Cotton Yield and Quality Responses to Sulfur Applications

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More attention needs to be paid to S requirements of no-till cotton in Tennessee and other cotton-producing states where S deficiencies may occur. Applying about 20 lb S per acre can increase lint yields and fiber micronaire of cotton on no-till fields with low S levels in Tennessee and similar environments.

Sulfur deficiencies in cotton have been observed more frequently in recent years due to increased use of S-free fertilizers, greater removal of S from soil by crops with higher yields, lower S deposits to soil from the atmosphere, and less use of S-containing pesticides. Crop-available S is relatively low in some Cotton Belt soils due to low soil organic matter and the high likelihood of sulfate leaching. Light-textured and well-drained soils are more likely to be S deficient. No-till fields may exhibit S deficiency at times when soil temperatures are low, limiting S mineralization from organic matter. Little information is available about S application effects on cotton yields and fiber quality of economic importance in Tennessee and other states in the Cotton Belt region.

Figure 1. Cotton plants fertilized without S (left) and 30 lb S per acre (right).

A replicated field trial was conducted on a non-irrigated Dexter loam soil in Jackson, TN during 2008-2010 to evaluate the effects of S on cotton lint yields and fiber properties under no-tillage. Initial soil test S levels in the top 6 in. were rated low according to A & L Laboratories, Memphis, TN. Four S application rates (i.e. 0, 10, 20, and 30 lb S/A as potassium sulfate) were broadcast to designated plots before cotton planting each year. All plots received 80 lb N and 120 lb K_2O per acre each year. The cotton cultivar was 'PHY375WRF'. Soil S content was measured using the Mehlich 3 method. Leaf blade samples were taken from the highest fully expanded main-stem leaves, usually three or four nodes from the terminal at early-bloom. Leaf samples were dried at 60°C for 72 hours and ground through a 2-mm screen. Leaf samples were digested using nitric acid and hydrogen peroxide, and the digest was analyzed for total S on an ICP. Relative lint yields were calculated using the following method in order to minimize the influences of year (due to weather conditions, etc.) on lint yields. The highest numeric value of yield among all treatments within each year was assumed to equal 100% yield for that year. The percentage values relative to this maximum value were calculated for the other treatments within that year. The relative lint yield averages over 2008-2010 were calculated based on the relative yields of these three individual years.

Sulfur Deficiency Symptoms in Cotton

Sulfur deficiency symptoms gradually appeared in the zero-S plots by about 40 days after planting each year. Plants without S fertilization showed classical S deficiency symptoms, such as pale green to yellow leaves in the upper part of plant, while 30 lb S/A treated plants grew normally **(Figure 1)**. These symptoms became less apparent as the crop grew larger and began to set fruit at about 70 days after planting.

Common abbreviations and notes: S = sulfur; N = nitrogen; K = potassium.

Table 1. Soil S content at mid-bloom as affected by S application rates.

S rate	2008	2009	2010	Average
lb/A		lb/A		
0	27b†	22a	36c	28c
10	26b	23a	39bc	29bc
20	27b	23a	40b	30b
30	31a	29a	45a	35a

†Values in each column followed by different letters are statistically different at $p = 0.05$.

In-Season Soil Test S Levels

In 2008, 30 lb S/A generated a higher soil test S level at mid bloom than the other three lower rates **(Table 1)**. In 2009, 30 lb S/A tended to increase soil S level, although the level was not statistically different from the other S rates. In 2010, 20 and 30 lb S/A resulted in higher soil S compared to zero S. The 3-year average soil test S level at mid-bloom was 25% higher with 30 lb S/A than zero S fertilization. Soil test S was higher in 2010 than in 2008 and 2009, reflecting the positive effects of higher temperatures during the 2010 summer on S release from soil organic matter.

Leaf S Concentrations

Leaf S concentrations at early-bloom were consistently affected by S applications in all 3 years (**Table 2**). The 20 and 30 lb S/A rates had higher leaf S levels than zero S each year. On average, leaf S concentrations were statistically different among the four S rates with 30 lb S/A having the highest leaf

Table 2. Leaf S concentrations at early-bloom as affected by S application rates.

S rate	2008	2009	2010	Average
lb/A	- - - - - - - - - - - - - - - -	%	- - - - - - - - - - - - - - - -	
0	0.28b†	0.31b	0.23d	0.27d
10	0.31b	0.37b	0.31c	0.33c
20	0.35a	0.43ab	0.37b	0.38b
30	0.38a	0.45a	0.40a	0.41a

†Values in each column followed by different letters are statistically different at p = 0.05.

Table 3. Lint yields at harvest as affected by S application rates.

S rate	2008	2009	2010	Average
lb/A	- - - - - - - - - - - - - - - -	lb/A	- - - - - - - - - - - - - - - -	
0	2,083b†	1,280a	1,602a	1,655b
10	2,160ab	1,307a	1,728a	1,731ab
20	2,221a	1,413a	1,729a	1,788a
30	2,253a	1,388a	1,757a	1,799a

†Values in each column followed by different letters are statistically different at p = 0.05.

Table 4. Fiber micronaire at harvest as affected by S application rates.

S rate	2008	2009	2010	Average
lb/A				
0	4.32a†	3.53a	4.62b	4.16b
10	4.47a	3.65a	4.85a	4.32a
20	4.50a	3.65a	4.82a	4.32a
30	4.54a	3.70a	4.83a	4.36a

†Values in each column followed by different letters are statistically different at p = 0.05.

S level. Sulfur concentrations ranging from 0.25 to 0.80% in the youngest mature leaf blade are considered sufficient for cotton at early bloom in the southern United States (SAAESD, 2009). According to this criterion, leaf S concentration was not sufficient under zero S in 2010; while all other leaf S concentrations were sufficient regardless of S application rate and year in this trial.

Lint Yields

In 2008, application of 20 or 30 lb S/A increased lint yields by 7 to 8% compared to zero S **(Table 3)**. In 2009, lint yield response to S applications was nearly significant (p = 0.054). Lint yields tended to increase in 2010, although differences were not statistically significant among S applications rates. It appears that high temperatures during the summer of 2010 may have decreased the cotton response to S application. Averaged over the three seasons, applying 20 or 30 lb S/A increased lint yields by 8 to 9% over zero S. The response bar graph of relative lint yields on 3-year averages to S application rates visually shows a quadratic plateau relationship between lint yields and S application rates **(Figure 2)**.

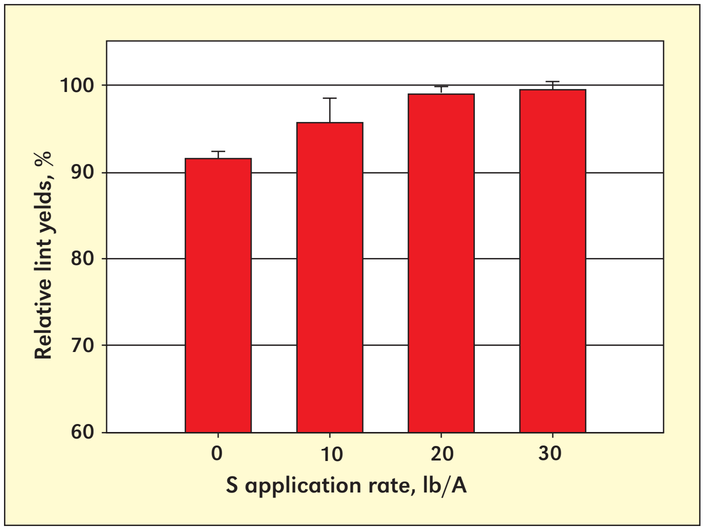

Figure 2. Responses of relative lint yields to S application rates on 3-year averages (2008-2010) at Jackson, TN. The error bars show the standard deviations for relative lint yield averages.

Fiber Quality

Fiber micronaire responded to S applications in 1 out of 3 years **(Table 4)**. The S applications produced 4 to 5% increases in micronaire compared to zero S in 2010. When the 3-year results were combined, application of 10, 20, or 30 lb S/A increased micronaire by 4 to 5% relative to zero S. However, other fiber quality properties including length, uniformity, strength, and elongation were not affected by S applications (data not shown).

Summary

Applying about 20 lb S/A can increase lint yields and fiber micronaire of cotton on no-till fields with low S levels in Tennessee and similar environments. More attention needs to be paid to potential S requirements of no-till cotton in Tennessee and other cotton producing states where S deficiencies may become more common due to increased use of low-S fertilizers, adoption of high yielding cultivars, more intensive cropping systems, and lower atmospheric S deposits. BC

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Reference

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