2007

Sulfur Deficiency in Northeast Iowa Alfalfa Production

Brian J. Lang
Iowa State University, bjlang@iastate.edu

John E. Sawyer
Iowa State University, jsawyer@iastate.edu

Stephen K. Barnhart
Iowa State University

Sulfur Deficiency in Northeast Iowa Alfalfa Production

Abstract
Historically, sulfur (S) deficiency has not been an issue for crop production in Iowa. Previous research reported sufficient plant available S for crop production on most soil associations. Recent studies across Iowa in corn and soybean production were consistent with results of previous research. The exception was a longstanding 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 silt loam and loam soils in northeast Iowa has exhibited a slowly worsening problem with areas in fields of stunted growth and poor coloration. Recent investigations determined the growth problems were largely due to S deficiency.

Keywords
Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

Sulfur Deficiency in Northeast Iowa Alfalfa Production

Brian Lang, extension crop specialist
John Sawyer, associate professor
Steve Barnhart, professor
Department of Agronomy

Introduction

Historically, sulfur (S) deficiency has not been an issue for crop production in Iowa. Previous research reported sufficient plant available S for crop production on most soil associations. Recent studies across Iowa in corn and soybean production were consistent with results of previous research. 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 silt loam and loam soils in northeast Iowa has exhibited a slowly worsening problem with areas in fields of stunted growth and poor coloration. Recent investigations determined the growth problems were largely due to S deficiency.

This project was designed to study the sulfur (S) fertilization needs in several locations in northeast Iowa and to determine S fertilizer recommendations for alfalfa.

Materials and Methods

In 2005, on-farm trials were conducted on established alfalfa fields near Elgin, Gunder, and West Union. These sites were selected because there were large areas in these fields with both poor and good alfalfa plant coloration and growth. Within each poor and good coloration area, three fertilizer treatments were established and replicated three times. The treatments consisted of a 0 application, 40 lb S/acre as ammonium sulfate, and 40 lb S/acre as calcium sulfate (gypsum). The treatments were applied after first cut. Alfalfa harvests included second cut and third cut in 2005 at all three sites, and first cut in 2006 at the Elgin and Gunder sites.

In 2006, on-farm trials were conducted on established alfalfa fields near Wadena, West Union, Waucoma, Nashua, Waukon, and Lawler. These trials compared different rates of S. Sites were selected to offer a wide range of responses, in that they were established on different soil types and exhibiting different degrees of poor to good coloration. Calcium sulfate was applied in the spring at 0, 15, 30, and 45 lb S/acre with either three or four replications in each trial. Most sites were harvested at second and third cut, the Nashua site was harvested for four cuts and some harvest coordination issues resulted in losing second cut at West Union and the third cut at Lawler.

Results and Discussion

In 2005, dry matter yields of S fertilized plots on the good coloration area were not different from that of the unfertilized treatment (Table 1). However, S fertilized plots on the poor coloration areas more than doubled yields in 2005 and nearly doubled yields in 2006. Plant analysis for the untreated poor areas was 0.14% S, well below the recommended sufficiency level of 0.25% S. Plant analysis for the untreated good areas was also considered deficient at 0.22% S, but by a very small margin. The S fertilizer treatments in the poor coloration areas increased the dry matter yield almost to the yield in the good coloration areas. The two sulfate containing fertilizers provided similar results. Other soil characteristics, soil type, P and K soil test levels, pH, sulfate-S soil test levels, organic matter, and cation exchange capacity were largely similar within the sites (data not shown). Any soil test P at the Elgin and Gunder sites and soil test K at the West Union site, did not explain differences found with the S fertilizer treatments. The S soil test results did not correspond to the coloration differences in the fields, the percentage S differences found in the plant analysis, or yield responses to applied S.

In 2006, the sites with poor coloration had lower percent S plant analysis (Table 2) and greater dry matter yield responses to S fertilizer (Table 3). The two sites with plant S above 0.25% with no applied S did not have statistically significant yield increases from applied S. The S soil test did not correspond to percentage S plant analysis, yield response to applied S, or soil organic matter. Those sites with yield responses to S fertilizer leveled off at about 25 lb of S/acre (Table 3).

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 large economic losses on a field scale. Most of the soils involved are lower organic matter, side slope positions, silt loam soils, i.e. Fayette silt loam and Downs silt loam. However, lighter textured loam soils have also responded to S fertilizer in these trials, i.e. Wapsie loam in 2006, Winneshiek loam and Saude loam in 2005 (data not shown). Heavily manured soils do not appear to have S deficiency problem.

Currently, if S deficiency is found (i.e. plant analysis ranging <0.23 to 0.25%, Figure 1), the amount of S fertilizer recommended is usually 20 to 30 lb S/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 of S/acre was still profitable in most trials. Additional research would help refine these recommendations.

Table 1. Alfalfa forage yield, S plant analysis, and S crop removal with topdress applications of S fertilizer in field areas with poor and good coloration of alfalfa.

	2005[1]						2006[2]	
	Cuts 2+3		Cut 2		Cuts 2+3		Cut 1	
Sulfur	Dry matter yield		Plant top Sulfur		Sulfur removal		Dry matter yield	
	Observed Growth Area							
Treatment[3]	Poor	Good	Poor	Good	Poor	Good	Poor	Good
	ton/acre		- - - % S - - -		lb S/acre		ton/acre	
None	1.18a	2.99a	0.14a	0.22b	2.8a	10.6b	1.10a	2.04a
Am. sulfate	2.76b	3.26a	0.40d	0.35c	16.5cd	18.2de	2.18b	2.22a
Ca. sulfate	2.49b	3.21a	0.41d	0.37c	15.3c	18.1e	2.14b	2.19[a]

[1]Three field sites in 2005, Elgin, Gunder, and West Union, Iowa.
[2]Two field sites in 2006, Elgin and Gunder, Iowa.
[3]Sulfur (ammonium sulfate and calcium sulfate) were applied at 40 lb S/acre after first cut in 2005.
[4]Treatment means within a column followed by the same letter are not different, 90% probability level.

Table 2. Alfalfa plant S concentration and site characteristics, 2006.

	Site					
Sulfur rate[1]	Wadena	Waucoma[2]	Nashua	Waukon	West Union	Lawler
lb S/acre	- % S -					
0	0.14	0.21	0.33	0.18	0.18	0.27
15	0.20	0.30	0.35	0.29	0.24	0.36
30	0.30	0.43	0.34	0.40	0.29	0.39
45	0.39	0.36	0.37	0.41	0.28	0.37
Soil SO_4-S, ppm	7	3	7	1	6	3
Soil OM, %	3.1	2.1	4.2	3.8	3.3	2.6
Soil	Fayette sl	Wapsie l	Floyd-Clyde l	Fayette sl	Fayette sl	Ostrander l

[1]Sulfur applied as calcium sulfate in April at Nashua and in May at the other sites.
[2]Waucoma site had 10 lb of elemental S applied in spring across the entire field.

Table 3. Alfalfa total dry matter for the harvests collected in 2006.

	Site					
Sulfur rate[1]	Wadena	Waucoma[2]	Nashua	Waukon	West Union	Lawler
lb S/acre	ton/acre					
0	1.32	1.85	6.73	1.39	0.78	2.14
15	2.59	3.06	6.98	2.97	1.05	2.11
30	2.76	3.14	6.85	3.33	1.07	2.11
45	2.92	3.24	7.14	3.58	1.07	2.07
Significance (90%)	*	*	NS	*	*	NS
Max. rate, lb S/acre	25	22	0	29	12	0
Cut harvested	2+3	2+3	1+2+3+4	2+3	3	2+4

[1]Sulfur applied as calcium sulfate in April at Nashua and in May at the other sites.
[2]Waucoma site had 10 lb of elemental S applied across the entire field in spring.

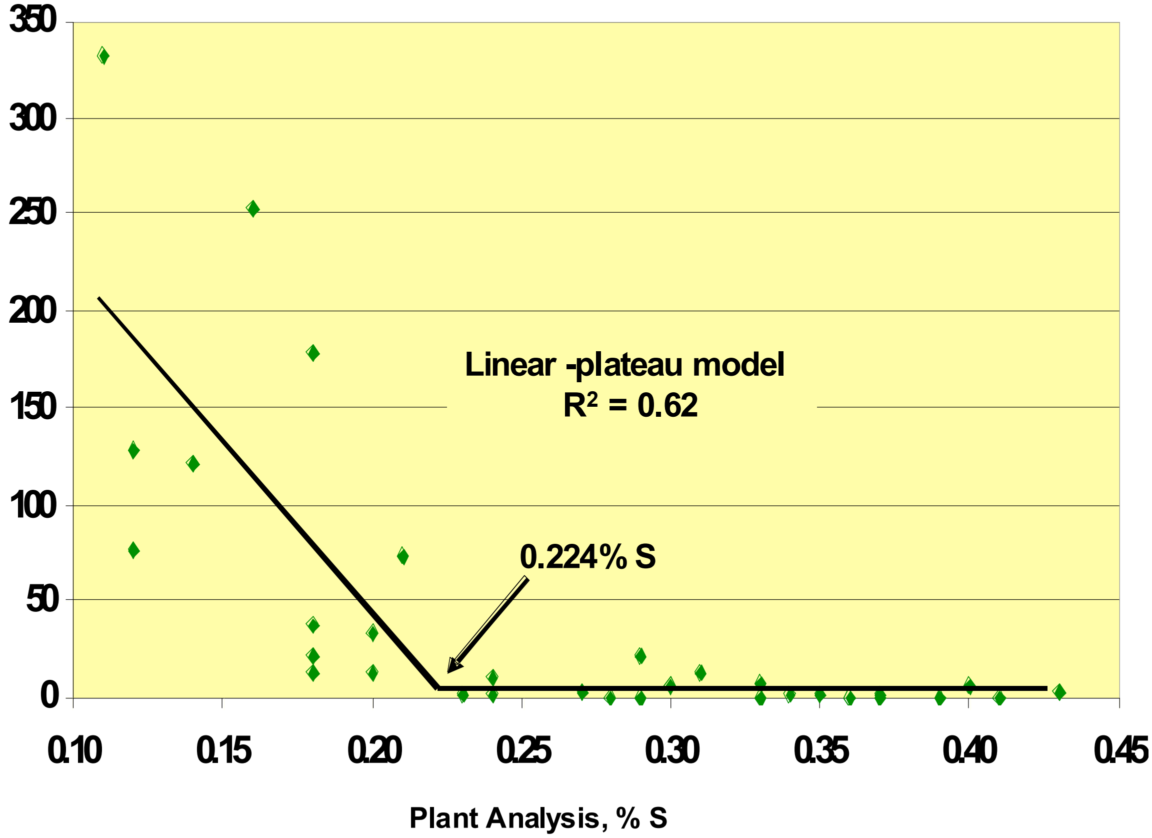

Figure 1. The percentage yield increase from S fertilization relative to the alfalfa plant S concentration with no S applied.