RESPONSE OF DRYLAND AND IRRIGATED COTTON TO POTASSIUM FERTILIZATION

Dennis L. Coker, Derrick M. Oosterhuis, and Robert S. Brown[1]

RESEARCH PROBLEM

Cotton (*Gossypium hirsutum* L.) fiber yield and fiber elongation, strength, and micronaire depend on properly managed potassium (K) nutrition. Widespread K deficiencies have been noted in Arkansas beginning at first flower and persisting as the developing bolls exert a greater demand on plant K resources. Information is lacking about the management details of K fertilization practices for maximum production profitability when water is limiting under irrigated or rainfed systems. The principal objective for this study was to evaluate the effect of water-deficit stress and K deficiency on the final yield components of field-grown cotton.

BACKGROUND INFORMATION

Modern cotton cultivars have greater total K requirements compared to earlier cultivars and the K uptake window to satisfy those requirements has been compressed (Varco, 2000). Factors that interfere with the strong source-sink relationship of K in cotton will directly influence the efficiency of K use and the potential for high lint yields (Oosterhuis, 1995). Although K may be taken up in luxury amounts by the cotton plant prior to peak demand, K deficiencies may occur late in the growing season when the large developing boll load becomes the dominant sink for available K. Yield and economic advantages have been realized by timely foliar applications of K to supplement soil-applied K and to correct K deficiencies (Oosterhuis, 1999). Field studies conducted over a five-year period on foliar K fertilization of irrigated cotton showed that the maximum yield benefit occurred from applications made between one and three weeks after first bloom (Weir, 1999). However, the impact of mid-season water-deficit stress on the efficiency of foliar K uptake and yield response to foliar K feeding remains unclear.

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[1] Research specialist, distinguished professor, and research assistant, Crop, Soil, and Environmental Sciences Department, Fayetteville.

RESEARCH DESCRIPTION

Cotton growth, K partitioning, and lint yield under limited water and K inputs were studied in 1999 in a field environment at Rohwer (Coker and Oosterhuis, 1999) and in 2000 at Clarkedale and Rohwer (Coker and Oosterhuis, 2000). The following information reflects the same study continued in 2001 at Clarkedale. Eight treatment combinations of well-watered (W) or dryland (D) conditions, high soil-K (H) or low soil-K (L), and with foliar-applied K (F) or without foliar-applied K (N) were arranged in a split-split plot design with five replications. Each plot consisted of four rows 50 ft long at Clarkedale, spaced 38 inches apart. At Clarkedale, cultivar Suregrow 747 was planted into a well-drained Calloway silt loam on 9 May 2001. Preplant granular KCl fertilizer was hand broadcast to designated plots at Clarkedale on 26 April according to University of Arkansas soil test recommendations (Sabbe, 1998). Foliar KNO_3 was applied for four consecutive weeks starting one week after first flower with a CO_2-pressurized backpack sprayer. Beginning at the pinhead square (PS) stage, the water status of the soil profile in each plot was monitored using screen-cage thermocouple psychrometers buried at a depth of 24-cm. The plant-water status of all treatments was monitored using end-window thermocouple psychrometers starting at PS. Growth, dry matter, photosynthesis, and K concentration in organ tissues were measured at key phenological stages [PS, first flower (FF), first flower + 3 weeks (FF+3), and first flower + 5 weeks (FF+5)]. Final lint yield and components of yield were determined by mechanically harvesting the two center rows of each plot and also by hand-picking a 1-m length of each of two yield rows and counting the number of bolls.

RESULTS

Lint yields were numerically greater from all treatment combinations compared to the previous season at Clarkedale (Table 1). Rainfall amounts were greater and more evenly dispersed throughout the boll development stage compared to the previous season at Clarkedale and likely contributed most to the observed yield differences.

Overall, the trends in cotton yield response to soil-applied or foliar-applied K in 2001 were similar to previous seasons at either Rohwer or Clarkedale. Foliar K had no significant ($p \leq 0.05$) effect on lint yield under either level of soil K and well-watered or dryland conditions in 2001 at Clarkedale. However, we did observe a 4.5% increase in lint yield, across both locations and three seasons, in response to foliar-applied K under low soil-K, but not high soil-K conditions. Lint yield tended to increase numerically in response to foliar-applied K under irrigated or dryland conditions in 2001 at Clarkedale. We did not observe any noticeable differences between irrigated or dryland lint yield response to application of foliar-K from an average across the two locations and three seasons. Lint yield response to soil-applied K tended to be slightly negative under dryland conditions but numerically positive under irrigated conditions at Clarkedale in 2001. Across both locations and three growing seasons, soil-applied K increased the mean lint yield by 5% under well-watered conditions and decreased lint yield by 3% under dryland conditions.

PRACTICAL APPLICATION

The 2001 growing season seemed to contrast with the previous two seasons in which extreme hot and dry conditions throughout the peak boll-filling stage appeared to limit gains in lint yield from foliar-K feeding under well-watered or dryland conditions. At Rohwer, lint yield did not respond to foliar K under either water regime where upper-medium to high soil-K levels were measured at planting. At Clarkedale, soil-K resources fell into the marginal to medium range of existing recommendations and foliar-K added to lint yield under dryland or well-watered conditions, particularly in plots where no K was applied to the soil.

Thus far, our studies have shown that the preplant soil-K status should be strongly considered when making decisions about foliar-K fertilization and that response to foliar-K feeding will differ little between irrigated and dryland cotton. Lint yield significantly improved in response to added soil-K at Rohwer under well-watered conditions during the 2000 season and there was a trend for numerically higher lint yield in response to soil-applied K under irrigated conditions for other seasons and locations. However, under dryland conditions there has not been a noticeable response to soil-applied K across seasons and locations. Therefore, it appears that use of preplant soil-applied K may be particularly important for maximum economic yield from cotton under irrigated conditions, and the use of foliar-applied K (supplementing soil-K resources) can be equally beneficial to cotton lint yield under dryland or irrigated conditions in the Mississippi Delta region of Arkansas.

ACKNOWLEDGMENTS

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Table 1. Mean lint yield response of field-grown cultivar 'SG 125' over two seasons and cultivar 'SG 747' from one season to mid-season foliar K and preplant soil-applied K averaged over the water, soil-K, and foliar-K treatments, respectively. Rohwer, 1999 and 2000; Clarkedale, 2000 and 2001.

	Lint yield					
	Rohwer		Clarkedale			
Treatment	1999	2000	2000	2001	Mean	Change
	----------	----------	(lb/A^{-1})	----------	----------	[lb/A (%)]
Avg. over water[z]						
High soil-K, no foliar-K	1135	1123	948	1359	1141	
High soil-K, with foliar-K	1133	1116	956	1342	1137	none
Low soil-K, no foliar-K	1113	1088	887	1287	1094	
Low soil-K, with foliar-K	1153	1074	985[y]	1359	1143	+49(4.5%)
Avg. over soil-K[z]						
Well-watered, no foliar-K	1366	1452	1241	1434	1373	
Well-watered, with foliar-K	1394	1448	1292	1446	1395	+22(1.6%)
Dryland, no foliar-K	882	758	593	1212	861	
Dryland, with foliar-K	894	742	649	1255	885	+24(2.8%)
Avg. over water and soil-K						
No foliar-K	1126	1105	917	1323	1118	
With foliar-K	1143	1094	970	1350	1139	+21(2%)
Avg. over foliar-K						
Dryland, high soil-K	847	724	640	1228	860	
Dryland, low soil-K	929	776	602	1239	887	-27(3%)
Well-watered, high soil-K	1421	1514	1264	1473	1418	
Well-watered, low soil-K	1338	1386[y]	1269	1407	1350	+68(5%)
Water X soil-K	–[x]	–[x]	–[w]	–[w]		
Avg. over water and foliar-K						
High soil-K	1134	1119	952	1350	1139	
Low soil-K	1133	1081	936	1323	1118	+21(1.9%)

[z] No significant ($p \leq 0.05$) interactions observed between main effects.
[y] Significant at $p \leq 0.05$ for the paired treatments.
[x] Significant at $p \leq 0.05$ for treatment interaction.
[w] No interaction.