



Northern NY Agricultural Development Program 2007-2008 Project Report

Can sulfur addition increase alfalfa yield and quality in Northern New York?

Project Leader(s):

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Cooperating Producers:

- Bob Hanno (Lewis County)
- Tony Gilbert, Adon Farms (St. Lawrence County)

Background: Alfalfa is an important forage crop in Northern New York (perennial, high protein levels, ability to fix N from the air, deep rooting system that allows continued biomass production in dry periods and reduces risk of leaching losses). Over the past decades, S deposition has decreased substantially from 20-25 lbs S/acre in 1984 to currently as low as 5-6 lbs S/acre in some regions, raising questions about the S status of all field crops but especially alfalfa, a crop with high DM yields and S content. Assuming an average tissue S content of 0.25%, a 4 ton/acre harvest (85% DM) removes about 17 lbs S/acre. If we assume 6 lbs S/acre deposition, 11 lbs S/acre is needed from other sources to match crop removal on an annual basis. Soil organic matter (OM) is a

source of additional S but on sandy low OM soils, this S supply might not be sufficient. Manure addition could alleviate a potential S deficiency (about 1 lbs S/1,000 gallons) but applications above 4,000 gallons/acre could pose phosphorus (P) accumulation problems and other management challenges including burn and smothering upon heavier manure applications (<http://nmsp.css.cornell.edu/publications/factsheets/factsheet16.pdf>).

Sulfur deficiency can impact not only yields but also protein quality of alfalfa as S is closely associated with nitrogen in the process of protein and enzyme synthesis, and a constituent of aminoacids and vitamins. Deficiencies in these aminoacids and vitamins can greatly impact milk production, increase the need for imported feed and hence negatively impact farm N, P, and K balances and increase environmental loss.

Coarse-textured soils that are low in OM are most likely to cause S deficiency in high S consuming crops such as alfalfa. A survey S status of alfalfa fields New York was done in 2007 by sampling 2nd year alfalfa fields (top 15 cm of the alfalfa stand at the bud to early bloom stage). This included 10 NNY sites several of which showed low S levels (less than 0.25%). Within the Northern New York region, St Lawrence, Lewis and Essex counties have a substantial acreage on such soils. The current S status of alfalfa in Northern NY is, however, unknown most importantly because we lack calibrated tools for determining deficiencies in advance of a yield or quality decline. Our objectives were to: (1) evaluate six soil test methods for their ability to determine soil S increase upon S addition; and (2) determine S responsiveness of four NNY sites. The proposed work includes more detailed soil and crop response testing for four sites with low tissue S.

Methods:

Soil incubation study:

Our goal was to identify a soil test that can be used to determine S deficiency prior to occurrence of deficiency symptoms or yield decline. Four soils (three NNY soils and one eastern NY site) were incubated with 6 rates of S (0, 25, 50, 75, 100 and 150 lbs S/acre applied as gypsum). Soil samples were analyzed with six different extraction chemistries and two detection methods (ICP versus spectrophotometer). The chemical extraction methods were:

1. Potassium phosphate (KH_2PO_4)
2. Monocalcium phosphate ($\text{Ca}(\text{H}_2\text{PO}_4)_2$)
3. 1.0 N neutral (pH 7) ammonium acetate (NH_4OAc)
4. Calcium chloride (CaCl_2)
5. Morgan solution
6. Mehlich 3 solution

On-farm S response studies:

On-farm S response trials were conducted on four NNY sites including two farm sites in St Lawrence County, one farm location in Lewis County and one in Essex County (Willsboro Research Farm). The treatments (four replications) include a no-S control and two S sources (CaSO_4 and $\text{K}_2\text{SO}_4\cdot\text{MgSO}_4$) both added at a rate of 150 lbs S/acre. These treatments are consistent with work in 1981-1983 conducted by Klausner et al. (1984)

allowing for direct comparison with this earlier study. These treatments were applied at each site after 1st cutting, and soil samples from all spots were taken at this time. Forage quality samples and yield measurements will be taken at 2nd and 3rd cuttings. Soil samples were taken again after 3rd cutting.

Results:

Soil Incubation:

Of the six methods tested, the CaCl₂ extraction method was the best method (limited variability in response to S addition due to detection method or soil to soil differences and a linear response to addition of S with a relatively large slope of the linear equation (Figure 1).

On-farm sulfur trials:

Two sites that tested below 0.25 ppm tissue S (Willsboro site and one of the two St Lawrence sites) showed a significant yield response to sulfur addition. The other two sites were non-responsive to additional S. Thus, the current interpretations for tissue testing (<0.25 ppm indicates a deficiency) seems correct, based on the four sites in the study. We had 4 additional sites in this co-funded study (non-NNY) and results from these sites are still being summarized. All soils need to be analyzed for CaCl₂ extractable S to determine critical soil test levels.

Conclusions/Outcomes/Impacts: The results of the soil incubation study are very promising. The best test for sulfur detection is the CaCl₂ test. We will be analyzing the soil of the field trials (2008 and 2009) for this new soil S test and, if funds become available, invite farmers to submit samples to the laboratory so we can do a larger assessment of the S status of NNY soils.

Outreach: The project was discussed at winter meetings and field crop retreats. However, as the results of the field trials and the incubation were not known until mid-December, additional extension activities will need to take place in 2009. We are currently working on a journal article on the soil testing component of the project, to be submitted in early 2009. We will generate an extension article on the work once the journal article has passed peer review. We plan to develop an Agronomy Fact Sheet on the findings of the soil testing component as well and we will include discussions of sulfur needs for alfalfa in our nutrient management workshops.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education. The field trials will need to be continued for a second year before we can conclude on the effectiveness of the soil test identified as most promising in the incubation study (CaCl₂ extraction) and the need for S across NNY farms. Forage samples also need to be analyzed for forage quality (awaiting the results of samples that were submitted). We propose to do an assessment of soil S levels once the soil testing component is completed (in 2009) and to complete the second year of field trials for this project in 2009 as well. Once results are compiled, extension talks and documents will be developed and the soil test (assuming field work confirms its use as S test) will be released for general use for farmers and their advisors.

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Reports and/or articles in which the results of this project have already been published. The initial results of the soil testing component were presented at the Northeastern Branch of ASA/SSSA/CSSA meeting this year. They were shared with the extension educators but no formal extension articles could be written yet as we are still analyzing the remaining samples.

Person(s) to contact for more information (including farmers who have participated: The four field trials were conducted at the Willsboro Farm, two St Lawrence locations (Peter Barney, Consultant) and one Lewis County location (leadership by Joe Lawrence, CCE of Lewis County).

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