Sulfur Effects on Cotton Yield Components

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Little is known about the effects of S deficiency on cotton yield components. In container-grown cotton, S deficiency reduced seedcotton weight and the number of bolls per plant, leaving a greater proportion of bolls at first-position fruiting sites.

Soil available S is generally low in the Cotton Belt region due to the hot and humid climate and high likelihood of sulfate leaching. Increased use of S-free fertilizers, greater S removal from soil by crops with higher yields, less S deposition to soil from the atmosphere, and decreased use of S-containing pesticides have contributed to more S deficiencies in crops during recent years. Little is known about the effects of S deficiency on cotton yield components, and there are few guidelines available about S fertilization to optimize cotton production in Tennessee and other states in the Cotton Belt region.

A container-grown cotton study was conducted at Jackson, TN during 2008 to 2010 to examine the effects of S deficiency on cotton yield components. Cotton cultivar 'PHY375WRF' was planted each year in 15 gallon pots placed outdoors. The rooting medium was a blend of Fafard 2-B and 3-B mixes in 2008 and Fafard 2-B mix in 2009 and 2010 (BWI Companies, Memphis, Tennessee).

Container-grown cotton plants receiving low and high rates of S fertilization. Plants under low S treatment are in the foreground; plants under high S treatment are in the background.

Two S treatments, consisting of low and high S concentrations in solution, were applied to the pots by drip irrigation each year. The low S concentration treatment supplied 0 ppm S in 2008 and 1 ppm S in 2009 and 2010 as potassium sulfate. The high S concentration treatment supplied 20 ppm S in the irrigation solution each year. Six replications of the S treatments were applied on a 3-day interval from pre-square to early bloom growth stage each season. The differential nutrition phase of the experiment was followed by a recovery phase in which the high-S treatment was applied to all plants. Adequate amounts of other essential nutrients were supplied to all plants throughout the season. Leaf blade samples were taken from the highest fully expanded main-stem leaves, usually three or four nodes from the terminal at early-bloom and late bloom.

Sulfur Deficiency Symptoms

Classical S deficiency symptoms began to appear in low S concentration-treated plants at about 10 days after treatment began each year (see Photo). Symptoms became more severe until the recovery phase of the trial started, during which the S-deficient plants produced new vegetative growth in response to the restoration of S nutrition. Plants under the high S concentration treatment grew normally.

Leaf Nutrient Concentrations

The low S treatment significantly reduced S concentrations in leaves at early bloom compared to the high S treatment during the differential nutrition phase of the study in all 3 years (**Table 1**). However, as S nutrition was restored during the recovery phase, leaf S concentrations were not significantly different between the two treatments at late bloom in any year. This result was expected because the low S treated plants had been fed with adequate S for several weeks before the later sampling date.

Table 1. Sulfur effects on leaf S concentrations at early and late bloom stages.

Growth stage	Year	Low S	High S
		---------- % ----------	
Early bloom	2008	0.08b	0.17a
	2009	0.08b	0.23a
	2010	0.14b	0.16a
	Average	0.10b	0.19a
Late bloom	2008	0.41a	0.34a
	2009	0.27a	0.30a
	2010	0.27a	0.26a
	Average	0.32a	0.30a

Values in each row followed by a different letter are statistically different at p = 0.05.

The low S treatment had higher N, P, K, Ca, and Mg concentrations in leaves than the high S treatment during the differential nutrition phase on the 3-year averages (**Table 2**). One possible explanation for the higher concentrations of these nutrients in leaves with the low S treatment is that the low S-treated plants grew more slowly than those receiving high S, reducing the effect of nutrient dilution due to plant growth.

Common abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; Ca = calcium; Mg = magnesium; S = sulfur; ppm = parts per million.

Table 2. Sulfur effects on leaf N, P, K, Ca, and Mg concentrations at early bloom (3-year averages).

	- - - - - - - - - - - - - Concentration in leaf, % - - - - - - - - - - - - -				
S treatment	N	P	K	Ca	Mg
Low	4.46a*	0.69a	2.81a	2.01a	0.51a
High	3.46b	0.32b	1.76b	0.88b	0.39b

Values in each column followed by a different letter are statistically different at p = 0.05.

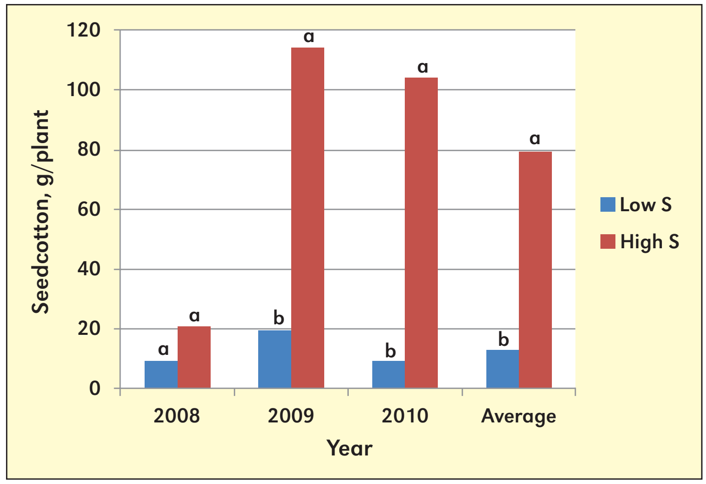

Figure 1. Sulfur effects on seedcotton yield. Values in each year or average followed by a different letter are statistically different at p = 0.05.

Seedcotton Yields and Yield Components

Seedcotton weight per plant on sympodial branches was significantly reduced under the low S treatment in 2009 and 2010 and on the 3-year averages (**Figure 1**). Seedcotton weight per boll of sympodial branches was also significantly decreased in the low S treatment averaged over the 3 years (**Table 3**).

The low S treatment significantly reduced the total number of harvestable bolls per plant on the 3-year averages (**Table 3**). The low S treatment produced a higher percentage of first-position bolls than the high S treatment averaged over the 3 years. These results suggest that S deficiency affected distal bolls more severely than first-position bolls.

On the 3-year averages, the low S treatment significantly reduced the number of locules per boll (**Table 3**). However, the number of seeds per locule or the first position fuzzy seed index was not affected by S treatment when the 3-year results were combined (**Table 3**). The lack of treatment effects on fuzzy seed index was noteworthy, given the role of S as an amino acid component in cotton seed.

Summary

Low S treatment induced visible S deficiency symptoms and reduced leaf S concentrations, but leaf concentrations of other nutrients usually were higher in S-deficient plants. Sulfur deficiency reduced seedcotton weight per boll and per plant, averaged over the 3 years. Sulfur deficient plants usually produced fewer bolls per plant, with a greater proportion of bolls at first-position fruiting sites. Sulfur deficiency also reduced locules per boll on a 3-year average. Results indicate that several cotton yield components may be adversely affected by S deficiency during early growth stages, even if adequate S nutrition is restored later in the season. BC

Table 3. Sulfur effects on yield components of sympodial branch bolls (3-year averages).

Treatment	Seedcotton, g/boll	Bolls/ plant	Bolls at first position, %	Locules/ boll	Seeds/ locule	Seed index, g/100 seeds
Low S	2.6b	4.9b	70.6a	3.4b	4.9a	9.0a
High S	3.7a	19.1a	37.0b	4.0a	4.8a	9.8a

Values in each column followed by a different letter are statistically different at p = 0.05.

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