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Potassium Nutrition Effects on Lint Yield and Fiber Quality of Acala Cotton

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ABSTRACT

Although results from in vitro ovule culture studies have demonstrated a specific K requirement for fiber growth, a direct association between the K status of the cotton (*Gossypium hirsutum* L.) plant and fiber quality has not been established under field conditions. To evaluate this relationship, a single cultivar (1985) and two cultivars (1986 and 1987) were grown with 0, 120, 240, or 480 kg K ha^{-1} in 10 blocked replicates of each K level on an irrigated, vermiculitic soil. There was a significant seed-cotton yield response to applied K in each year. Lint yield, however, increased relatively more than seed yield, resulting in a greater lint percentage as plant K supply increased. The greater lint percentage reflected increased fiber length and secondary wall thickness (measured as a micronaire index) obtained from plants that received fertilizer K. For both cultivars, the fiber length, micronaire index, fiber strength and percent elongation, and fiber length uniformity ratio (dependent variables) were each positively related to (i) fiber K concentration at maturity, (ii) leaf K concentration at early bloom, and (iii) an index of soil K availability as independent variables in regression analyses. Comparison of cultivar regressions, however, indicated that fiber quality of 'Acala GC510' was higher than that of 'Acala SJ2' at low fiber, leaf, or soil K levels. We conclude that K supply to cotton fruit is an important determinant of fiber quality under field conditions, and that the K requirement for producing high lint yield with acceptable quality may differ among genotypes.

Both lint yield and fiber quality are important determinants of the economic return from cotton production. Although K application increases plant growth and lint yield on K-deficient soil, the effects of increased plant K supply on fiber quality are less clear (Kerby and Adams, 1985).

Using an in vitro ovule culture technique, Dhindsa et al. (1975) demonstrated that fiber extension depends on turgor pressure, which appears to be controlled by a K^+-malate osmoregulation system in developing fibers. In field-grown plants, Leffler and Tubertini (1976) found K to be the most abundant cation in cotton fiber, with concentrations exceeding 20 g K kg^{-1} on a dry weight basis 10 to 14 d after anthesis, decreasing to about 7 g K kg^{-1} at maturity.

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Despite the apparent K^+ requirement for fiber growth, results from field experiments have not indicated a consistent improvement in fiber length or thickness of the secondary wall (measured as a micronaire index) from fertilizer-K addition on soils where a yield response to K application was obtained. Under rainfed conditions, K addition was not found to influence fiber quality traits (Nelson and Ware, 1932; Pettiet, 1973), whereas Bennett et al. (1965) reported a considerable increase in fiber length and micronaire index from K addition on an irrigated soil. The relationship between fiber quality parameters and fiber or plant K status was not examined in these studies and, thus, it is difficult to interpret the inconsistent effects of K fertilization on fiber quality across different environments, cultivars, and crop management systems.

The purpose of this study was to evaluate the effects of fertilizer-K addition on lint yield and fiber quality of irrigated cotton on a soil where growth was severely limited by K deficiency. It also was our objective to characterize the relationship between fiber quality parameters and the K concentration in the fiber, leaf K supply, and soil K availability.

MATERIALS AND METHODS

Site Description, Experimental Design, and Crop Management

The experiment was conducted on a Grangeville sandy loam (coarse-loamy, mixed, thermic Fluvaquentic Haploxeroll) in a farmer's 17-ha field in Kings County, California (36° 18′ N, 119° 18′ W). The soil contains significant quantities of vermiculite and biotite mica at various stages of weathering and has a large K^+ fixation capacity at interlayer sites between clay sheets (Page et al., 1967; Shaviv et al., 1985). Soil pH was 7.6 and soil nutrients other than K and N were present at adequate levels.

Four K-addition levels of 0, 120, 240, or 480 kg K ha^{-1} were arranged in a randomized complete-block design with 10 replicates. Individual treatment plots were 11.6 × 150 m, each 12 rows wide with beds spaced 0.97 m apart on center. In 1985, Acala SJ2 (hereafter referred to as SJ2) was planted across the entire field. In 1986, either SJ2 or Acala GC510 (hereafter referred to as GC510) were randomized as subplots, each six beds wide, within K-rate mainplots. In 1987, SJ2 or GC510 subplots were established in the 0 and 480 kg K ha^{-1} mainplots; intermediate K-rate mainplots were planted with GC510 only.

In each year, fertilizer K (KCl) was surface applied and incorporated by disking in March. Potassium rates were reapplied to the same mainplots such that cumulative application rates were 0, 360, 720, and 1440 kg K ha^{-1} by the 3rd yr. Cotton was planted between 13 to 20 Apr. in each year. Irrigation, N fertilization, and pest control followed recommended practices. There were no indications that water stress, N supply, or pest pressure negatively influenced cotton yields in this 3-yr study. Greater detail concerning crop management and soil properties are provided elsewhere (Cassman et al., 1989b).

Sampling Procedures, Yield, and Fiber-Quality Measurements

Due to the large plot size, all plant and soil samples were taken from two separate locations (or "sample areas") within each replicate plot. In all 3 yr, seed cotton was hand picked from open bolls at maturity in mid-October, harvesting 9 m of row from each sample area. Yield determinations were therefore based on a seed-cotton harvest from 18 m of row in each plot. Seed cotton was stored for 2 wk, protected from weather, to reach moisture equilibrium. After this period, samples were weighed and a 2 to 3 kg subsample was ginned in a 20-saw experimental Continental Eagle Murray gin system.

Lint and fuzzy seed were weighed after ginning, and lint percentage was calculated as the ratio of lint weight to lint plus fuzzy seed weight. In 1985 and 1987, a 50-g lint subsample from all replicates of the 0 and 480 kg K ha^{-1} treatments was sent to the Textile Res. Ctr. at Texas Tech University, Lubbock, TX, for fiber quality analysis on a high-volume instrument system. In 1986, only 6 of the 10 replicates were sampled for quality analyses. Measured quality traits included the upper-half mean fiber length, micronaire index, fiber strength, percent elongation before breaking, and the fiber-length uniformity ratio. A separate lint subsample was taken for nutrient analysis.

Fuzzy seed was delinted by mixing 100 g with 15 mL concentrated H_2SO_4 for 1.5 min, followed by rinsing with distilled water. Delinted seed samples were dried at 60 °C, and mean delinted seed weight and weight loss after delinting (i.e., fuzz weight) were determined.

In 1987, 10 representative plants were taken from each of the two sample areas in 0 and 480 kg K ha^{-1} treatments at early bloom on 11 July. Whole plants were partitioned to stems, leaves, and fruiting structures.

Soil was taken from sample areas within K-rate mainplots on 21 July 1987 from the 0 to 0.2- and 0.2 to 0.4-m depth intervals. Soil samples were pooled across cultivar subplots within a mainplot, since sample areas from adjacent cultivar subplots were less than 4 m apart. A separate set of soil samples taken from cultivar subplots in mainplots without fertilizer-K addition indicated that variation in soil K levels was negligible between neighboring subplot sample areas.

Nutrient Analyses

All plant tissues were oven dried at 60 °C to constant weight, and nutrient concentrations were based on these oven-dry weights. Leaves and delinted seed were ground to pass a 40-mesh (0.37-mm) screen. Lint samples were weighed directly for nutrient analysis. Plant material was digested in an H_2SO_4–H_2O_2 mixture. Cations were measured by atomic absorption spectrometry, N by the indolephenol blue method (Mitchell, 1972), and P in the same digest, after neutralizing excess acidity (Throneberry, 1974), by the method of Murphey and Riley (1962).

Water-soluble soil K^+ was measured after placing 3 g soil, 30 mL H_2O, and one drop of toluene in 50-mL centrifuge tubes for 7 d at 25 °C with daily shaking for 30 min at 180 revolutions min^{-1} on an orbital shaker. Potassium was determined in clear supernatants after centrifugation at 9000 *g* for 15 min and reported as the K concentration in the water phase. Results from another study conducted at this site demonstrated that seed cotton yield was more closely related to water-soluble K^+ in the 0 to 0.4-m depth interval than to 1 *M* NH_4–extractable K^+ (Cassman et al., 1989a). Mean water-soluble K^+ in the 0 to 0.4-m layer was calculated as the average of values obtained from the 0 to 0.2- and 0.2 to 0.4-m depths in each mainplot sample area.

Statistical Analyses

Analyses of variance to evaluate the effects of K application and cultivar on lint and seed yields, lint percentage, mean seed weight, fiber quality parameters, and plant nutrient concentrations were based on pooled observations

Table 1. Lint and seed yield, and lint percentage of two Acala cotton cultivars as influenced by K fertilization on a vermiculitic soil in 1986 and 1987.

		1986			1987		
Annual K rate	Cultivar	Lint yield	Seed† yield	Lint percentage	Lint yield	Seed† yield	Lint percentage
kg ha^{-1}		kg ha^{-1}		%	kg ha^{-1}		%
0	SJ2	759	1330	36.3	722	1149	38.6
	GC510	1046	1660	38.7	1028	1484	40.9
120	SJ2	908	1547	37.0			
	GC510	1148	1802	38.9			
240	SJ2	952	1626	36.9			
	GC510	1202	1863	39.3			
480	SJ2	1087	1813	37.5	1238	1899	39.4
	GC510	1319	2040	39.3	1411	1953	41.9
Mean	SJ2	927	1579	36.9	980	1522	39.0
	GC510	1179	1842	39.0	1220	1719	41.9
ANOVA:							
	K rate	***	***	***	***	***	***
	Cultivar	***	***	***	***	***	***
	K × cultivar	NS	NS	NS	*	*	NS

*,*** Significant at the 0.05 and 0.001 probability levels, respectively. In 1986, mean separation [LSD (0.05)] for main effects of K rate was 66 and 98 kg ha^{-1} for lint and seed yield, respectively, and 0.4% for lint percentage.

† Ginned seed yield before delinting.

Table 2. Effect of fertilizer-K addition on fiber quality traits of two Acala cotton cultivars, 1986 crop year.

		Fiber quality traits				
Annual K rate	Cultivar	Length	Micronaire index	Strength	Elongation	Uniformity ratio
kg ha^{-1}		mm		kN m kg^{-1}	%	
0	SJ2	27.5	3.58	214	5.3	80
	GC510	27.7	3.88	210	5.5	82
480	SJ2	28.5	4.05	227	5.8	81
	GC510	28.3	4.28	226	5.9	82
Mean	SJ2	28.0	3.81	221	5.5	81
	GC510	28.0	4.08	218	5.7	82
ANOVA:						
	K rate	*	**	*	*	NS
	Cultivar	NS	**	NS	**	NS
	K × cultivar	NS	NS	NS	NS	NS

*,** Significant treatment effect at the 0.05 and 0.01 probability levels, respectively.

from the two sample areas taken from each treatment plot. Individual observations from each sample area were used for regressions of fiber quality parameters on lint, leaf, or soil K variables. For all regressions, both linear and quadratic models were tested. Quadratic regressions are presented only when the quadratic coefficient had a significant F value ($P < 0.05$). If regressions for both cultivars were linear, regression coefficients and y intercepts were compared for the two cultivar regressions (Snedecor and Cochran, 1974).

RESULTS

Seed cotton yield increased linearly as the rate of K addition increased in each of the 3 consecutive yr of this study (Cassman et al., 1989b). Averaged across K-rates and yr, lint and seed yield of GC510 was 19% greater than yield of SJ2 (Table 1). The lint yield response to increased K supply was relatively greater than the seed yield response, and this was reflected in a greater lint percentage with fertilizer-K addition for both cultivars. Mean seed weight after delinting and the residual lint weight per fuzzy seed after ginning was unaffected by K-rate treatments in both cultivars (data not shown).

In 1985 when only SJ2 was grown, fiber length increased from 28.1 mm in control treatments without K application to 28.8 mm in treatments with 480 kg K ha^{-1} ($P < 0.01$). Other fiber quality parameters were not affected significantly by K-rate treatments in that year. After K-rate treatments were reapplied in 1986 and again in 1987, fiber quality traits of both cultivars tested were markedly improved in treatments that received fertilizer K (Tables 2 and 3).

The K concentration in fiber at maturity was 14% greater in treatments that received 480 kg K ha^{-1} yr^{-1} than in treatments without added K, but the concentration of K in delinted seed was not influenced by K rate (Table 3). Potassium was the most abundant mineral element in mature fiber (Table 4), and the elemental composition of fiber found in this study is in close agreement with values reported by Leffler and Tubertini (1976). Although the K concentration of fiber differed significantly with K rate, total cation equivalents in fiber were similar, due to greater Na concentration in low-K fiber from plants grown without added K.

The range of values obtained for quality parameters and fiber, leaf, and soil K variables are shown in Table 5. Micronaire index, fiber strength, and elongation had the greatest amplitude among fiber quality traits, and leaf K concentration at early bloom varied considerably more than the K concentration in fiber at maturity across K-rate and cultivar treatments.

Each of the fiber quality traits was positively related

Table 3. Effect of fertilizer-K addition on the K concentration of lint and delinted seed, and on fiber quality parameters of two Acala cotton cultivars in 1987.

		K concentration		Fiber quality characteristics				
Cumulative fertilizer-K addition	Cultivar	Lint	Delinted seed	Length	Micronaire index	Strength	Elongation	Uniformity ratio
kg ha^{-1}		g kg^{-1}		mm		kN m kg^{-1}	%	
0	SJ2	5.64	11.76	27.9	3.23	218	5.1	0.80
	GC510	5.17	11.88	28.1	3.85	220	5.7	0.82
1440†	SJ2	6.26	11.72	28.7	3.76	234	5.6	0.81
	GC510	6.06	11.85	28.5	4.21	231	6.2	0.83
Mean	SJ2	5.95	11.74	28.3	3.49	226	5.3	0.81
	GC510	5.62	11.85	28.3	4.03	226	5.9	0.82
ANOVA:								
	K rate	***	NS	***	***	***	***	***
	Cultivar	***	**	NS	***	NS	***	***
	K × cultivar	**	NS	***	NS	NS	NS	NS

,* Significant treatment effect at the 0.01 and 0.001 probability levels, respectively.

† Cumulative total from annual application of 480 kg K ha^{-1} made before planting cotton in 1985, 1986, and 1987.

Table 4. Effect of fertilizer-K addition on nutrient concentrations in fiber at maturity (dry-wt. basis) in two Acala cotton cultivars in 1987.

Cumulative fertilizer-K addition	Cultivar	N	P	K	Na	Ca	Mg	Σ cations
		Nutrient concentration of fiber						
kg ha^{-1}		— g kg^{-1} —		——— mmol$_c$ kg^{-1} ———				
0	SJ2	1.8	0.6	145	54	21	51	271
	GC510	1.9	0.7	133	57	19	50	259
1440†	SJ2	1.8	0.7	161	38	20	53	272
	GC510	1.8	0.6	155	35	18	53	261
ANOVA:								
	K rate	NS	NS	***	***	NS	NS	NS
	Cultivar	NS	NS	***	NS	NS	NS	NS
	K × cultivar	NS	NS	**	NS	NS	NS	NS

,* Significant treatment effect at the 0.01 and 0.001 probability levels, respectively.
† Cumulative total from annual application of 480 kg K ha^{-1} made before planting cotton in 1985, 1986, and 1987.

to fiber K concentration at maturity (Table 6), leaf K concentration at early bloom (Table 7), and water-soluble K^+ in soil at 0 to 0.4-m depth (Table 8). Likewise, the concentration of K in mature fiber was positively associated with leaf and soil K supply (Table 9).

Cultivar regression equations often differed, as indicated by linear and quadratic forms for cultivar regressions with the same dependent and independent variables (Tables 7 and 8). In most cases, examination of y intercepts and regression coefficients indicated that fiber traits of GC510 varied less than those of SJ2 in relation to fiber, leaf, or soil K levels when cultivar regressions were both linear (Table 6) or quadratic (Tables 7 and 8). Less variation in fiber quality of GC510 across a wide range of K-supply levels also was indicated by a lower coefficient of variation for most of the quality traits (Table 5). But the degree to which cultivar regressions differed depended on the fiber quality trait. For example, the relationship between fiber length and fiber or leaf K concentration was similar for both cultivars (Fig. 1), whereas regressions of micronaire index on fiber or leaf K concentration were significantly different (Fig. 2).

DISCUSSION

Although most of the K in mature cotton fruit is found in the carpel walls, or bur, the K content of fiber and bur is nearly equivalent in the first 25 d after anthesis (Leffler and Tubertini, 1976). During this 25-d period after anthesis, fiber elongation is completed and secondary wall thickening begins (DeLanghe, 1986). This synchrony of K accumulation and fiber growth rate also was noted by Dhindsa et al. (1975),

Table 5. Mean values, range, and coefficient of variation for fiber quality parameters, plant tissue K concentration, and soil K levels obtained from fertilizer-K addition treatments for two Acala cotton cultivars in 1987.

Variable (units)	Cultivar	Mean†	Range: Minimum value	Range: Maximum value	Coefficient of variation
					%
Fiber length	SJ2	28.3	27.2	29.5	1.9
(mm)	GC510	28.3	27.4	29.2	1.3
Micronaire index	SJ2	3.49	2.80	4.30	13.4
	GC510	4.03	3.50	4.50	7.0
Fiber strength	SJ2	226	198	262	6.4
(kN m kg^{-1})	GC510	226	198	246	5.0
Fiber elongation	SJ2	5.3	4.8	6.2	6.0
(%)	GC510	5.9	5.4	6.4	4.7
Fiber uniformity	SJ2	81	78	82	1.4
ratio	GC510	82	80	84	1.3
Fiber K					
concentration	SJ2	5.95	4.89	7.44	9.0
(g kg^{-1})	GC510	5.62	4.45	6.71	11.1
Leaf K					
concentration	SJ2	10.92	7.19	18.87	27.7
(g kg^{-1})	GC510	10.42	7.46	16.89	21.3
Water-soluble soil K (mg K L^{-1}, 0–0.4 m)		1.02	0.54	1.72	32.8

† For all fiber quality and tissue K parameters, each cultivar mean is based on 40 observations, i.e., two samples taken from each of the 10 replicate-cultivar subplots with 0 or 480 kg K ha^{-1}. Soil K means are based on 20 observations, since only K-rate mainplots were sampled.

Table 6. Relationship between fiber quality parameters and K concentration in fiber at maturity (FK, in g K kg^{-1}) in two Acala cotton cultivars (n = 40 for each cultivar).

Dependent variable (units)	Cultivar	Regression equation	r^2	F value
Fiber length	SJ2	Y = 24.9 + 0.56(FK)	0.34	19.4***
(mm)	GC510	Y = 26.4 + 0.35(FK)	0.35	20.6***
Micronaire index	SJ2	Y = 0.35 + 0.53(FK)	0.38	22.8***
	GC510	Y = 2.08 + 0.35(FK)	0.60	56.0***
Fiber strength	SJ2	Y = 153 + 12.3(FK)	0.23	11.2**
(kN m kg^{-1})	GC510	Y = 153 + 12.8(FK)	0.50	37.8***
Fiber elongation	SJ2	Y = 3.0 + 0.39(FK)	0.43	28.4***
(%)	GC510	Y = 4.4 + 0.27(FK)	0.35	20.4***
Fiber uniformity				
ratio	SJ2	Y = 75 + 0.96(FK)	0.22	10.6**
	GC510	Y = 77 + 0.87(FK)	0.27	13.9***

,* Significant at the 0.01 and 0.001 probability levels, respectively.

Table 7. Relationship between fiber quality parameters and leaf K concentration at early bloom (LK, in g K kg^{-1}) in two Acala cotton cultivars (n = 40 for each cultivar).

Dependent variable (units)	Cultivar	Regression equation†	r^2	F value
Fiber length	SJ2	Y = 24.3 + 0.57(LK) − 0.018(LK)^2	0.65	34.4***
(mm)	GC510	Y = 25.1 + 0.50(LK) − 0.018(LK)^2	0.46	15.5***
Micronaire index	SJ2	Y = 2.20 + 0.12(LK)	0.58	53.0***
	GC510	Y = 0.98 + 0.48(LK) − 0.017(LK)^2	0.68	40.1***
Fiber strength	SJ2	Y = 126 + 15.4(LK) − 0.54(LK)^2	0.38	11.1***
(kN m kg^{-1})	GC510	Y = 192 + 3.2(LK)	0.40	25.4***
Fiber elongation	SJ2	Y = 4.5 + 0.08(LK)	0.53	42.9***
(%)	GC510	Y = 3.7 + 0.34(LK) − 0.01(LK)^2	0.51	19.6***
Fiber uniformity ratio	SJ2	Y = 73 + 1.07(LK) − 0.035(LK)^2	0.45	15.4***
	GC510	Y = 73 + 1.40(LK) − 0.053(LK)^2	0.30	7.8**

,* Significant at the 0.01 and 0.001 probability levels, respectively.
† Quadratic regressions are shown only when the quadratic coefficient was significant at $P < 0.05$.

Table 8. Relationship between fiber quality parameters and water-soluble soil K^+ levels (SK, in mg K L^{-1}) in two Acala cotton cultivars (n = 40 for each cultivar).

Dependent variable (units)	Cultivar	Regression equation†	r^2	F value
Fiber length	SJ2	$Y = 26.6 + 2.1(SK) - 0.47(SK)^2$	0.53	20.8**
(mm)	GC510	$Y = 27.2 + 1.5(SK) - 0.38(SK)^2$	0.40	12.2***
Micronaire index	SJ2	$Y = 2.31 + 1.38(SK) - 0.26(SK)^2$	0.51	19.3***
	GC510	$Y = 3.14 + 1.13(SK) - 0.25(SK)^2$	0.54	22.0***
Fiber strength	SJ2	$Y = 188 + 49.5(SK) - 11.1(SK)^2$	0.31	8.3**
(kN m kg^{-1})	GC510	$Y = 203 + 26.4(SK) - 4.9(SK)^2$	0.33	9.1***
Fiber elongation	SJ2	$Y = 4.9 + 0.36(SK)$	0.49	36.6***
(%)	GC510	$Y = 5.2 + 0.89(SK) - 0.19(SK)^2$	0.44	14.2***
Fiber uniformity ratio	SJ2	$Y = 77 + 3.98(SK) - 0.89(SK)^2$	0.44	14.5***
	GC510	$Y = 80 + 2.82(SK) - 0.66(SK)^2$	0.27	6.4**

,* Significant at the 0.01 and 0.001 probability levels, respectively.
† Quadratic regressions are shown only when the quadratic coefficient was significant at $P < 0.05$.

Table 9. Dependence of fiber K concentration at maturity on leaf K status at early bloom and on soil K supply as reflected by water-soluble soil K^+ levels, and the relationship between leaf K status and soil K supply in two Acala cotton cultivars.

Dependent variable (units)	Independent variable (units)	Cultivar	Regression equation†	r^2	F value
fiber K ($g\ kg^{-1}$)	leaf K ($g\ kg^{-1}$)	SJ2	$Y = 4.33 + 0.15X$	0.69	84.8***
		GC510	$Y = 0.12 + 0.79X - 0.024X^2$	0.81	81.0***
leaf K ($g\ kg^{-1}$)	soil K ($mg\ L^{-1}$)	SJ2	$Y = 3.53 + 7.90X - 1.12X^2$	0.74	53.3***
		GC510	$Y = 4.57 + 6.52X - 1.08X^2$	0.70	42.8***
fiber K ($g\ kg^{-1}$)	soil K ($mg\ L^{-1}$)	SJ2	$Y = 5.25 + 0.59X$	0.44	30.0***
		GC510	$Y = 4.80 + 0.69X$	0.48	35.7***

*** Significant at the 0.001 probability level.
† Quadratic regressions are shown only when the quadratic coefficient was significant at $P < 0.05$.

who demonstrated a specific K^+ requirement for fiber development in an in vitro ovule culture system.

A specific K^+ requirement for fiber elongation suggests that plant K supply would affect fiber quality, especially fiber length. In 1985 when annual K-rate treatments were first applied, addition of K at 480 kg ha^{-1} resulted in a 22% increase in lint yield of SJ2 and a significant increase in fiber length. The other fiber quality traits, however, were not measurably affected by K-rate treatments in the 1st yr of this study.

After two further applications of K rates to the same treatment plots in 1986 and 1987, lint yield of SJ2 was 72% greater at the highest level of K addition (with a cumulative total application of 1440 kg K ha^{-1}) than in control treatments without K addition. Application of fertilizer K also resulted in a higher lint percentage (Table 1) and a considerable improvement in each of the five fiber quality parameters tested (Tables 2 and 3).

The cumulative yield response to repeated annual applications of K reflects the K fixation characteristics of the vermiculitic soil at the study site (Cassman et al., 1989b). The more pronounced effects of fertilizer-K addition on fiber quality in 1987 was due to a wider range in soil K levels, plant K uptake, and cotton growth than the 1st and 2nd yr of the study.

A positive, linear relationship between each of the fiber quality parameters and the K concentration in mature fiber (Table 6) indicates that adequate K supply to developing fruits was an important determinant of lint quality under field conditions. Likewise, the close association between fiber and leaf K concentrations at early bloom or an index of soil K availability (Table 9) suggests that fiber K supply is dependent on adequate soil K fertility and plant K nutrition.

While the positive relationship between fiber length and plant K supply is consistent with the findings of Dhindsa et al. (1975), the effect of K supply on the micronaire index and fiber strength indicates a K requirement for the process of secondary wall thicken-

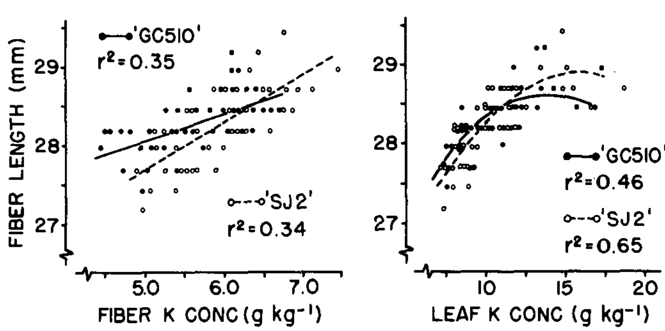

Fig. 1. The relationship between fiber length and K concentration in fiber at maturity or in leaves of plants sampled at early bloom on 11 July 1987. Separate regressions are shown for Acala cotton cultivars SJ2 and GC510; regression equations are presented in Tables 6 and 7. Cultivar y intercepts and slopes did not differ significantly ($P < 0.05$) for the linear regressions of fiber length on fiber K concentration.

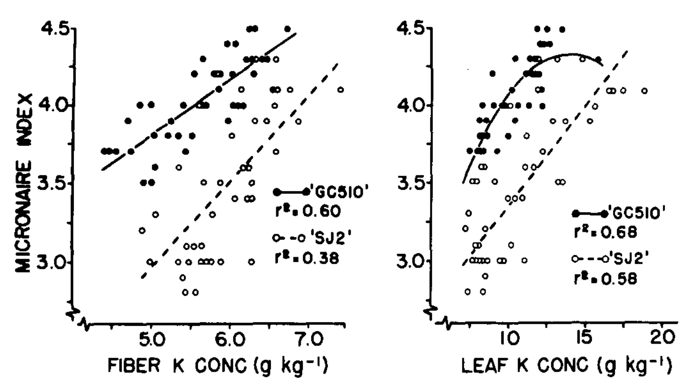

Fig. 2. The relationship between fiber micronaire index and K concentration in fiber at maturity or in leaves of plants samples at early bloom on 11 July 1987. Separate regressions are shown for Acala cotton cultivars SJ2 and GC510; regression equations are presented in Tables 6 and 7. Cultivar y intercepts differed ($P < 0.001$) for the linear regressions of micronaire index on fiber K concentration, although slopes were similar.

ing. Elevated levels of Na in low K fiber (Table 4) did not compensate for the K requirement of wall thickening or fiber extension. The K requirement for fiber development was not replaceable by Na, and this also was noted in the ovule culture studies of Dhindsa et al. (1975).

Mean weight of delinted seed and the weight proportion of residual lint on fuzzy seed after ginning was not affected by K-rate treatments in either cultivar. Therefore, the effect of K supply on lint percentage was associated with a larger relative increase in lint yield than in seed yield with fertilizer-K addition. Development of longer fiber with a thicker secondary wall that resulted from increased plant K supply accounted for the greater lint percentage in plants better supplied with K.

A delay in plant maturity also may affect fiber quality, because proportionately more of the harvested bolls are derived from fruit set at later fruiting positions. Fruit set later in the season are at a relative disadvantage for acquiring growth assimilates, due to shorter day length, cooler temperatures, and competition from earlier-set bolls. Evaluation of fruiting patterns in this experiment was reported elsewhere (Cassman et al., 1989a). Fertilizer-K addition had little effect on the proportional distribution of harvestable bolls in GC510 and tended to increase the proportion of later maturing bolls in SJ2. It is therefore unlikely that the effect of K supply on fiber quality and lint percentage resulted from differences in fruiting patterns induced by K-rate treatments.

Both cultivars evaluated in this study are commercial cultivars. Together they accounted for about 90% of the 500 000 ha planted to cotton in California each year since 1987. Seed cotton yield of GC510 was considerably greater than yield of SJ2 when soil K supply was not adequate, and this was related to cultivar differences in K uptake efficiency from this vermiculitic soil (Casman et al., 1989a).

Although increased plant K supply resulted in higher lint quality in both cultivars, the relationship between fiber quality and fiber, leaf, or soil K status was considerably different for the two cultivars. Most notable was the large difference in *y* intercepts for cultivar regressions of micronaire index on fiber K concentration (Fig. 2). In general, fiber quality of GC510 was consistently better than in SJ2 at low fiber and leaf K concentrations (Tables 6 and 7) or low soil K levels (Table 8), as indicated by comparison of *y* intercepts and regression coefficients. Cultivar differences of this magnitude suggest that it may be possible to select cotton genotypes which have a lower soil or tissue K requirement for producing high lint yield with acceptable fiber quality. Identification of the physiological basis for such genotypic variation would facilitate breeding efforts in this area.

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