Sulfur Fertilization Can Double Alfalfa Yields

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Stunted yellowing alfalfa plants became widespread in fields in Southwestern Wisconsin, Northwestern Illinois, and Northeastern Iowa during the 2009 growing season. A preliminary field study of sulfur applications in 2010 in Southwest Wisconsin resulted in 0-8% yield increases in areas with normal looking alfalfa and 50-120% yield increases in areas with stunted yellowing alfalfa. An MFA grant funded an expanded sulfur fertilizer study for the 2011 growing season. The study consisted of three sulfur fertilizer treatments and a check treatment established on three farms.

The Midwest used to receive ~20 lbs/ac of sulfur per year from acid rain. This has been reduced to 2-4 lb/ac over the last 25 years. Alfalfa removes 4-6 lbs of sulfur per ton of forage produced. Currently, supplemental sulfur fertilizer is being integrated into alfalfa fertilizer recommendations in fields where deficiency symptoms occur. This study examined alfalfa yield response to sulfur and guidelines to avoid fertilizer applications that may be ineffective.

Methods and Materials

For the fertilizer field study the experimental layout followed a randomized complete block design, with four fertilizer treatments and six replicates, three set within two different sections of a field. Fields were stratified into two sections based on visual differences between normal looking alfalfa and stunted yellowing alfalfa identified in the fall of 2010. Three replicates were randomly placed within each of the two sections (because of fall to spring advance of stunted yellowing alfalfa in the study field of Farm 1, four replicates were placed in stunted yellowing alfalfa and two were placed in normal looking alfalfa). One replicate was placed in each of the two stratified areas of fields on Farms 2 and 3.

Individual plot sizes measured 10' x 20', with sampling in the middle 3' strip to reduce inter-plot interference. Fertilizer treatments were: no fertilizer, 130 lb/ac $CaSO_4$, 100 lb/ac $(NH_4)_2SO_4$, and 140 lb/ac K_2SO_4. These treatments supply ~24 lbs of sulfur per acre and were applied by hand prior to 2011 spring green-up on Farm 1 and were applied after first cutting on Farms 2 and 3. Yields were obtained from a 3' x 10' strip in each plot for first through third cutting on Farm 1 and for second through fourth cutting on Farms 2 and 3.

Data collection consisted of alfalfa tissue samples with corresponding 0-6" soil samples collected in each of the two areas of the field and analyzed at the UW Soil and Plant Analysis Laboratory. These plant samples and corresponding soil samples were collected from check plots at first cutting and at third cutting from all plots to determine treatment effect on tissue nutrient concentrations. Forage quality was tested for all treatments in each field.

Soil samples were taken from fertilizer treatment plots on study fields as well as from additional farms for Aphanomyces lab testing at the UW-Madison Plant Pathology Department.

Results

Sulfur can significantly increase, and in some cases double, yields when symptoms of sulfur deficiency (stunted or yellowing plants) are present.

The fertilizer treatments were applied to yellow, stunted, or abnormal areas of alfalfa and to areas of normal alfalfa in the same field. At harvest, tissue samples with corresponding soil samples were taken to determine fertility conditions in the fertilizer treatment areas. In 2010, tissue sulfur levels in normal alfalfa were .24% or higher with an average level of .16% in the abnormal looking alfalfa. For 2011 sulfur tissue tests ran .40% or higher in the normal alfalfa and averaged .16% in the abnormal alfalfa.

In 2010, sulfur applications applied after first cutting increased yields an average of 88% in the abnormal areas of the field. In these areas yields doubled in some individual plots. Only small yield increases were seen in the normal areas of the field. In 2011, fertilizer treatments were applied earlier at spring green-up with four replications in abnormal or yellow areas and two replications in normal alfalfa. These earlier fertilizer applications increased yields approximately one ton on first cutting in abnormal areas of the field. The normal areas showed no or only small yield increases.

The 2010 study showed nearly equal yield responses in both second and third cuttings. In 2011, the greatest response was seen in first cutting with diminishing response through second and third cuttings. In 2010, the fertilizer treatments were put on after first cutting and showed a carryover yield response in first cutting the following year. In 2011, however, yield response declined in each successive cutting, and this response was seen in neighboring fields that received 100 lbs of ammonium sulfate before first cutting, and were showing recurring symptoms of sulfur deficiency by late-October, indicating insufficient supplemental sulfur fertilizer. Heavy

Table 1. Alfalfa yield response to sulfur.

	2010 Yields (2nd & 3rd Cuttings)		
	Without Sulfur	**With Sulfur**	**Yield Response**
Normal Alfalfa	2.4	2.5	.1 ton/ac (4%)
Yellowing Alfalfa	1.9	3.2	1.3 ton/ac (68%)
	2011 Yields (Farm 1 - 1st, 2nd & 3rd Cuttings)		
	Without Sulfur	**With Sulfur**	**Yield Response**
Normal Alfalfa	5.4	5.2	(.2) ton/ac (0%)
Yellowing Alfalfa	3.2	4.9	1.7 ton/ac (53%)

rainfall after first cutting may have moved sulfur lower in the soil limiting plant available sulfur. This has raised unanswered questions about the best application rate and timing for fields with known sulfur deficiency.

The visual response to sulfur occurred over a two week period in the areas of fields that exhibited sulfur deficiency. Sulfur fertilizers have produced a significant economic return in these areas. If yellow alfalfa with low sulfur tests makes up a significant proportion of a field, the potential yield response to added sulfur may more than offset the cost of fertilizer applied to the areas of the field with little yield response where alfalfa growth appears to be normal.

Producers can assess sulfur levels and the potential for a yield response to sulfur by plant tissue testing. Fields testing below .25% tissue sulfur levels showed significant yield benefit from sulfur. Areas testing higher than .25% sulfur saw small or no yield increase.