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Forage

Beef Cattle

Soil

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LEGUMES REQUIRE SULFUR TO FIX NITROGEN

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SUMMARY

Sulfur is necessary for plant growth and development and has been shown to be deficient in most East Texas soils. With the current high cost of nitrogen, many producers are again thinking in terms of legumes as the major source of nitrogen for forage production. Sulfur increases the effectiveness of nitrogen fixing organisms. Clover with ample sulfur produced more forage which contained much more total nitrogen than plants stressed for sulfur. Ample sulfur was necessary to promote effective nitrogen fixing nodule production.

OBJECTIVES

To characterize the growth, nitrogen fixation, and nodulation characteristics of arrowleaf clover plants stressed for sulfur.

PROCEDURE

Arrowleaf clover was planted in a greenhouse on September 7, 1977 using two soils with an established sulfur deficiency. The soil was well fertilized with the major nutrients. Rates of sulfur used were 0, 5.6, 11.2, and 22.4 kg/ha (0, 5, 10, and 20 lbs/acre) applied as gypsum. Dry forage yield was measured at 54, 93, and 125 days after planting by clipping the same treatments three times. At the end of the third harvest roots were washed free of soil, nodules rated for size, and the actual number of nodules on the roots were counted.

RESULTS

The influence of sulfur on the forage produced is shown in Table 1. Note at the first harvest sufficient sulfur was available from any treatment to meet the needs of the clover. By the end of the second harvest enough sulfur has been removed until a growth response to each incremental amount of sulfur added is readily seen. At the third harvest time all sulfur has apparently been exhausted from the lowest rate since it is the same as the check receiving no sulfur. However, there is enough

residual sulfur left at the two higher application rates to give a growth response.

Forage production is influenced by soil type as shown in Table 2. The increases in forage production from sulfur additions is the same from one soil to the other, but the clover grown on Cuthbert soil yields more at any rate of applied sulfur than that grown on the Darco soil.

The nitrogen content of the forage produced is influenced differently by the sulfur rate used as the soil type changes (Table 3). Note at harvest #1 with the Darco soil, the nitrogen content of the sulfur blank (0 rate) is measurably higher than the highest sulfur rate. The most information concerning the influence of sulfur on the nitrogen content is at harvest #3 where the Darco soil shows no definite relation to sulfur rate. At harvest #3 the Cuthbert soil shows a decrease in nitrogen content with decreasing sulfur rates.

The ratings for effective nitrogen fixing nodules are shown in Table 4 and illustrate how the sulfur applications and soil type influence nitrogen fixation. The amount of effective nitrogen fixing nodules for Cuthbert soil (Table 4) almost parallels the nitrogen content at harvest #3 (Table 3). The total number of nodules is greater on the Darco soil (Table 4) but these were small and ineffective in nitrogen fixation.

The important overall measurement in nitrogen efficiency is the total nitrogen in the harvested plants. The total nitrogen in the harvested plants was found to increase directly with sulfur rate applied (Table 5). The Cuthbert soil was found to be higher than the Darco soil (Table 6) in the total amount of nitrogen contained in the harvested plants. This difference was found at all rates of sulfur applied.

Table 1. Dry forage production of arrowleaf clover fertilized with sulfur.

Sulfur Rate		Dry Forage Yield (g/pot)		
kg/ha	lbs/acre	Harvest #1	Harvest #2	Harvest #3
0	0	1.06 b†	1.50 d	0.67 c
5.6	5	2.07 a	1.91 c	0.69 c
11.2	10	1.98 a	2.22 b	0.90 b
22.4	20	1.89 a	2.49 a	1.13 a

†Numbers in columns followed by the same letter are not different at the 5% level according to Duncan's new multiple range test.

Table 2. Influence of soil type on dry forage yield of arrowleaf clover.

Soil Type	Forage Production (g/pot)		
	Harvest #1	Harvest #2	Harvest #3
Darco (sandy)	1.30 b†	1.83 b	0.81 a
Cuthbert (loamy)	2.20 a	2.23 a	0.89 a
Soil difference	0.90	0.40	0.08

†Numbers in columns followed by same letters are not different at the 5% level according to Duncan's new multiple range test.

Table 3. Nitrogen content of arrowleaf clover as influenced by sulfur rate and soil type.

Sulfur Rate		Harvest #1		Harvest #2		Harvest #3	
kg/ha	(lbs/ac)	Darco	Cuthbert	Darco	Cuthbert	Darco	Cuthbert
		%					
0	(0)	3.99 a†	3.26 cd	3.07 a	2.42 b	2.50 cd	1.80 e
5.6	(5)	3.72 abc	3.14 d	2.37 b	2.48 cd	2.73 bc	2.81 bc
11.2	(10)	3.84 ab	3.26 cd	2.49 b	2.83 ab	2.22 de	3.07 ab
22.4	(20)	3.40 bcd	3.05 d	3.09 a	2.92 ab	2.77 bc	3.38 a

†Numbers in same harvest followed by same letter are not different at the 5% level according to Duncan's new multiple range test.

Table 4. Arrowleaf clover nodule characteristics as influenced by sulfur rate and soil type.

Sulfur Rate		Rating for size of nodules		Actual number of nodules on roots of one plant	
kg/ha	(lbs/ac)	Darco	Cuthbert	Darco	Cuthbert
0	(0)	0.5 d†	0.9 cd	19 a	10 b
5.6	(5)	0.7 d	1.7 c	20 a	8 b
11.2	(10)	1.0 cd	2.7 b	20 a	10 b
22.4	(20)	1.4 cd	5.9 a	24 a	10 b

†Numbers followed by the same letter are not different at the 5% level according to Duncan's new multiple range test.

Table 5. Total nitrogen in harvested arrowleaf clover plants as influenced by sulfur rate.

Sulfur Rate kg/ha	Sulfur Rate (lbs/ac)	Harvest #1	Harvest #2	Harvest #3	Total in all Harvests
		mg N/pot			
0	(0)	36.1 b†	40.2 c	14.3 c	90.6 c
5.6	(5)	69.7 a	46.3 c	19.0 bc	135.1 b
11.2	(10)	69.4 a	59.1 b	23.9 b	152.4 ab
22.4	(20)	60.2 a	74.4 a	34.6 a	169.2 a

†Numbers in same harvest followed by same letter are not different at the 1% level according to Duncan's new multiple range test.

Table 6. Total nitrogen in harvested plants as influenced by soil type.

Soil Type	Harvest #1	Harvest #2	Harvest #3
	mg N/pot		
Darco (sandy)	48.2 b†	50.1 b	20.7 b
Cuthbert (loamy)	69.5 a	60.0 a	25.1 a
Soil difference	21.3	9.9	4.4

†Numbers in same harvest followed by same letter are not different at the 1% level according to Duncan's new multiple range test.