IS THERE A NEED TO PROVIDE N AND S TO CANOLA IN ANY GIVEN RATIO?

Rigas E. Karamanos[1], Tee Boon Goh[2] and Don P. Poisson[1]
[1]Western Cooperative Fertilizers Limited, P.O. Box 2500, Calgary, AB T2P 2N1,
[2]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
re.karamanos@westcoag.com

INTRODUCTION

The importance of N and S nutrition of canola is well recognized (Janzen and Bettany 1984; Bailey 1986; Grant and Bailey 1993; Jackson 2000; Malhi and Leach 2002). Agronomists today are recommending that a N:S ratio of between 5:1 and 7:1 is adhered to when fertilizer N and S are applied. This is also reflected in the provincial recommendations. Thus, Alberta Agriculture, Food and Rural Development (2001) point out that optimum canola requires an N:S ratio of 7:1; Saskatchewan Agriculture, Food and Rural Revitalization (2001) suggests that canola requires an available N to S ratio of about 5 to 7 to optimize yield and that applying high rates of N without S can lead to a lower yield than if no N was applied; Manitoba Agriculture and Food (2001) suggests that application of fertilizer in a N:S ratio of 8:1 to 5:1 will usually supply adequate sulphur. In none of these publications is there a reference to the "starting" levels of either N or S, thus leaving the impression that the recommended ratio should be adhered to independent of the original soil test N and S values.

Work on the N:S ratio of applied fertilizers to canola is very limited. Derivation of optimum ratios has been coincidental to concurrent application of N and S to achieve proper crop balance on severely S deficient soils, but it has not been ascertained whether an "optimum" N:S ratio is required even on soils that are sufficient in either or both of these two major nutrients.
We attempted to answer three questions in this study:

1. Does "balance of N and S nutrition" mean a certain N:S ratio?
2. Are ratios of applied N and S an artefact of fertilizing S deficient soils?
3. Is an "optimum" N:S ratio required even on soils that are sufficient in either or both of these two major nutrients?

Does "Balance of N and S Nutrition" Mean a Certain N:S Ratio?

General estimates of the amount of nitrogen and sulphur removed by canola are compared to those of other common crops in Saskatchewan, i.e., hard red spring wheat, barley, flax, peas and lentils in Figures 1 and 2. Canola probably represents the most demanding crop compared to other common crops grown on the prairies as far as the uptake of N and S is concerned. Indeed, taking the ratio of removed N and S (Figure 3), it might be concluded that as far as removal of these two nutrients is concerned a 5:1 N:S ratio is indeed desirable. However, the question still remains whether this implies that the ratio of applied or soil plus applied N and S must also be 5:1.

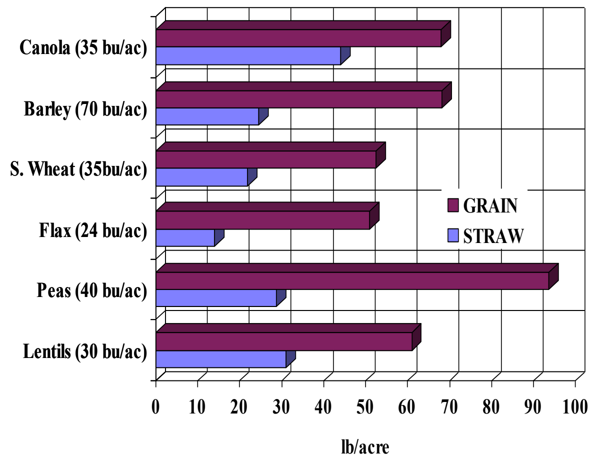

Figure 1. Nitrogen removal by common crops.

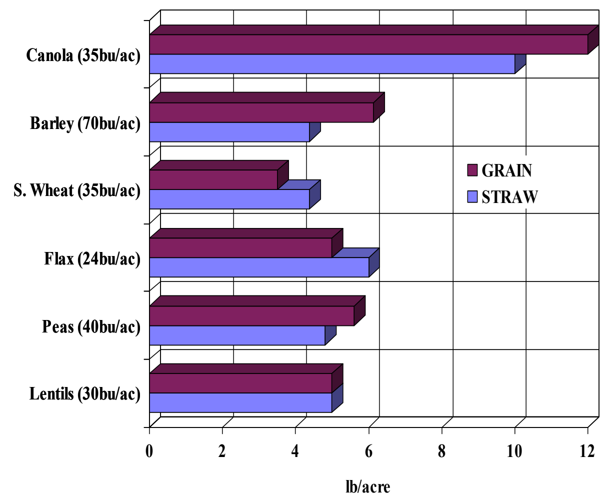

Figure 2. Sulphur removal by common crops.

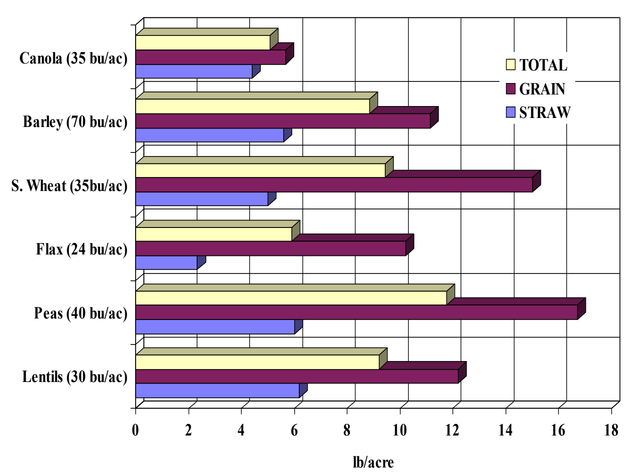

Figure 3. N:S ratio of Nitrogen and Sulphur removed by common crops.

Are Ratios of Applied N and S an Artefact of Fertilizing S Deficient Soil?

Janzen and Bettany (1984) and Nyborg et al. (1974) observed decreases in canola (rapeseed) yield as a result of N application, when N was applied alone to S deficient soils. Janzen and Bettany (1984) estimated an optimum ratio of available N to available S in the soil to be 7 to 1. However, the soil in the growth chamber study contained 11 mg kg-1 NO3-N and 5.6 mg kg-1 SO4-S. Reduction in seed yield due to N application in that experiment occurred only when SO4-S application rates were less than 4 mg kg-1 (deduced from Figure 1).

Work by Malhi and Leach (2002) showed that although a N and S balance was necessary to obtain optimum canola yields, the N:S ratio appeared to have little meaning, since there were no further yield increases once S deficiency was corrected (Figure 4).

Is an "Optimum" N:S Ratio Required Even on Soils That Are Sufficient in Either or Both of These Two Major Nutrients?

To ascertain whether an "optimum" N:S ratio should be adhered to even on soils that are S sufficient, four trials were established in 2002 (Table 1). The soils in these trials contained S levels that are considered sufficient.

Sulphur as ammonium sulphate (20.5-0-0-24) was applied in three N:S ratios (1.5:1, 6:1 and 12:1) in conjunction with six rates of N fertilizer (0, 36, 72, 108, 144, and 180 lb N/acre) applied as urea (46-0-0) in a split-split-plot design with canola cultivars (conventional, liberty link system, roundup ready system) as main plots, N:S ratios as sub-plots and N rates as sub-sub-plots. All treatments were replicated four times.

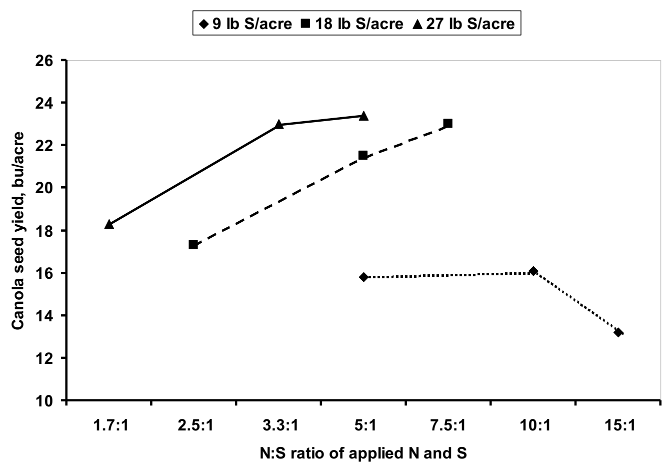

Figure 4. Maximum canola yield was obtained in the experiments by Malhi and Leach (2002) by application of 90 lb N and 18 lb S/acre. Application of 135 lb N and 27 lb S (same ratio of 5:1) produced similar yields (adapted from Malhi and Leach 2002).

Table 1. Nitrogen and S levels in the soils of the 2002 trials.

	Ft. Saskatchewan			Sylvania			Rosebank			Miami		
	N	S	N:S	N	S	N:S	N	S	N:S	N	S	N:S
Mean	110.2	114.7	1.0	32.3	62.1	0.8	125.4	98.7	1.9	81.5	159.4	1.0
Std dev.	42.6	22.6	0.4	21.7	74.7	0.5	31.9	74.5	1.2	23.4	150.2	0.6
Median	99.0	109.0	0.9	25.4	41.0	0.7	121.5	74.0	1.7	85.5	76.0	1.0
Max	244.0	176.0	2.3	134.0	450.0	2.6	221.0	398.0	6.2	139.0	480.0	2.4
Min	56.8	78.0	0.4	15.6	20.0	0.0	73.0	36.0	0.0	26.0	38.0	0.1

Plots at Sylvania were seeded on May 18, at Miami May 25, Ft. Saskatchewan on May 28 and at Rosebank on June 1, 2002. Growing conditions in Manitoba were less than ideal with hot temperatures during canola flowering that resulted in pod abortion. The Ft. Saskatchewan and Sylvania sites were dry to begin with, but timely rains resulted in improved growing conditions. The plots were harvested on September 18 at Miami, September 20 at Rosebank, October 3 at Sylvania, October 7 at Ft. Saskatchewan using a Wintersteiger Nurserymaster Elite experimental combine and the grain samples were dried at 60^{o}C by forced air and weighed to determine grain yield.

The results from all tests were subject to ANOVA and regression analysis using SYSTAT 8.0 (SPSS Inc. 1998).

RESULTS AND DISCUSSION

The effect of fertilizer N rate was significant ($P<0.001$) in all experiments. Hybrid yielded significantly higher ($P<0.05$) than conventional canola cultivars in all experiments; therefore, they were all combined into one graph (Figure 5). There were no significant differences in the yields obtained for hybrid canola at various N:S ratios, however, conventional canola yields were restricted at the high and low N:S ratios when N rate exceeded 108 lb N/acre.

All soils in these experiments contained S levels that are considered to be adequate, hence, application of fertilizer N and S in three distinct ratios (1.5:1, 6:1 and 12:1) had virtually no impact on the yield of hybrid canola.

To derive a critical level of soil plus fertilizer N for optimum yield of canola, the yields from seventeen site-years were expressed as a percentage of the maximum yield obtained for the trial. They were then plotted against soil (0-12") plus applied N (Figure 6). The N and S levels in the 12-24" depth were not included as presence of gypsum in many soils caused the S levels to exceed what was set as the upper detection limit to be reported without dilution of sample extracts by the soil testing laboratories. Maximum yield for hybrid canola was obtained with an additional 30 lb N/acre.

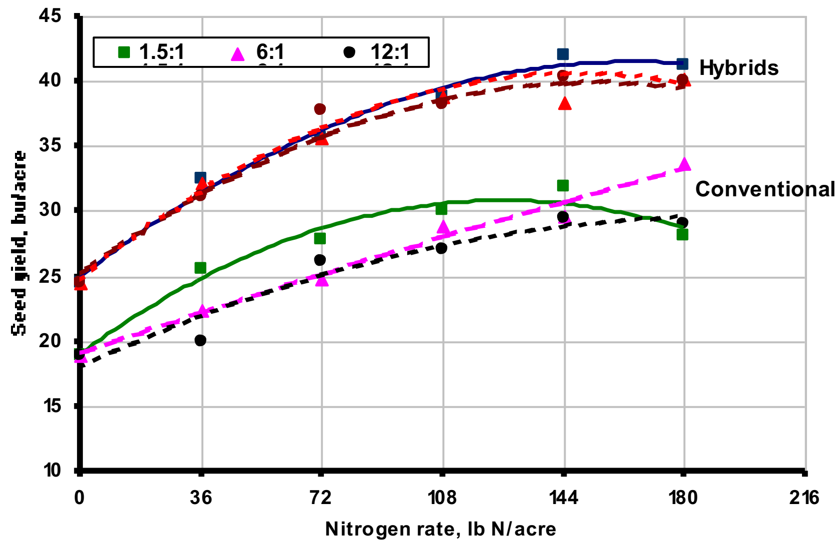

Figure 5. Comparison of overall yield obtained for canola hybrids to that of conventional canola cultivars based on applied N rates (Westco 4 site-years; 2002).

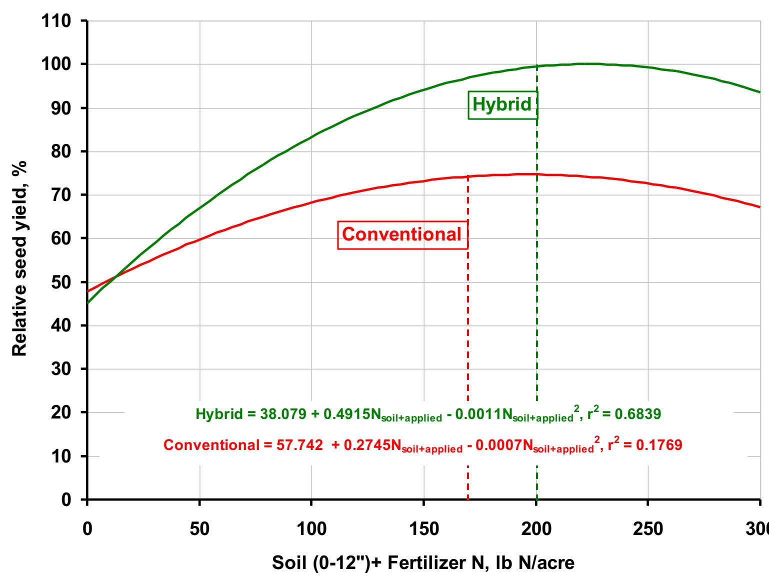

Figure 6. Comparison of relative yield of canola hybrids to that of conventional canola cultivars based on soil + applied N (Westco 17 site-years; 1999-2002).

CONCLUSIONS

Canola yield is highly dependent on N fertility. Optimum yields of canola are derived so long as individual N and S requirements are fulfilled. Most of S deficiencies seem to be corrected with approximately 20 lb S/acre, although more severe S deficiencies may require levels of S application closer to 30-35 lb S/acre. Spatial variability of S may necessitate a blanket application of 10 lb S/acre even on soils that test sufficient in S. Nitrogen requirements to obtain optimum yield of hybrid canola cultivars are higher than that of conventional canola cultivars. Once an N or S deficiency is corrected, there appears to be little need for balancing N and S application rates at any particular ratio, especially with canola hybrids.

REFERENCES

Alberta Agriculture, Food and Rural Development. 2001. Sulphur fertilizer application in crop production. [Online] Available: http://www.agric.gov.ab.ca/agdex/500/542-10.pdf [25 Nov. 2002].

Bailey, L.D. 1986**.** The sulphur status of eastern Canadian prairie soils: Sulphur response and requirements of alfalfa (*Medicago sativa* L.) rape (*Brassica napus* L.) and barley (*Hordeum vulgare* L.) Can. J. Soil Sci. 66: 209-216.

Grant, C. A. and Bailey, L.D.1993**.** Fertility management in canola production. Can. J. Plant Sci.73: 651

Jackson, G.D. 2000**.** Effects of N and S on canola yield and nutrient uptake. Agron. J. 92: 644-649.

Janzen, H.H. and Bettany, J.R. 1984**.** Sulfur nutrition of rapeseed: I. Influence of fertilizer nitrogen and sulfur rates. Soil Sci. Soc. Am. J**.** 48**:** 100-107.

Malhi, S.S. and Leach, D. 2002**.** Optimizing yield and quality of canola seed with balanced fertilization in the parkland zone of western Canada. *In* Soils and Crops 2002. [CD-ROM] Available: Extension Division, University of Saskatchewan, Saskatoon, SK.

Manitoba Agriculture and Food. 2001**.** Canola – production and management. [Online] Available: http://www.gov.mb.ca/agriculture/crops/oilseeds/bga01s01.html [25 November 2002].

Nyborg, M, Bentley, C.F. and Hoyt, P.B. 1974. Effect of sulphur deficiency. Sulphur Inst. J. 10: 14-15.

Saskatchewan Agriculture, Food and Rural Revitalization. 2001**.** Sulphur fertilization in crop production. [Online] Available: http://www.agr.gov.sk.ca/docs/crops/integrated_pest_management/soil_fertility_fertilizers/scs0195.asp#top [25 November 2002].

SPSS Inc. 1998**.** SYSTAT 8.0. Chicago, IL.