

**THE MANAGER**

**CROPPING STRATEGIES**

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In the past the sulfur for crop growth was supplemented by power plant emissions and phosphorus fertilizers containing sulfur. These sulfur sources are disappearing.

# Rethink added sulfur for alfalfa

For decades, sulfur hasn't typically been among the nutrients regularly supplied to field crops. It was believed that sulfur (S) supplied from three sources was sufficient to balance crop removal: deposition of S from the air, such as from coal-fired power plant emissions; soil sulfur supplied through mineralization of organic matter, including manure; and S contained in fertilizers such as ammonium sulfate, super phosphate and rock phosphate, as well as pesticides.

The introduction of sulfur-free phosphorus fertilizer and pesticides has resulted in reduced S application to soils. And atmospheric S deposition rates have declined since the passing of the Clean Air Act in 1970. In the 1980-1984 period, the average total S deposition rate for the four longest running weather stations in New York was estimated to be about 14 lbs. S per acre. Compare that to 2008 when the estimated total S deposition rate was 9 lbs. S per acre.

With increasing crop yields and declining deposition levels, the question arises: Should we expect a crop response from addition of S to crops like alfalfa that take up a lot of sulfur? (Table 1)

**The research**

In 2008 and 2009, Cornell Cooperative Extension

educators and staff of the Cornell Nutrient Management Spear Program (NMSP) identified eight New York farm fields that were likely to be S deficient. That is no manure history, sandy soils and/or low organic matter.

At each location, we compared three treatments: gypsum, K-Mag® and no S (control). The sulfur sources were applied at a rate of 150 lbs. S per acre after first cutting of a second- or third-year alfalfa stand. This is a much higher rate than normally applied, but we wanted to ensure the rate was adequate to drive a response if there was going to be

**Table 1. Estimated S removal rates with harvest of common Northeast field crops**

Crop	S removal (lbs. S)
Corn silage	0.693 lbs/ton (35% DM)
Shelled corn*	0.048 lbs/bu. (85% DM)
Ear corn*	0.057 lbs/bu. (85% DM)
Alfalfa hay	4.88 lbs/ton (90% DM)
Alfalfa silage	1.72 lbs/ton (35% DM)
Grass hay	3.11 lbs/ton (90%)
Grass haylage	1.44 lbs/ton (35% DM)
Soybeans*	0.16 lbs/bu (87% DM)



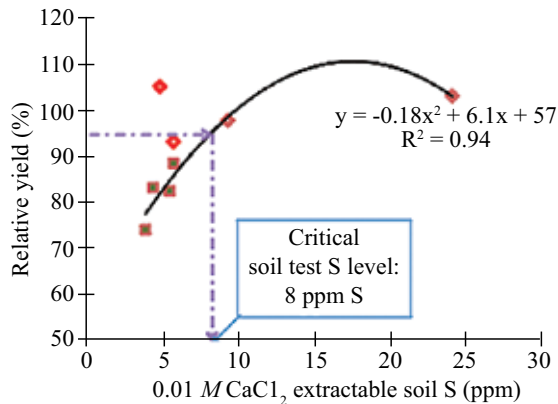
The number one priority for fertility management is soil pH. For alfalfa the target pH is 7.0. Photo by Karl Czymmek

**FYI**

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- Jerry Cherney is the E.V. Baker Professor of Agriculture at Cornell's Department of Crop and Soil Sciences. Email: jhc5@cornell.edu
- The on-farm trials were conducted in collaboration with Cooperative Extension educators Carl Albers, Mike Stanyard, Tom Kilcer, Peter Barney, Joe Lawrence and Mike Davis. Other collaborators included Greg Godwin, Kevin Dietzel, Chie Miyamoto of the NMSP and Debbie Cherney of the Department of Animal Science. These farmers hosted the trials: Bob Hanno, Tony Gilbert, Brandon Hoad, Curt Hopkins and Roger Arliss.

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**Figure 1. Sulfur soil test predicts relative yield**



The exception is sites where soil pH is below optimal. Two of these eight sites (in red) had a pH of 6.2 or lower, causing a small or no response in yield only after S addition.

one. We also wanted to see if there would be S carryover year to year.

Soil was sampled at 0 to 8 inches before S application and again after third or fourth cutting in 2008. Sulfur was not applied in 2009 to see if there was any carryover from 2008. We sampled soils at green-up and after last harvest. In total, 17 harvests were analyzed in 2009. Tissue samples from the top 6 inches of the plants were taken just before harvest at third cutting.

### The findings

- Four of the eight locations showed a yield increase with S addition, regardless of the product applied.

- Soil testing in 2008 showed an average soil S level of 7 ppm at first cutting before sulfur application, 6 ppm at third cutting where no S was applied and 23 ppm with the application of S.

- Sampling at green-up in 2009 indicated no carryover from 2008. The soil test levels averaged 4 ppm where no S had been applied and 5 ppm with S addition.

One exception occurred where 5,000 gallons of manure per acre were applied after first cutting and after soil sampling in 2009. Soil test S levels doubled due to this manure application, indicating that S deficiencies aren't likely for fields with a recent manure history.

- For seven of the eight locations, tissue testing identified whether a crop yield response was likely. The critical level for deficiency was 0.27% and is similar to the 0.25% critical level typically cited. This suggests that our current guidance for tissue testing of alfalfa is accurate. At one location, the tissue test was 0.20%, but we did not measure a yield response with S addition. Tissue S levels increased with S addition from 0.24% to 0.33% across all sites.

- Yield increases ranged from 0.3 to 0.6 tons per acre for regrowth cuttings. Yield response may have been higher had treatments been applied in advance of first cutting.

- Sulfur addition increased protein levels for four of the 17 cuttings taken in 2008. The estimated milk production per ton of alfalfa, predicted using Milk2006, wasn't impacted, nor were other quality indicators such as neutral detergent fiber and fiber digestibility.

- All soil samples were analyzed for calcium chloride (CaCl<sub>2</sub>) extractable S. We tested this weak extraction solution to see if it would accurately predict S responsiveness. It did for six of the eight sites with a critical level of 8 ppm.

- At one location, the relative yield without S addition was 93% of the yield we obtained after S addition, but the yield difference was not statistically significant. The second location was the same field where tissue testing predicted a yield response, but no response was measured. The soil test was 5 ppm.

Why was the response to S absent in the location with a tissue test of 0.20% and a soil S test of 5 ppm? And why do we have inconsistent results for a second location where the tissue test was sufficient and the soil test was deficient? Soil pH was the problem.

Further soil testing showed both locations had a 6.2 pH at the start of the trials in 2008 and dropped to 5.8 at the end of 2009. The desirable pH for alfalfa is 7.0. This showed that adding S won't overcome the negative impact of low pH. It's also a reminder of the importance of getting the fundamentals right: pH must be in the proper range for the crop being grown in order to reap the benefits of other investments.

### Lessons so far

1. The number one priority for fertility management is soil pH. For alfalfa, the target pH is 7.0.

2. There are S deficient sites in New York. Potentially they are coarse textured, low organic matter fields with no recent manure history. If manure is applied, S deficiency in the year of application or even the following year is highly unlikely.

3. Tissue testing can confirm a potential S deficiency. Take the top 6 inches of 12 to 15 plants at early bloom and analyze for total S. Use a critical value of 0.25% S to determine responsiveness.

4. Soil testing based on a 0.01 M CaCl<sub>2</sub> extraction can be used to predict the likelihood of a response to S application. Current research supports a critical value of 8 ppm.

This is valid if soil pH is in the optimal range since crop response to S only occurs if other nutrients don't limit production.

The new soil sulfur test method is being published and can be easily implemented by soil testing laboratories this year once the method is available.

5. For S deficient sites, consider small – 20 to 30 lbs. S per acre – annual applications of S-containing fertilizers rather than large multi-year applications. □