Do we need to add more S fertilizer at high N rates for optimum canola yield, seed quality, and uptake of S and N?

S. S. Malhi[1] and D. Leach[1]

[1]Agriculture and Agri-food Canada, Research Farm, Highway 6 South, P.O. Box 1240, Melfort, Saskatchewan, Canada S0E 1A0

BACKGROUND

- Crop requirements for S and N are closely linked because both are used for protein and chlorophyll synthesis in higher plant species.
- Canola has a high S requirement, which is greater than that of cereals, as canola has higher protein content and a higher proportion of the amino acids cysteine and methionine compared to cereals.
- On marginally S-deficient soils in the Parkland region, application of high rates of N and other fertilizers in combination with more frequent production of high yielding canola (*Brassica napus L. or B. rapa* L.) cultivars causes rapid depletion of S and nutrient imbalance in soil, and S deficiency and yield reduction in crops.
- Deficiency of S at any growth stage can cause considerable reduction in seed yield because S is immobile in plants. Therefore, a constant supply of available S to canola plants is thus needed throughout the growing season to prevent any seed yield loss due to S deficiency.
- Information on the optimum combination of fertilizer N and S rates on frequency and severity of S deficiency, and yield and quality of canola under field conditions in the Canadian prairies is needed.

OBJECTIVE

- To determine the influence of fertilizer N and S rate combinations on yield, seed quality, and uptake of S and N for canola.

MATERIALS AND METHODS

- Field experiments were conducted on four S-deficient Gray Luvisl (Boralfs) soils in northeastern Saskatchewan (Table 1).
- Precipitation during the experimental growing seasons was near normal.
- There were 16 fertilization treatments based on factorial combination of four rates of N (0, 50, 100 and 150 kg N ha^{-1}) and four levels of S (0, 10, 20 and 30 kg S ha^{-1}).
- The source of S was potassium sulphate (K_2SO_4) and of N was ammonium nitrate (NH_4NO_3).
- Each treatment was replicated four times in a randomized complete block design (RCBD).
- All fertilizers were broadcast on surface and incorporated into soil.
- Data were recorded on yield, total S concentration, S uptake, and N uptake of seed and straw, and protein and oil concentration of seed.

RESULTS

- All four site-years showed similar trends for almost all parameters measured. The S x N interactions were significant for most parameters. So, the results on S x N interaction effects are presented as means of four site-years.
- In the absence of S application, increase in N rate made the S deficiency symptoms more severe, reduced yield, S concentration, oil concentration, S uptake and N uptake in seed, and generally tended to have no effect or some increase in yield, S uptake, and N uptake in straw up to 50 or 100 kg N ha^{-1} and reduced these at higher N rates.
- When S was applied, yield, S concentration, S uptake and N uptake in seed as well as the yield and S uptake in straw increased with increasing N rate; but maximum benefits were attained when S was applied at 20 kg S ha^{-1} and sometimes at 30 kg S ha^{-1}.
- Irrespective of S rate, fertilizer N had no consistent effect on total S concentration, but reduced oil concentration and increased protein concentration in canola seed.
- With S fertilization, yield, S uptake and N uptake in seed and straw, and total S concentration and oil concentration in seed were substantially increased, whereas there was no consistent variation in protein concentration in seed.
- Response of these parameters to S application was generally greater at higher N rates. Sulphur and N uptake measured in both seed and straw indicated that significant N x S interaction effects were more frequent and pronounced for seed yield than for straw yield, indicating that response to N rate was relatively more dependent on the S level for seed than for straw.

CONCLUSIONS

- The use of S fertilizer was critical to avoid negative effects from N fertilization on canola, and to obtain a positive response of canola from N fertilization in S-deficient soil conditions, especially on yield, S concentration, oil concentration and S uptake of seed.
- In the absence of S fertilizer, application of N alone reduced canola yield, S concentration, oil concentration, and S and N uptake in seed drastically.
- As S application alone increased yield, S concentration, oil concentration, protein concentration, S and N uptake of seed, and yield and N uptake of straw, it was clearly the nutrient more limiting than N at these sites.
- The relative response of canola to S application was generally greater at high N rates.
- When yield, and S and N uptake were measured in both seed and straw, the response of canola to increasing N rate was more dependent on the S level for seed than for straw.
- Overall, the results indicate an increased requirement for S application when a high rate of N is applied to attain optimum canola yield and seed quality.

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Table 1. Some characteristics of soils for the different site-years in northeastern Saskatchewan

Site-year	Great Group[Z]	Depth (cm)	Texture	Organic matter (%)	pH (1:2 water)	SO_4-S (mg kg^{-1})	NO_3-N (mg kg^{-1})
Tisdale 1999	Gray Luvisol	0-15	Sandy loam	4.6	6.5	10.0	5.6
		15-30			7.2	10.0	4.8
		30-60			7.2	8.0	3.6
Porcupine Plain 1999	Gray Luvisol	0-15	Loam	3.2	7.1	7.4	6.6
		15-30			7.8	7.4	3.2
		30-60			8.4	6.8	2.8
Tisdale 2000	Gray Luvisol	0-15	Sandy loam	4.6	6.7	7.4	6.2
		15-30			7.0	6.2	2.6
		30-60			7.3	4.8	2.0
Archerwill 2000	Gray Luvisol	0-15	Sandy loam	5.4	7.7	7.8	8.0
		15-30			7.8	6.0	5.8

[Z] Based on Canadian Soil Classification System.

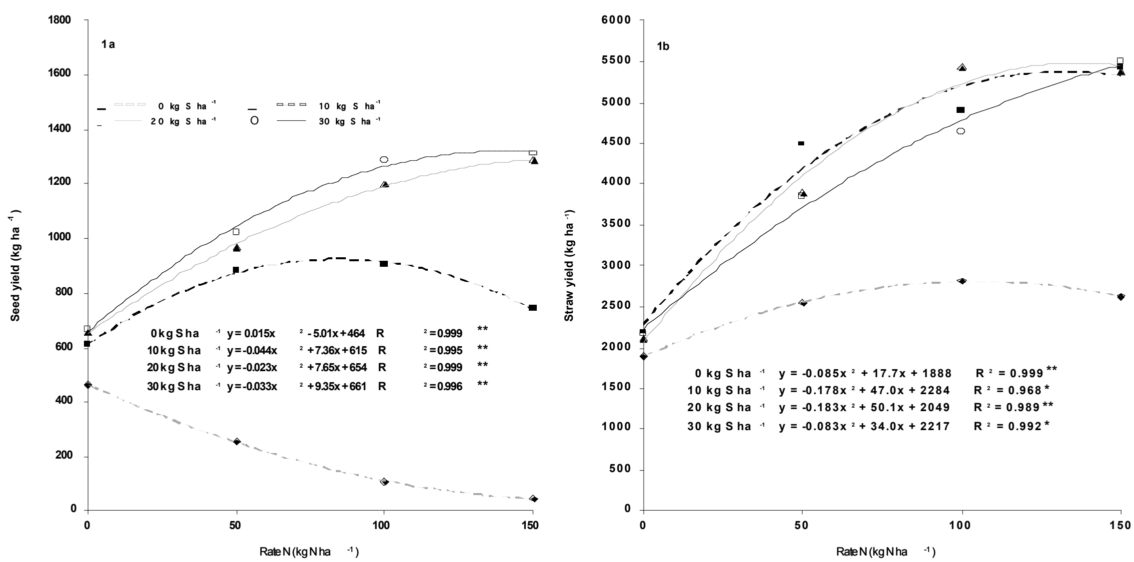

Figure 1. Seed and straw yield of canola at different N rates as influenced by S rate, averaged for the four site-years in northeastern Saskatchewan

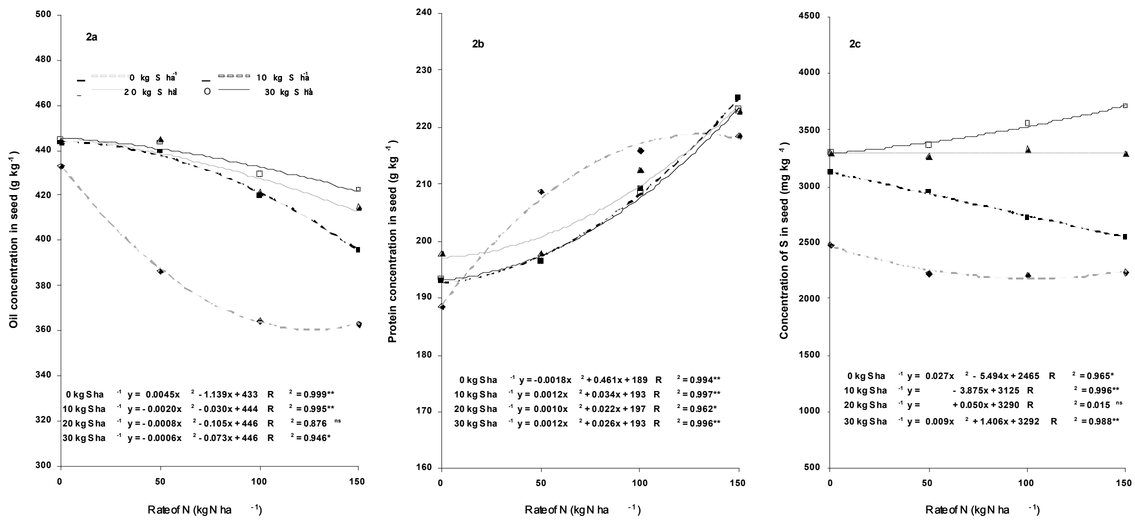

Figure 2. Oil content, protein content and concentration of S in seed of canola at different N rates as influenced by S rate, averaged for the four site-years in northeastern Saskatchewan.

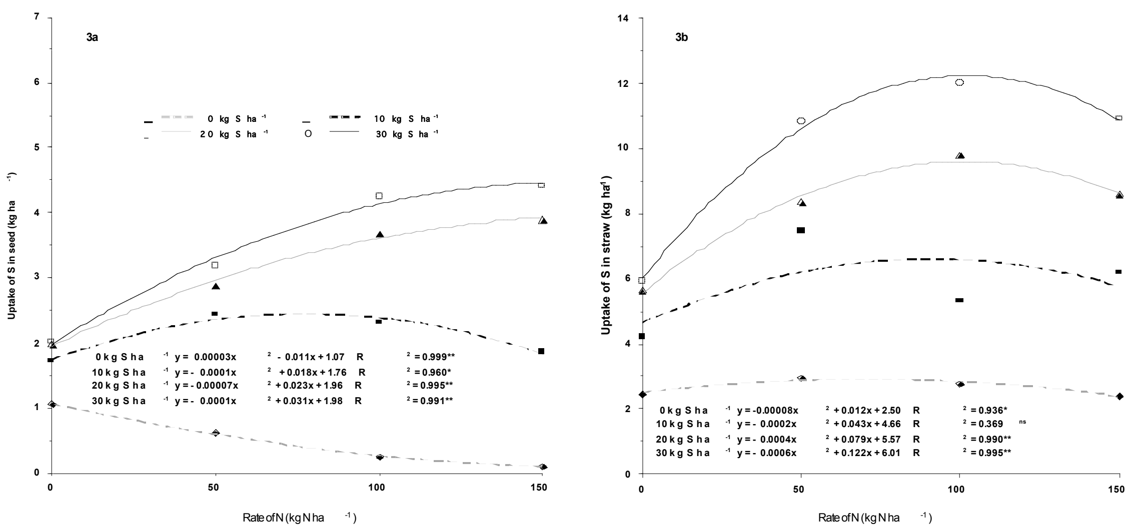

Figure 3. Uptake of S in seed, straw and seed+straw of canola at different N rates as influenced by S rate, averaged for the four site-years in northeastern Saskatchewan.

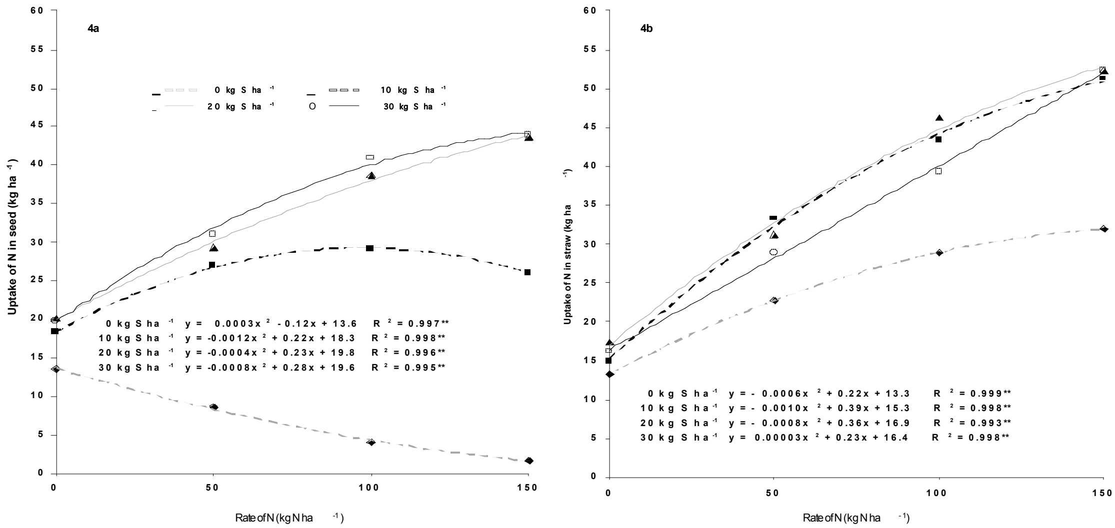

Figure 4. Uptake of N in seed, straw and seed+straw of canola at different N rates as influenced by S rate, average for the four site-years in northeastern Saskatchewan.