



FIELD EVALUATION OF FOLIAR-APPLIED FERTILIZERS ON THE GROWTH AND YIELD OF COTTON

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RESEARCH PROBLEM

Proper plant nutrition for optimal crop productivity in cotton requires that nutrient deficiencies be avoided. However, nutrient deficiencies often occur for a variety of reasons, most of which can be rectified by timely application of the deficient nutrient. In crop production, this usually entails a soil application prior to planting, or foliar applications may be appropriate after canopy closure or when a specific nutrient is urgently required. Foliar fertilization may lead to less concern about ground- and surface-water contamination, with nitrates in particular, and less scrutiny of the use of commercial fertilizers. This is particularly important because of current attention being focused on environmental protection. The increased use of foliar fertilizers in cotton production in the last decade is due in part to changes in production philosophy. The change to cotton cultivars which fruit in a shorter period of time and mature earlier has placed greater emphasis on understanding plant uptake and utilization of nutrients. Current crop monitoring techniques also focus attention on plant development and make it easier to combine concomitant foliar fertilization because of the large number of aerial applications that are already made for pest control. There is, however, only a limited understanding of foliar fertilizer use by the cotton plant and the effect on the physiology of the cotton plant has not been clearly documented. The objective of this study was to evaluate the benefits and effect of foliar-applied fertilizers on mid-season petiole nutrient concentrations, growth, and yield of field-grown cotton.

BACKGROUND INFORMATION

Due to its indeterminate growth and sympodial fruiting habit, cotton (*Gossypium hirsutum* L.) is very responsive to nitrogen (N) and potassium (K) fertility manage-

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ment. Nitrogen is used in large quantities throughout the life cycle of the cotton plant (Bassett et al., 1970), but difficulties arise in maintaining an adequate balanced supply during the vegetative and reproductive stages of growth. Oosterhuis (1999) concluded that this was partly due to the decreasing ability of the root system to meet the increasing requirements of the developing boll load. Cotton-fiber yield and fiber elongation, strength, and micronaire depend on properly managed K and boron (B) 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. Yield and economic advantages have been realized by timely foliar applications of K to supplement soil-applied K and to correct K deficiencies (Coker and Oosterhuis, 2000; Weir, 1999).

RESEARCH DESCRIPTION

Currently available commercial fertilizers were tested in two field experiments. The studies were planted into a Calloway silt loam at the Delta Branch Station, Clarkedale, in northeast Arkansas. Treatments in both studies consisted of (1) a control with no added foliar fertilizer, and (2) individual foliar fertilizers or plant growth regulator (mepiquat chloride) applied according to recommended rates. The foliar applications were applied with a CO₂ backpack sprayer in 10 gallons of water starting at pinhead square or first flower and continued at 2, 3, and 4 weeks after first flower. The experimental design for either study was a randomized complete block with 6 replications. Cotton cv. Suregrow 747 was planted on 9 May at approximately 55,000 seed/acre. Two weeks after planting, all plots were thinned to a uniform plant population of 3 plants/row foot. The plot size consisted of four 38-inch rows, each 50 feet long. Pre- and post-plant fertilization, irrigation, weed control, and insect control were managed according to current University of Arkansas recommendations.

Petioles were sampled and analyzed at the University of Arkansas Agricultural Diagnostic Laboratory at Fayetteville to follow the effects of the foliar fertilizers. Components of yield were determined at harvest by hand-sampling the bolls from two meters of row from the two center rows of each plot. Lint yield was determined by mechanically harvesting the two center rows of each plot at 60% open boll. Fiber quality (HVI) was determined using 120 g of sub-sampled lint from the hand-harvested bolls.

RESULTS AND DISCUSSION

Lint Yield and Fiber Quality (Supplemental N, K Study)

Treatment comparisons of open boll number, boll weight, gin turnout, and lint yield did not show clear trends or significant differences ($P=0.05$) (Table 1). Previous studies have shown that foliar-applied N fertilizers did not consistently improve cotton

yields depending on how favorable the seasonal growing conditions were (Oosterhuis and Gomez, 2001). Other studies have shown that the beneficial effect on lint yield from mid-season foliar-applied N and K fertilizers appear to be governed primarily by soil nutrient availability (McConnell et al., 1999; Coker and Oosterhuis, 2000) and fruit load (Oosterhuis and Bondada, 2001). Fiber micronaire, strength, length, uniformity, and elongation from the untreated check were not significantly ($P=0.05$) different compared to the foliar-applied urea, Tricert, Agri-Gro, Helena Chemical products, or KNO_3 (Table 2).

Petiole Nutrients (Supplemental N, K Study)

We found considerable variation between replications and between treatments for the level of petiole nutrients at three (Table 3) and five weeks (Table 4) after first flower. Petiole P concentration was significantly ($P=0.05$) higher in response to foliar-applied Tricert-K compared to the control at three weeks after first flower. Petiole K and S concentrations tended to be numerically greater following one application of Tricert-K versus the control and were significantly higher ($P=0.05$) compared to the P concentration in petioles collected from the urea treated plots. At five weeks after first flower, petiole P, K, and S concentrations were higher ($P=0.05$) following three applications of Tricert-K compared to the untreated check. These observations gave us indication that the plant canopy was effectively absorbing the foliar-applied Tricert-K product thereby raising the potential to increase yield by maintaining an adequate supply of nutrients for the rapidly developing boll load.

Lint Yield and Fiber Quality (Supplemental Foliar Nutrient Study)

We did not observe significant differences ($P=0.05$) in open boll number, boll weight, gin turnout, and lint yield between the non-treated control plots and those that received mid-season applications of foliar-applied LOAD (Stoller Enterprises, Inc., 7% B and 0.004% Mo) or mepiquat chloride (Table 5). This lack of yield response to our supplemental, mid-season B product could be explained in part by the high levels of B shown in the pre-season soil test analysis, ie. 1.9 lb. B/acre. As with the 2001 supplemental N and K study, fiber micronaire, strength, length, and uniformity from the untreated check were not significantly ($P=0.05$) different compared to the foliar-applied LOAD products or mepiquat chloride (Table 6).

PRACTICAL APPLICATION

The primary objective of our studies was to evaluate the benefit from supplemental foliar-applied N, K, and B fertilizers on cotton lint yield and fiber quality. Overall, lint yield and fiber quality did not respond significantly to our supplemental foliar fertilizers or mepiquat chloride applied during the 2001 growing season. This was partly due

to near sufficient levels of nutrients for irrigated cotton in our soils at planting time. Rainfall amounts during the 2001 growing season were more frequent throughout the boll development stage, compared to the previous two seasons at Clarkedale (see page 12); therefore, favorable weather reduced plant stress during the boll development period. Very light mid-season insect pressure also helped to minimize plant stress as well as aiding greater square and boll retention.

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Table 1. Yield component response of furrow-irrigated, field-grown cotton cv. 'SG 747' to foliar fertilizer sprays applied at pinhead square (PS) or 2, 3, and 4 weeks after first flower (FF). Clarkedale, 2001.

Treatment	Components of yield			
	Open bolls (# m ⁻²)	Boll weight (g boll ⁻¹)	Gin turnout (%)	Lint yield (lb acre ⁻¹)
Control	88 abc ^z	4.57 ab	41.1 a	1541 a
Urea (23-0-0), 1.1 gal/A @ FF+2,3, and 4 weeks	87 abc	4.73 ab	41.1 a	1522 a
Urea (23-0-0), 1.1 gal/A + Agrotain ^y @ FF+ 2,3, and 4 weeks	90 abc	4.69 ab	40.8 ab	1516 a
Urea (23-0-0), 4.4 gal/A + Agrotain @ FF+ 2,3, and 4 weeks	85 bc	4.69 ab	41.4 a	1524 a
Trisert CB (26-0-0), 1 gal/A @ FF+2,3, and 4 weeks	95 a	4.5 b	39.8 b	1505 a
Trisert CB (26-0-0), 1gal/A + Agrotain @ FF+ 2,3, and 4 weeks	82 c	4.88 a	40.7 ab	1544 a
Agri-Gro, 32 oz/A @ FF+ 2,3, and 4 weeks	89 abc	4.51 b	40.2 ab	1531 a
HM9951, 1 qt/A @ PS	85 bc	4.85 ab	40.7 ab	1588 a
HM9849, 2 qt/A @ PS	85 bc	4.63 ab	40.7 ab	1525 a
KNO ₃ , 10 lb prod./A @ FF+2,3, and 4 weeks	92 ab	4.55 ab	40.4 ab	1524 a
Trisert-K (5-0-20-13S), 2 gal/A @ FF+2,3, and 4 weeks	86 bc	4.76 ab	40.2 ab	1511 a
LSD _(0.05)	8	0.36	1.3	NS ^x

^z Numbers followed by the same letter within a column are not significantly (P=0.05) different.

^y 0.14% ai of urea applied.

^x NS = non significant (P=0.05).

Table 2. Fiber quality (HVI) response of furrow-irrigated, field-grown cotton cv. 'SG 747' to foliar fertilizer sprays applied at pinhead square (PS) or 2, 3, and 4 weeks after first flower (FF). Clarkedale, 2001.

Treatment	Fiber quality				
	Micronaire	Strength (g tex ⁻¹)	Length (in)	Uniformity (%)	Elongation (%)
Control	4.15 ab ^z	29.4 ab	1.14 a	83.9 ab	8.48 ab
Urea (23-0-0), 1.1 gal/A @ FF+2,3, and 4 weeks	4.15 ab	28.8 abc	1.12 ab	83.6 ab	8.23 b
Urea (23-0-0), 1.1 gal/A + Agrotain ^y @ FF+ 2,3, and 4 weeks	4.22 a	29.5 a	1.13 ab	84.3 a	8.32 ab
Urea (23-0-0), 4.4 gal/A + Agrotain @ FF+ 2,3, and 4 weeks	3.88 bc	29.1 abc	1.15 a	83.9 ab	8.47 ab
Trisert CB (26-0-0), 1 gal/A @ FF+2,3, and 4 weeks	3.78 c	27.9 c	1.13 ab	83.5 ab	8.37 ab
Trisert CB (26-0-0), 1gal/A + Agrotain @ FF+2,3, and 4 weeks	4.03 abc	28.9 abc	1.14 ab	84.0 a	8.40 ab
Agri-Gro, 32 oz/A @ FF+2,3, and 4 weeks	3.85 bc	28.1 bc	1.11 b	82.9 b	8.48 ab
HM9951, 1 qt/A @ PS	4.12 ab	28.9 abc	1.14 a	83.8 ab	8.45 ab
HM9849, 2 qt/A @ PS	4.25 a	29.3 abc	1.15 a	83.9 ab	8.55 a
KNO ₃ , 10 lb prod./A @ FF+2,3, and 4 weeks	3.93 abc	28.7 abc	1.13 ab	83.7 ab	8.45 ab
Trisert-K (5-0-20-13S), 2 gal/A @ FF+2,3, and 4 weeks	3.78 c	28.7 abc	1.14 ab	83.9 ab	8.40 ab
LSD _(0.05)	0.33	1.4	0.03	1.05	0.31

^z Numbers followed by the same letter within a column are not significantly (P=0.05) different.

^y 0.14% ai of urea applied.

Table 3. Petiole nutrient concentration at first flower plus three weeks (FF3) of furrow-irrigated, field-grown cotton cv. 'SG 747' that received foliar fertilizer sprays at pinhead square (PS) or 2, 3, and 4 weeks after first flower (FF). Clarkedale, 2001.

Treatment	FF3 petiole nutrient concentration			
	NO ₃ -N ($\mu\text{g g}^{-2}$)	P ($\mu\text{g g}^{-2}$)	K (mg g^{-1})	S ($\mu\text{g g}^{-2}$)
Control	9397 a ^z	4591 b	49.8 bc	1662 a
Urea (23-0-0), 1.1 gal/A @ FF2, 3, and 4 weeks	8115 ab	4698 b	47.3 c	1413 bc
Urea (23-0-0), 1.1 gal/A + Agrotain ^y @ FF2, 3, and 4 weeks	6983 ab	4892 ab	47.7 c	1394 c
Urea (23-0-0), 4.4 gal/A + Agrotain @ FF2, 3, and 4 weeks	5355 b	5151 ab	49.8 bc	1407 bc
Trisert CB (26-0-0), 1 gal/A @ FF2, 3, and 4 weeks	9241 a	4935 ab	50.7 abc	1614 ab
Trisert CB (26-0-0), 1gal/A + Agrotain @ FF2, 3, and 4 weeks	9429 a	4917 ab	54.8 ab	1639 a
Agri-Gro, 32 oz/A @ FF2, 3, and 4 weeks	8552 ab	5037 ab	54.5 ab	1630 a
HM9951, 1 qt/A @ PS	9485 a	4797 ab	55.8 ab	1705 a
HM9849, 2 qt/A @ PS	8652 ab	5017 ab	56.7 a	1585 abc
KNO ₃ , 10 lb prod./A @ FF2, 3, and 4 weeks	8929 a	4714 b	50.0 abc	1550 abc
Trisert-K (5-0-20-13S), 2 gal/A @ FF2, 3, and 4 weeks	9059 a	5414 a	55.0 ab	1755 a
LSD _(0.05)	3392	619	6.7	210

^z Numbers followed by the same letter within a column are not significantly (P=0.05) different.

^y 0.14% ai of urea applied.

Table 4. Petiole nutrient concentration at first flower plus five weeks (FF5) of furrow-irrigated, field-grown cotton cv. 'SG 747' that received foliar fertilizer sprays at pinhead square (PS) or 2, 3, and 4 weeks after first flower (FF). Clarkedale, 2001.

Treatment	FF5 petiole nutrient concentration			
	NO ₃ -N (µg g ⁻²)	P (µg g ⁻²)	K (mg g ⁻¹)	S (µg g ⁻²)
Control	9397 a ^z	4591 b	49.8 bc	1662 a
Control	1256 a ^z	1520 b	22.8 de	1064 b
Urea (23-0-0), 1.1 gal/A @ FF2, 3, and 4 weeks	1154 a	1877 ab	24.8 bdce	941 b
Urea (23-0-0), 1.1 gal/A + Agrotain ^y @ FF2, 3, and 4 weeks	871 a	1974 ab	24.0 cde	933 b
Urea (23-0-0), 4.4 gal/A + Agrotain @ FF2, 3, and 4 weeks	1018 a	1777 b	28.8 ab	943 b
Trisert CB (26-0-0), 1 gal/A @ FF2, 3, and 4 weeks	1274 a	1738 b	22.3 e	960 b
Trisert CB (26-0-0), 1gal/A + Agrotain @ FF2, 3, and 4 weeks	1188 a	1854 ab	26.3 abcde	1017 b
Agri-Gro, 32 oz/A @ FF2, 3, and 4 weeks	745 a	2069 ab	24.5 bcde	980 b
HM9951, 1 qt/A @ PS	879 a	1849 ab	26.5 abcde	1038 b
HM9849, 2 qt/A @ PS	715 a	1886 ab	27.7 abc	927 b
KNO ₃ , 10 lb prod./A @ FF2, 3, and 4 weeks	1167 a	1918 ab	27.2 abcd	1105 b
Trisert-K (5-0-20-13S), 2 gal/A @ FF2, 3, and 4 weeks	947 a	2394 a	30.8 a	1324 a
LSD _(0.05)	740	591	4.8	180

^z Numbers followed by the same letter within a column are not significantly (P=0.05) different.

^y 0.14% ai of urea applied.

Table 5. Yield component response of furrow-irrigated, field-grown cotton cv. 'SG 747' to foliar-applied fertilizer or mepiquat chloride (PIX) at pinhead square (PS), first flower (FF), 2 weeks following first flower (FF2), and 4 weeks following first flower (FF4). Clarkedale, 2001.

Treatment	Components of yield			
	Open bolls (# 2m ⁻¹)	Boll weight (g boll ⁻¹)	Gin turnout (%)	Lint yield (lb acre ⁻¹)
Control	88 abc ^z	4.57 ab	41.1 a	1541 a
Control	174 a ^z	3.81 a	42.7 a	1103 a
LOAD, 1.0 gal/A @ FF	174 a	3.71 a	43.0 a	1063 a
LOAD, 1.0 gal/A @ FF + 0.5 gal/A @ FF2	168 a	3.70 a	42.7 a	1050 a
LOAD, 2.0 gal/A @ FF	173 a	3.89 a	42.9 a	1104 a
PIX, 8 oz/A @ FF, FF2, and FF4	175 a	3.91 a	41.8 a	1100 a

^z Numbers followed by the same letter within a column are not significantly (P=0.05) different.

Table 6. Fiber quality (HVI) response of furrow-irrigated, field-grown cotton cv. 'SG 747' to foliar-applied fertilizer or mepiquat chloride (PIX) at pinhead square (PS), first flower (FF), 2 weeks following first flower (FF2), and 4 weeks following first flower (FF4). Clarkedale, 2001.

Treatment	Fiber quality			
	Length (in.)	Strength (g tex ⁻¹)	Uniformity (%)	Micronaire
Control	1.11 a ^z	29.3 a	83.1 a	3.92 a
LOAD, 1.0 gal/A @ FF	1.12 a	29.4 a	83.3 a	3.80 a
LOAD, 1.0 gal/A @ FF + 0.5 gal/A @ FF2	1.10 a	28.6 a	83.0 a	4.05 a
LOAD, 2.0 gal/A @ FF	1.10 a	28.5 a	83.2 a	3.93 a
PIX, 8 oz/A @ FF, FF2, and FF4	1.12 a	29.0 a	83.5 a	3.85 a

^z Numbers followed by the same letter within a column are not significantly (P=0.05) different.