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FOLIAR POTASSIUM, LINT YIELDS, AND FIBER QUALITY

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Abstract

Eight varieties of cotton were grown in six different potassium (K) regimes. Yield and fiber quality response to pre-plant soil applied and foliar K was evaluated over a three-year period. Two of the three years foliar K increased cotton lint yields. Micronaire was also increased 2 out of three years with increasing K rates. Staple length was increased while staple strength was decreased with increasing K rates.

Introduction

Cotton is an important crop in Southeast Missouri and the relatively short growing season encourages producers to plant cotton varieties that mature quickly. These varieties achieve maximum yields by setting relatively greater number of bolls in a shorter time. This increased boll load per day requires that nutrients be available to the plant in greater rates per day. Potassium is an essential nutrient for cotton production because it is involved in maintaining plant water status, cell turgor pressure, and controlling the opening and closing of stomata. The opening of the stomata controls the availability of CO_2 and potassium has an indirect control over photosynthetic activity. Potassium is also involved in cellulose synthesis. Eighty-five percent of K movement in the soil is by diffusion. Since diffusion is a relatively slow process, K fertilization is required to maintain high levels of exchangeable K. Rapid plant growth and uptake may deplete K around the root surfaces. During peak flowering a cotton crop may require 3 to 4 lbs. of K per day and this may be larger than Southeast Missouri soils are capable of supplying. The objective of this study was to evaluate the affect of mid-season foliar potassium applications on the lint yields and fiber quality of modern cotton varieties.

Methods and Materials

A cotton study was conducted on a field at the University of Missouri-Delta Center Lee Farm (36^{o}N, 89^{o}W) in Pemiscot County, Missouri in 2001, 2002, and 2003. The eight varieties of cotton were planted on a Tiptonville silt-loam series soil (Typic Argiudoll, fine-silty, mixed, thermic) in early May of each year. Soil samples of the study area were collected from the 0 to 15-cm depth before planting. The soil test recommendation for K for this area was for a maintenance fertilization of 28 kgha^{-1} of K_2O. Forty-seven kgha^{-1} of KCl was applied in early April each year to plots scheduled for pre-plant K. The nitrogen recommendation was 112 kgha^{-1} N. Urea-Ammonium nitrate 32% liquid fertilizer was applied at a rate of 28 kgha^{-1} at planting and the remainder (84 kgha^{-1}) was applied at first-square (mid-June). Other than potassium fertilization the standard practices for cultivating dry land cotton in Southeast Missouri were employed.

The experimental design was a split plot with potassium treatment as main plot cotton variety as the sub-plot. The main plot K treatments are listed in Table 1. Mid-season foliar K applications were made using a Schwiess 4 row self-propelled high clearance sprayer at full bloom and full bloom + 10 days. The cotton varieties were STV 373, DP 1218BR, FM 958, FM 819, DP 436RR, PSC 355, STV 474, and BXN 47.

Plant height was measured twice during the growing season, following the second foliar K application and at cutout. A boll count was conducted prior to harvest, in early October of each year. Cotton petiole samples were collected twice during each growing season at the same time as plant height was measured. These samples represent the petiole of the fourth fully expanded leaf counted down from the top. These samples were collected following each potassium application. The petioles were dried, ground, digested using H_2SO_4 and H_2O_2, and analyzed by atomic absorption for K content. In late October of each year the two middle rows of each strip were mechanically harvested and the seed cotton weighed and recorded. The seed cotton was ginned using a 20-saw Continental gin stand proceeded by an inclined cleaner and feeder extractor. The gin stand was followed by one stage of lint cleaning. Lint samples from each plot were sent to the International Textile Research Center for fiber quality analysis using a high volume instrument.

Statistical analyses of the data were performed with SAS (1990) using General Linear Modeling procedures. Fisher's Protected Least Significant Difference (LSD) was calculated at the 0.05 probability level for making treatment mean comparisons.

Results and Discussion

The F Probability of K treatment, variety, and K by variety interactions affects on plant growth and petiole K levels are presented in Table 2. In 2001 and 2003 plant height at full bloom was affected by both K treatment and variety. In 2002 plant height at full bloom was only affected by variety. Each year plant height at cutout was significantly affected by both K treatment and cotton variety. Foliar K applications generally increased plant heights. In 2001 levels of potassium were significantly effected both K treatment and variety at full bloom. But neither factor produced significant differences for the cut out sampling in 2001. In 2002 petiole K levels were affected by both K treatment and variety for both sampling periods. In 2003 K treatment affected petiole K levels for both sampling periods. However, variety did not affect petiole K levels at cutout. There was not a K by variety interaction during any year. During two of the three years foliar K treatments significantly affected petiole K levels at cut out. Increasing K rates generally increased petiole K levels at cut out (Figure 1). This indicates that K fertilization (soil or foliar) was effective in supplying K to the cotton plants. This petiole K is available to influence the development of late season bolls.

The F Probability of K treatment, variety, and K by variety interactions affects on yields and fiber quality parameters are presented in Table 2. In 2001 variety was the only varable effecting cotton lint yields. In 2002 cotton lint yields were affected by K treatment and variety. This also was a K by variety interaction. In 2003 yields were significantly affected by K treatment and cotton variety. In 2002 and 2003 foliar K treatments generally increased lint yields compared to treatments not receiving foliar K (Figure 2). In 2001 the fiber property micronaire was only affected by cotton variety. In 2002 micronaire was affected by K treatment and variety. This also was a K by variety interaction. The micronaire response of individual varieties to K fertilization can be divided into two categories, consisting of four varieties each. In the first category (ST 474, DP 436RR, FM 958, and FM 819) there was a consistence increase in micronaire with increasing K fertilization (Table 3). For the remaining varieties (STV 373, DP 1218BR, PSC 355, and BXN 47) micronaire was inconsistently affected by K treatment. In 2003 micronaire was significantly affected by K treatment and variety. In 2003 foliar K treatments generally increased micronaire compared to treatments not receiving foliar K (Figure 3). In 2001 and 2003 the fiber property length was affected only by variety. In 2002 length was affected by K treatment and variety. This also was a K by variety interaction. Foliar K fertilization generally produced longer fibers (Figure 4). In 2001 fiber strength was affected by variety only. In 2002 fiber strength was affected by K treatment and variety. This also was a K by variety interaction. In 2003 fiber strength was affected by K treatment and variety. Pre-plant K fertilization generally produced weaker fibers (Figure 5).

Conclusions

The authors speculate differences in the response of yield and fiber quality to foliar K applications for the three years can be attributed to differences in weather conditions during the boll-filling period following cutout. Bolls produced early in the season have the benefit of the soil applied K only. Weather during the early and mid season was similar all three years. The increasing levels of petiole K at cutout for 2002 and 2003 indicate foliar treatments were effective at supplying K to the cotton plants. In 2001 dry cool weather was not favorable for filling out late season bolls with quality fiber. This combined with no significant differences in petiole K at cut out could have limited yield response. Hot weather combined with abundant rain in fall of 2002 allowed the cotton plants to take advantage of available K. The late season bolls were to be filled with longer, higher micronaire fibers. Both 2001 and 2002 were not typical fall weather years. 2003 was much more typical in terms of fall weather. The results for yield and fiber quality response to foliar K fertilization for 2003 would be more typical.

Table 1. Potassium treatments and application dates for 2002.

Treatment #	Pre-plant K	Peak bloom K	Peak bloom +10 K
1	0	0	0
2	0	5	0
3	0	5	5
4	25	0	0
5	25	5	0
6	25	5	5

Table 2. F Probability for data parameters collected in 2001, 2002, and 2003.

Plant height						
Source	2001		2002		2003	
	Full bloom	Cut out	Full bloom	Cut out	Full bloom	Cut out
	---F Probability---					
K fertilizer	0.0015	0.0260	0.4698	0.0036	0.0226	0.0003
Variety	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
K*Variety	0.6252	0.6330	0.2566	0.6724	0.8991	0.9564

Petiole K						
Source	2001		2002		2003	
	Full bloom	Cut out	Full bloom	Cut out	Full bloom	Cut out
	---F Probability---					
K fertilizer	0.0001	0.4691	0.0598	0.0001	0.0451	0.0048
Variety	0.0005	0.2860	0.0700	0.0245	0.1309	0.0110
K*Variety	0.2596	0.7323	0.6826	0.9954	0.3547	0.9280

Lint yield			
Source	2001	2002	2003
	---F Probability---		
K fertilizer	0.3842	0.0001	0.0367
Variety	0.0046	0.0001	0.0001
K*Variety	0.2548	0.0001	0.9633

Micronaire			
Source	2001	2002	2003
	---F Probability---		
K fertilizer	0.8077	0.0001	0.0646
Variety	0.0001	0.0001	0.0001
K*Variety	0.6408	0.0001	0.2527

Length			
Source	2001	2002	2003
	---F Probability---		
K fertilizer	0.4153	0.0001	0.4295
Variety	0.0001	0.0001	0.0001
K*Variety	0.7671	0.0001	0.8485

Strength			
Source	2001	2002	2003
	---F Probability---		
K fertilizer	0.5802	0.0001	0.0572
Variety	0.0001	0.0001	0.0001
K*Variety	0.3858	0.0001	0.4864

Table 3. Affect of potassium fertilizer applications on micronaire of ST474, DP436RR, FM958, and FM819 averaged across varieties in 2002.

K treatment	Micronaire (units)	T group
Untreated	4.40	C
5 lbs foliar	4.46	ABC
10 lbs foliar	4.42	BC
25 lbs soil	4.56	A
25 lbs soil + 5 lbs foliar	4.55	A
25 lbs soil + 10 lbs foliar	4.53	AB

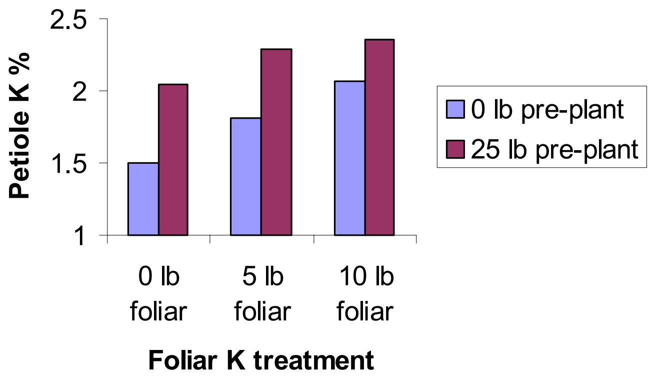

Figure 1. Petiole K levels averaged for all varieties at cut out in 2002.

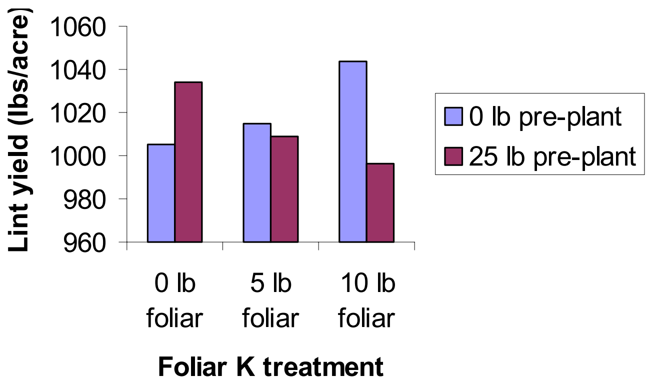

Figure 2. Cotton lint yields averaged for all varieties in 2002.

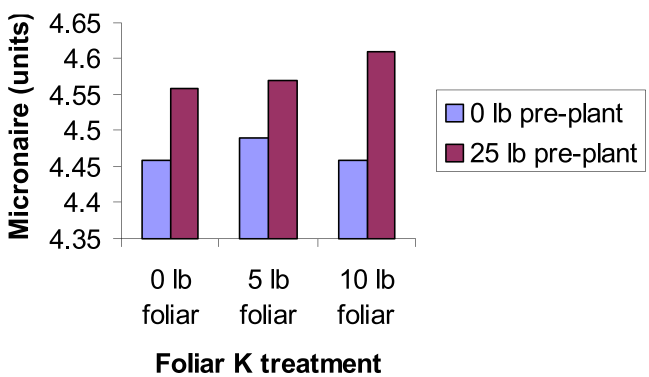

Figure 3. Cotton fiber micronaire readings averaged for all varieties 2002.

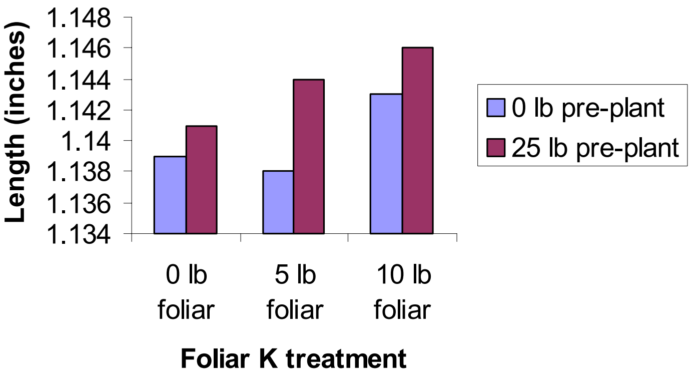

Figure 4. Cotton fiber lengths averaged for all varieties 2002.

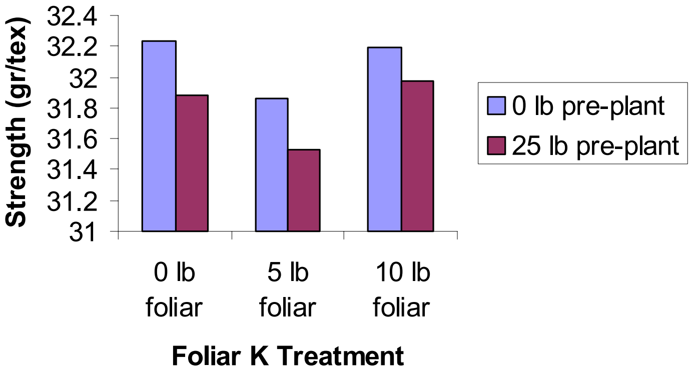

Figure 5 Cotton fiber strength averaged for all varieties 2002.