Response of Alfalfa to Sulphur Application

Heartland SCIA Partner Grant – Final Report

Purpose:

Develop recommendations for source, rate and timing of Sulphur (S) application in alfalfa and refine tools to identify S-responsive sites, such as tissue and soil testing.

Sulphur deposition has been decreasing in the past few decades and now crop requirements are not being met in some situations. A preliminary forage trial showed that S fertilization can increase forage yield, quality and profit. Currently there are no Ontario recommendations for fertilizing alfalfa or other crops with S, no Ontario S soil test and the alfalfa critical tissue concentration is under review. This project will provide data on rates, sources and timing of application and tools to identify fields with potential for increased yield, quality and profit through S application. This is the second year for the trial. The Heartland project is in conjunction with a larger S research project in collaboration with University of Guelph. In 2014 we also evaluated K uptake and removal, and effect on soil K levels.

Methods:

In fall 2013, five alfalfa sites were established (Mitchell, Hesson, Wallenstein, Hamilton, Elora) with the following treatments:

1. Control - no nutrients (0);
2. Control - muriate of potash (, spring-applied, 142 lb. K_2O/ac (KCl);
3. Elemental, fall-applied, 50 lb. S/ac (Ele50);
4. Elemental, fall-applied, 100 lb. S/ac (Ele100);
5. Sulphate of potash, spring-applied, 50 lb. S/ac (K_2SO_4).

Another demonstration site with 3 replications was established at Elora for the FarmSmart Expo held in July 2014. Results are presented separately.

Treatments were arranged in a randomized block design with 4 replications. Elemental S was broadcast mid-November 2013 on Ele50 and Ele100 treatment plots. In 2014, sulphate of potash was broadcast, and muriate of potash on the KCl and both Ele treatments. In addition the two 2013 sites (Hesson and Wallenstein) were split, with all treatments repeated (fall 2013, spring 2014) on half the plot to examine effect of residual (fall 2013) and repeated application (fall 2013 & spring 2014) of fertilizer.

Yield was measured from 2-cuts, other than Mitchell, which was a 3-cut system. Feed quality was measured on second cut. Nutrients were determined in whole plant samples at each harvest. Diagnostic tissue (top 6” late bud/early bloom) was collected prior to first and second cut for S analysis. Tissue analysis included both S and potash (K). The soil was sampled in fall 2013, spring 2014 prior to fertilizer application, after1st cut, and again in fall 2014. Samples were from both 0-6 and 6-12” depth and from both residual and re-applied fertilizer plots. All soil samples were extracted for S using Mehlich; selected samples had basic soil test analysis. Soil K levels were also evaluated using

OMAFRA accredited procedures. For all experiments, soil samples were dried unless sent immediately to the lab.

Results:

Results presented are preliminary and include the 3 sites conducted by Heartland Region.

Yield Results: Response to sulfur was highly variable by location and year. Visual responses to sulphur fertilizer in forage height and colour were observed, particularly in later cuts (Figure 2). In 2014, sulphur application increased yield in 2nd and 3rd cut, but not 1st cut. Total yield was improved by 1500 kg/ha (1350 lb. /ac D.M.) on average. Yield increase with spring-applied sulphate of potash at 50 lbsS/ac was the same as with fall-applied elemental S (Figure 3). Elemental 50 S rate was as effective as the Ele 100 S rate, although tissue S concentration was higher for Ele 100 S. In both years of trials, yield of later cuts were more responsive than early ones. In 2013, Ele 100 S rate improved yield more than Ele 50, but was not statistically significant (Figure 4). Residual fall application of elemental or K_2SO_4 was as good as spring applied treatments.

Alfalfa Tissue Tests: Table 1

Plant tissue S concentration was similar in 1st and 2nd cuts. S concentration in diagnostic alfalfa tissue in the controls (0 S) was 0.26 ppm (range 0.2 – 0.3 ppm). In S – treated plots, tissue S concentrations increased, usually the most with the sulphate of potash K_2SO_4 treatment. In both years, the control S plant tissue concentrations were similar and equal to or below the critical S level (0.25%). S concentration in muriate of potash (KCL) treatment was equal or less than the control, it is possible that the chloride may be interfering with S uptake.

Alfalfa/Grass Mix: Table 1

Sulphur application increased the proportion of alfalfa in first cut harvested grass-alfalfa mix, by similar amounts across treatments.

Soil S Levels

Spring soil S concentrations in the controls (no S) were equal to or less than 8 ppm (considered low) for all three sites in both years. Sulphur application, both residual and reapplied treatments increased soil S levels but was unrelated to yield response to sulphur. There was no evidence that S from any treatment leaching down over winter. Sulphate of potash increased soil S at 0-6” and 6-12” depth more than other treatments.

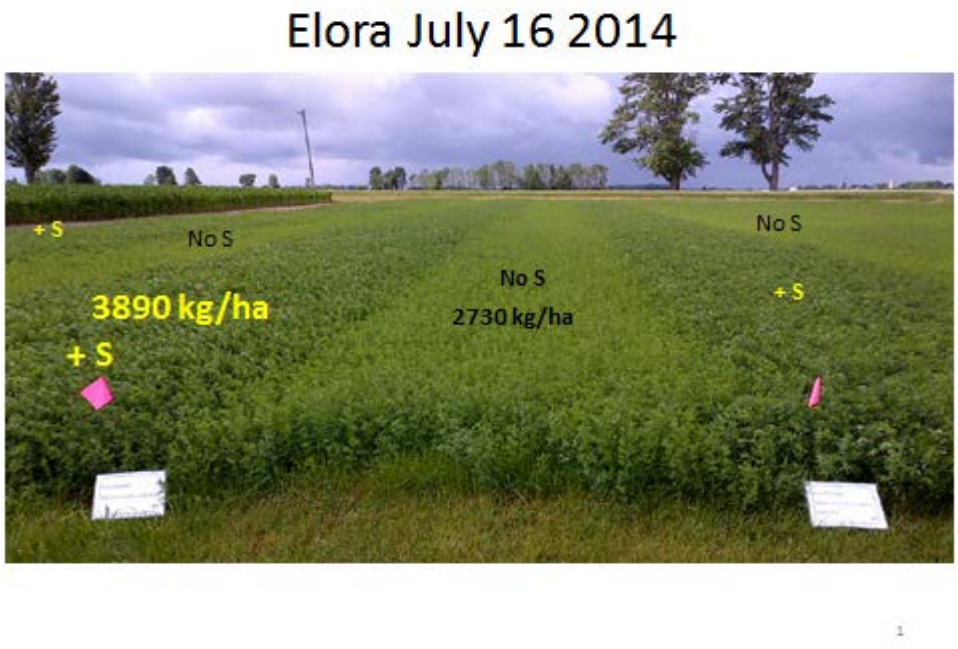
Potash Removal and response

In 2014, muriate of potash did not improve yield over the control (with no nutrients) at any of the 3 sites (soil test K or 132, 144, 74). No potash is recommended when soil K is above 150 ppm K (threshold). It is interesting that at 2 of 3 sites, forage yields with muriate of potash were slightly less than the control, particularly at the Mitchell site where soil K level (74 ppm initial) was the lowest. It is possible Cl (in KCl fertilizer) may be interfering with S uptake. The ratio of crop removal to change in soil K was higher than that generally regarded of 20:1. In 2014 the ratio of K_2O removed to soil test K drawdown averaged 6 (6 kg K_2O removed per unit change) in soil test K, with a range of 2 to 9 kg K_2O: ppm soil test K. This ratio of removal: soil test K change is higher than the

20:1 standard commonly used. Initial soil K levels and soil CEC will affect this removal ratio.

Farm Smart Expo Demo (Elora)
Yield was only collected on the 2nd cut and average of 3 strips was 3890 kg/ha with S and 2730 without S (stdev 300 kg/ha); a yield response of 1160 kg/ha, which would pay the cost of fertilizer (about $213/ha) with the one cut. A similar response was observed for third cut visually, not measured. Both soil and tissue indicated that S was needed. Tissue top 6" prior to first cut was 0.20% (June 17) and soil S 6 ppm, soil test K 34 ppm. Sulfate of potash was applied, 200 lb. /ac (36 lb. S/ac) on 23 June 2014. Second cut alfalfa tissue was collected July 25, and plot was harvested Aug 8. Diagnostic tissue prior to 2nd cut was 0.20%±0.002 (below critical 0.25 %) with no S applied and 0.39% ± 0.036 where sulphur was applied. Tissue N increased from 4.2 to 4.8% and K increased from 1.2 to 1.5% with sulfate of potash as compared with the check.

Figure 1: FarmSmart Expo Demo



Summary:

Alfalfa response to S fertilizer application was profitable on some sites, with similar yield for fall-applied elemental S and spring-applied sulphate of potash. The observed responses supported a critical concentration of 0.25% in top 6 inches of the alfalfa plant at late bud to early bloom. Response to S is highly variable between fields and years. In the absence of a reliable soil S test, the alfalfa plant tissue test can be used to determine the need for sulphur. Soil S supply can vary considerably across a field, so tissue samples should be collected from different parts of the field. Our tissue tests showed some variation in %S content between cuts, so sampling more than once is advised. Results showed that elemental S applied in the fall (50 kgS/ac) or sulphate of potash, spring applied at 50 lbsS/ac (277 lbs/ac product -18% S) is adequate. Manure is a

valuable source of S, but the sulphur content is variable and should be determined through a manure analysis.

The relationship between forage crop K removal and change in soil K needs further evaluation. Our trials indicated a ratio of 6:1; 6 Kg K20 removal per unit change in soil K. This is higher than previously thought (20:1 kg K20 removal: unit change in soil K)

Next Steps:

Data from 2 other University of Guelph sites will be included and analyzed. The work will support recommendations and incorporation into the OMAFRA Field Crop Agronomy Guide.

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Figure 1. Visual response to sulphur fertilizer application (100 lb. S/ac fall-applied elemental to the right of the stake), third cut, Mitchell site.

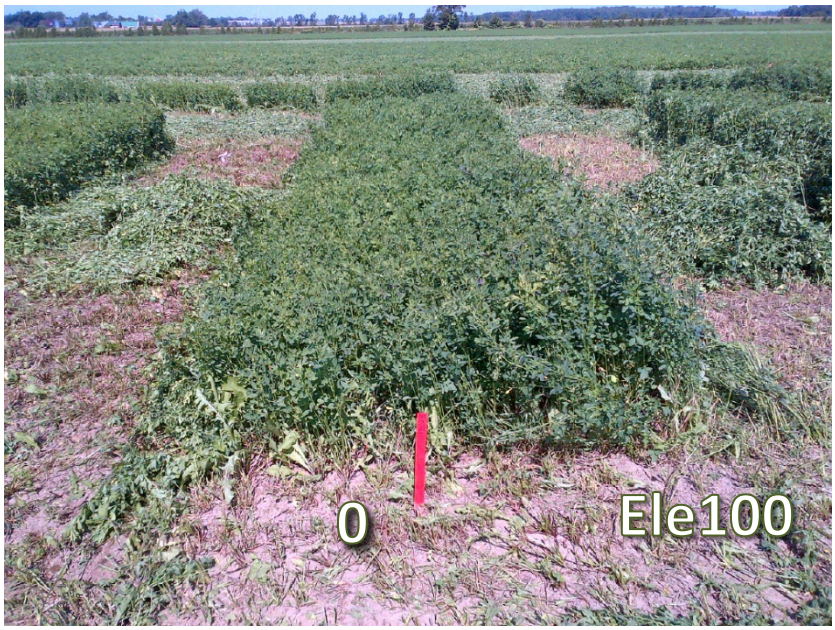

Figure 2: 2014 Forage yields

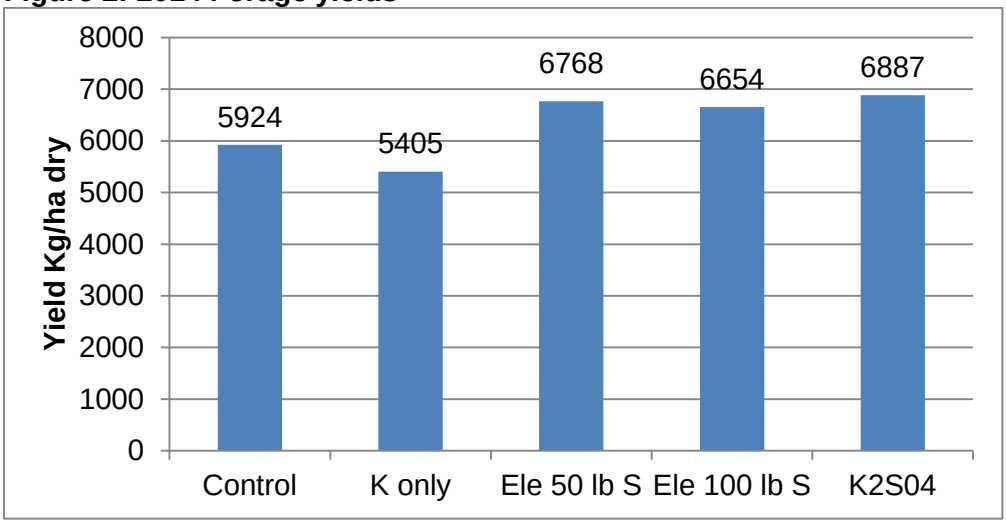

Figure 3: 2013 Forage Yields

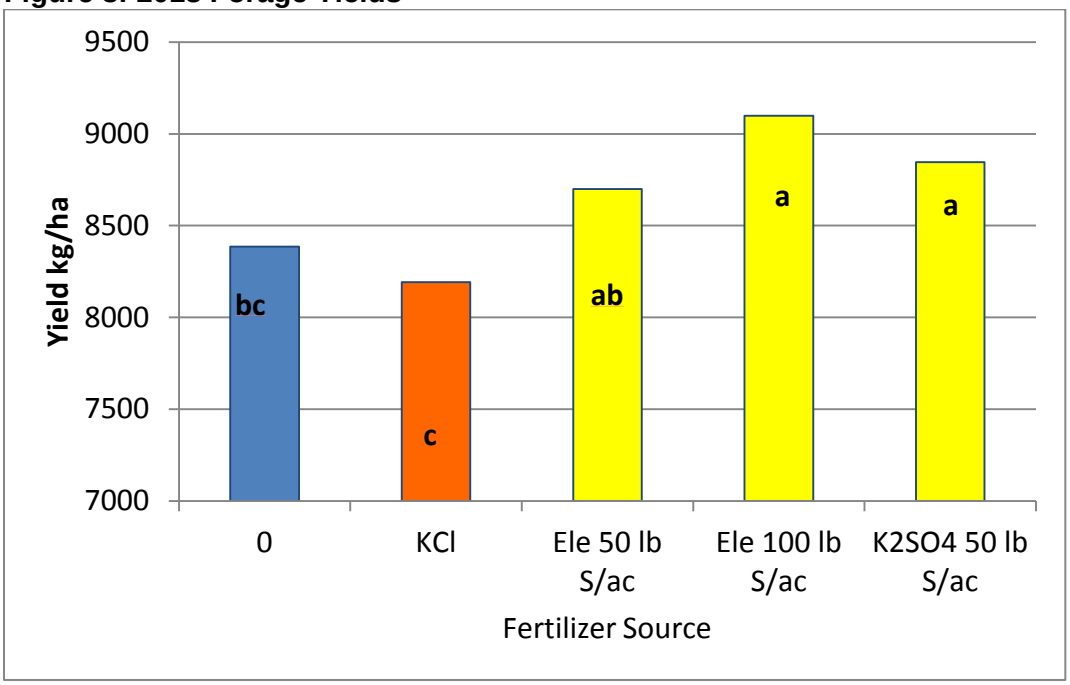

Figure 3. Forage response to sulphur fertilizer source and time of application, sum of 2 or 3 cuts, average of 3 South ON sites, 2013. Means with the same letter are not significantly different ($P \leq 0.05$) as determined by protected LSD test.

Table 1: 2014 Alfalfa S Concentration and % Alfalfa w/w

Treatment	AlfalfaTissue[1] % S top 6"	% Alfalfa[2] by weight 1st cut
Control	0.25	37
Ele 50 lb S	0.27	50
Ele 100 lb S	0.30	51
K^2S0^4	0.29	50
Potash (KCl) only	0.24	38

1. % S is average 1st and 2 cut, top 6" at bud stage
2. % alfalfa is % alfalfa of total forage weight in 1st cut

Project Contacts:

Brian Hall, OMAFRA, brian.hall@ontario.ca

Figure 4. Alfalfa field suffering from Sulphur deficiency