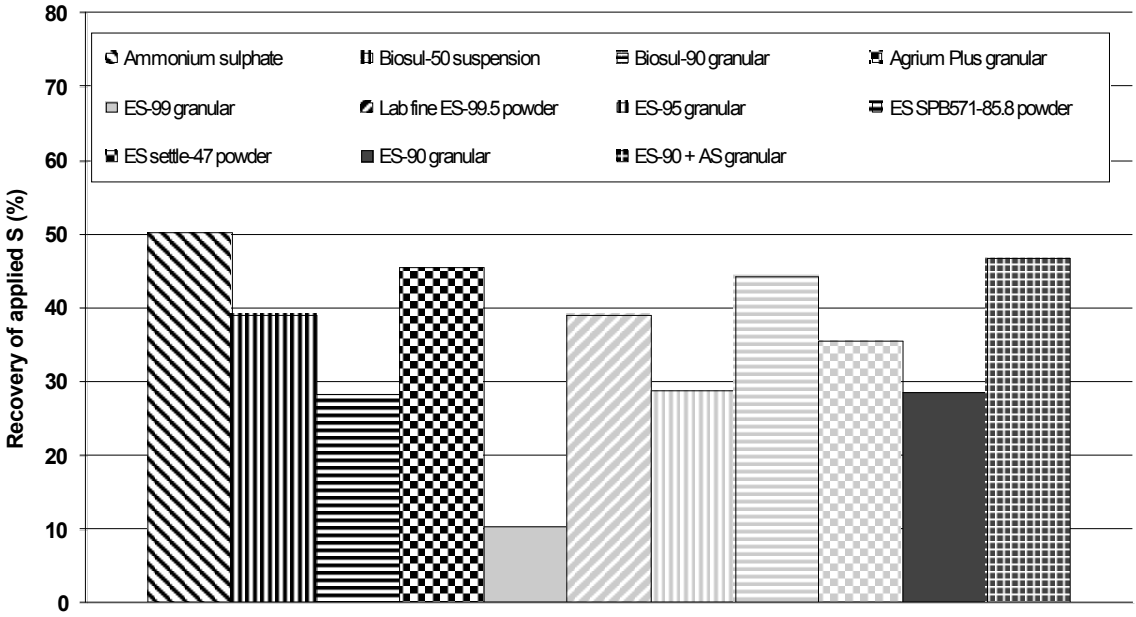

Figure 6. Recovery of applied S in canola seed from various S fertilizers applied at two rates (15 and 30 kg S ha^{-1}) at Canwood (Experiment 3) in Northwestern Saskatchewan in 2001 (averaged across the two S rates).