Sulphur Fertilizers for Alfalfa

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Introduction

Alfalfa produced for dehydrated forage and for seed is an important industry in northeastern Saskatchewan. Alfalfa has a relatively high nutritional requirement for sulphur, and the crop is frequently produced on sulphur deficient Grey Wooded soils. Previous research has proven that ammonium sulphate is the more effective sulphur fertilizer for annual crops in all fertilizer placement systems (Karamanos and Janzen, 1991; Johnston et al, 1999; Mahli and Leach, 2000). Elemental sulphur fertilizer pellets must be first physically degraded then biologically oxidized to sulphate for plant uptake. This process is too slow to provide sufficient sulphate to annual crops in the western Canadian climate.

There remained some question if elemental sulphur may be effective for fertilization of long-term forages, where there is more opportunity for oxidation of the elemental sulphur. Surface application of elemental sulphur on alfalfa should provide the ideal conditions for physical breakdown of elemental sulphur fertilizer pellets and subsequent oxidation to sulphate for plant uptake. Some of the newer elemental sulphur fertilizer products are claimed to be more readily physically degraded than older products, so could have a fit for alfalfa rotations.

Previous research has examined the relative value of elemental sulphur in forage crops. In each of these trials, elemental sulphur has been an inferior sulphur fertilizer relative to sulphate fertilizers (Table 1). The earlier trials measured crop response only in the year after sulphur application, and not with current elemental sulphur products. However, the field experiments of Mahli et al (2000) demonstrated that sulphate fertilizer was able to maintain forage yields better than commercial elemental sulphur fertilizers over the course of a three-year trial (Figure 1). If elemental sulphur fertilizer is not able to efficiently supply a forage crop with available sulphate over a long-term period, there is little potential for these fertilizers to be part of fertilizer management packages in western Canada. The experiment described in this paper was partly developed to assess if elemental sulphur could be recommended for long-term fertilization of alfalfa crops.

Table 1. Yield increase of forage crops from elemental S fertilizer application relative to yield increase from sulphate fertilizer application on sulphur responsive sites in western Canada.

Source	Crop	Location	Relative Efficiency of Elemental S (% of SO4)
Shalin, 1948	Alfalfa	Saskatchewan	59
Newton et al, 1948	Alfalfa	Alberta	63
Cairns and Carson, 1961	Alfalfa	Saskatchewan	32
Bentley et al, 1955	Alfalfa	Alberta	19
Ukrainetz, 1969	Alfalfa	Saskatchewan	66
Mahli et al, 2000	Grass	Alberta	34

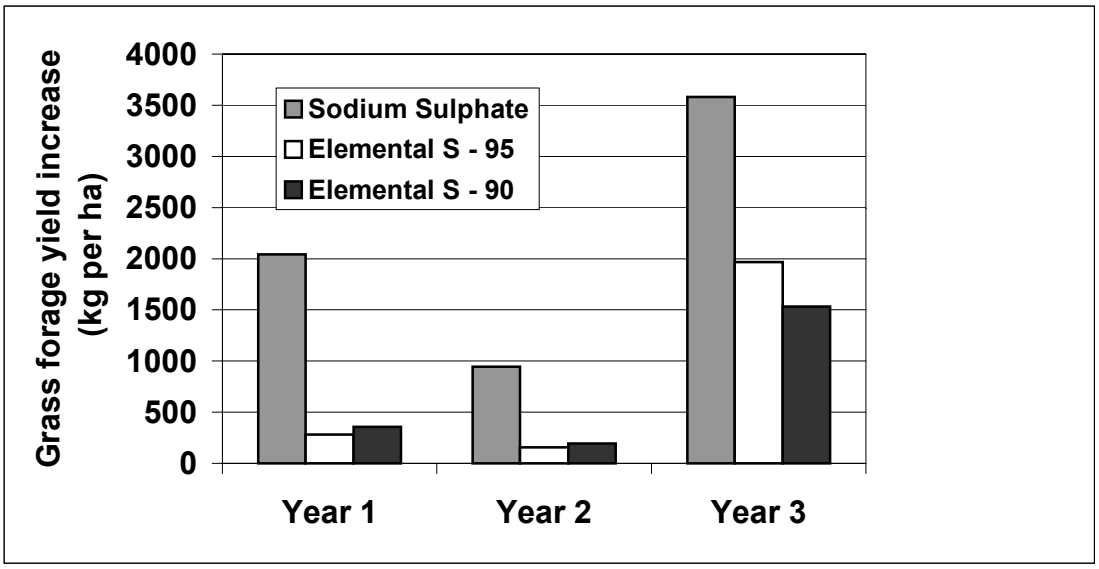

Figure 1. Response of forage grass to sulphate and two commercial elemental sulphur fertilizers over a three-year period (*from Mahli et al, 2000*).

Materials and Methods

This paper summarizes data from a field project designed to estimate the economical value of fertilizing alfalfa produced for dehydration in northeastern Saskatchewan. The site was at Star City, Saskatchewan on a Grey Wooded loam soil known to be sulphur deficient. Alfalfa produced for dehydration is grown under three-year production contracts, so this trial followed yield responses over a three period.

The treatments and rates of fertilizer nutrients were:

1. Control, no fertilizer
2. 100 lb/acre P_2O_5 as 12-51-0
3. 200 lb/acre K_2O as 0-0-62
4. 50 lb/acre S as 21-0-0-24
5. Combined treatments 2, 3, 4
6. 45 lb/acre N as 46-0-0 as N check to treatment 5
7. 50 lb/acre S as 0-0-0-90 elemental sulphur (Tiger 90)
8. 50 lb/acre S as 0-0-0-95 elemental sulphur (Sulfer 95)

All fertilizers were broadcast applied without incorporation on established alfalfa in the spring of the first year of forage production. The alfalfa was established the previous year under a cover crop of canola.

Alfalfa yields were measured with square meter samples cut just before the fields were commercially harvested. The alfalfa was cut twice per year, generally in early flowering. The fresh samples were weighed in the field, and subsamples were taken to determine dry weight ratios. Yield was then calculated and reported as total dry yield per acre.

Composite soil samples were taken (0-12") prior to spreading fertilizer. The soil test data for the site (ppm) were: available N (10 ppm), P (8 ppm), K (60 ppm) and S (3 ppm).

Results and Discussion

Growing conditions and alfalfa yields were very good for the duration of the trial. Significant yield increases were measured to treatments with added sulphur and phosphorus (Table 2). The yield benefit from P and K appeared to be additive. Total yield was significantly higher for the sulphate fertilizer treatment over both elemental sulphur treatments. There was no significant difference in yields between the two elemental sulphur fertilizers.

Table 2. Total dry matter yield of alfalfa over three-year period of trial.

Fertilizer treatment	Total dry matter yield over 3 years (tonne per acre)
Check	2.69
P	3.67*
K	2.55
S (ammonium sulphate)	8.34*
P + K + Sulphate	9.56*
N	2.71
Tiger 90 elemental sulphur	6.68*
Sulfer 95 elemental sulphur	6.59*

*treatment yield significantly higher than check (P = 0.05)

Ammonium sulphate produced a larger yield increase than either elemental sulphur in each of the three years of the experiment (Table 3). Despite good environmental conditions for physical breakdown and oxidation of the elemental sulphur, these products were unable to sustain sufficient sulphur nutrition for the alfalfa crop. Ammonium sulphate was not only a better sulphur source for immediate crop use, but also a better fertilizer for long-term nutrition.

Table 3. Alfalfa yield (dry tonne per acre) when fertilized with sulphur fertilizers.

Fertilizer Treatment	Year 1	Year 2	Year 3
Check	1.10	1.08	0.50
Ammonium sulphate	2.59	3.25	2.50
Tiger 90	1.25	3.22	2.21
Sulfer 95	1.64	3.35	1.60

Conclusion

This experiment mirrors the results of Mahli et al (2000). Ammonium sulphate proved to be an effective source of sulphur both for immediate crop use and for the duration of a three-year alfalfa stand. Elemental sulphur fertilizers did not adequately supply available sulphur at any point of the alfalfa rotation, and cannot be recommended as a reliable sulphur fertilizer for either annual crops or perennial forages in Saskatchewan.

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