



Cornell Sulfur Test for Alfalfa

Sulfur

Sulfur (S) is an essential plant nutrient for processes such as photosynthesis and nitrogen (N) fixation (see Agronomy Factsheet 34). Following the passing of the Clean Air Act in 1970 and the introduction of sulfur (S)-free phosphorus fertilizer and pesticides, incidental addition of S to fields through atmospheric deposition (from power plant discharges and other sources) and fertilizer application has decreased drastically in New York. As an example, the total S deposition at the Musgrave Research Farm at Aurora, NY was estimated to be 14 lbs/acre in 1979-1981 versus 6 lbs/acre in recent years. A crop of alfalfa hay yielding 4 tons/acre can remove up to 20 lbs S/acre so it is not surprising that some alfalfa fields showed an economic yield response to S addition in recent studies. This raises the question: "What management tools are available for making decisions about S management of alfalfa?"

In this factsheet, we discuss tissue testing for S for alfalfa management, and introduce a new soil test for S assessment for alfalfa.

Sulfur Response Field Research

Tissue Testing

Recent field trials conducted in New York State support a critical value for tissue samples (top 6 inches of the plants taken just prior to 3rd cutting), of 0.27% (Figure 1A), similar to the 0.25% critical values commonly reported in the literature. These critical values only apply when fields are managed at the proper pH for alfalfa (target pH of 7.2). Based on these data, if the tissue S content exceeded 0.25%, the alfalfa has enough S for optimum growth. If the tissue level is less than 0.25% a yield response to S addition can be expected.

Soil Testing

A comparison of six different soil tests for S showed one of the six tests to be superior to others in reflecting the plant available S status of soils. This test is a 0.01 M CaCl₂ extraction

conducted with a 1:5 (weight:volume) ratio of soil and extraction solution and a 30 minute shaking time, followed by filtration of the solution (to separate solution and soil) and determination of S in the extraction solution. This test will be referred to as the Cornell Sulfur Test. Initial research shows that alfalfa will respond to additions of S when the Cornell Sulfur Test level is 8 ppm or less (Figure 1B).

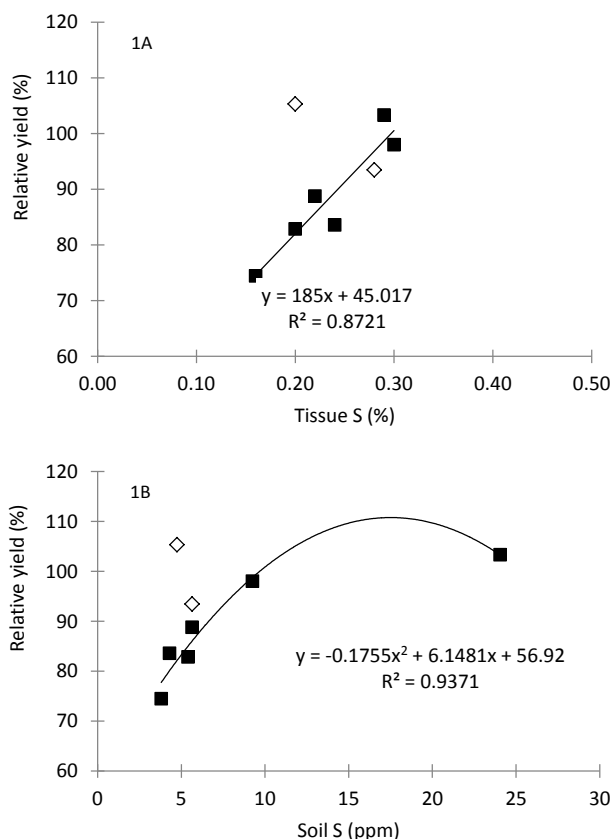


Figure 1: Tissue S content (A) and 0.01 mol L⁻¹ CaCl₂ extractable soil S (B) as predictors for relative yield of alfalfa (the ratio of yield without and yield with the addition of 150 lbs S/acre). The open diamonds indicate two locations with suboptimal pH (6.2 or lower).

More site-years of S response studies, covering a wider diversity of soils, field histories, and climatic conditions, are needed to fully test the utility of soil and tissue testing for S management of alfalfa.

Sulfur in Corn-Alfalfa Rotations with Manure

Evaluation of Cornell Sulfur Test levels over a corn and alfalfa rotation, where manure was applied in the spring of the corn years and no manure application took place during the alfalfa years, showed buildup of S levels under the corn years but a rapid decline in soil test S levels under the alfalfa years (Figure 2).

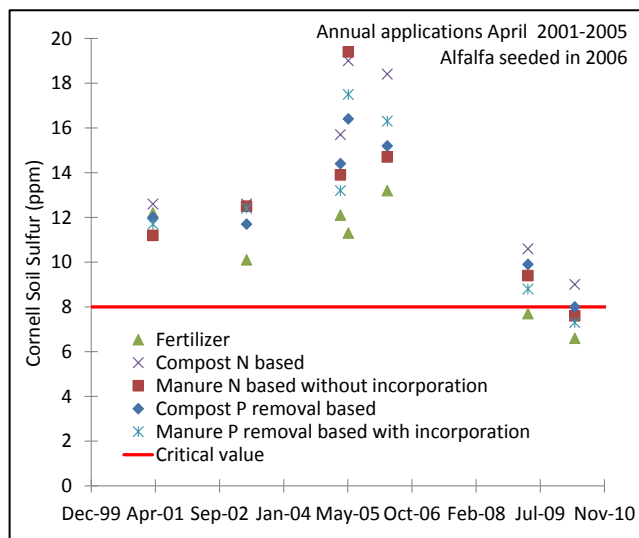


Figure 2: Soil 0.01 M CaCl₂ extractable S over a corn and alfalfa rotation. Corn was grown for 5 years (2001-2005) and amended with 20 versus 34 tons/acre compost, or 9,000 versus 20,000 gallons/acre liquid manure (N-based and P removal-based). The inorganic N treatment received 150 lbs N/acre (S-free) during the corn years. Alfalfa was seeded in 2006 and no further manure or compost application took place after that.

These results suggest the potential of S deficiency and hence alfalfa response to manure (or fertilizer S) addition in the later years of the alfalfa stand. For this reason, 3rd or higher year alfalfa fields should be tested for S content, and manure or fertilizer S application should be considered if soil and/or tissue testing show the potential for a yield response.

Soil and Tissue Sampling

Soil samples for the Cornell Sulfur Test should be taken at 1st cutting with the same sampling and handling methods as used for regular soil samples (0-8 inches, see Agronomy Fact Sheet #1). Since field sampling procedures are identical, the same sample can be used for regular fertility assessment as well as for the Cornell Sulfur Test. Soil samples should be submitted to: Quirine Ketterings, Nutrient Management Spear Program Laboratory, Department of Animal Science, 323 Morrison

Hall, Cornell University, Ithaca NY 14853. See <http://nmsp.cals.cornell.edu> to download a sample submission form.

Tissue samples should include the top 6 inches of 30-35 individual plants just prior to 3rd cutting (early bloom). The total S analyses can be conducted by a number of laboratories. Tissue samples should be packaged in paper bags to avoid rotting prior to arrival in the laboratory. Samples can be air-dried prior to submission.

Conclusion

Both tissue and soil testing for S were effective in predicting an alfalfa yield increase from S fertilization for the sites in this study. The New York data support a critical tissue S level of 0.25% S for samples taken at the 3rd cutting (top 6 inches of the plant). The soil test data suggest a critical level of 8 ppm S (0.01 mol L⁻¹ CaCl₂ extractable S, 0-8 inch soil samples) with samples taken at 1st cutting. Fields are not likely to be S responsive in the year manure is applied or the next year but non-manured alfalfa fields should be monitored for S over time given that buildup of S under corn years with annual application of manure or compost can be followed by a rapid decline in soil S when no manure is applied to alfalfa.

Additional Resources

- Nutrient Management Spear Program Agronomy Fact Sheet Series: nmsp.cals.cornell.edu/index.html
- Nutrient Guidelines for Field Crops in New York: nmsp.cals.cornell.edu/guidelines/nutrientguide.html

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information



Cornell University
Cooperative Extension

Nutrient Management Spear Program
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