

Sulfur Fertilization on Cotton for Sandy Loam and Silt Loam Soils

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In recent years, reductions in sulfur emissions from coal-burning electric power facilities have reduced acid rain to streams and rivers. This has indirectly diminished a “free” supply of sulfur to agriculture. Sulfur is required for the formation of many proteins essential for plant growth. Leaf and petiole tissue testing in Missouri has shown sulfur deficiencies in wheat, rice, corn, and cotton fields with sandy soils. Sulfur deficiencies are more common in cold, wet growing seasons than hot, dry seasons. Soil sulfur is most available to plants in the sulfate form. Sulfate is negatively charged similar to nitrate and easy leaches from sandy soil. The primary supplier of sulfur to plants is soil organic matter mineralization. Since sandy soils often contain less organic matter than loamy soils, they usually have a lower potential for supplying crop S needs.

In 2003 and 2004, cotton fields were found on the Malden Ridge with light green and yellow leaves, which tested low in sulfur. Most soils on the Malden Ridge in Southeast Missouri are sandy. In 2004, supplies of ammonium sulfate fertilizer were scarce at mid-season when the S deficiencies were found. Fertilizer dealers had to transport ammonium sulfate by truck from West Virginia.

The objective of an experiment started in 2005 was to evaluate different forms of sulfur fertilizer and application rates on cotton in Southeast Missouri. Field experiments were conducted on a Tiptonville silt loam soil (1.5% organic matter, 15 meq/100g soil cation exchange capacity) at Portageville and a Malden fine sand soil (0.8% organic matter, 3.8 meq/100 g soil cation exchange capacity) at Clarkton, Missouri. The test site at Clarkton also contained a small area of Broseley loamy fine sand.

A randomized block design with four replications was used. Dry fertilizer materials were broadcast and incorporated before planting. Ammonium sulfate, agricultural elemental sulfur, gypsum (calcium sulfate), and Epsom Salt (magnesium sulfate) were evaluated at 0, 6, 12, and 18 lb S per acre. Two 10% S foliar ammonium sulfate liquid formulations were evaluated at 0.13, 0.26, and 1.0 lb S per acre. Sulfur Plus™ (10% S) is derived from ammonium sulfate in a proprietary organic complex (Delta Formulation, Greenville, Mississippi). Both were tank mixed with glyphosate herbicide and sprayed 20 gallons per acre at 3 to 4 true cotton leaf stage.

Sand texture was not consistent between all plots at Clarkton in 2005. A different field was selected in 2006 which helped increase uniformity in the experiment. Averaged across years, petiole S concentrations were lower on the Malden fine sand compared to the Tiptonville silt loam. This is due in part to the differences in organic matter between the two soils. Averaged across years, sulfur fertilization increased yields more effectively on the sand site compared to the loam (Figure 1). On sandy soil, cotton lint yields were highest when fertilized with S at 12 lb S per acre.

Petiole S content was also highest at 12 lb S per acre (Table 1). In a low supplying soil S condition, sulfur fertilization helps cotton plants utilize N more effectively because both elements are required to make proteins in leaves. Sometimes petiole N will increase to high levels in cotton plants if S is deficient. We found that S fertilizer decreased the N:S ratio in cotton plants on the Malden fine sand. Although each rate of sulfur fertilization produced a lower N:S ratio than the check, there was no difference between the ratios of the three application rates. Generally, no cotton yield increases were found

with N:S was less than 25. Epsom salt provided the highest petiole S content on the silt loam, although yields were not increased. On the Malden fine sand, Epsom salt produced the highest lint yield, as well as the second highest petiole S content (Table 2).

Table 1. Leaf greenness and petiole nitrogen and sulfur and cotton lint yield from rates of soil-applied sulfur averaged across types of fertilizer [ammonium sulfate, elemental sulfur, calcium sulfate (gypsum), and magnesium sulfate (Epsom salt)] on a Tiptonville silt loam at Portageville, Missouri and a Malden fine sand at Clarkton, Missouri in 2005 and 2006.

Preplant fertilizer lb S/acre	Tiptonville silt loam					Malden fine sand				
	Leaf green ¹	Petiole			Lint yield	Leaf green	Petiole			Lint yield
		N	S	N:S			N	S	N:S	
		-----ppm-----			lb/acre		-----ppm-----			lb/acre
0	44	16375	923	18	812	46	11913	316	39	671
6	45	16560	1215	16	800	50	11752	514	22	655
12	45	17282	1296	14	824	51	11330	524	21	759
18	45	17250	1312	14	824	50	10572	485	20	703

¹ Leaf greenness was read with a Minolta SPAD chlorophyll meter. Leaf and petiole measurements on the Tiptonville silt loam were made on July 22. Measurements on the Malden fine sand were made on August 10.

Table 2. Leaf greenness and petiole nitrogen and sulfur and cotton lint yield from sulfur fertilizers averaged across rates of sulfur on a Tiptonville silt loam at Portageville, Missouri and a Malden fine sand at Clarkton, Missouri in 2005 and 2006.

Fertilizer	Tiptonville silt loam					Malden fine sand				
	Leaf green ²	Petiole			Lint yield	Leaf green	Petiole			Lint yield
		N	S	N:S			N	S	N:S	
		-----ppm-----			lb/acre		-----ppm-----			lb/acre
Check	44	16375	923	18	858	46	11913	316	39	705
Am sulfate	45	17067	1291	15	855	50	11197	551	18	760
Elemental S	45	16429	1185	15	889	50	12290	414	27	730
Gypsum	45	16958	1300	15	879	50	10684	514	20	716
Epsom salt	44	17667	1322	15	824	50	10701	550	18	772
Am sulfate ¹	47	19917	836	24	872	48	4391	337	15	693
S Plus ^{TM 1}	46	17450	1310	17	863	49	10917	456	22	760

¹ Treatments were foliar-applied rates at 0.13, 0.26, and 1 lb S/acre in a tank-mix with glyphosate herbicide.

² Leaf greenness was read with a Minolta SPAD chlorophyll meter. Leaf and petiole measurements on the Tiptonville silt loam were made on July 22. Measurements on the Malden fine sand were made on August 10.

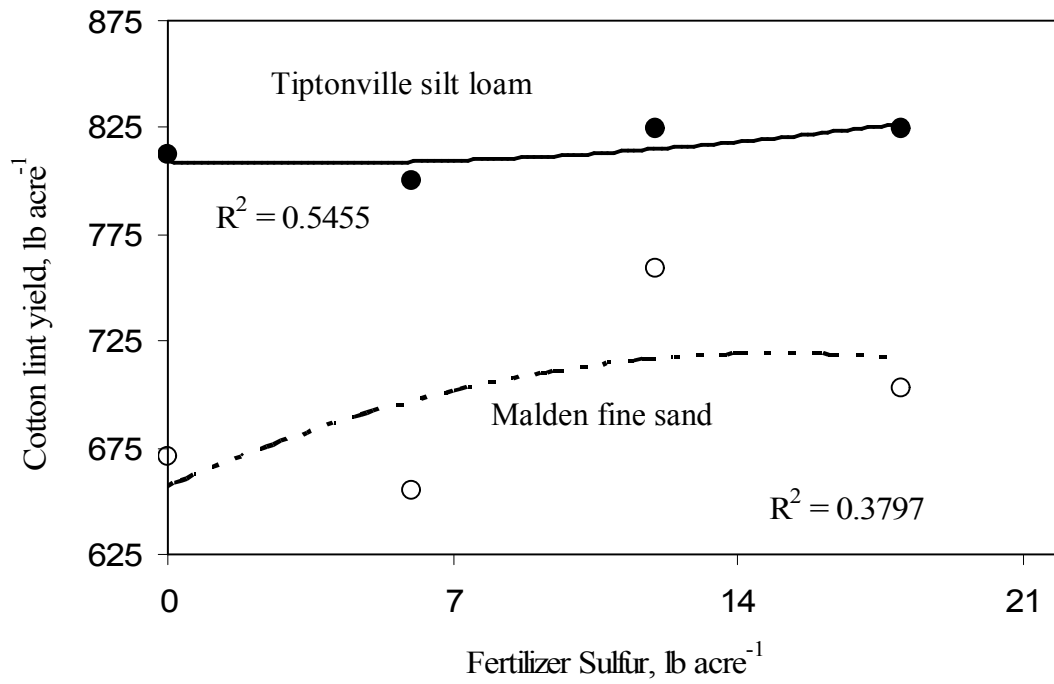


Figure 1. Effect of rate of soil applied sulfur averaged across years and types of fertilizer on cotton lint yield on silt loam and sandy loam soils.