CALIFORNIA

Potassium Research Boosts Cotton Production

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Irrigated cotton is a major crop in California's San Joaquin Valley. In the past 20 years, new cultural production techniques and cultivars have substantially increased yields. Recent research has focused on updating fertility management of the current high yielding Acala cotton varieties. A primary research focus has been late-season K deficiencies which limit lint yield on approximately one-fifth of the annual acreage (1.1 million acres in 1994).

California studies show the value of soil and plant petiole testing in predicting potassium (K) response by cotton in the San Joaquin Valley. Subsoil samples (5 to 15 inches) provided the best relationship. Greater than 60 percent K fixation in laboratory studies was indicative of K responding soils.

Potassium deficiency has been identified as a compound problem, partially the result of the mineralogy of the subsoils of the San Joaquin Valley and partly related to cotton root physiology. Earlier California studies have associated cotton K deficiency with vermiculitic soils which strongly adsorb K, making fertilizer or crop residue K relatively unavailable.

Cotton root densities are significantly lower in the surface soil than crops such as barley, soybeans and corn. Studies have indicated that cotton root density and surface area are significantly greater at a soil depth of approximately 5 to 15 inches. For these reasons, late-season cotton K deficiency is attributed to high vermiculitic clay content and low available K in subsoils as well as cotton root systems of relatively low surface root density.

California Studies

Field experiments were conducted at a total of 30 locations in 1993 and 1994 in Merced, Kings, Fresno, Madera, Kern, and Tulare counties to evaluate seed/lint yield response to K fertilization. All locations were planted to the Acala cotton variety Maxxa. Cultural production practices followed those of the individual producer. Fertilizer treatments were 0 and 400 lb/A of K_2O as KCl banded to a depth of six inches adjacent to the row at squaring. Previous research indicated significant lint yield responses to K_2O rates of this magnitude.

Preplant soil samples at each location at depths of 0 to 5, 5 to 15, and 15 to 30 inches were evaluated for available K using the following tests: 1.0 N ammonium acetate; Mehlich 3; ammonium bicarbonate-DTPA (AB-DTPA); 1.0 N boiling nitric acid; 1.0 N barium acetate; Unocal release rate test (a proprietary procedure); 0.02 N calcium chloride; sequential water washing; saturated paste water extraction; and resin exchange. Soil K fixation potential was measured by a method developed by California researchers.

Cotton petiole samples were taken for analysis at three phenological growth stages beginning at first bloom. The plots were harvested at maturity. Seed and lint yield and lint quality were determined.

TABLE 1. Effects of fertilizer K on Acala cotton (Maxxa) lint yields (partial listing).

Location	Lint yield, lb/A Control	Lint yield, lb/A 400 lb K_2O/A	Yield change due to K, lb/A
93-4	1,643	1,761	118
93-6	1,143	1,438	295 *
93-10	1,567	1,815	248 *
93-11	1,370	1,509	139
93-12	762	1,131	369 *
93-13	1,107	1,263	156 *
94-1	1,475	1,645	170
94-5	983	1,085	102
94-7	1,419	1,664	245 *
94-9	1,373	1,529	156 *
94-10	1,396	1,578	182 *
94-11	1,436	1,558	122

San Joaquin Valley, CA *Significant at P<0.05

Results

There were significant lint yield responses ($P<0.05$) to K fertilization at 4 of 16 locations in 1993 (**Table 1**). Control plot yields ranged from 747 to 1,728 lb/A. Average yield increase to 400 lb/A of K_2O on the responsive sites was 174 lb/A. Three of 14 locations produced a significant lint yield response ($P<0.05$) to K fertilization in 1994. The yield increase on the responsive sites averaged 165 lb/A.

The extractants that gave the best prediction of cotton yield response were 1.0 N ammonium acetate, Mehlich 3, 0.5 N AB-DTPA, and 1.0 N barium acetate. The extractants that did not correlate with yield in this study were nitric acid, saturated paste, resin exchange, and the Unocal procedure. Lint yield response was best predicted using soil samples from 5 to 15 inches, independent of the soil extractant utilized. The higher correlations of yield response to extractable K in subsurface samples is attributed to higher root density at this depth compared to surface samples, indicating the importance of this soil depth to K nutrition of cotton and probably to other nutrients as well. These results confirm previous research of Dr. Ken Cassman on similar soils in the San Joaquin Valley.

Based on Cate-Nelson statistical analysis, the soil critical value for the 5 to 15 inch depth separating responsive from non-responsive soils (95 percent maximum yield) is 110 parts per million (ppm) using the 1.0 N ammonium acetate (**Figure 1**) or the Mehlich 3 extractant. These two methods predicted lint responses on approximately 80 percent of the responding sites. The AB-DTPA and barium acetate soil K extractants were equally good predictors of cotton lint yield response based on the Cate-Nelson statistical analysis. The critical levels for these latter two extractants were 65 and 75 ppm, respectively. It is hypothesized that these four extractants are generally better due to their decreased propensity for extracting K from the clay minerals that is unavailable to the plants.

Cotton petiole concentrations of K at peak bloom were highly correlated with

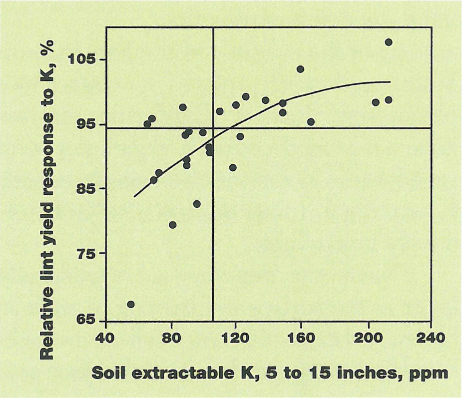

FIGURE 1. Lint yield response of cotton to fertilizer K relative to soil K extractable by ammonium acetate, 5 to 15 inch depth. San Joaquin Valley, CA.

Mid-Season K deficiency is shown in this cotton field in the San Joaquin Valley.

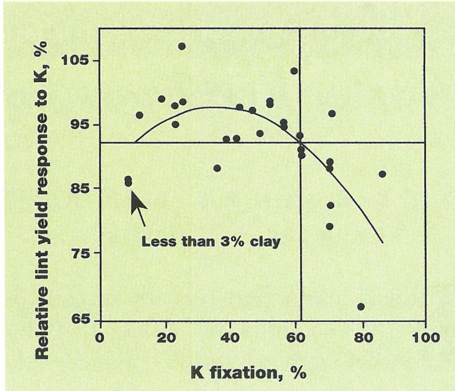

FIGURE 2. Lint yield response of cotton to fertilizer K relative to soil K fixation, 5 to 15 inch depth. San Joaquin Valley, CA.

the subsoil (5 to 15 inch depth) K extracted with 1.0 N ammonium acetate and Mehlich 3. The relationship was best described using quadratic functions (data not shown).

The K fixing capacity of soil is also related to lint yield response. Soils that were capable of fixing more than 60 percent of applied K under laboratory conditions showed lint yield responses at a majority of responding locations (**Figure 2**). Soils with a K fixing capacity less than 60 percent, except for three site-year locations, did not have significant lint yield responses to K fertilizer. The one responding site which had less than 20 percent K fixation was also very low in clay and in ammonium acetate extractable K throughout its profile. These results suggest that subsoil K fixation is indicative of sites likely to respond to K fertilization. Further studies involving particle size analysis suggest that K fixation is generally associated with the fine silt fraction of these subsoils and is attributed to vermiculitic minerals.

Summary

This research strongly supports an integrated soil-plant analysis program which evaluates both soil K availability and K fixation potential in conjunction with in-season petiole analysis in developing a K fertilizer management program for Acala cotton in the San Joaquin Valley of California. A soil testing strategy using preplant subsoil samples representative of the cotton root zone using standard soil K extractants is useful in predicting the probability of crop response to K fertilization.

This project is continuing with emphasis on fertilizer rate calibration. Additional work is planned to evaluate residual soil fertilizer K on subsequent cotton petiole K and lint yields and on K fixation by subsoils across the San Joaquin Valley. BC

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