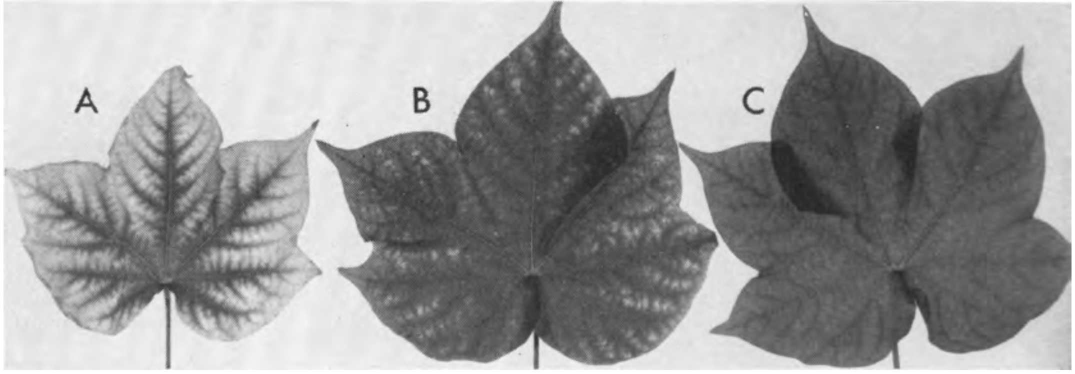
The main reason large rates of potassium are required on cotton soils in the San Joaquin Valley, is that most of the added potassium becomes fixed within the soil and is not available to the cotton plant. This soil condition, resulting in small amounts of exchangeable potassium and large potassium-fixing capacities, may be widely prevalent within the valley, according to recent chemical and mineralogical analyses of many soils—and is reflected in plant deficiencies and large potassium fertilizer requirements.



Potassium deficiency on 4-month-old cotton leaves: A, acutely deficient; B, deficient; and C, normal.

High Potassium Needs of San Joaquin Valley Cotton Soils Related to Fixation Problem

A. L. PAGE · F. T. BINGHAM · T. J. GANJE

THE CORRECTION of potassium deficiencies, appearing in recent years in San Joaquin Valley cotton soils, requires large applications of potassium fertilizers. Most of the affected California soils require application rates in excess of 150 pounds of potassium per acre, as compared with soils in the South and Southeastern States which rarely require rates in excess of 50 pounds of potassium per acre for correction of deficiencies on cotton.

A greenhouse and laboratory study was initiated to analyze the need for such unusually high rates of potassium fertilizers. Two soils (Soil 1—Dinuba sandy loam, and Soil 2—San Joaquin silty loam), selected from areas where potassium deficiency symptoms occurred on cotton, were used for the study. Both soils were obtained near Fresno and are derived from granitic alluvium. Their clay fraction is predominantly micas, with lesser amounts of montmorillonite and vermiculite.

CHEMICAL CHARACTERISTICS OF SOILS AFTER CROPPING

K added (air dry wt. basis)	Fixed K*	△ Exchangeable K†	△ Soil solution K‡	Exchange capacity
Pounds per acre				me/100 g
San Joaquin soil				
0	0	0	0	7.84
320	280	12	2	7.48
480	400	12	2	7.33
800	630	24	3	7.03
Dinuba soil				
0	0	0	0	3.20
320	250	8	2	2.88
480	340	16	2	2.77
800	520	88	17	2.54

* Using exchange capacity difference as the criterion.

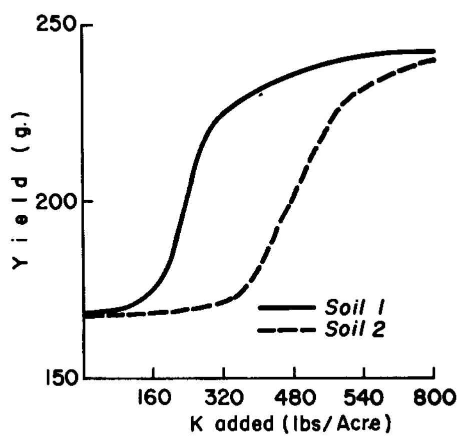
† △ Exchangeable K = (exchangeable K for treated soil) minus (exchangeable K for control).

‡ △ Soil solution K = (soil solution K for treated soil) minus (soil solution K for control).

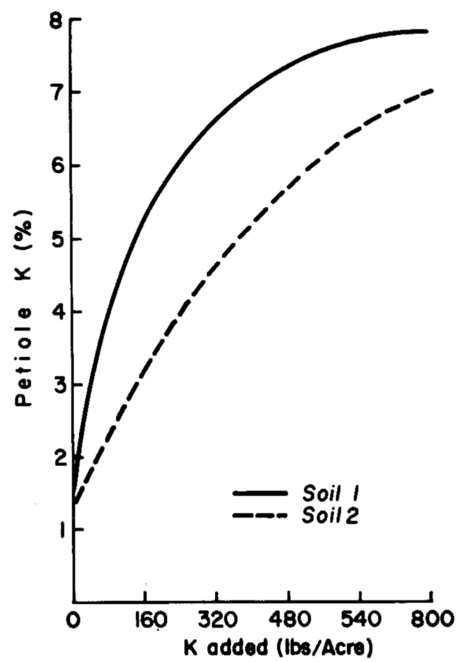
Thirteen kilograms of soil in three-gallon pots were treated with K_2SO_4 at rates ranging up to 800 pounds of potassium per acre and were cropped to cotton. Adequate and uniform amounts of nitrogen and phosphorus were added to all pots. Each treatment was replicated eight times in a randomized complete block design. Petiole samples taken at monthly intervals were analyzed for the major and minor elements. The plants were harvested after four months and soils were analyzed for exchange capacities and exchangeable and soluble cations.

Vegetative yields and per cent potassium in the petioles from 1- and 4-month-old plants are presented in the graphs. The Dinuba soil contained larger amounts of potassium in the soluble form and higher percentages of exchangeable potassium, which probably accounts for the larger amounts found in the petioles from plants grown on this soil as shown in graphs 2 and 3.

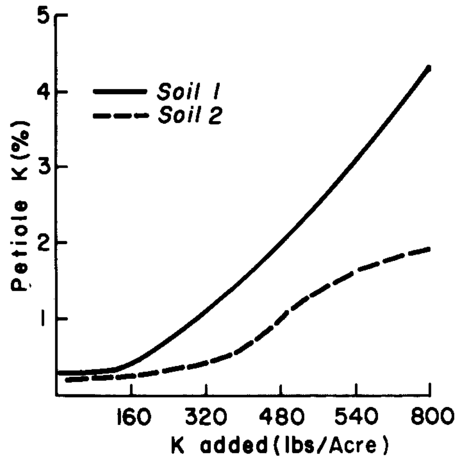
Results show that the potassium content of petioles from cotton plants generally decreases as the plant matures. The potassium content of petioles from 1-month-old plants grown on both soils



Graph 1—Influence of potassium application rate on the vegetative yield of cotton plants (Soil 1—Dinuba sandy loam; Soil 2—San Joaquin silty loam).



Graph 2—Influence of potassium application rate on the potassium content of petioles from 1-month-old cotton plants.



Graph 3—Influence of potassium application rate on the potassium content of petioles from 4-month-old cotton plants.

(graph 2) was increased at all added levels. However, levels of potassium in the petioles from 4-month-old plants on the Dinuba soil were practically the same until the amount applied equaled or exceeded 320 pounds per acre, as shown in graph 3. Similarly, on the San Joaquin soil, the potassium content of petioles did not change until the amount applied equaled or exceeded 480 pounds per acre. Results suggest that either young cotton plants are capable of utilizing higher percentages of the added potassium or it becomes increasingly unavailable to the cotton plants as a function of time.

Significant increases in vegetative yields were obtained at the same application rates where potassium responses were indicated by analysis of petioles from 4-month-old plants, as shown in graph 1. The petioles contained adequate amounts of all other essential plant nutrients, therefore the data show conclusively that the soils were potassium-deficient and that unusually large applications are required to correct these deficiencies. Also, results suggest that a value from 1 to 1.5% potassium in petioles of 4-month-old cotton plants is adequate.

The failure of potassium soil applications to correct potassium deficiencies of plants in many cases is correlated with the capacity of the soil to fix or irreversibly adsorb potassium. Irreversible adsorption of potassium reduces the exchange capacity of the soil. Exchange-capacity determinations can then be used as a means to ascertain the amount of added potassium fixed by this mechanism.

The exchange capacities of the soils after harvesting the cotton plants showed a progressive decrease (see table) as the amount of potassium was increased. The magnitude of the decreases in exchange capacities shows that the amounts of added potassium fixed by irreversible adsorption on the Dinuba soil ranged from 66 to 80%, and 81 to 90% on the San Joaquin soil.

After cropping, only small percentages of the added potassium could be recovered in the exchange complex or soil solution. Addition of 800 pounds of potassium per acre resulted in increases of only 24 pounds of exchangeable potassium per acre for the San Joaquin soil and 88 pounds for the Dinuba soil. Except for the highest potassium application on the Dinuba soil, the potassium in the soil solution did not change appreciably as a result of treatment.

A. L. Page is Assistant Professor of Soil Science; F. T. Bingham is Associate Professor of Soil Science; and T. J. Ganje is Laboratory Technician II, Department of Soils and Plant Nutrition, University of California, Riverside.

ROW WIDTH, PLANT POPULATION STUDIES IN COTTON

RESULTS FROM this two-year preliminary study indicate that, although increased cotton yields may be obtained by increasing plant populations, the yield increases are not in proportion to the population increases. Increasing the population up to two or three times the normal number (from 42 to 21 or 14 inches between rows) apparently reduces the yield per plant to the extent that total yield per acre is only slightly increased. Increasing the plant population even more causes a reduction in yield. Reducing plant populations below normal very quickly decreases yield. Although the 40-inch row-width has been a customary practice, rather than one of proven maximum efficiency, a change to greater plant populations through narrower rows was not yet indicated by these tests.

Cotton is customarily grown as a row crop with rows spaced from 36 to 42 inches apart, depending on where it is grown and cultural practices used. With acreage allotments in effect there has been an increasing emphasis on maximum production as well as production efficiency. Wider row spacings have received attention, as evidenced by the popularity of skip-row cotton.

Theoretically, high yields are possible through reduced row-widths and increased plant populations. Yields of 2½ to 3½ and sometimes 4 bales have been obtained from 40-inch spaced rows with plant populations of 39 to 40,000 plants per acre in a growing season from April to November. The possibility of obtaining higher yields through greater plant populations in narrower row-widths—or a more efficient production of the same yield by requiring fewer bolls per plant and therefore a shorter growing season—led to the initiation of a study at the Southwestern Irrigation Field Station at Brawley.

Seven, 14, and 21-inch spacings were used in a 1961 comparison with the regular 40-inch row-width. With three to four plants per foot of row this gave populations of approximately 220,000 at the 7-inch row-width; 110,000 at 14 inches; 70,000 at 21 inches; and 39,000 at the regular 40-inch row-width.

The plots were hand-picked five times, starting on August 23 (about 50 days after first bloom) and finishing on December 1. The yield level of slightly over three bales per acre, picked from the 40-inch row-width in December, was reached by the 21-inch width in early October, indicating that an increased efficiency of production may be obtained by increasing plant populations. The 1961 data also showed that the best row-width may be somewhere between 21 and 40 inches. The highest yield at all picking dates was obtained from the 21-inch row-width. The yields from the 7 and 14-inch row-widths were only slightly higher than the 40-inch row-width.

In 1962 a total of 10 row-widths were tested, from 7 to 70 inches at 7-inch intervals. The 14, 21, 28, and 35-inch row-widths gave the highest yield although only slightly (and non-significantly) higher than the 42-inch width. Yields from the 7 and 49-inch row-widths were intermediate while the lowest yields were obtained from the 56, 63, and 70-inch widths.

Further investigations into other row-widths and plant spacing combinations are needed. Different cultural practices, particularly irrigation and fertilization, harvesting methods, and suitable varieties may need to be studied also to determine the possibility of this approach to more efficient cotton production.—*Peter van Schaik, Research Agronomist, USDA, and Associate Specialist in Agronomy, University of California, Davis.*