THE EFFECT OF SULFUR FERTILIZATION OF YIELD AND QUALITY OF CORN AND ALFALFA

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The importance of sulfur (S) fertilizers for crop production in Minnesota has been recognized for several years. In past research, the use of S had increased crop production only on the sandy soils. Since the soil organic matter is a major reservoir of S for plant use, there is always some question about the need for S in a fertilizer program where soils are not sandy but, yet, have a low organic matter content.

It is well known that S is an important component of some amino acids in plants and this is important in the formation of plant proteins. The percentage of protein in plant material is one common measure of the quality of that material for use as an animal feed. In Minnesota, both alfalfa and corn silage are important feed sources for the livestock industry. If the quality of this forage can be improved, this enhances the value of the forage and may result in improved profit from the livestock enterprise.

Although the effect of fertilizer S on the yield of both corn and alfalfa has been studied in detail, very little attention has been devoted to the measure of the effect of fertilizer S on the quality of forage crops (alfalfa and corn silage). This report summarizes the initial results of a study designed to measure the effect of fertilizer S on both the yield and quality of corn and alfalfa.

Experimental Procedures:

This study was initiated in the spring of 1984 and was continued through 1986. For alfalfa, fertilizer S at rates of 25, 50, 75, and 100 lb./acre were broadcast to established stands and compared to a control treatment. Relevant soil properties are summarized in Table 1.

Either 3 or 4 cuttings were taken from each location. Cutting schedules were dependent on weather, but were planned to be at 35 day intervals. Whole plant samples were taken from each plot for each cutting. These samples were dried, ground and analyzed for total S and protein, acid detergent fiber (ADF), and neutral detergent fiber (NDF) percentages. A standard procedure utilizing Near Infra Red (NIR) technology was used to measure protein, ADF, and NDF percentages.

For corn, various rates of S (0, 10, 20, 40 lb./acre) were combined with rates of N (0, 75, 150, 225 lb./acre) in a complete factorial design. The N rates were split only for the sandy sites. Adequate amounts of P, K, and Zn were used

at all sites. All fertilizer materials were broadcast and incorporated before planting. Relevant soil test values for the corn experimental sites are summarized in Table 2.

Ear leaf samples were collected from all plots at silking. Total dry matter production was measured at physiological maturity. Whole plant samples were also collected at this time. The ear leaf samples were analyzed for N and S. The whole plant samples were analyzed for S, N, protein, ADF, and NDF. The NIR techniques were used to analyze for protein, ADF, and NDF.

Results and Discussion:

To date, use of fertilizer S has increased alfalfa yield only at the Staples location (Table 3). In 1985, a rate of 25 lb. S/acre nearly doubled production. The soil texture at the Staples site is a sandy loam and a response to fertilizer S would be expected when alfalfa is grown on this sandy soil. In both 1984 and 1986, an annual application of 25 lb. S/acre was sufficient to produce maximum yield.

Although quality measurements were made on alfalfa from all cuttings in this study, data from only the first cutting are summarized for this report (Table 4). Results from other cuttings were similar. In both 1984 and 1985, the use of fertilizer S had no significant effect on protein, ADF, and NDF content of the alfalfa tissue. Plant samples collected in 1986 had not yet been analyzed at the writing of this report.

The influence of fertilizer S on grain yield of corn is summarized in Table 5. As would be expected, the broadcast application of 20 lbs. S/acre produced a significant yield increase at Staples in 1984. Data from Staples in 1985 were quite variable. It is important to note that 10 lb. S/acre produced a significant increase in grain yield at the Goodhue County site in 1984 but not in 1985. The soil at both sites had a silt loam texture. There was, however, a major difference in the organic matter content. In 1985, the organic matter (3.6%) was apparently adequate to meet the S requirements of the corn crop.

A large amount of emphasis cannot be placed on the data from the 1984 Goodhue site at this time. Alfalfa growing on soils with similar organic matter values has not responded to broadcast S applications. Several sites with similar properties were selected for study in 1986 and grain yields had not been recorded at the time of this writing.

At the sites which responded to use of fertilizer S, the rate of S required to maximize yield was the same for all N rates (data not shown). Therefore, these results show that rate of fertilizer S does not have to be adjusted for the N rate used.

The effect of fertilizer S on the quality of corn silage harvested at physiological maturity has been inconsistent to date. At all locations, fertilizer S has had no significant effect on crude protein content (data not shown). The percentages of both ADF and NDF were reduced by S fertilization at the Goodhue County site in 1984. These reductions, although small, indicate some possible enhancement of the quality of corn silage by S fertilization. Additional data must be collected before definite conclusions can be made.

Summary:

It is not possible to make concrete conclusions from field data collected in 2 years of research. Nevertheless, there are some general statements that can be made. These are:

1. Use of fertilizer S improved yield of alfalfa grown on a sandy soil but had no significant effect on yield when alfalfa is grown on fine textured soils.

2. Application of S had no significant effect on the percentage of CP, ADF, and NDF in alfalfa tissue for all cuttings.

3. Use of S increased yield of corn grown on a sandy soil. The response at the Goodhue County site in 1984 is of special importance. Sulfur fertilization, however, had no significant effect on total dry matter produced.

4. The percentage of crude protein in corn tissue at physiological maturity was improved with N but not S fertilization.

5. Neither applied N nor S had a consistent effect on the percentage of both ADF and NDF in the tissue of corn at physiological maturity.

Table 1. Soil Properties (0-6 in.) for experimental sites where fertilizer S was applied to alfalfa.

Soil Property	Site and Year: Staples (84)	Winona Co. (84)	Goodhue Co. (85)	Goodhue (J) Co. (86)	Goodhue (P) Co. (86)	Staples (86)	Wabasha Co. (86)
pH	7.0	6.7	6.7	6.7	7.0	7.2	6.0
P, lb./acre (Bray & Kurtz #1)	77	26	40	69	64	81	25
K, lb./acre (1N $NH_4C_2H_3O_2$)	152	139	312	255	211	145	117
O.M., %	med.	low	3.1	2.2	2.4	2.3	3.0
SO_4-S, ppm	5.0	7.5	7.5	5.0	6.5	5.0	8.5

Table 2. Soil properties (0-6 in.) for experimental sites where fertilizer S was applied to corn.

Soil Property	Site and Year: Staples (84)	Goodhue Co. (84)	Staples (85)	Goodhue Co. (85)
pH	7.1	6.6	6.5	7.0
P, (lb./acre) (Bray & Kurtz #1)	91	56	52	147
K, (lb./acre) (1N $NH_4C_2H_3O_2$)	178	231	139	402
organic matter	med.	1.6	med.	3.6
SO_4-S	4.0	9.0	2.0	6.0

Table 3. Effect of rate of applied S on total alfalfa yield.

S Applied	Staples[1] (84)	Winona[2] (84)	Goodhue[3] Co. (85)	Goodhue (J)[2] Co. (86)	Goodhue (P)[2] Co. (86)	Staples[2] (86)	Wabasha[2] (86)
	Site and Year						
lb./acre	ton dry matter/acre						
0	3.0	4.2	5.2	4.1	4.6	2.6	4.5
25	3.7	4.0	5.4	4.2	4.8	4.5	4.4
50	3.5	4.1	5.0	4.3	5.0	4.6	4.6
75	3.6	4.2	5.5	4.3	5.0	4.7	4.4
100	3.5	4.0	5.3	4.0	4.7	4.6	4.6

[1] Total of 2 cuttings

[2] Total of 3 cuttings

[3] Total of 4 cuttings

Table 4. Effect of rate of applied S on the quality of 1st cutting alfalfa.

Location	Year	Measurement	S Applied (lb./acre) 0	25	50	75	100	C.V.
			%					
Staples	84	Protein	20.9	21.9	21.6	21.9	21.9	2.4
Staples	84	ADF	32.2	31.9	31.7	31.8	32.6	2.6
Staples	84	NDF	47.2	46.1	46.1	45.2	46.5	3.1
Winona Co.	84	Protein	24.4	24.2	24.0	24.1	24.1	3.3
Winona Co.	84	ADF	30.4	29.6	30.2	29.8	29.3	3.0
Winona Co.	84	NDF	42.1	42.1	41.7	41.2	41.0	3.6
Goodhue Co.	85	Protein	19.6	20.1	20.9	20.8	20.4	3.9
Goodhue Co.	85	ADF	31.6	31.8	30.0	30.1	31.7	4.1
Goodhue Co.	85	NDF	42.2	41.6	39.4	39.7	40.7	3.7

Table 5. Effect of rate of applied S on grain yield of corn.

S Applied	Site and Year			
	Staples (84)	Goodhue (84)	Staples (85)	Goodhue (85)
lb./acre	bu./acre			
0	122.4	154.7	89.9	119.9
10	132.4	166.7	89.8	120.6
20	137.8	165.3	91.6	126.6
40	128.6	168.9	102.0	123.3
PR>F	.06	.01	.11	.26
BLSD (.05)	12.7	7.5	-	-
C.V., %	12.1	6.5	11.1	8.3

PROCEEDINGS

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