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Effect of Sulfur and Boron Fertilization on Alfalfa

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Abstract
Historically, sulfur (S) deficiency has not been an issue for crop production in Iowa. Research results as recent as 2002 on corn and soybeans were consistent with previous results. The exception was a long-standing suggestion to apply S as commercial fertilizer or livestock manure for alfalfa production on sandy soils.

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Effect of Sulfur and Boron Fertilization on Alfalfa

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Introduction

Historically, sulfur (S) deficiency has not been an issue for crop production in Iowa. Research results as recent as 2002 on corn and soybeans were consistent with previous results. The exception was a long-standing suggestion to apply S as commercial fertilizer or livestock manure for alfalfa production on sandy soils.

However, over the past decade, alfalfa grown on some silty loam and loam soils in northeast Iowa exhibited a slowly worsening problem with areas in fields of stunted growth and poor coloration. Research in 2000–2006 in northeast Iowa found that these problems were largely due to S deficiency.

Boron (B) is another essential element for plants that has been adequate for crop production. Alfalfa has a higher demand for B than most other crops. It is common to recommend B fertilization for alfalfa grown on sandy soils, but limited research in the past has usually not shown a yield response to B fertilization on loam soils. This research trial will reevaluate the effect of both sulfur and boron fertilization on alfalfa.

Materials and Methods

In 2009, an alfalfa stand was planted on a Readlyn loam soil, 3.3 percent organic matter, at the ISU Northeast Research Farm, Nashua, Iowa. The research trial consisted of four treatments with seven replications. The treatments were: 1) no fertilizer, 2) fertilized with B, 3) fertilized with S, and 4) fertilized with S and B. Sulfur was applied at 40 lb/acre as calcium sulfate (gypsum), and B was applied at 2 lb/acre as Borate-48. These applications were applied in October 2009 for the 2010 production year, and in March 2011 for the 2011 production year. Alfalfa was harvested three times in 2010 and four times in 2011. Harvests were done with a Carter harvester flail chopper with weigh bin. Alfalfa plant tissue samples were collected at late bud stage in May of each year. Potato leafhopper was controlled as needed for the duration of the trial.

Results and Discussion

Yield results are presented in Table 1. Sulfur fertilizer applications increased alfalfa yields in both years of the trial, while boron fertilizer applications had no affect on yield.

Soil test information is provided in Table 2. The S soil test is not a reliable tool for S fertilizer recommendations. The University of Wisconsin calculates a sulfur availability index (SAI), which takes into account the S soil test, estimated S from precipitation, subsoil S, and any S from manure applications. An index >40 means a response to added S is unlikely. Between 30 and 40, the S need should be confirmed by plant analysis. Less than 30 suggest S should be added. However, in this trial the SAI was not a reliable indicator of S needs. Plant analysis is a better indicator for determining S deficiency.

The B soil test for alfalfa is considered to be a fair tool by the University of Wisconsin for which to base B fertilizer recommendations. On loam soils, optimum is 0.9–1.5 ppm. However, plant analysis is still considered to be a more reliable indicator, with B sufficiency suggested at >30 ppm.

Plant analysis in Table 3 indicated that alfalfa was marginally S deficient. Previous research determined that alfalfa plant samples testing less than 0.23 percent are considered S deficient. Plant analysis of B appeared to be adequate (>30 ppm) except for the S only treatment. However, there was no additional yield response from B fertilization in the S + B treatment. A plant analysis of <20 ppm is considered B deficient.

Sulfur deficiency problems exist in northeast Iowa alfalfa production fields. The majority of S deficiency problems occur in areas within fields, not entire fields. However, this non-uniformity can still account for significant economic losses on a field scale. Most of the soils involved are lower organic matter (<3%) and in side slope positions. However, this trial with 3.3 percent organic matter loam soil also responded to S fertilization. Heavily manured soils do not usually have S deficiency.

This trial provides additional evidence that most loam soils have adequate levels of B for alfalfa production. Additional research on lighter textured soils in Iowa should be conducted to verify and update B fertilizer recommendations for alfalfa. In the meantime, published recommendations from the University of Wisconsin provide general interpretations for B soil tests and plant analysis.

Currently, if S deficiency is found in alfalfa (i.e. plant analysis <0.23% S), the amount of S fertilizer recommended is 20–30 lb/acre. Where deficiencies occurred in the 2006 trials, the first 15 lb of S/acre gave the largest incremental increase in yield, but the next 15 lb was still profitable in most trials.

Table 1. Alfalfa forage dry matter yields with and without S and B fertilization.

Treatment	2010	2011	2-yr avg.
	- - - - - - - tons/acre - - - - - - -		
None	6.15a	6.44a	6.30a
Boron (B)	6.10a	6.68a	6.39a
Sulfur (S)	6.91b	7.85b	7.38b
B + S	6.67ab	8.07b	7.37b
LSD $_{0.05}$[1]	0.63	0.78	0.64

[1]LSD=least significant difference. Means followed by the same letter in the same column are not significantly different with 95 percent certainty.

Table 2. Soil test results for S and B, and the calculated SAI for both years of the trial.[1]

	2010			2011		
	SAI	S	B	SAI	S	B
Treatment		ppm			ppm	
None	47	7.8	0.7	54	7.5	0.7
Boron (B)	52	6.9	1.0	48	5.8	1.1
Sulfur (S)	49	7.4	0.7	51	6.7	0.6
B + S	50	7.0	0.9	51	6.7	0.8

[1]SAI = sulfur availability index.

Table 3. Plant analysis results for sulfur (S) and boron (B) for both years of the trial.

	2010		2011	
	S	B	S	B
Treatment	%	ppm	%	ppm
None	0.22	30	0.19	36
Boron (B)	0.17	46	0.20	66
Sulfur (S)	0.39	24	0.47	18
B + S	0.36	43	0.43	57