# CROP RESPONSES TO SULPHUR AND MICRONUTRIENTS ON SELECTED SOILS OF SASKATCHEWAN

D.J. Tomasiewicz and D.M. Marantz
Saskatchewan Soil Testing Laboratory
University of Saskatchewan, Saskatoon, Saskatchewan

Large increases in yield of canola frequently occur due to nitrogen (N) and sulphur (S) fertilization on soils deficient in these nutrients in Saskatchewan. Decreased growth and yield due to N application without adequate S nutrition have been documented (Janzen and Bettany 1984). Also, effects of boron (B) fertilization, and of the interaction of S and B, on canola yields, have been reported (Nuttall et al. 1986). In general, the soils of Saskatchewan suspected of being least fertile with respect to B are also those on which canola is a major crop and serious N and S deficiencies are common, i.e. the lighter soils of the Gray and Gray Black Soil Zones.

Two experimental sites were established in 1986 to study the response of canola to N, S, and B fertilization and interactions among those nutrients. Two soils of the Gray-Black Soil Zone, generally low in the nutrients of interest in this work, were selected (Table 1).

Table 1 Soil Characteristics and Spring Test Levels of 1986 NSB Experimental Sites*

| Site Location | Depth (cm) | Texture | O.M. (%) | pH | Soil Test Nutrient Levels (kg/ha) $NO_3$-N | $SO_4$-S | B | P | K | Cu | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Carrot River (NW9-49-11-W2) | 0-15 | Loamy Sand | 3.0 | 8.1 | 6 | 4 | 0.4 | 17 | 146 | 0.6 | 1.6 |
| | 15-30 | Loamy Sand | | 8.4 | 2 | 2 | 0.1 | | | | |
| | 30-61 | Loamy Sand | | 8.6 | 4 | 4 | 0.4 | | | | |
| Tisdale (NE28-43-15-W2) | 0-15 | Loam | 2.8 | 6.4 | 66 | 3 | 0.2 | 25 | 263 | 1.6 | 3.8 |
| | 15-30 | Clay Loam | | 6.8 | 11 | 2 | 0.2 | | | | |
| | 30-61 | Clay Loam | | 7.2 | 9 | 4 | 0.4 | | | | |

* texture by hand estimate; pH as determined in 1:1 soil:water suspension; 0.001 M $CaCl_2$ extractable $NO_3$-N and $SO_4$-S; N $NH_4OAc$ extractable B; 0.5 N $NaHCO_3$ extractable P and K; D.T.P.A. extractable Cu and Zn

This material was presented along with the 1986-1987 Saskatchewan Soil Testing Laboratory Report (Tomasiewicz, D.J. 1987, these proceedings).

A split-split plot (2 x 4 x 3 factorial) experimental design with four replicates was used. The main plot treatments were 0 and 2.2 kg/ha B applied as a 40% $B_2O_3$-equivalent sodium borate fertilizer product. The main plots were split by strips of 0, 84, and 168 kg/ha N treatments (as ammonium nitrate), as well as by strips of 0, 17, 34, and 50 kg/ha S treatments (as sodium sulphate) applied perpendicular to the N treatments within each main plot. All fertilizers (including blanket applications of P and K) were broadcast and incorporated prior to seeding. The Tisdale site inadvertently received a blanket banded N application of 67 kg/ha N.

Abnormally dry conditions existed until July, limiting yield potentials; the highest yielding treatments producing average seed yields of about 1.4 and 2.0 t/ha at the Tisdale and Carrot River sites, respectively.

Plant stand density, as measured at the four-leaf stage, was greatly reduced by N fertilization. At the Carrot River site, plant counts were reduced by 29 and 56%, at 84 and 168 kg/ha N, respectively; the corresponding reductions at Tisdale were 7 and 30%. Remaining plants in affected treatments appeared to compensate quite effectively by later season growth.

Analysis of variance of seed yield data showed significant ($P<0.05$) simple effects of N and of S at each site. A SxB interaction was also significant at each site. In addition, the yields at Carrot River were also affected by B and by a NxS interaction.

The effects of S and B applications at the optimum selected N application rate for each site (i.e. 0 kg/ha N at Tisdale and 84 kg/ha N at Carrot River) are tabulated (Table 2), as well as the effects of N and S without B application (Table 3). Due to the high degree of variability in the yield data (as indicated by the standard deviations), many of the differences among means for selected treatment combinations are not significant even where rather large. Therefore, even where treatments are significantly influencing yield, the magnitude of those effects may not always be accurately reflected by the treatment means.

The SxB interaction was significant and negative at both sites; B itself significantly reduced yields at the Carrot River site. Although plant tissue B concentrations were, in general, almost doubled by B application (data not presented), they were not increased to a range regarded as toxic.

Table 2 Effect of S and B Fertilizers on Seed Yield of Canola (1986)

| Site | B Rate (kg/ha) | S Rate (kg/ha) 0 | 17 | 34 | 50 |
|---|---|---|---|---|---|
| | | Yield ± s (t/ha) | | | |
| Carrot River | 0 | 0.75±0.14 | 1.54±0.30 | 1.80±0.33 | 2.03±0.38 |
| (84 kg/ha N treatment only) | 2.2 | 0.84±0.73 | 1.01±0.70 | 1.72±0.28 | 1.90±0.08 |
| Tisdale | 0 | 0.24±0.12 | 0.99±0.24 | 1.41±0.61 | 1.42±0.14 |
| (0 N treatment only) | 2.2 | 0.35±0.40 | 0.91±0.14 | 1.10±0.52 | 0.88±0.63 |

Table 3 Effect of N and S Fertilizers on Seed Yield of Canola (using data from 0 B treatments only) (1986)

| Site | N Rate (kg/ha) | S Rate (kg/ha) 0 | 17 | 34 | 50 |
|---|---|---|---|---|---|
| | | Yield ± s (t/ha) | | | |
| Carrot River | 0 | 0.77±0.16 | 0.87±0.12 | 1.08±0.21 | 0.96±0.12 |
| | 84 | 0.75±0.14 | 1.54±0.30 | 1.80±0.33 | 2.03±0.38 |
| | 168 | 0.38±0.37 | 1.54±0.42 | 1.34±0.42 | 1.76±0.56 |
| Tisdale | 0 | 0.24±0.12 | 0.99±0.24 | 1.41±0.61 | 1.42±0.14 |
| | 84 | 0.09±0.13 | 0.31±0.20 | 1.30±0.81 | 0.96±0.31 |
| | 168 | 0.33±0.55 | 0.28±0.15 | 1.19±0.36 | 1.00±0.74 |

In fact, all treatment means for tissue B concentration at flowering were in the "low" range based on criteria currently in use at the Saskatchewan Soil Testing Laboratory (i.e. 0-20 ppm B). Based on these results, those criteria should be reviewed.

At the Tisdale site, the 67 kg/ha N banded over the entire area was obviously sufficient for the dry growing conditions, so all N response was negative. The lack of a significant NxS interaction is also likely due to the absence of a true N check treatment. The response to N and the NxS interaction were both strongly positive at the Carrot River site.

Duplicate copper (Cu) and zinc (Zn) strip trials were carried out adjacent to each of the main NSB plot sites. Eleven kilograms per hectare each of actual Cu and Zn, applied as the sulphates, were used. No significant yield responses to either treatment were measured.

Sulphur/Copper Trials -- Brown and Dark Brown Soil Zones

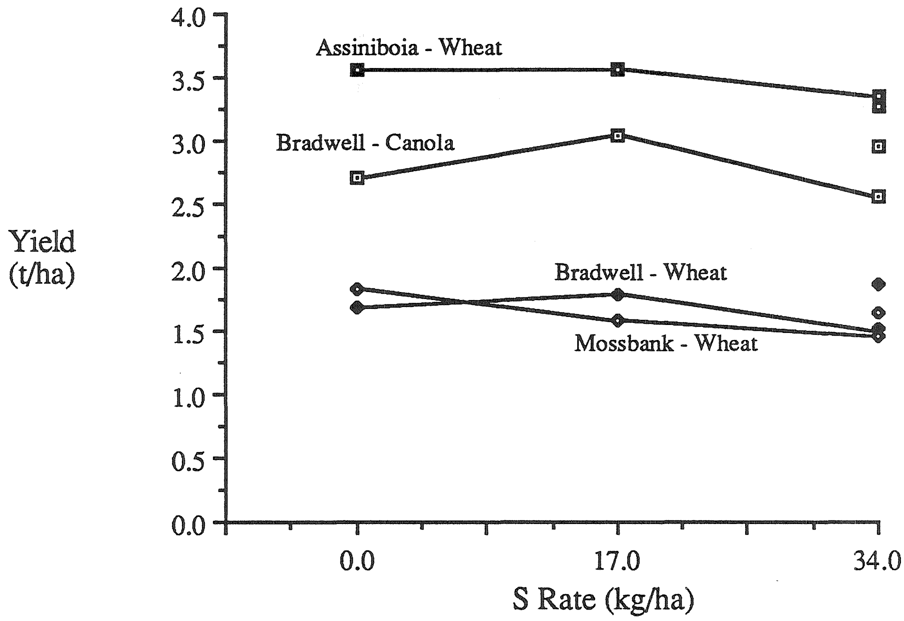
Relatively low soil test levels of sulphur ($SO_4$-S to 61 cm) are not uncommon in soils of the Brown and Dark Brown Soils Zones (including fine-textured soils, see Tomasiewicz, 1987, these proceedings). However, there have been few documented yield responses to S fertilizer application on those soils. Four trials were set out in 1986 on four such low S testing soils (Table 4). Although two of the sites were high in extractable $SO_4$-S at the time of plot establishment, all sites had tested low at an earlier sampling as well as at samplings (of the checks only) during the growing season. The Assiniboia site checks tested only 23 kg/ha in $SO_4$-S to 61 cm at the crop tillering stage. Treatments of 0 kg/ha S, 17 kg/ha S, 34 kg/ha S, and 34 kg/ha S plus 11 kg/ha Cu were used, replicated six times at each site. Ammonium sulphate and copper sulphate were used as the S and Cu sources, broadcast and incorporated prior to seeding.

Table 4 Selected Soil/Site Characteristics - 1986 S/Cu Experimental Sites*

| Site | Soil Zone | Texture | Crop | Spring $SO_4$-S (kg/ha) 0-15 cm | 0-61 cm | Soil Test Cu (kg/ha) |
|---|---|---|---|---|---|---|
| Bradwell | Dark Brown | Fine Sandy Loam | Canola | 7 | 30 | 1.2 |
| Bradwell | Dark Brown | Fine Sandy Loam | Wheat | 7 | 21 | 1.2 |
| Assiniboia | Brown | Silty Clay Loam | Wheat | 27+ | 105+ | 3.6 |
| Mossbank | Brown | Clay Loam | Wheat | 10 | 57+ | 3.6 |

* analytical methods as indicated in Table 1.

Within each site, none of the treatments yielded significantly ($P<0.10$) more than the 0S/0Cu check (Figure 1), using a paired t-test for comparisons. The yield of the 34S/0Cu treatment was less than that of the check ($P<0.01$) at Mossbank, and the 34S/11Cu treatment at Assiniboia produced less grain than the check ($P<0.10$). The only other significant effects on yield were at the canola (Bradwell) site, where the yield at 34S/0Cu was less than those at either 34S/11Cu ($P<0.05$) or 17S/0Cu ($P<0.10$).




Note: Yields of 34S/11Cu treatments are indicated by graphed points without connecting lines

Figure 1: Seed yields from 1986 S/Cu trials.

The lack of apparent response to S fertilizer at these sites (even for production of a very high yield of canola on a low $SO_4$-S soil), and the temporal variation in test levels, suggests that further work in this area is warranted to provide soil test S recommendation criteria more in line with observed responses (or lack of responses) in the Brown and Dark Brown zones.

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