Sulphur Responses of Crops in North-Western Ontario

Purpose:

1. To determine if crop growth and yield can be improved with the addition of sulphur fertilizer.
2. To determine the optimum rate and form of sulphur fertilizer to add.
3. To assess whether sulphate sulphur soil tests can be used as an indicator of the need for additional sulphur.

Methods:

Field trials were established in fields in the Dryden area of Kenora District. Nine co-operators initially expressed interest, and seven of these applied the fertilizer treatments. There was one sweet corn grower, and the balance of the sites were in forages.

Soil samples were collected in the fall of 2006 from the 0-15 and 15-30 cm depths. Analyses were conducted for pH, buffer pH, P, K, Mg, Sulphate Sulphur and organic matter.

Fertilizer treatments were applied in the early May, 2007. Application rates were 0, 170, 340, 510 kg/ha gypsum (0, 32, 64 and 96 kg/ha sulphate sulphur) plus an additional treatment of100kg/ha of elemental sulphur, repeated three times on most farms. Additional treatments, replicated twice, were blends of urea and ammonium sulphate to provide 15, 30 and 45 kg/ha of sulphate sulphur, along with 40 kg/ha of nitrogen.

Whole plant tissue samples were collected from each of the treatments in the forage fields prior to crop harvest, in late June of 2007. Ear leaves were collected from each of the treatments in the sweet corn plot when the corn was tasselling. Concentrations of the major mineral nutrients were analyzed, plus feed quality in the forage samples.

Yields from each treatment in the forage fields were estimated by counting the number of bales harvested and multiplying by the average weight per bale. It was not possible to collect yield data from the sweet corn site.

Results:

Soil Tests:

Table 1 summarizes the soil tests from the nine fields in the study. The range of values indicates that either soil pH or low phosphorus have limited yields in each of the fields.

Table 1: Summary of Soil Test Results from Kenora District Sulphur Trials, All results are for 0-15 cm samples, except Sulphate-S

	pH	B pH	OM %	P	K	Mg	Ca	Zn – ppm	Zn Index	Mn - ppm	Mn Index	SO_4-S kg/ha (0-30 cm)
Minimum	5.6	6.5	2.68	4	167	577	2358	0.62	17.2	5.1	13.9	104.6
Maximum	6.76	6.8	4.72	46	354	876	3922	1.9	32	12.2	35.9	177.4
Median	**6.12**	**6.57**	**3.16**	**8**	**216**	**765**	**3478**	**0.78**	**20.3**	**5.98**	**22.3**	**107.6**

Figure 1: Range of Soil pH values in KDSCIA Sulphur Plots

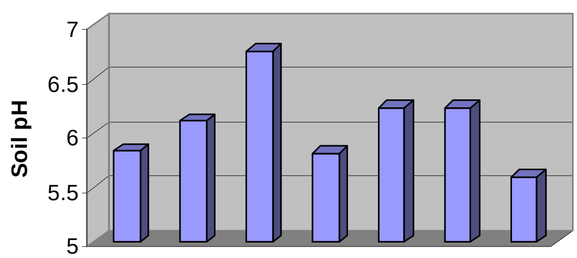
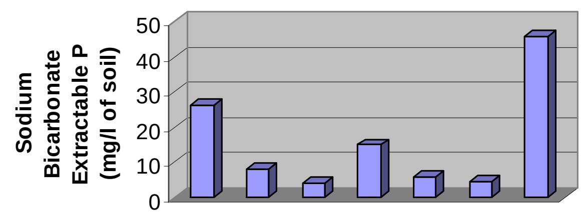
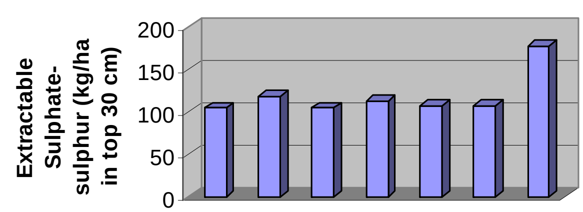


Figure 2: Range of Soil Test P values in KDSCIA Sulphur Plots



Figures 1 and 2 show the soil test values for soil pH and soil test P in each of the fields. Any pH value below 6.0 is likely to limit crop growth, particularly for legumes. Any P soil test below 10 is likely to limit crop growth, and some fields were significantly below this value.

Figure 3: Range of Sulphate-sulphur values in soil tests from KDSCIA Sulphur Plots



The Sulphate-sulphur soil test values, shown in Figure 3, were all in a narrow range with the exception of the sweet corn site, which had a much higher sulphate sulphur concentration. One of the goals of this study was to determine if the soil test was a useful tool for predicting which fields would respond to added sulphur fertilizer, and if so, what the appropriate critical level would be.

Tissue Analysis:

Median values for the plot yields and plant tissue concentrations with the various treatments are shown in Table 2. Impact on the mineral concentrations in the forage was minimal with any of the treatments. There was a tendency for S concentration in the plant tissue to be higher where ammonium sulphate or gypsum was applied than where no sulphur or elemental sulphur were applied.

Table 2: Median Yield and Plant Tissue Concentrations in forage samples from KDSCIA S Project.

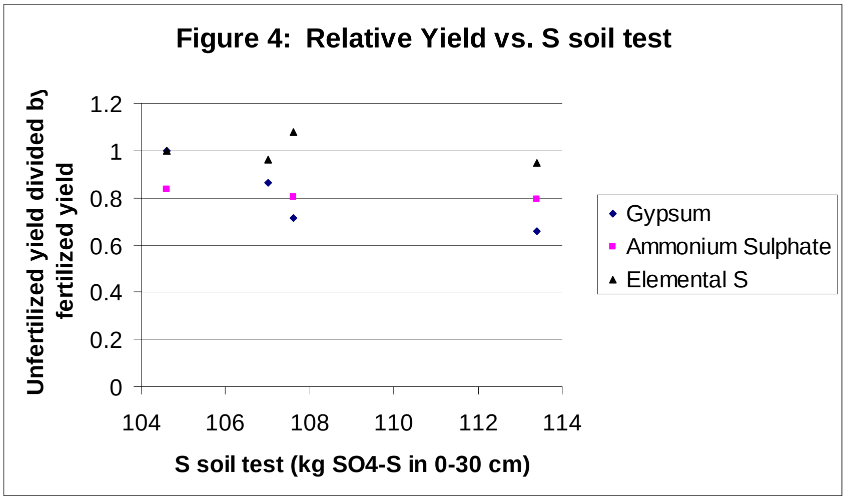
Material applied	S Rate (kg/ha)	Yield (kg/ha)	Crude Protein	P	K	Ca	Mg	S	TDN
AS	0	2649	9.6	0.22	2.09	0.29	0.13	0.13	56
AS	15	3448	9.9	0.20	2.16	0.31	0.12	0.17	58
AS	30	4108	10.0	0.20	2.20	0.30	0.14	0.14	59
AS	45	4287	10.5	0.21	2.26	0.30	0.14	0.16	58
Gypsum	0	5543	9.6	0.22	2.09	0.29	0.13	0.13	56
Gypsum	32	5283	11.0	0.21	2.18	0.31	0.14	0.16	56
Gypsum	65	6115	9.9	0.21	2.08	0.29	0.12	0.15	57
Gypsum	97	6359	9.2	0.21	2.01	0.27	0.11	0.15	56
Elemental S	100	5548	9.6	0.23	2.08	0.28	0.13	0.13	56

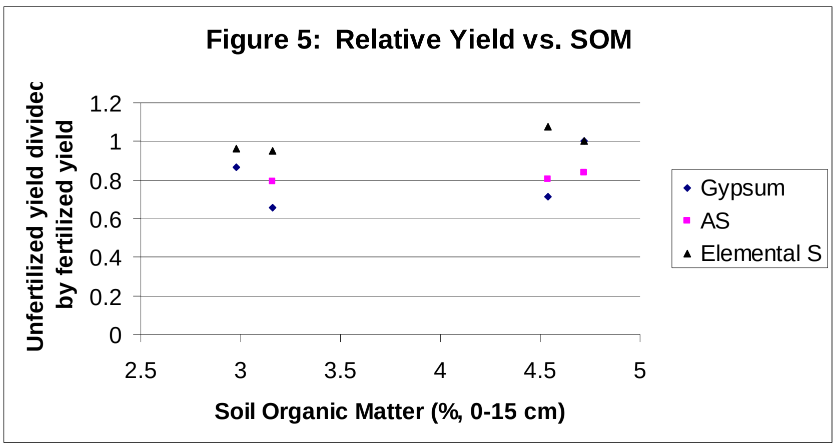
Yield Responses:
The median yields from each treatment are shown in Table 2. You should only compare yields within the Ammonium Sulphate values, and within the Gypsum + Elemental S values, since not all of the sites had yield measurements for all the treatments. The cooperators noted that the sulphur treatments, particularly with ammonium sulphate, appeared more vigorous and darker green than the check strips.

Of more interest than the absolute yield is the yield response to added sulphur. Both the gypsum and ammonium sulphate treatments caused a yield increase, although it appeared to take more S from gypsum to generate the same yield increase than from ammonium sulphate. Some of this difference will be due to the nitrogen included in the ammonium sulphate treatment, and some to the greater solubility of the ammonium sulphate.

If the soil test was a good indicator of the need for added sulphur, we should be able to determine a “critical soil test level” by plotting the relative yield (fertilized divided by unfertilized) by the sulphur soil test. The expected pattern is that the responsive sites (where the unfertilized yield is a smaller fraction of the fertilized yield) would be clustered at the lower soil test values, with the non-responsive sites (relative yield = 1) at the higher soil test values. Figure 4 shows this comparison for the sites in this study, and it is clear that the soil test is a poor predictor of the need for added sulphur.

In some American states, it has been suggested that soil organic matter might be a better predictor of S requirements than the soil sulphur content. Figure 5 shows this relationship for the Kenora plots. Once again, the soil test does not appear to be a good predictor of the need for additional sulphur for optimum crop yields.





Summary:

Forage crops in Kenora District appeared to respond favourably to applications of fertilizer materials containing sulphur. The rate of ammonium sulphate that was predicted to generate maximum yields was 50 kg S/ha. The Gypsum treatment showed a linear response to added S, so yield was still increasing with an application of 97 kg S/ha. Optimum rates would be lower than this, depending on the relative values of the forage and the fertilizer material. Elemental sulphur did not appear to increase crop yields or tissue S concentration in the year of application.

Other factors will have interfered significantly with the ability of crops to respond to added sulphur, particularly low soil pH and low phosphorus soil tests. The response to sulphur may have been much greater if these limitations were not present.

Soil tests did not appear to be useful for predicting the need for added sulphur.

Next Steps:

The basic agronomic restrictions of low soil test P and low soil pH need to be addressed, which would also allow a greater proportion of legume in the forage stands. Following this, the response to sulphur fertilizers should be re-evaluated. In the interim, it would be reasonable for farmers in this area to routinely be including sulphate sulphur as part of their fertilizer program for forages.

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Location of Project Final Report:

NLARS, Kemptville Campus, University of Guelph.