Survey of Cotton Soils Shows Several Factors Related to Potassium

By C.C. Mitchell

A survey of 292 Alabama cotton fields in 1990 and 1991 found that potassium (K) soil tests in plow-layer samples did not reflect actual K status of cotton plants growing in those soils. The soil tests indicate that 60 percent of the fields were high or very high in K, while plant analysis indicated 61 percent of the samples were deficient in K at early bloom.

REPORTS from throughout the Cotton Belt have suggested that modern varieties and cultural practices may result in widespread K deficiencies in cotton. Impressive yield responses have been recorded from both surface and subsoil K applications on cotton land that tested medium to high for K in the plow layer, but low in the subsoil.

Soil test summaries from the Auburn University Soil Testing Laboratory indicate that plow-layer K in soil samples submitted for cotton has actually increased slightly over the past 25 years, while soil test phosphorus (P) has declined (**Figure 1**). However, rarely do cotton producers encounter P deficiencies, and plow-layer P soil tests are well correlated with cotton yield.

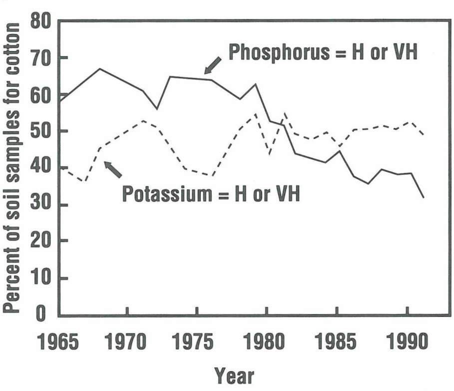

Figure 1. Long-term trends in soil test P and K in soil samples for cotton tested by the Auburn Soil Testing Laboratory.

Alabama Cotton Survey

Because of widespread concern about K nutrition of cotton and a need to identify other soil fertility factors which may limit cotton yields in Alabama, a statewide cotton survey was conducted during the 1990 and 1991 growing seasons. Leaf samples and plow-layer soil and subsoil samples were collected at early bloom from 292 randomly selected cotton fields in Alabama cotton-producing counties.

Nematode soil samples were also collected from the same fields in late September. The purposes of these samples were to 1) determine the fertility status of the topsoil and subsoil, 2) identify potential cotton nutritional problems based on leaf analysis, and 3) identify the extent of plant parasitic nematode problems in Alabama cotton.

Low K in Leaf Samples

Sixty-one percent of the cotton leaf samples were rated below sufficiency for K (less than 1.5 percent K at early bloom), Table 1. The percentage was much higher in the coarse-textured Lower Coastal Plain soils and much lower in the finer textured soils of the Limestone Valleys. This is the most dramatic observation from the survey. Plow-layer soil samples (**Table 1**) and long-term trends in soil test values from the Auburn Soil Testing Laboratory (**Figure 1**) give no indication of this situation.

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POTASSIUM deficiency is shown in this cotton field on Coastal Plain soil in Alabama. Traditional methods of soil testing and plant analysis may need to be modified for today's varieties and yield goals.

Low Subsoil K

Soil tests from the Alabama survey indicated that 60 percent of the fields were high or very high in plow-layer K, which is very close to the trend for K in plow-layer samples tested by the Auburn Soil Testing Laboratory (**Figure 1**). However, analyses of subsoil samples indicate that 80 percent of the survey fields were low to medium in K. Potassium doesn't move downward as rapidly as once thought–even in sandy soils. Long-term soil fertility studies in Alabama, one continued since 1911 and six since 1929, indicate considerable K accumulation in surface soil horizons.

Table 1. Selected analyses and observations from Alabama cotton fields.

Observation	Limestone Valley (n=135)	Upper Coastal Plain (n=57)	Lower Coastal Plain (n=100)	Alabama average
	% of samples			
Leaf samples at early bloom				
Leaf N < 3.50%	0	1	3	2
Leaf N > 4.50%	68	60	54	61
Leaf P < 0.30%	20	4	1	10
Leaf K < 1.50%	44	68	80	61
Leaf K > 3.00%	0	0	0	0
Soil samples				
pH < 5.0 in plow layer	2	2	4	3
pH < 5.0 in subsoil	8	16	22	14
K = low in plow layer[1]	3	0	7	3
K = low in subsoil	25	30	32	29
K = high in plow layer[1]	74	70	34	60
K = high in subsoil	27	9	18	19
Soil characteristics				
Depth to B horizon < 12 inches	98	90	91	93
Traffic pan within 12 inches of surface	19	63	41	44

[1]Based upon calibration for Alabama Soils in Alabama Experiment Station, Cir. 251 (1981).

Traffic Pans in Coastal Plain Soils

A characteristic of many coarse-textured Coastal Plain soils is the tendency to develop traffic pans at the depth of plowing where the coarser surface soil is mixed with the finer textured subsoil. **Sixty-three percent of the fields in the Upper Coastal Plain of Alabama had traffic pans within 12 inches of the surface;** 41 percent of the Lower Coastal

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Plain soils had traffic pans. During the survey, we found that many Lower Coastal Plain growers routinely practice in-row subsoiling at or before planting to fracture a traffic pan, whereas most Upper Coastal Plain cotton growers do not practice subsoiling.

Excessive N and Subsoil pH

Excessive nitrogen (N, > 4.5 percent) in 61 percent of the leaf samples at early bloom may indicate that a potential exists for excessive vegetative growth later in the season if weather conditions are favorable. Excessive N could also aggravate K uptake. Subsoil pH was below 5.0 in 22 percent of the Lower Coastal Plain fields and 16 percent of the Upper Coastal Plain fields. This could also restrict root growth into the subsoil.

Reniform and Root Knot Nematodes

Reniform and root knot nematodes have been shown to reduce K uptake. These two pests were found extensively in Coastal Plain soils, but rarely together in the same field. Root knot nematodes were found in 57 percent of the Lower Coastal Plain fields and in 13 percent of the Upper Coastal Plain fields. Only 5 percent of the Limestone Valley cotton fields had root knot nematodes present. Reniform nematodes, which may reduce K uptake more significantly than root knot, were found in 40 percent of the Upper Coastal Plain fields, in 9 percent of the Lower Coastal Plain fields and in only 3 percent of the Limestone Valley fields. Parasitic nematodes cannot be ignored as a factor in the increasing concerns about K nutrition of cotton in the Southeast.

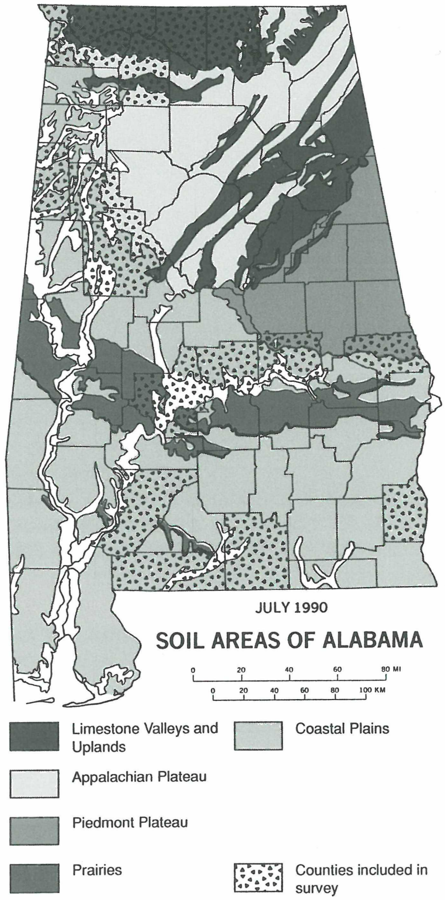

Figure 2. Alabama cotton-producing counties sampled during 1990 and 1991 growing seasons. Counties were grouped based upon the soil physiographic region as 1) Limestone Valley, 2) Upper Coastal Plain or 3) Lower Coastal Plain.

Summary

Potassium accumulation by surface soil horizons and low subsoil K, the presence of root-restricting traffic pans in Coastal Plain soils, reniform and root knot nematodes, extremely acid subsoils, and excessive N may all play a part in low leaf K observed during this survey and in K problems observed in other Mid-South cotton fields. Earlier maturing and higher yielding varieties may also stress the root system to take up enough K during a shorter period of growth. Traditional, plow-layer soil tests for K may not be enough to adequately predict the need for additional K fertilization, and leaf K sufficiency levels currently used may need adjustment for the newer varieties and high yields of cotton. ■