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How Can Cotton Plants Best Exploit Potassium In Soil?

In search of an answer, Alabama researchers vary positioning of K in soil profile to study its effects on crop yield, K uptake, and root length density.

Summary: *Recent potassium (K) fertilization studies on cotton have concentrated on deep K placement to deter late-season K deficiencies. Little is known, however; about the efficiency of the cotton plant in removing K from various positions in the soil profile. Hence, we initiated a two-year field study at two sites in 1992 to determine the cotton plant 's ability to remove K from different positions in the soil. Potassium as a KCl solution (as well as rubidium as a RbCl solution) was injected to depths of 0, 3, 9, 15, and 21 inches. In 1994, K uptake was maximized on a Decatur soil when the greatest proportion of the soil profile received K. However; no significant differences in uptake were observed between surface- and deep-applied treatments at each location. Root length density measurements were not significantly different for surface-or deep-applied K. K uptake data for both years suggest that surface application of K, or incorporation of applied K into the plow layer; is sufficient for cotton.*

Cotton is the number one row crop grown in the state of Alabama. Increased reports of late-season potassium (K) deficiencies, and recent surveys revealing low subsoil K for many soils in the Southeast, prompted studies to correct these deficiencies via deep placement of K. Little is known, however, about the cotton

plant's ability to exploit K in the subsoil. Since cotton is a tap-rooted plant, the efficiency of roots inhabiting various soil profile depths must be defined before late-season K deficiency can be solved. This study employs K uptake, as affected by K fertilizer placement, in its attempt to define the efficiency of cotton root systems in exploiting K in the soil. Rubidium as a RbCl solution was also injected into the soil profile as a tracer for K.

Low-K sites

Both sites were selected for their low soil test K. Test areas were established in the fall of 1990 by planting wheat. In the summer of l 991, sorghum-sudangrass was planted. Both forages were clipped and the clippings were removed to reduce the amount of available K in the soil. In 1992, the Lucedale soil had a "low" soil test rating in the 0 to 6-inch and 6- to 12-inch depths. The Decatur soil had a "low" soil test rating in the top 0- to 10-inch depth, and a "medium" soil test rating at a depth of 10 to 20 inches.

Each treatment area consisted of 39.4-inch rows extending to the inter-row center on either side of the row. Deltapine 5690 was grown in 40-inch rows and treatments were applied the day after planting.

A grid was placed over the treatment area and liquid KCl and liquid RbCl were applied in the spring by making 36 injections per plot. The KCl solution was injected at a test rate of 120 lbs/A of K_2O. For the 3-inch depth, rates of 0, 0.25, 0.5, 1, and 2 times the test rate were used to define the K response curve. In addition to single injection

Table 1. Dry matter production and potassium uptake for cotton, Mullins, et al., Auburn University, 1994.

	Decatur SiL		Lucedle SCL	
	Dry Matter	K Uptake	Dry Matter	K Uptake
	- - - - - - - - lba/A - - - - - - - -			
0	7,874	71.4	7,074	79.9
Surface	9,200	84.5	7,452	84.1
3 inches	7,580	69.1	7,838	84.3
9 inches	8,096	81.3	9,084	101.9
15 inches	6,920	67.3	8,313	83.1
21 inches	7,596	65.8	7,713	91.7
Surface/3 inches	8,111	80.1	9,437	129.7
Surface/3/9 inches	7,523	81.7	9,357	105.7
Surface/3/9/15 inches	8,396	86.2	9,740	116.9
Surface/3/9/15/21 inches	9,156	101.6	7,155	87.4
Band/Surface	7,257	73.9	7,358	93.2
Band/3 inches	7,558	78.3	8,530	97.0
Band/9 inches	8,423	83.8	7,860	83.1
Foliar/0 soil K	6,803	64.1	7,328	83.4
Foliar/3 inches soil K	7,929	83.1	7,742	95.1
Foliar/9 inches soil K	8,242	80.9	8,359	91.4

depths, select combinations of injection depths were made.

Just prior to leaf shed, whole plants were harvested from each plot, partitioned into parts, dried, and weighed. Each part was analyzed for rubidium and potassium.

Four 1.25-inch diameter root cores were taken per plot at positions relating to 0, 5, 10, and 20 inches from the row center. Sub-samples were made by cutting the cores into 6-inch increments from the surface to 24 inches.

Decatur silt loam

Yield. There were no significant differences between surface and surface to 21-inch applications in the number of boils produced or total dry matter production (Table 1).

K uptake. At this site, K uptake in sterns and leaves and total K uptake was maximized by the combination injection of K from the surface to 21 inches (i.e., surface, 3, 9, 15, 21 inches) as shown in Table 1. This treatment effectively fertilized a greater proportion of the soil profile than did the surface applied K. Uptake by leaves and stems in this treatment was significantly greater than the surface and 3-inch injection treatments. Total K uptake from this combination treatment, however, was not significantly different from the surface K treatment. Band applications of K, single injections at various depths, and foliar treatments did not result in higher uptake as compared to the surface K treatment.

Rb uptake. Total Rb uptake was affected by placement for all plant parts. RbCl applied at the 3-inch depth yielded highest Rb uptake with a stair-step decrease in Rb uptake with increasing depth of injection.

Root length density. First year root length density measurements by position from the center of the row and depth in the soil profile showed no consistent differences among treatments. Since no significant differences existed among treatments, all treatment means were combined for position and depth (Table 2).

Table 2. Root length density means by position and depth, Millins, et al., Auburn University, 1993.

Distance from center of row	Subsample Depth	Decatur SiL	Lucedale SCL
inches	inches	- - - - - - cm/cm3 - - - - - -	
0	0-6	2.07	1.52
	6-12	1.19	1.03
	12-18	1.34	0.74
	18-24	1.11	0.51
5	0-6	1.84	1.04
	6-12	1.25	0.69
	12-18	1.58	0.65
	18-24	1.03	0.55
10	0-6	1.65	0.77
	6-12	1.16	0.73
	12-18	1.64	0.64
	18-24	1.11	0.54
20	0-6	1.61	0.69
	6-12	1.32	0.78
	12-18	1.59	0.80
	18-24	1.08	0.61

Lucedale sandy clay loam

Yield. The surface to 3-inch and surface to 15-inch combinations produced higher yields than surface alone (Table 1). However, the yield difference was not sufficient to show statistical significance.

K uptake. Total K uptake was affected by the rate of applied K. Highest K uptake was achieved with the combination injection treatments. As shown in Table 1, the surface/3-inch combination was followed by the surface/3/9/l 5-inch combination. Surface banding K and injecting the band to a depth of 3 inches resulted in higher total K uptake when compared to surface broadcast alone, but these differences were not statistically significant. Foliar treatments applied in combination with soil applications of K also resulted in higher K uptake as compared to surface treatments, but, again, these differences were not significant.

Rb uptake. Rubidium uptake for all plant parts was affected by placement. Total Rb uptake for single injections to 9 inches provided the highest uptake.

Root length density. Root length density measurements by position from the center of the row and depth in the soil profile showed no consistent differences among treatments. Since no significant differences existed among treatments, all treatment means were combined for position and depth (Table 2).

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