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Petiole nutrient concentrations of upland cotton, Gossypium hirsutum L

Marshall Clayton Smith

To the Graduate Council:

I am submitting herewith a thesis written by Marshall Clayton Smith entitled "Petiole nutrient concentrations of upland cotton, Gossypium hirsutum L." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

G. M. Lessman, Major Professor

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March 1, 1972

To the Graduate Council:

I am submitting herewith a thesis written by Marshall Clayton Smith entitled "Petiole Nutrient Concentrations of Upland Cotton, Gossypium Hirsutum L.". I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

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PETIOLE NUTRIENT CONCENTRATIONS OF UPLAND COTTON, *GOSSYPIUM HIRSUTUM* L.

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Marshall Clayton Smith

March 1972

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ABSTRACT

Experiments were conducted at seven locations in 1969 and 1970 to determine the effects of growth stage, location differences, and cultivars on the Ca, Mg, K, and P concentrations of cotton petioles.

In general, nutrient content of cotton petioles was affected more by growth stage and location than by cultivar difference.

Calcium and K concentration usually decreased as the cotton plants approached maturity while Mg and P varied with location.

Acala 1517D was generally higher in Ca and P concentrations than were any of the other nine cultivars tested. Coker 417 was high in Mg while the Stoneville cultivars were high in K. The high yielding Stoneville 213 was consistently low in Ca and Mg. Acala 1517D was the lowest yielding of all cultivars tested. When using plant analysis to diagnose nutrient levels in cotton, particular consideration should be given to the cultivars sampled. In this experiment more differences were found among cultivars at mid bloom than at any other physiological growth stage investigated.

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CHAPTER I

INTRODUCTION

While previous studies have shown that genotype influences nutrient concentrations in other crops, there is only limited evedence which relates genetics with nutrient concentrations in cotton.

The objective of this experiment was to determine what effect year, location, and sampling date had on cotton petiole nutrient (Ca, Mg, K, and P) concentrations of several cultivars and the relationship of these concentrations to yield.

CHAPTER II

REVIEW OF LITERATURE

During the last ten yeard, many cotton growers, particularly those in the arid Southwest, have used plant analysis to diagnose the nutrient level of cotton plants and to adjust the fertility status of soils on which cotton is grown. During the 1966 season, approximately 6,000 hectares of cotton soils in the Imperial Valley of California were checked for nitrogen level by plant analysis. However, plant analysis has been used less frequently to investigate the level of Ca, K, Mg, and P in coton soils.

There are numerous reports of research in which many different plant parts were analyzed more frequently than were stems, roots, bolls, blades plus petioles, or the upper, middle, and lower one-third of the plant. A few researchers such as Olson and Bledsoe (40) analyzed the entire above-ground portion of the plant. Such an approach presents many problems because all of the above-ground material must be harvested, dried, and ground. If the field were sampled more than once, the plant population stedily decreased with each consecutive sampling.

Using the solution culture technique, Joham (27) conducted an experiment to find which part of the plant would be most suitable for sampling. He analyzed lower, middle, and upper stems as well as petioles and leaves. He found highly significant positive correlations between the nutrient concentration in petioles and the nutrient levels in the substrate. He also found that the petiole from the most

recently matured leaf most nearly reflected the nutrient status of the entire plant. This petiole was found at the third or fourth node from the apex. Never-the-less some researchers have continued to analyze leaf blades.

Fullmer and Stromberg (19) conducted an experiment in California in which they applied various rates of K fertilizer to cotton. Their results indicated that sandy soils could be considered deficient in K when the extractable K of the top 30 centimeters was below 60 ppm, and that the critical level for fine-textured soils was 100 ppm. Whenever the K level in petioles of 130 day old plants was less than 2.0 percent, a yield response was obtained from added K the following season. Potassium deficiency symptoms did not occur, however, unless the K content of petioles was below 1.5 percent 130 days after planting. Stromberg (49) obtained a high positive correlation between the concentration of K in the petiole and extractable K from the soil. He further stated that petioles at early bloom, approximately 75 days after planting, should contain at least 4.5 percent K and 130 days after planting the petioles should contain at least 1.0 percent K. This was somwhat less than the 1.5 percent proposed by Fullmer and Stromberg (19). Stromberg (49) suggested that the soil must contain 60 ppm of K for optimum cotton procuction.

In a two-year California cotton experiment, Bennett et al. (7) analyzed many different plant parts for K. They applied K to the soil in rates ranging from 70 to 560 kilograms of K per hectare. The K concentration of all of the plant parts increased progressively as the application rates increased. The K concentration of more mature

leaves and petioles was affected to a greater extent by K applications than any other plant part and therefore was considered to be the best indicator of the K status of the cotton plant. In 1960 maximum yields were produced at the 560 kilogram application rate. However, in 1961 the maximum yield was produced at only the 280 kilogram rate. In both years maximum yield produced was 5600 kilograms of seed cotton per hectare. Plant height and boll size also increased with greater application rates. The results of a four-year experiment conducted by Overton and Parks (41) in Tennessee indicated that 112 kilograms of N, 47 kilograms of P_2O_5, and 93 kilograms of K_2O per hectare produced maximum yields of cotton on soils which were low in these three elements.

Because of the scarcity of experimental data, critical levels of P in cotton leaves and petioles have yet to be determined. Fuller (17) found that the total P concentration of cotton leaves and petioles was significantly increased by P applications to the soil. However, seed cotton yields were not increased by P applications. Conflicting results were found by Fuller et al. (18). Neither yields nor petiole concentrations were increased by P applications to the soil. The soil P level was not reported in either experiment. Fuller (17), Fuller et al. (18), and Abott, McGeorge, and Breazeale (1) reported fluctuations of P concentrations at different stages of growth. This was observed in both leaves and petioles.

Lancaster (18), and Longnecker, Thaxton, and Lyerly (32) reported that a close relationship existed between the Mg concentration in the leaves and exchangeable Mg in the soil. Fluctuations in the Mg content of the petioles during the growing season made petioles unreliable as indicators of the Mg status of cotton plants. Therefore, Gheesling and

Perkins (22) suggested that leaves should be used. This conflicted with data presented by Fullmer and Stromberg (19) which indicated that Mg concentration of the petioles varied only slightly during the season. Page and Bingham (42) proposed that when the Mg concentration of the petiole is below 0.1 to 0.2 percent, a Mg deficiency is possible.

Olson and Bledsoe (40) found that the above ground portion of the cotton plants contained an average of 105 kilograms of Ca per hectare. Most of the Ca was found to be concentrated in the leaves. Mehlick and Reed (39) reported that the total uptake of Ca increased as the percent Ca saturation in the soil increased. Because of the rarity of Ca dificient soils, there were no reports of critical Ca levels.

Olson and Bledsoe (40) reported N, Ca, and K to be present in quantities much greater than the amounts of P and Mg. This fact has been confirmed by many other experiments. Many reports indicated that cotton plants grew and produced some lint under wide variations of Ca, K, Mg, and P concentration. Abbott, et al. (1) failed to show any correlation between fiber yield and tissue concentrations of P, K, Ca, or Mg on fertile irrigated Arizona soils. Therefore, no attempt has been made to determine optimum tissue concentrations of Ca, Mg, P, and K.

Mehlich and Reed (39) and Lunt and Nelson (35) found that Ca and Mg in the cotton plants decreased with increasing levels of K applications to the soil. Mehlich and Reed (39) also reported that increasing degrees of Ca saturation antogonized K when the soil K

exceeded .08 milliequivalents and Ca exceeded 50 percent base saturation. Joham (27) observed negative correlations between petiole Ca and Mg and substrate K. Page, et al. (44) and Page and Bingham (42) reported that Mg levels in the plant decreased with increased soil applications of K. Helmy, et al. (25) reported a strong reciprocal or negative correlation between Ca and Mg and a weak negative correlation between Mg and K. K antagonized the uptake of Ca and Mg, and Ca and Mg also antagonized K uptake.

Lundegardh (34) stated that for the antagonistic reaction of K ⇆ Ca the transition point occurred near equivalence. Thus, if the ratio K/Ca was greater than one, the K uptake was only slightly influenced by variations in Ca concentrations while Ca uptake was reduced by K additions. When the K/Ca ratio was less than one, Ca dominated and restricted K uptake while variations in K concentration had little effect on Ca uptake.

Because of ion antagonism, Mehlich and Reed (39) used the Ca/K ratio to explain ion relationships. Stanford, et al. (48) reported, and Carmona (11) confirmed, that Ca + Mg/K ratios of 3.5 or less were found in corn plants whose growth appeared normal while ratios of 5.0 or above were found in plants showing marked symptoms of K deficiency. Freeman (16), Gallaher (20), Larson and Pierre (30), and Lucas and Sarseth (33) reported that corn yields increased as the Ca + Mg/K ratio decreased.

From a two year cotton experiment in Arizona, Abbott, et al., (1) reported the Ca/Mg ratio in the leaves to be about six during the early stages of growth but four at a more mature stage. The ratio

was slightly less in the stalks. The concentration of both elements was also lower in the stalks than in the blades. Helmy, et al., (25) reported the Ca + Mg/K ratio to be fairly constant at both the 45 and 85-day samplings.

Using a formula proposed by Bray (9), Mehlich (38) was able to point out a reasonable correlation between soil and cotton tissue analysis. Bray's formula:

$$\text{Calcium in the plant} = \frac{\text{Ca}}{\text{Ca (Cca)} + \text{Mg (Cmg)} + \text{K (CK)}} \text{E}$$

where the values of Ca, Mg, and K are the milliequivalents of exchangeable ions in the soil, Cca, Cmg, and Cx are coefficients of absorption by plants and E is the amount of cations found in the plant.

Bassett, et al., (4) found that dry matter production in cotton followed a sigmoid growth curve. Only 2 to 4 percent of the total dry matter had been accumulated at first square and 7 to 10 percent at first flower, two-thirds of the total seasonal dry matter was produced during a six-week period in late July and early August.

Many reports have indicated that K concentration in the petiole decreases with age of the plant. Although there were minor fluctuations, Fullmer and Stromberg (19) found Ca and Mg concentration in the petioles remained fairly constant as the plant matured. Abbott, et al., (1) in an experiment with irrigated cotton in Arizona, reported an increase in the blade Ca content as the plants matured but a decrease in the stalk Ca content. Magnesium concentration in the leaf blades was higher at the 90-day sampling than at either the 60

of 135-day sampling. However, the Mg concentration in the stalks decreased as the plants matured. Joham (27) reported fluctuations in the petiole P concentration as the plant matured.

Many reports have linked genotype and nutrient composition for various crops. Pandita and Andrew (45) reported that late maturing cultivars of tomatoes had higher P concentration than early maturing cultivars. After analyzing corn tissue, Freeman (16), Ashburn (3), and Gallaher (20) found significantly different concentrations Ca, K, Mg, P, and N among genotypes. Gorsline, et al., (23) reported significant differences among genotypes of corn for Sr, Ca, Zn, K, Mg, Mn, Bo, and Fe concentrations but not for Al, Cu, and P concentrations. Whitfield and Smika (50) reported that nutrient concentrations of Cu, Mn, and P differed widely among wheat cultivars. Apparently each cultivar has an optimum temperature for maximum nutrient uptake just as cultivars have optimum temperatures for growth. Mack (36) reported that Ca, Mg, K, and P concentrations of snap bean varied significantly among genotypes. Shea, Gabelman, and Gerloff (47) concluded that the gene responsible for K uptake in snap beans was recessive.

MacKenzie, et al., (37) analyzed cotton petioles of several cultivars for nitrate-nitrogen. He obtained significant differences among them. Acala 4-42 petioles contained less N than Deltapine or the experimental cross R-15. However, the cultivar differences were small when compared to the differences which resulted from different application rates. Foy, et al., (15) experimenting with many cultivars, concluded that Pima S-2, Acala 4-42, and Acala 44-10 were more tolerant

to exchangeable Al than such Eastern cultivars as Deltapine Smooth Leaf and Coker 100A. Gregg and Paymaster 101A were moderately tolerant while Acala 1517D was the least tolerant. They could not explain why some western cultivars, developed on high pH soils which were low in exchangeable Al, were more tolerant to exchangeable Al than Eastern cultivars.

Page, et al., (44) compared the K concentration of Acala 4-42 and Acala-Strain 11 petioles and found no significant difference between them. Using a nutrient cultivar technique, Helmy, et al., (25) found that the leaf blades of Egyptian cotton contained less Mg than those of American Upland.

In Puerto Rico Samuels, et al., (46) conducted an experiment with five cultivars of long staple cotton. The cultivars contained different amounts of N, P, and K in the leaf blades. However, the cultivars which contained the highest amounts of nutrients were often the lowest yielding. The P content of leaf blades of 73-day-old cotton ranged from 0.29 to 0.45 percent while the K content ranged from 2.70 to 16.9 percent. Yields were reported only in relative values.

CHAPTER III

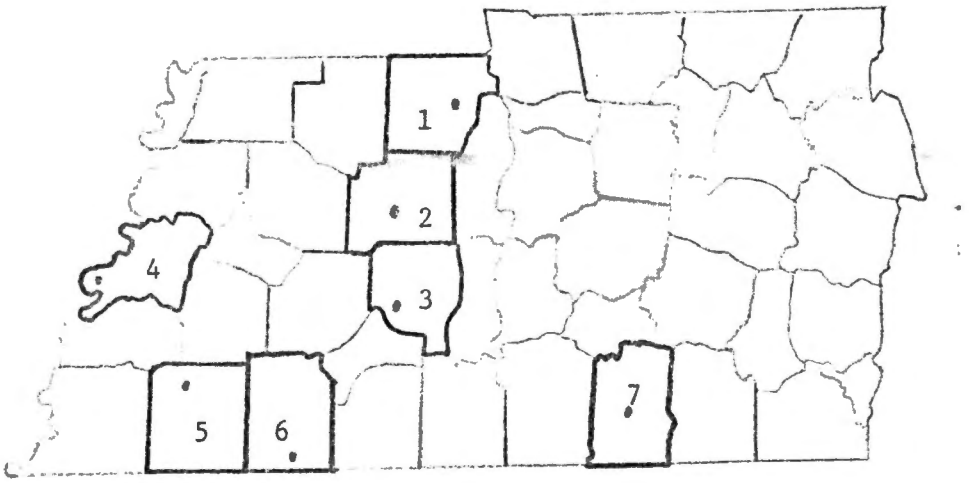
MATERIALS AND METHODS

The University of Tennessee Agricultural Experiment Station conducted cotton cultivar trials in 24 cotton producing counties in Middle and West Tennessee. The objectives of the trials were to test commercially important cultivars for yield, fiber quality, and disease resistance under a number of different soil and climatic conditions. A cultivar nutrient experiment was incorporated into these trials to obtain additional information without the added cost of planting and harvesting additional plot areas. Six of the locations in West Tennessee and one in Middle Tennessee were selected to test cultivars for differences in nutrient content grown under soil and management conditions. These locations are shown in Figure 1 and their corresponding soils are listed in Table 1.

These locations were selected because of soil uniformity, absence of disease the previous year, and high degree of interest of the cooperating farmers.

The experiments occupied the same area each year except for the Fayette and Hardeman County experiments which were moved to nearby locations in 1970. The Fayette County 1970 experiment was moved because of early flooding while the 1970 Hardeman County experiment was moved because of excessive growth of johnsongrass in 1969.

Ten cultivars shown in Table 2 were included at every location and were sampled for the research reported here. Because the Stoneville



1. Henry
2. Carroll
3. Henderson
4. Lauderdale
5. Fayette
6. Hardeman
7. Lawrence

Figure 1. Location of seven cotton cultivar trials in Tennessee.

TABLE 1

LOCATIONS AND SOIL TYPES

Location	Soil Types
Carroll	Memphis silt loam
Fayette	Collins silt loam Falaya silt loam
Hardeman	Memphis silt loam
Henderson	Lexington silt loam
Henry	Memphis silt loam
Lauderdale	Morganfield silt loam Robinsonville silt loam Adler silt loam
Lawrence	Crider silt loam Pembroke silt loam

TABLE 2

COTTON CULTIVARS TESTED FOR NUTRIENT COMPOSITION

Cultivars	Abbreviations
Stoneville 213	ST 213
Deltapine 45A	DPL 45A
Dixie King 11	DK 11
Deltapine 16	DPL 16
Auburn M	Aub M
Coker 417	Coker 417
Acala 1517D	AC 1517D
Rex Smooth Leaf 66	Rex SL
Hancock	Hancock
Stoneville 508 (1969 only)	ST 508
Stoneville 603 (1970 only)	ST 603

Pedigree Seed Company removed Stoneville 508 from the market after the 1969 season, it was replaced by Stoneville 603 at all locations in 1970.

Field Plot Design

A randomized complete block design consisting of six replications was used at each location. The field at Carroll County contained two distinct soil types; Memphis and Henry, which are quite different in their chemical and physical properties. Therefore the two replications on the Henry soil were not sampled in this experiment. In 1969 at Henderson County, one replication was excluded because of a sampling error.

Row width was 96.5 centimeters everywhere except at Lauderdale and Henry Counties where it was 101.6 centimeters. All plots were four rows wide and most were 18.3 meters long. Because of limited space at Hardeman County in 1970 the plots were only 13.7 meters long.

Fertility Levels

Fertilizer was broadcast uniformly over the experimental area before planting at recommended rates. The amounts applied at each location are shown in Table 3. Extra nitrogen was sidedressed at three locations in 1969.

In the spring of 1969 soil samples were taken randomly at each experiment site. From the results of the pH test from these soil samples, the soils were limited to raise the pH to 6.5. In 1970 the new Hardeman and Fayette sites were limed before planting time.

TABLE 3

NUTRIENTS APPLIED ANNUALLY AT EACH LOCATION

Location	Plant Nutrient		
	N	P	K
	----------Kg/Ha----------		
Carroll	95	90	45
Fayette	85	70	35
Hardeman	60	50	25
Henderson	65	65	35
Henry	85	70	35
Lauderdale	25*	75	40
Lawrence	85	65	35

*In 1969 an additional 20 Kg/Ha of N as $NaNO_3$ was sidedressed.

Cultural Practices

Acid-delinted seed were planted at rates of approximately 148,000 seed per hectare using a modified two-row corn planter. Table 4 lists the planting dates. After seedling emergence, skips were replanted.

Recommended rates of the herbicide tifluralin were incorporated into the soil before planting at all locations except Lawrence County where nitralin was used instead. The preemergence herbicide fluometron was applied in a 35.6 centimeter band over the row immediately after planting at all locations each year except at Fayette County where it was broadcast in 1969. All other locations were cultivated three times and hand-hoed when necessary to insure adequate weed control.

Collection of Field Data

The 1969 crop was sampled twice during the growing season, approximately at early and mid bloom. In 1970, cotton was sampled at early, mid, and late bloom in order to provide a clearer picture of nutrient composition of various cultivars and their differences.

For tissue samples, at least 20 petioles were taken randomly from the middle two rows of each plot. Petioles were taken from the most recently matured leaf which was usually found at the third of fourth node from the apex. Tissue sampling dates are listed in Table 5.

The soil of each plot was sampled with a soil probe to a depth of 15 centimeters. Ten probes were taken along the length of each plot from the middle of the two center rows.

TABLE 4

PLANTING DATES IN 1969 AND 1970 AT EACH LOCATION

Location or County	Planting Date	
	1969	1970
Carroll	5/2	5/7
Fayette	4/24	5/7
Hardeman	4/2	5/9
Henderson	5/1	5/5
Henry	4/29	5/5
Lauderdale	4/23	5/6
Lawrence	-	5/7

TABLE 5

TISSUE SAMPLING DATES AT EACH LOCATION

Locations	1969	
	First	Second
Lauderdale	7/9	7/26
Henderson	7/10	7/28
Fayette	7/10	7/29
Carroll	7/11	7/28
Henry	7/11	7/30
Hardeman	7/12	7/29

Locations	1970		
	First	Second	Third
Lauderdale	7/9	7/29	8/11
Henderson	7/10	7/31	8/12
Carroll	7/13	7/31	8/12
Henry	7/13	7/13	8/13
Fayette	7/14	7/30	8/14
Hardeman	7/16	7/30	8/14
Lawrence	7/18	8/1	8/14

The two middle rows of each plot were harvested with a one row cotton picker. The seed cotton from each plot was weighed and a sample taken for ginning. The gin sample was weighed before and after ginning to get the percent gin turnout which in turn was used to calculate lint yield. Cotton was harvested on dates listed in Table 6.

Laboratory Analysis

Tissue samples were dried overnight at 65°C, ground in a Wiley mill, and stored in plastic bags. The wet oxidation procedure developed by Gieseking, Snider, and Getz (22) was modified and used to digest tissue samples. The modification is further described in Appendixes A and B. Potassium, Ca, Mg, and P were determined by the Technician Autoanalyzer.

Soil samples were air dried and ground. A 1:1 soil to water ratio was used to determine pH on a Fisher model 210 pH meter.

Plant nutrients were extracted by the North Carolina double acid method which is further described in Appendix D. The extract was analyzed by the Technician Autoanalyzer for Ca, K, Mg, and P.

Statistical Methods

Lint yields per hectare as well as the Ca, K, Mg, and P concentrations in both tissue and soil were analyzed by the computer using the statistical Analysis System (new SAS) developed by Barr and Goodnight (5).

Analyses of variance were computed on an individual experiment basis to determine differences in concentrations of each of the four

TABLE 6

COTTON HARVEST DATES AT EACH LOCATION

Location	1969		1970	
Harvest	First	Second	First	Second
Carroll	9/18	10/21	10/23	11/16
Henderson	9/25	11/10	9/22	11/6
Lauderdale	9/27	11/14	9/14	11/13
Fayette	10/3	11/24	11/14	-
Hardeman	10/9	11/24	11/4	-
Lawrence	10/13	11/14	10/28	11/20
Henry	10/17	11/21	10/23	11/17

elements among cultivars and growth stages. Combined analyses of variance were computed for each year to determine the effect of location. A combined analysis of variance was computed for both years to determine the differences between years as well as the effect of stages, locations, cultivars, and the more important interactions. Combining all locations and growth stages, analyses of variance were computed for each cultivar separately to determine if there were differences between location, stages, and interactions for each cultivar.

Because three growth stages were sampled in 1970 and only two in 1969, only the first two were included in the combined analysis. Only four replications and six locations were included in the combined analysis.

Because of the high amount of variation in nutrient concentrations of soils among plots at each location, analyses of coveriance were calculated at each location for each growth stage both in 1969 and 1970 where the regression coefficient was significant. When a significant difference was found among cultivars, the formula suggested by Finney (14) was used to obtain the standard error of the mean and Duncan's Multiple Range Test was used for all means separation.

All analyses of variance and coveriance were calculated as suggested by Goulden (24) and LeClerg, Leonard, and Clark (31).

CHAPTER IV

RESULTS

Soil Test Results

Soil samples were taken from each plot (each replication of each cultivar) at all locations and analyzed for pH level and the concentrations of various nutrients. Table 7 shows a frequency distribution of the number of plots at each location falling into various pH ranges. In 1969 more plots in Fayette and Henry Counties had high pH values than at other locations, and in 1970 more plots at Hardeman and Henry Counties were high. During both years the plots at the Henderson and Lauderdale locations were the most acid. In those counties where the plots were in the same field both years, the pH values were lower the second year.

Although the pH values covered a rather wide range from location to location, the soil test Ca concentrations were all in the high or very high categories. Average values for each location are shown in Figure 2. Where locations were the same both years, Ca concentrations were lower in 1970 than in 1969.

The available Mg concentrations (Figure 3) were very high at all locations except Lawrence County where they tested high. As with Ca, Mg concentrations tended to decrease from 1969 to 1970. At Henry they increased only slightly.

Figure 4 shows the average P concentration in soils at each location. There was more variation among locations in P concentration than with any of the other elements tested. The P concentration at

TABLE 7

PLOT FREQUENCY AND pH OF SOILS AT SEVEN LOCATIONS

Range	Locations and Number of Plots						
	Henderson	Lauderdale	Carroll	Hardeman	Henry	Fayette	Lawrence
1969							
8.5-8.0	0	0	0	0	0	0	
8.0-7.5	0	0	0	2	0	18	
7.5-7.0	0	0	8	5	59	22	
7.0-6.5	0	0	14	17	12	22	
6.5-6.0	14	7	13	36	1	10	
6.0-5.5	34	56	12	10	0	0	
5.5-5.0	24	9	1	2	0	0	
1970							
8.5-8.0	0	0	0	0	0	0	0
8.0-7.5	0	0	0	15	7	0	0
7.5-7.0	0	0	17	41	53	31	0
7.0-6.5	0	0	12	14	2	33	12
6.5-6.0	2	13	13	2	0	8	55
6.0-5.5	55	59	6	0	0	0	5
5.5-5.0	16	1	0	0	0	0	0

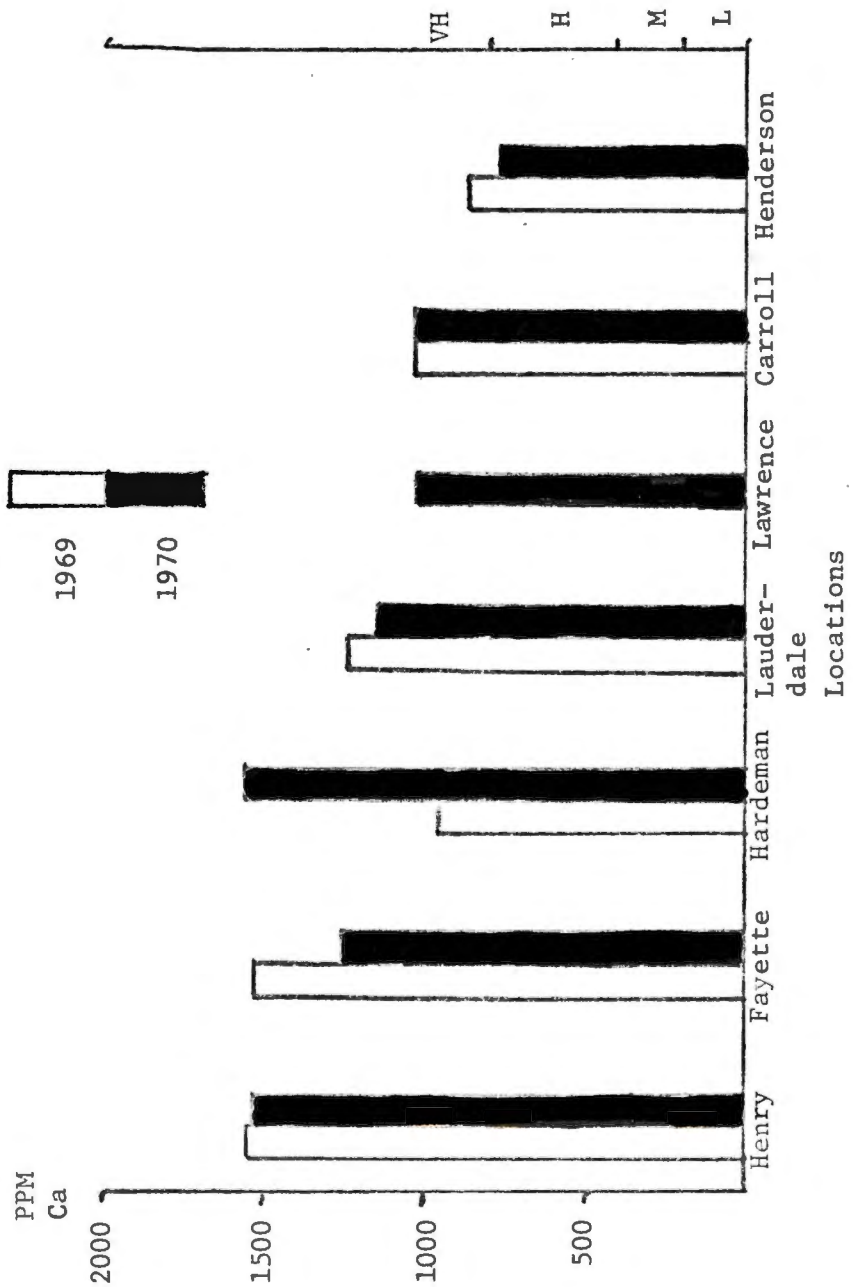


Figure 2. Mean soil calcium concentrations at seven locations in 1969 and 1970.

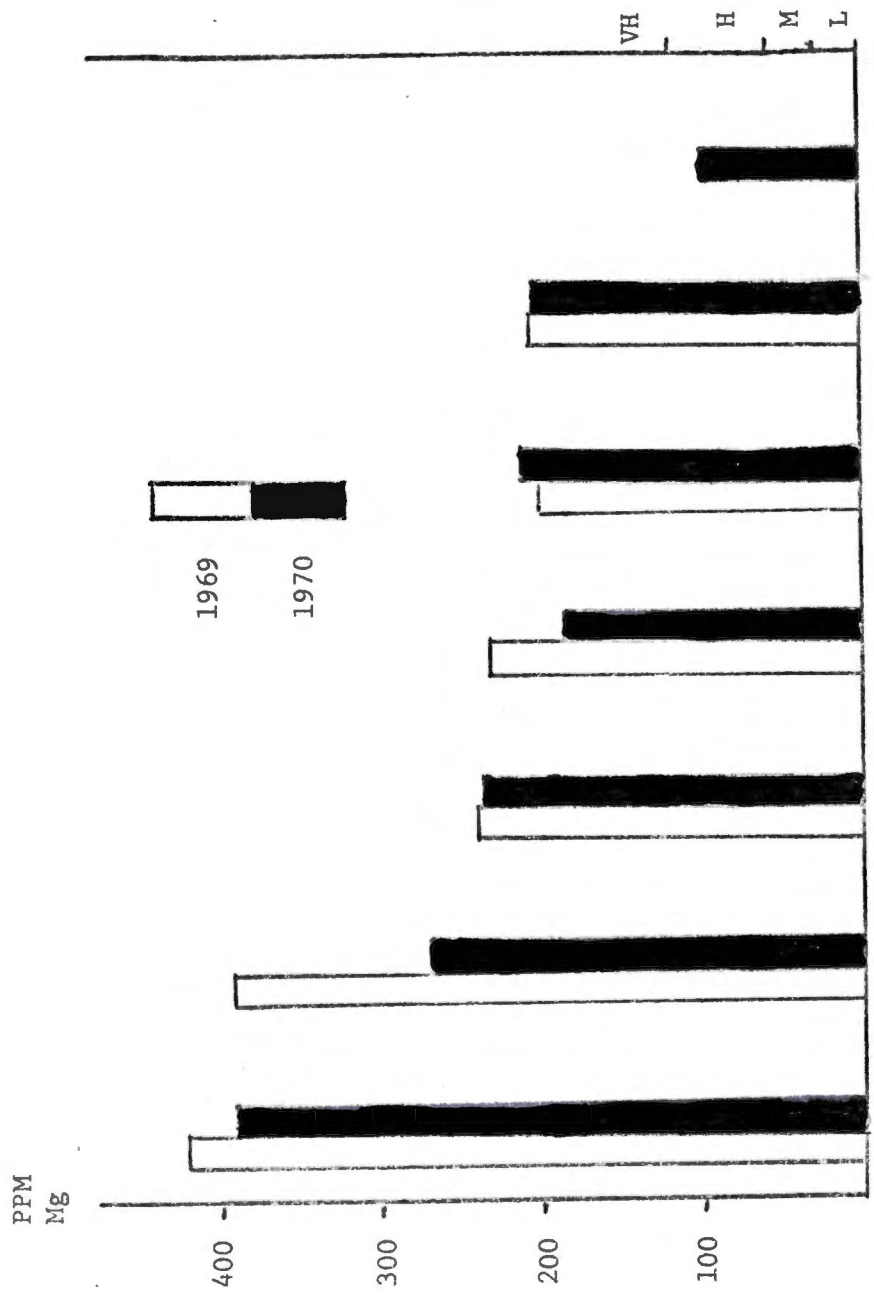


Figure 3. Mean soil magnesium concentrations at seven locations in 1969 and 1970.

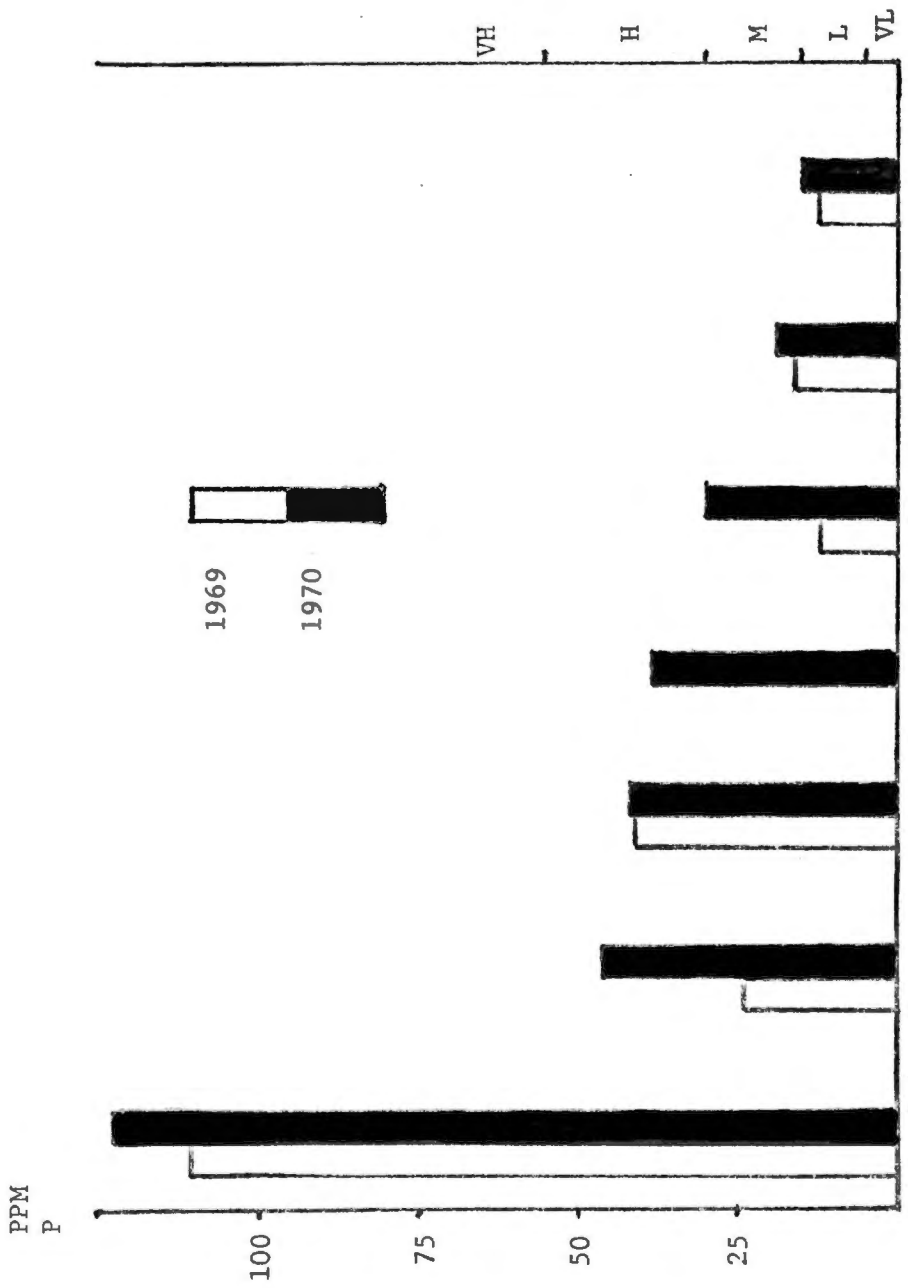


Figure 4. Mean soil phosphorus concentrations in soils at seven locations.

Lauderdale County was very high both years whereas at Hardeman County it was low both years. The soil at Henderson was low in 1969 but medium in 1970.

Figure 5 shows the levels of K at seven locations. The soil at Lawrence County was very high. Other locations tested medium or high both years except for Fayette County which was medium in 1969 and high in 1970.

Climatic Factors

Figures 6 and 7 show total monthly precipitation at the various locations. During July of 1969, rainfall at Carroll, Henderson, and Lauderdale remained rather low while Henry and Hardeman had higher amounts. During July of 1970, rainfall at Carroll, Henderson, and Lauderdale was greater than in July of 1969, while July rainfall at Fayette, Hardeman, and Henry was higher in 1969 than in 1970.

Average monthly temperatures are shown in Figures 8 and 9. Comparing locations and years, there was more variation among locations in May than any other month. During May of 1969, Henry and Henderson Counties had rather low average monthly temperatures. In May of 1970, Lawrence, Henry, and Carroll were colder than other locations.

Tissue Calcium Concentrations

Calcium concentrations differed significantly* among cultivars at different growth stages at some locations. Table 28, Appendix C

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*Unless otherwise specified, "significant" will refer to differences among means at the 0.05 level of probability, "highly significant" will refer to differences at the 0.01 level of probability.

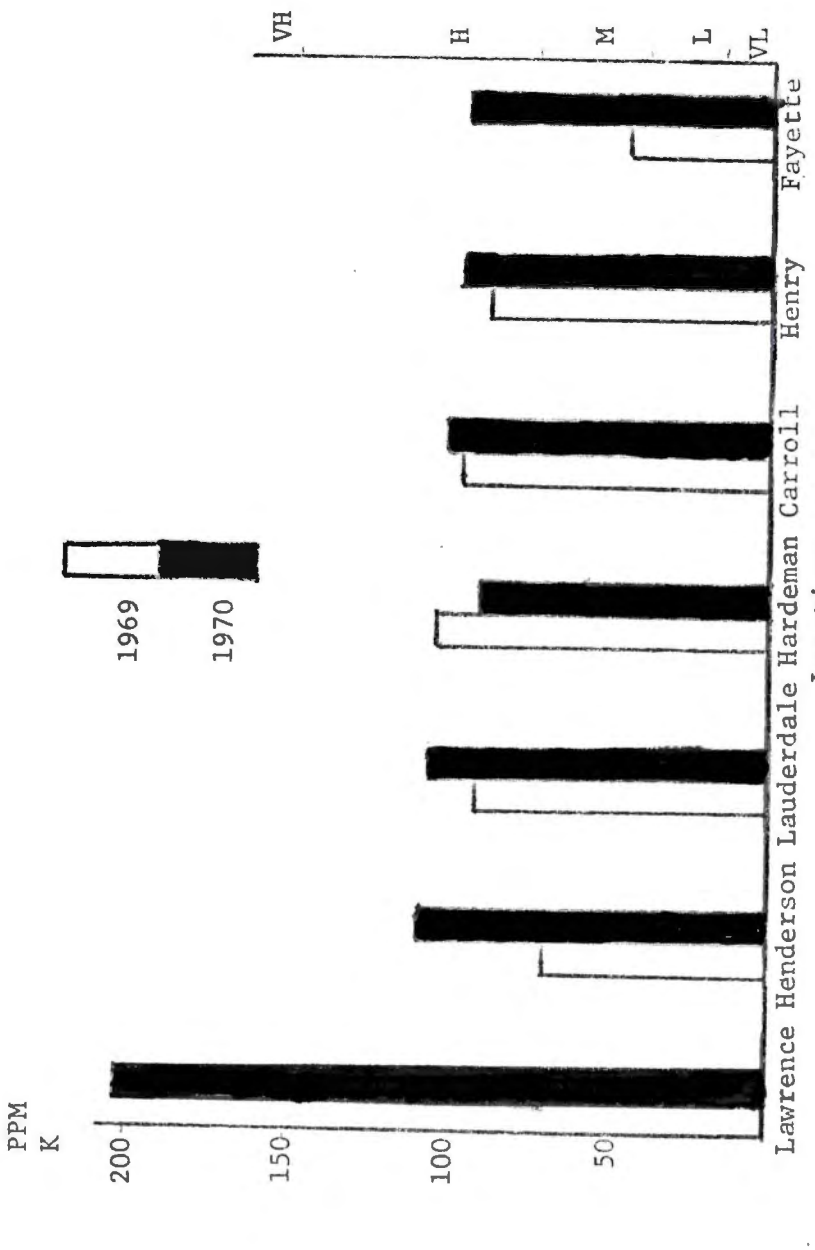

Figure 5. Mean potassium concentrations in soil at seven locations.

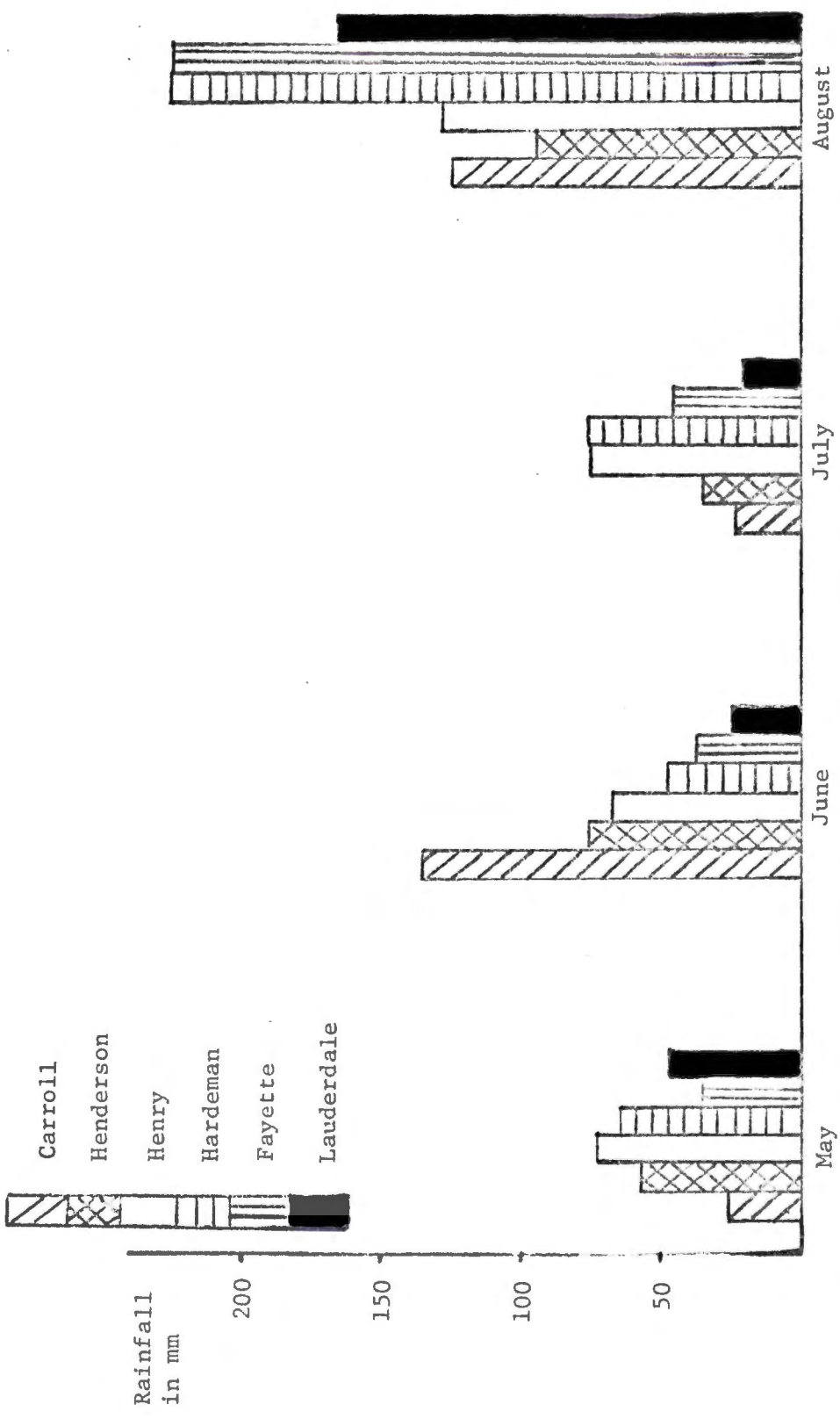

Figure 6. Rainfall (mm) at six locations in the 1969 cotton growing season.

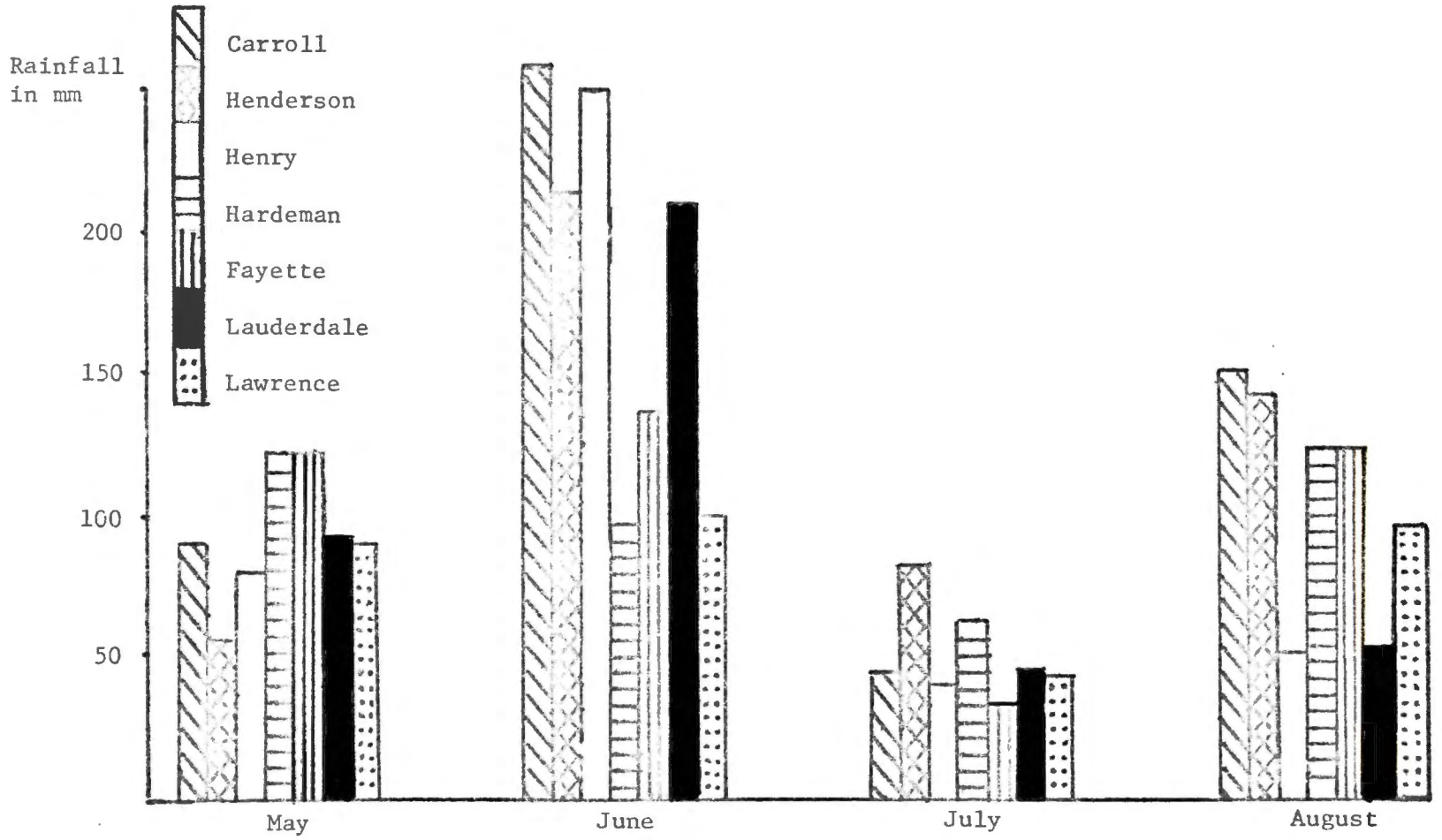

Figure 7. Rainfall (mm) at seven locations in the 1970 cotton growing season.

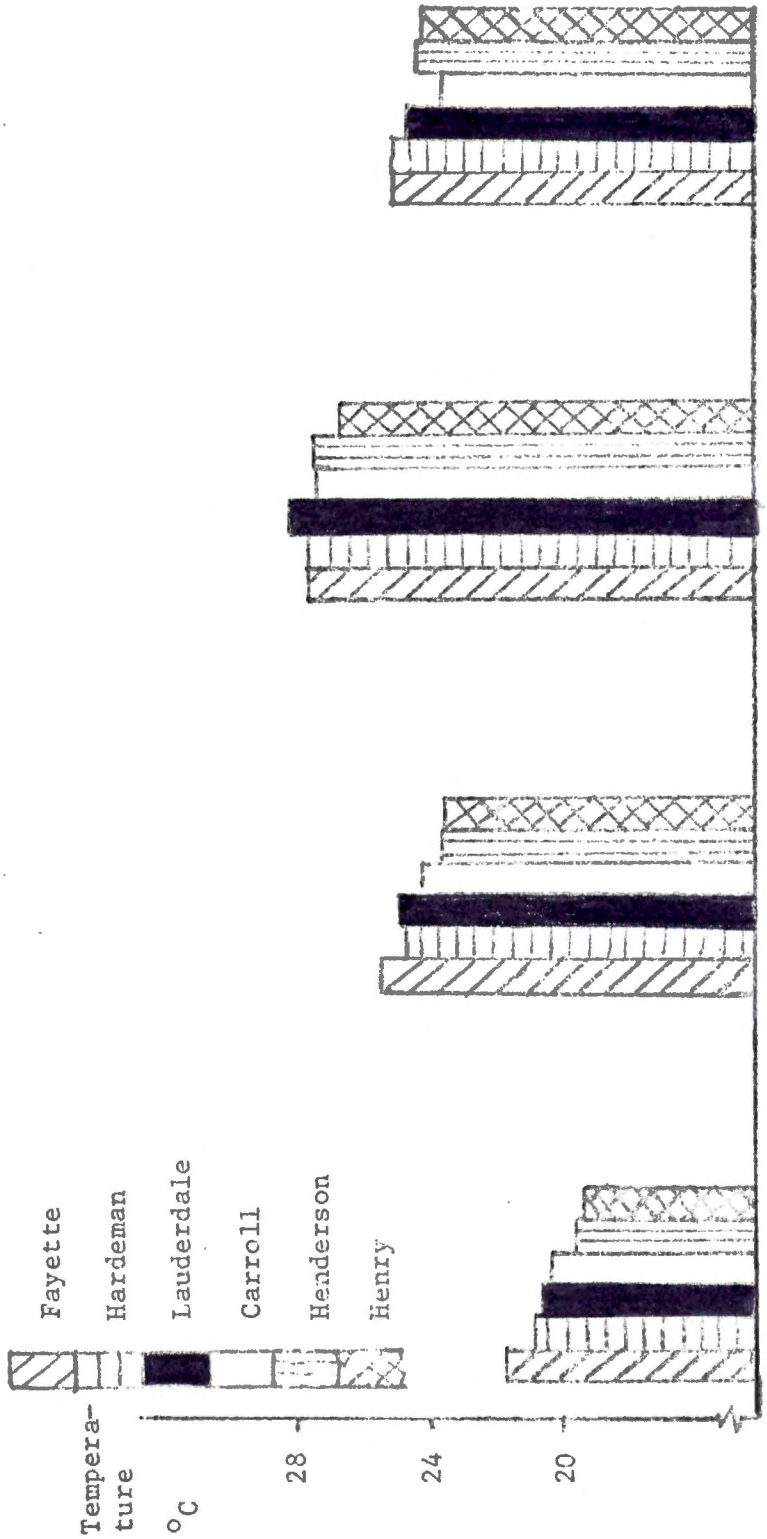

Figure 8. Average monthly temperature (celcius) at six locations in the 1969 cotton growing season.

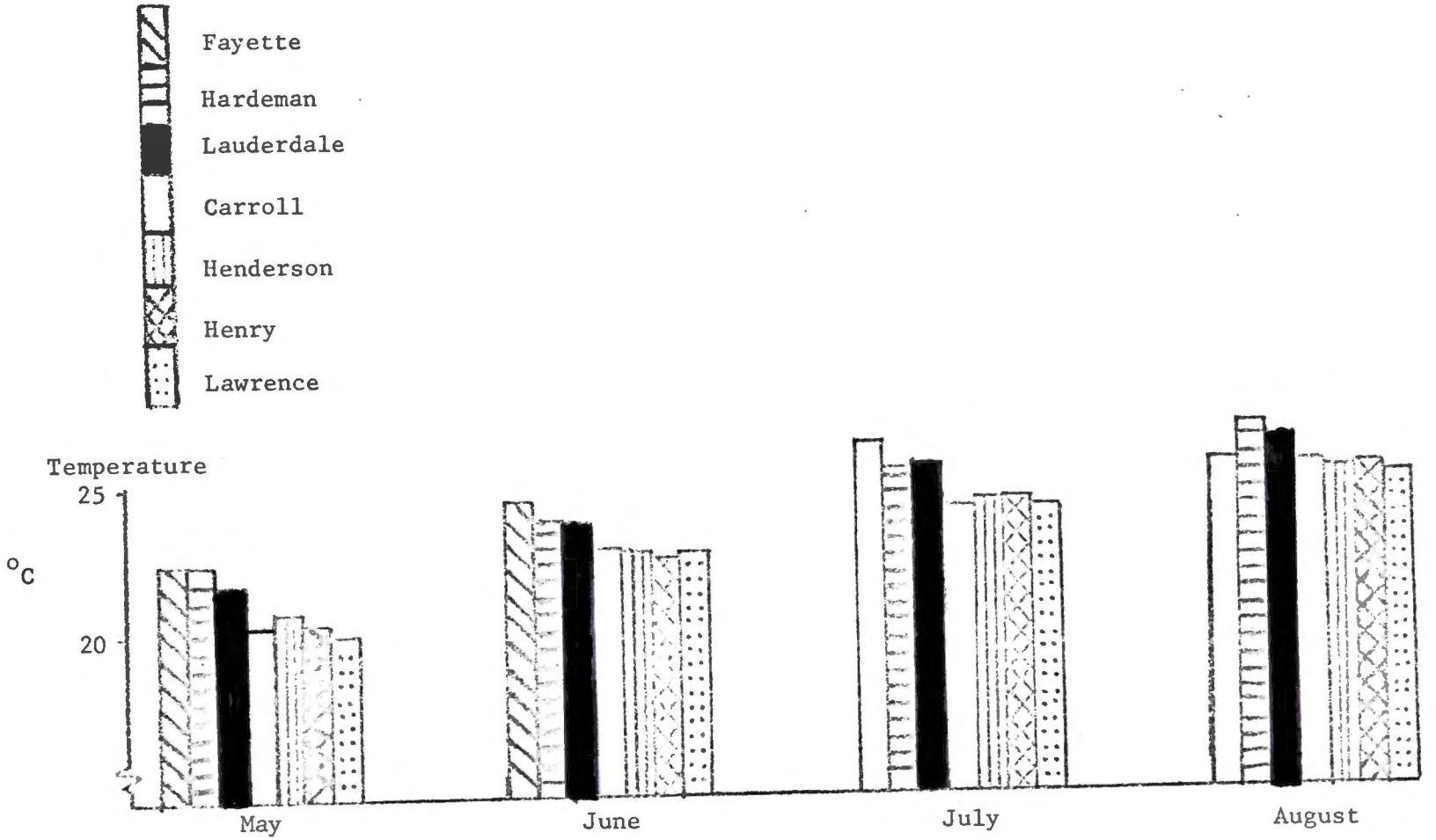

Figure 9. Average monthly temperature (celcius) at seven locations in the 1970 cotton growing season.

lists the growth stages and locations for each year and indicates where significant differences among cultivars occurred. More differences among cultivars occurred at the first growth stage. There were seven differences at the growth stage and only four at the second in the two years. In 1970 there were only two differences among cultivars at the second or third growth stage compared to four at the first.

Results from analyses of covariance show that significant regression ($P \leq 0.10$) occurred at eight of 33 tests. A greater number of positive regression tests were noted at the first growth stage than at the others. There were differences among cultivars in 13 of the 33 tests as indicated by analysis of variance, but the analysis of covariance revealed that cultivar adjusted mean values were significantly different in two additional tests. This brought the total to 15 tests which had differences among cultivars.

Table 8 shows that while Stoneville 213 was generally low in Ca concentration, Acala 1517D was usually high. This was also true for the adjusted means shown in Table 9.

Analysis of each location separately revealed that only Carroll County in 1969 and Lawrence County in 1970 had significant growth stages x cultivar interactions.

Results of combined analysis of the first two growth stages, six locations and two years are shown in Table 10. Acala 1517D possessed the highest Ca concentration and Stoneville 213 the lowest.

Table 29, Appendix C shows combined analyses for each year separately. There were differences among locations, cultivars, growth stages, and the location x growth stage interaction.

TABLE 8

MEAN CALCIUM CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AT SEVEN LOCATIONS IN 1969 AND 1970

Stage 1		Stage 2		Stage 3	
Cultivars	% Ca[1]	Cultivars	% Ca[1]	Cultivars	% Ca[1]
		1969 Fayette County			
Coker 417	1.97	AC 1517D	2.15		
DK 11	1.88	Coker 417	2.10		
Rex SL	1.73	Aub M	1.94		
DPL 45A	1.72	DPL 45A	1.93		
AC 1517D	1.69	DPL 16	1.93		
ST 508	1.67	ST 508	1.88		
Hancock	1.67	Hancock	1.85		
DPL 16	1.66	Rex SL	1.76		
Aub M	1.65	ST 213	1.63		
ST 213	1.43	DK 11	1.58		
Mean	1.71		1.88		
		1970 Fayette County			
Coker 417	2.34	AC 1517D	2.09	AC 1517D	1.90
AC 1517D	2.27	Coker 417	2.07	Rex SL	1.88
DK 11	2.22	Rex SL	1.99	Coker 417	1.87
Rex SL	2.15	Hancock	1.91	Aub M	1.84
DPL 45A	2.10	ST 603	1.91	ST 603	1.78
Aub M	1.92	DK 11	1.86	Hancock	1.76
ST 603	1.86	ST 213	1.76	DPL 45A	1.70
DPL 16	1.84	DPL 45A	1.72	DPL 16	1.70
ST 213	1.84	DPL 16	1.69	DK 11	1.69
Hancock	1.66	Aub M	1.60	ST 213	1.69
Mean	2.02		1.86		1.78
		1969 Henry County			
AC 1517D	2.59[a]	Aub M	1.86		
Rex SL	2.55[ab]	Rex SL	1.83		
DK 11	2.54[ab]	AC 1517D	1.81		
ST 508	2.49[abc]	DK 11	1.69		
Coker 417	2.41[abcd]	ST 508	1.69		
Aub M	2.39[abcd]	Hancock	1.65		
DPL 45A	2.38[abcd]	Coker 417	1.65		
Hancock	2.32[bcd]	DPL 16	1.60		
DPL 16	2.26[cd]	DPL 45A	1.57		
ST 213	2.18[d]	ST 213	1.53		
Mean	2.41		1.69		

TABLE 8 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Ca[1]	Cultivars	% Ca[1]	Cultivars	% Ca[1]
		1970 Henry County			
Aub M	2.58[a]	AC 1517D	2.31	AC 1517D	2.46
ST 603	2.45[ab]	Aub M	2.23	Coker 417	2.28
Hancock	2.44[ab]	Hancock	2.20	ST 603	2.23
Coker 417	2.39[abc]	Coker 417	2.16	Rex SL	2.13
Rex SL	2.33[abc]	ST 603	2.12	ST 213	2.08
DPL 16	2.29[abc]	Rex SL	2.12	Aub M	2.08
AC 1517D	2.14[abc]	DPL 16	2.08	Hancock	2.06
ST 213	2.12[bc]	ST 213	1.97	DPL 45A	1.98
DK 11	2.12[bc]	DK 11	1.97	DK 11	1.92
DPL 45A	2.08[c]	DPL 45A	1.95	DPL 16	1.90
Mean	2.29		2.11		2.11
		1969 Hardeman County			
AC 1517D	1.41	DPL 16	1.61		
Aub M	1.38	Aub M	1.55		
Coker 417	1.38	ST 508	1.47		
ST 508	1.35	DPL 45A	1.47		
Rex SL	1.34	AC 1517D	1.47		
Hancock	1.33	DK 11	1.42		
DPL 16	1.29	Hancock	1.33		
DK 11	1.29	Coker 417	1.32		
DPL 45A	1.26	ST 213	1.32		
ST 213	1.24	Rex SL	1.32		
Mean	1.31		1.43		
		1970 Hardeman County			
AC 1517D	2.10	Coker 417	1.98	AC 1517D	1.75
ST 603	1.89	Rex SL	1.97	DK 11	1.72
Aub M	1.82	Hancock	1.82	Aub M	1.72
Coker 417	1.75	ST 603	1.73	ST 603	1.70
DK 11	1.69	DPL 16	1.68	Coker 417	1.70
DPL 45A	1.67	DPL 45A	1.58	Hancock	1.50
Hancock	1.64	DK 11	1.58	ST 213	1.47
DPL 16	1.61	Aub M	1.52	DPL 45A	1.40
Rex SL	1.58	AC 1517D	1.48	Rex SL	1.40
ST 213	1.55	ST 213	1.38	DPL 16	1.32
Mean	1.73		1.67		1.57

TABLE 8 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Ca[1]	Cultivars	% Ca[1]	Cultivars	% Ca[1]
		1969 Henderson County			
AC 1517D	1.75	AC 1517D	1.82[a]		
ST 508	1.72	Aub M	1.76[ab]		
Hancock	1.66	Rex SL	1.74[ab]		
Rex SL	1.66	ST 508	1.71[ab]		
Coker 417	1.66	Coker 417	1.71[ab]		
Aub M	1.63	Hancock	1.67[abc]		
DPL 16	1.59	DK 11	1.64[abc]		
DPL 45A	1.58	DPL 16	1.58[bc]		
DK 11	1.56	DPL 45A	1.57[bc]		
ST 213	1.45	ST 213	1.44[c]		
Mean	1.63		1.66		
		1970 Henderson County			
Aub M	2.57[a]	ST 603	1.90	Aub M	1.83[a]
DK 11	2.49[a]	Aub M	1.89	Rex SL	1.74[ab]
AC 1517D	2.47[a]	Rex SL	1.87	ST 603	1.67[abc]
Hancock	2.45[a]	Coker 417	1.85	Coker 417	1.66[abc]
Rex SL	2.38[ab]	ST 603	1.84	DPL 16	1.63[bc]
DPL 16	2.25[abc]	ST 213	1.79	AC 1517D	1.61[bc]
Coker 417	2.37[abc]	DPL 16	1.76	Hancock	1.61[bc]
ST 603	2.31[abc]	Hancock	1.75	DK 11	1.59[bc]
DPL 45A	2.16[bc]	DK 11	1.68	DPL 45A	1.55[bc]
ST 213	2.14[c]	DPL 45A	1.65	ST 213	1.50[c]
Mean	2.36		1.80		1.64
		1969 Carroll County			
Rex SL	1.85[a]	Hancock	1.65[a]		
DK 11	1.84[a]	AC 1517D	1.63[a]		
ST 508	1.77[ab]	ST 508	1.62[ab]		
Coker 417	1.69[abc]	Aub M	1.60[ab]		
DPL 45A	1.67[abcd]	Rex SL	1.57[ab]		
DPL 16	1.64[bcd]	DPL 45A	1.55[ab]		
AC 1517D	1.62[bcd]	DPL 16	1.54[ab]		
Hancock	1.61[bcd]	DK 11	1.51[abc]		
Aub M	1.51[cd]	Coker 417	1.48[bc]		
ST 213	1.48[d]	ST 213	1.38[c]		
Mean	1.67		1.55		

TABLE 8 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Ca[1]	Cultivars	% Ca[1]	Cultivars	% Ca[1]
		1970 Carroll County			
Rex SL	2.70[a]	Rex SL	2.03[a]	Rex SL	1.63
Coker 417	2.50[ab]	Coker 417	1.97[a]	Aub M	1.60
DPL 16	2.42[abc]	DPL 16	1.94[ab]	ST 603	1.59
AC 1517D	2.32[abcd]	AC 1517D	1.86[abc]	DPL 45A	1.54
DPL 45A	2.30[abcd]	DPL 45A	1.80[abc]	DPL 16	1.48
Aub M	2.30[abcd]	ST 603	1.69[bc]	Coker 417	1.47
DK 11	2.27[abcd]	Hancock	1.66[c]	DK 11	1.43
ST 603	2.10[bcd]	DK 11	1.66[c]	Hancock	1.40
Hancock	1.92[cd]	Aub M	1.62[c]	AC 1517D	1.37
ST 213	1.90[d]	ST 213	1.61[c]	ST 213	1.28
Mean	2.27		1.78		1.48
		1969 Lauderdale County			
Aub M	1.85[a]	AC 1517D	1.73		
AC 1517D	1.84[a]	Rex SL	1.68		
Rex SL	1.84[a]	DK 11	1.59		
Hancock	1.84[a]	DPL 16	1.57		
DK 11	1.76[ab]	Aub M	1.57		
DPL 16	1.67[bc]	Coker 417	1.54		
DPL 45A	1.66[bc]	Hancock	1.53		
ST 508	1.66[bc]	ST 213	1.53		
Coker 417	1.62[bc]	ST 508	1.50		
ST 213	1.54[c]	DPL 45A	1.47		
Mean	1.73		1.57		
		1970 Lauderdale County			
Rex SL	2.02	Coker 417	1.87	ST 603	2.21
Aub M	1.96	Aub M	1.86	Rex SL	1.99
AC 1517D	1.96	ST 603	1.86	DK 11	1.98
Coker 417	1.86	AC 1517D	1.84	DPL 45A	1.94
Hancock	1.84	Rex SL	1.83	ST 213	1.92
ST 603	1.82	DPL 16	1.76	Aub M	1.86
DK 11	1.76	Hancock	1.68	DPL 16	1.85
DPL 16	1.75	DK 11	1.63	AC 1517D	1.85
DPL 45A	1.68	ST 213	1.59	Coker 417	1.83
ST 213	1.60	DPL 45A	1.55	Hancock	1.77
Mean	1.82		1.75		1.92

TABLE 8 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Ca[1]	Cultivars	% Ca[1]	Cultivars	% Ca[1]
		1970 Lawrence County			
AC 1517D	2.03^{a}	Coker 417	1.98	Aub M	2.00^{a}
Aub M	2.00^{ab}	Aub M	1.98	Rex SL	1.74^{b}
Coker 417	2.00^{ab}	DPL 16	1.88	ST 603	1.70^{bc}
DPL 16	1.92^{abc}	AC 1517D	1.87	AC 1517D	1.67^{bc}
Res SL	1.89^{bc}	ST 603	1.80	DPL 16	1.63^{bc}
DK 11	1.88^{bcd}	Rex SL	1.77	DK 11	1.62^{bc}
Hancock	1.82^{cd}	ST 213	1.76	Hancock	1.56^{bc}
ST 603	1.81^{cd}	Hancock	1.69	ST 213	1.55^{c}
DPL 45A	1.76^{d}	DPL 45A	1.67	Coker 417	1.55^{c}
ST 213	1.75^{d}	DK 11	1.65	DPL 45A	1.53^{c}
Mean	1.89		1.81		1.66

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 9

CALCIUM CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AND LOCATIONS IN 1969 AND 1970 ADJUSTED FOR SOIL CALCIUM CONTENT

1969 Stage 2		1970 Stage 2	
Cultivar	% Ca[1]	Cultivar	% Ca[1]
Henry County			
AC 1517D	1.84[a]	Aub M	2.27[a]
Rex SL	1.83[a]	AC 1517D	2.26[a]
Aub M	1.80[ab]	Hancock	2.23[ab]
DK 11	1.70[ab]	Rex SL	2.17[ab]
Coker 417	1.69[ab]	Coker 417	2.16[ab]
Hancock	1.65[ab]	ST 603	2.08[ab]
ST 508	1.63[ab]	DPL 16	2.06[ab]
DPL 16	1.63[ab]	DK 11	1.98[ab]
DPL 45A	1.60[ab]	ST 213	1.97[ab]
ST 213	1.57[b]	DPL 45A	1.91[b]
Carroll County			
Stage 1		Stage 1	
Cultivar	% Ca	Cultivar	% Ca
Rex SL	1.86[a]	Rex SL	2.72[a]
DK 11	1.78[a]	Coker 417	2.50[ab]
ST 508	1.74[a]	DPL 16	2.49[ab]
Coker 417	1.69[a]	DK 11	2.32[ab]
DPL 45A	1.69[a]	Aub M	2.31[ab]
AC 1517D	1.65[ab]	AC 1517D	2.30[bc]
Hancock	1.64[ab]	ST 603	2.20[bc]
DPL 16	1.62[ab]	DPL 45A	2.12[bc]
Aub M	1.56[ab]	Hancock	2.01[bc]
ST 213	1.45[b]	ST 213	1.77[c]

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 10

TISSUE CALCIUM CONCENTRATIONS OF TEN COTTON CULTIVARS FROM COMBINED ANALYSIS OF SIX LOCATIONS[1] AND FIRST TWO GROWTH STAGES

Cultivars	% Ca[2]
AC 1517D	1.91[a]
Rex SL	1.90[a]
DPL 16	1.90[a]
Coker 417	1.89[ab]
Aub M	1.87[ab]
[3]ST 508	1.86[ab]
DK 11	1.77[b]
Hancock	1.77[bc]
DPL 45A	1.74[c]
ST 213	1.62[d]

[1]Does not include Lawrence County.

[2]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

[3]ST 603 replaced ST 508 in 1970 and both were analyzed as the same cultivar.

When both years were included in the same combined analysis in Table 30, Appendix C, a difference was found between years. Additional differences were found among location x year and growth stage x year interactions.

Results of the combined analysis of variance of Ca concentrations for each cultivar calculated separately (Table 31, Appendix C) indicate that in 1969 there was a difference between growth stages for only five cultivars. Every cultivar had a significant growth stage x location interaction in one or both of the years.

Figures 10 and 11 and Table 11 show that Ca concentrations for each location, year, and growth stage as an average of all cultivars. Figures 10 and 11 show significant differences among growth stages while Table 11 shows statistical differences among locations.

Significant differences were found among growth stages at all locations except Henderson County in 1969 and Hardeman County in 1970. In 1969 the first growth stage was higher in Ca concentration than the second at only three locations. However, in 1970 the first growth stage was higher than the second at all locations. The third growth stage was never higher than the first but was higher than the second at Lauderdale County.

Cotton plants at the first growth stage had the highest Ca concentrations at Henry County in 1969 and at Henderson County in 1970. Fayette in 1969 and Henry in 1970 had the highest concentration at the second. At the third growth stage Henry County had the highest Ca concentrations. Average Ca concentrations were higher in 1970 than in 1969.

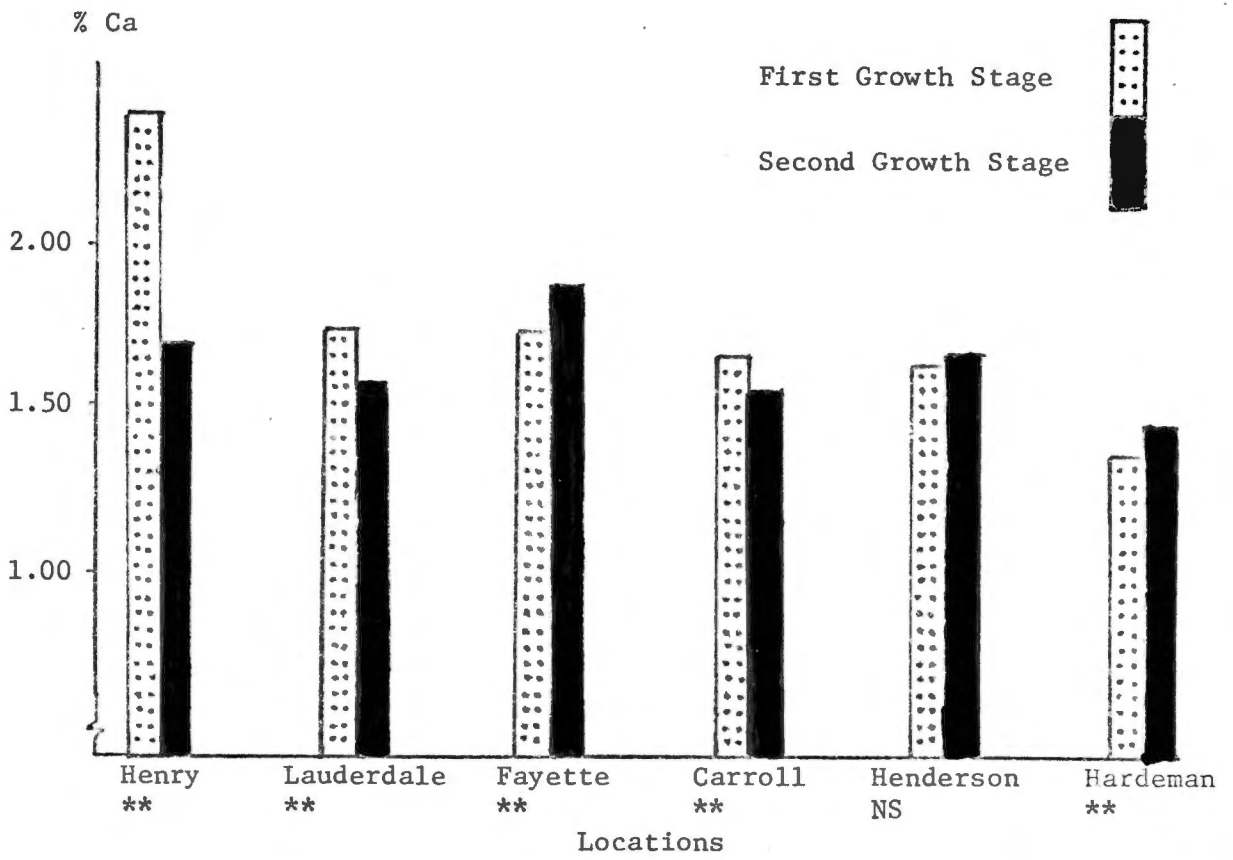

Figure 10. Mean concentrations of calcium in cotton petioles sampled at first (early bloom) and second growth stages (mid bloom) at six locations in 1969.

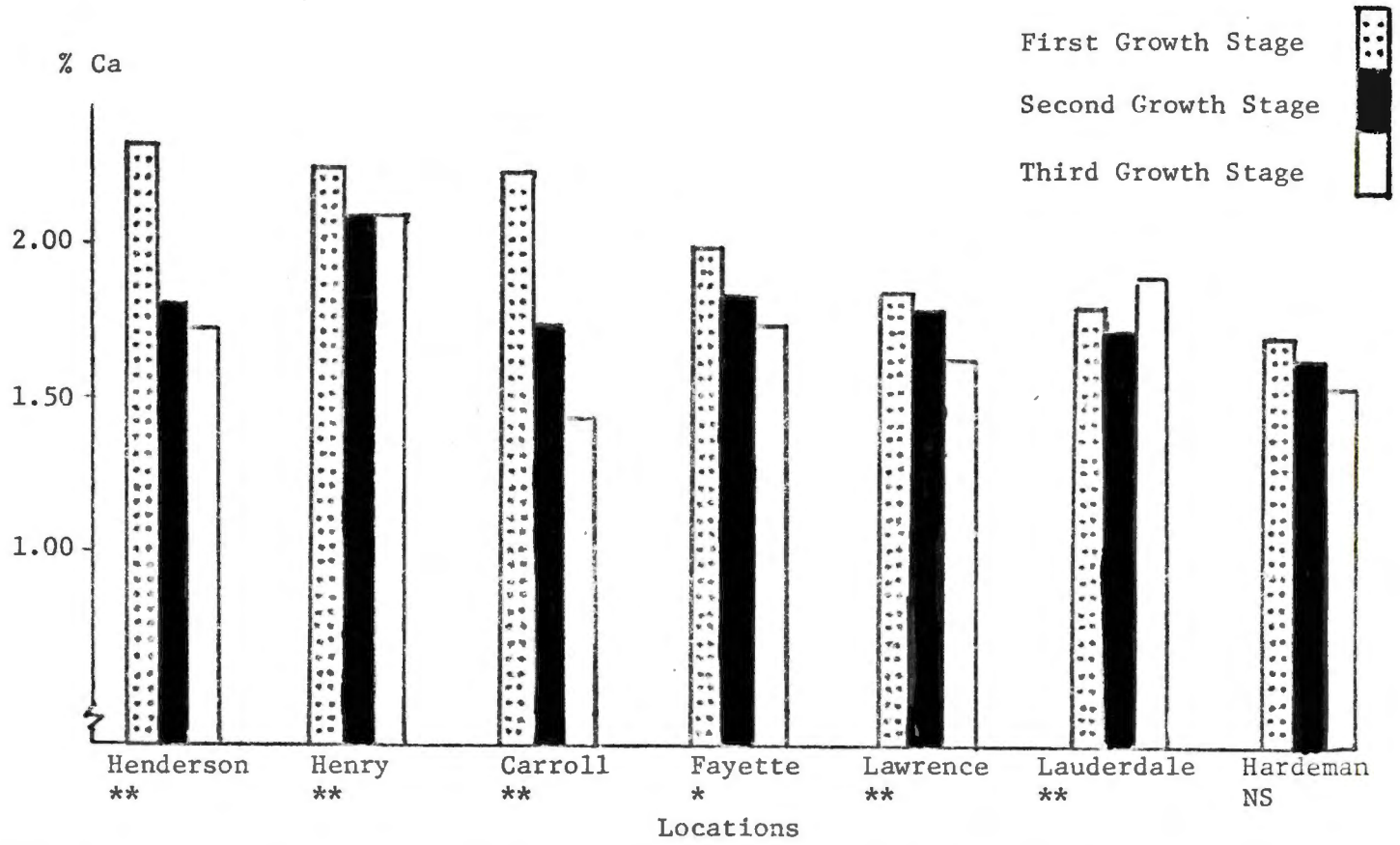

Figure 11. Mean concentrations of calcium in cotton petioles sampled at first (early bloom), second (mid bloom) and third growth stages (late bloom) at seven locations in 1970.

TABLE 11

MEAN[1] CALCIUM CONCENTRATIONS IN COTTON PETIOLES FOR DIFFERENT GROWTH STAGES AT SEVEN LOCATIONS

Stage 1		Stage 2		Stage 3	
Locations	% Ca[2]	Locations	% Ca[2]	Locations	% Ca[2]
1969					
Henry	2.41^{a}	Fayette	1.88^{a}		
Lauderdale	1.73^{b}	Henry	1.69^{ab}		
Fayette	1.71^{b}	Henderson	1.66^{ab}		
Carroll	1.67^{bc}	Lauderdale	1.57^{ab}		
Henderson	1.63^{bc}	Carroll	1.53^{ab}		
Hardeman	1.31^{c}	Hardeman	1.43^{b}		
Mean	1.75		1.63		
1970					
Henderson	2.36^{a}	Henry	2.11^{a}	Henry	2.11^{a}
Henry	2.29^{ab}	Fayette	1.86^{ab}	Lauderdale	1.92^{abc}
Carroll	2.27^{abc}	Lawrence	1.81^{ab}	Fayette	1.78^{bc}
Fayette	2.02^{abcd}	Henderson	1.80^{ab}	Lawrence	1.66^{bc}
Lawrence	1.89^{bcd}	Carroll	1.78^{ab}	Henderson	1.64^{bc}
Lauderdale	1.82^{cd}	Lauderdale	1.75^{b}	Hardeman	1.57^{bc}
Hardeman	1.73^{d}	Hardeman	1.67^{d}	Carroll	1.48^{c}
Mean	2.07		1.83		1.75

[1]Average of 10 cultivars.

[2]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

Tissue Magnesium Concentrations

Magnesium concentrations differed significantly among cultivars at different growth stages at some locations. Table 28, Appendix C, lists the growth stages and locations for each year and indicates where significant differences among cultivars occurred. More differences among cultivars occurred at the second growth stage than any other stage. In three instances differences existed at the first growth stage and six at the second in the two years. In 1970 four differences existed among cultivars at the third growth stage.

Results from analyses of covariance show that significant regression ($P \leq 0.10$) occurred at 13 of 33 tests. There was a greater number of positive regression tests at the first growth stage than at the others.

There were 11 of 33 tests which had differences among cultivars indicated by analysis of variance but analysis of covariance revealed that cultivar adjusted mean values were significantly different in three additional tests which brought the total to 14.

Table 12 shows that while Stoneville 213 was generally low in Mg concentration, Coker 417 was usually high. This was also the same for the adjusted means shown in Table 13.

Analysis of each location separately revealed that of all locations in both years only Hardeman and Lawrence Counties in 1970 had significant growth stage x cultivar interactions.

Results of combined analysis of two growth stages, six locations, and two years indicates that Coker 417 contained the highest concentration of Mg while Stoneville 213 had the lowest (Table 14).

TABLE 12

MEAN MAGNESIUM CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AT SEVEN LOCATIONS IN 1969 AND 1970

Stage 1		Stage 2		Stage 3	
Cultivars	% Mg[1]	Cultivars	% Mg[1]	Cultivars	% Mg[1]
		1969 Fayette County			
DK 11	.86[a]	Hancock	1.10[a]		
Res SL	.83[ab]	Rex SL	1.04[ab]		
Coker 417	.81[ab]	Coker 417	1.02[ab]		
Hancock	.76[abc]	ST 508	1.00[abc]		
ST 508	.74[abc]	DK 11	.98[abc]		
DPL 16	.73[abc]	DPL 45A	.97[abc]		
Aub M	.67[bc]	AC 1517D	.95[abc]		
AC 1517D	.65[c]	DPL 16	.94[bc]		
DPL 45A	.62[c]	Aub M	.88[bc]		
ST 213	.62[c]	ST 213	.85[c]		
Mean	.73		.98		
		1970 Fayette County			
DK 11	.96	Coker 417	.74[a]	DK 11	.64[a]
Coker 417	.95	DK 11	.72[a]	Aub M	.63[a]
DPL 45A	.89	Rex SL	.70[a]	Rex SL	.63[a]
Rex SL	.87	AC 1517D	.66[ab]	ST 213	.60[a]
AC 1517D	.87	Hancock	.63[ab]	Coker 417	.60[a]
Aub M	.83	ST 213	.63[ab]	AC 1517D	.59[a]
DPL 16	.80	ST 603	.57[bc]	Hancock	.58[a]
Hancock	.79	DPL 45A	.55[bc]	DPL 45A	.57[a]
ST 603	.78	Aub M	.50[bc]	ST 603	.57[a]
ST 213	.75	DPL 16	.48[c]	DPL 16	.47[b]
Mean	.85		.62		.59
		1969 Henry County			
Coker 417	.81	Coker 417	.80		
ST 508	.81	AC 1517D	.77		
DK 11	.81	DK 11	.74		
DPL 45A	.81	Rex SL	.73		
Rex SL	.81	Hancock	.73		
Hancock	.80	ST 508	.72		
AC 1517D	.78	DPL 45A	.71		
Aub M	.75	DPL 16	.68		
ST 213	.72	ST 213	.60		
DPL 16	.66	ST 213	.60		
Mean	.78		.72		

TABLE 12 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Mg[1]	Cultivars	% Mg[1]	Cultivars	% Mg[1]
		1970 Henry County			
ST 603	.79	Aub M	.82	Aub M	.82
Hancock	.74	Coker 417	.78	Coker 417	.77
Aub M	.74	DK 11	.75	DK 11	.76
Coker 417	.73	Rex SL	.73	Rex SL	.75
Rex SL	.70	AC 1517D	.72	AC 1517D	.73
DK 11	.70	ST 603	.72	ST 603	.71
DPL 16	.67	DPL 16	.71	Hancock	.71
ST 213	.64	Hancock	.69	DPL 16	.68
DPL 45A	.56	DPL 45A	.66	DPL 45A	.68
AC 1517D	.54	ST 213	.64	ST 213	.65
Mean	.68		.72		.73
		1969 Hardeman County			
Coker 417	.70	ST 508	.88		
ST 508	.68	DK 11	.86		
DK 11	.65	DPL 45A	.80		
DPL 45A	.64	DPL 16	.77		
DPL 16	.62	AC 1517D	.76		
Rex SL	.59	Rex SL	.68		
Hancock	.58	Hancock	.65		
AC 1517D	.57	Aub M	.64		
Aub M	.56	Coker 417	.63		
ST 213	.49	ST 213	.52		
Mean	.61		.72		
		1970 Hardeman County			
Hancock	.95	DPL 45A	1.17	Aub M	1.00
DPL 45A	.90	Hancock	1.05	Coker 417	.93
Aub M	.90	DPL 16	1.04	Hancock	.80
Coker 417	.89	Rex SL	1.01	AC 1517D	.79
AC 1517D	.87	AC 1517D	1.01	DK 11	.76
ST 603	.82	DK 11	.99	ST 603	.75
DK 11	.80	Aub M	.99	ST 213	.72
DPL 16	.79	ST 603	.96	Rex SL	.71
Hancock	.79	Coker 417	.95	DPL 16	.70
ST 213	.77	ST 213	.88	DPL 45A	.69
Mean	.85		1.00		.79

TABLE 12 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Mg[1]	Cultivars	% Mg[1]	Cultivars	% Mg[1]
		1969 Henderson County			
ST 508	1.12	ST 508	1.29[a]		
Coker 417	1.01	Coker 417	1.25[ab]		
Hancock	.98	DK 11	1.21[ab]		
DK 11	.94	Hancock	1.14[bc]		
Aub M	.92	Rex SL	1.12[bc]		
DPL 45A	.90	Aub M	1.07[cd]		
DPL 45A	.89	AC 1517D	1.05[cd]		
DPL 16	.89	AC 1517D	1.05[cd]		
Rex SL	.86	DPL 16	1.05[cd]		
AC 1517D	.84	DPL 45A	1.02[cd]		
ST 213	.82	ST 213	.97[d]		
Mean	.93		1.12		
		1970 Henderson County			
Rex SL	.97	DPL 45A	1.01	Coker 417	.93[a]
Coker 417	.97	Coker 417	.99	Rex SL	.87[ab]
AC 1517D	.96	Hancock	.95	Hancock	.86[ab]
Hancock	.93	Rex SL	.92	DPL 45A	.81[abc]
DK 11	.91	ST 213	.90	DK 11	.79[abc]
Aub M	.90	DPL 16	.86	Aub M	.78[abc]
DPL 45A	.86	DK 11	.86	DPL 16	.75[abc]
ST 213	.86	Aub M	.82	AC 1517D	.74[bc]
ST 603	.83	ST 603	.81	ST 603	.71[c]
DPL 16	.81	AC 1517D	.81	ST 213	.67[c]
Mean	.90		.89		.79
		1969 Carroll County			
Coker 417	.88[a]	Coker 417	.95[a]		
Rex SL	.83[ab]	DPL 45A	.90[abc]		
ST 508	.78[abc]	ST 508	.87[abc]		
DK 11	.77[abc]	AC 1517D	.85[abc]		
DPL 45A	.75[bc]	Hancock	.83[abc]		
DPL 45A	.75[bc]	DK 11	.82[bc]		
Hancock	.72[bcd]	Rex SL	.81[bc]		
AC 1517D	.67[cd]	DPL 16	.80[bc]		
ST 213	.64[cd]	Aub M	.76[cd]		
Aub M	.63[d]	ST 213	.65[d]		
Mean	.74		.82		

TABLE 12 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Mg[1]	Cultivars	% Mg[1]	Cultivars	% Mg[1]
		1970 Carroll County			
Rex SL	.99	DK 11	.88[a]	DK 11	.88[a]
DPL 16	.95	Coker 417	.86[a]	Coker 417	.81[ab]
Coker 417	.92	Rex SL	.86[a]	DPL 45A	.78[ab]
DK 11	.89	DPL 45A	.83[ab]	Aub M	.78[ab]
DPL 45A	.82	Hancock	.82[ab]	Rex SL	.78[ab]
Aub M	.81	DPL 16	.81[ab]	DPL 16	.74[abc]
AC 1517D	.77	AC 1517D	.70[ab]	Hancock	.72[abc]
Hancock	.72	ST 213	.69[ab]	ST 603	.68[bc]
ST 603	.69	Aub M	.68[ab]	ST 213	.59[c]
ST 213	.69	ST 603	.63[b]	AC 1517D	.58[c]
Mean	.83		.78		.74
		1969 Lauderdale County			
ST 508	1.11	ST 508	1.01		
DK 11	1.07	DK 11	.95		
Hancock	1.06	Hancock	.94		
Rex SL	1.01	AC 1517D	.91		
AC 1517D	.99	Coker 417	.91		
Coker 417	.98	Rex SL	.89		
DPL 45A	.97	DPL 45A	.85		
Aub M	.90	ST 213	.81		
DPL 16	.90	DPL 16	.77		
ST 213	.89	Aub M	.75		
Mean	.99		.88		
		1970 Lauderdale County			
AC 1517D	.65	DPL 45A	.74	Rex SL	.72
DPL 16	.64	DPL 16	.68	ST 603	.72
ST 213	.62	DK 11	.67	DPL 45A	.70
Hancock	.61	Coker 417	.66	Aub M	.68
DPL 45A	.60	Rex SL	.64	DK 11	.68
Aub M	.60	Aub M	.63	Hancock	.67
Coker 417	.58	ST 603	.62	AC 1517D	.67
DK 11	.55	AC 1517D	.62	ST 213	.65
ST 603	.54	Hancock	.60	Coker 417	.64
Rex SL	.49	ST 213	.55	DPL 16	.63
Mean	.59		.64		.68

TABLE 12 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Mg[1]	Cultivars	% Mg[1]	Cultivars	% Mg[1]
		1970 Lawrence County			
Coker 417	.59	Coker 417	.58	Aub M	.56[a]
DK 11	.59	DK 11	.56	DK 11	.53[a]
AC 1517D	.54	Aub M	.56	Rex SL	.52[a]
Aub M	.54	AC 1517D	.53	ST 603	.46[b]
ST 603	.50	DPL 16	.52	DPL 16	.46[b]
DPL 16	.50	ST 603	.48	Coker 417	.46[b]
Rex SL	.50	Hancock	.48	Hancock	.43[bc]
Hancock	.49	ST 213	.46	DPL 45A	.43[bc]
DPL 45A	.46	DPL 45A	.46	AC 1517D	.41[bc]
ST 213	.43	Rex SL	.46	ST 213	.39[c]
Mean	.51		.51		.47

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 13

MAGNESIUM CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AND LOCATIONS IN 1969 AND 1970 ADJUSTED FOR SOIL CALCIUM CONTENT

Stage 1		Stage 2		Stage 3	
Cultivars	% Mg[1]	Cultivars	% Mg[1]	Cultivars	% Mg[1]
		1969 Carroll County			
Coker 417	.83[a]	ST 508	.91[a]		
Rex SL	.82[ab]	Coker 417	.89[a]		
ST 508	.80[ab]	DPL 45A	.88[a]		
DK 11	.77[ab]	AC 1517D	.85[ab]		
DPL 16	.75[abc]	DK 11	.85[ab]		
DPL 45A	.74[abc]	Hancock	.83[ab]		
Hancock	.74[abc]	DPL 16	.83[ab]		
AC 1517D	.70[bc]	Rex SL	.81[abc]		
Aub M	.64[c]	Aub M	.74[bc]		
ST 213	.64[c]	ST 213	.66[c]		
		1970 Carroll County			
Rex SL	1.00[a]			DK 11	.87[a]
DPL 16	.95[a]			DPL 45A	.82[a]
Coker 417	.93[ab]			Coker 417	.81[ab]
DK 11	.88[ab]			Aub M	.79[ab]
Aub M	.83[ab]			Rex SL	.76[ab]
DPL 45A	.82[ab]			Hancock	.72[ab]
AC 1517D	.78[ab]			DPL 16	.71[ab]
Hancock	.72[ab]			ST 603	.65[ab]
ST 603	.70[ab]			ST 213	.62[b]
ST 213	.66[b]			AC 1517D	.60[b]
		1969 Hardeman County			
ST 508	.69[a]	ST 508	.86[a]		
Coker 417	.68[ab]	DK 11	.86[ab]		
DK 11	.64[abc]	DPL 45A	.81[abc]		
DPL 45A	.64[abc]	AC 1517D	.81[abc]		
DPL 16	.61[abcd]	DPL 16	.76[abc]		
Rex SL	.59[abcd]	Rex SL	.67[abc]		
Hancock	.58[abcd]	Hancock	.66[abc]		
AC 1517D	.57[bcd]	Aub M	.65[abc]		
Aub M	.56[cd]	Coker 417	.60[bc]		
ST 213	.53[d]	ST 213	.57[c]		

TABLE 13 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Mg[1]	Cultivars	% Mg[1]	Cultivars	% Mg[1]
		1969 Lauderdale County			
ST 508	1.10[a]				
DK 11	1.07[ab]				
Hancock	1.04[ab]				
Rex SL	1.02[ab]				
DPL 45A	.99[abc]				
AC 1517D	.98[abc]				
Coker 417	.98[abc]				
Aub M	.93[abc]				
DPL 16	.91[bc]				
ST 213	.86[c]				
		1969 Henderson County			
ST 508	1.09[a]				
Coker 417	1.02[ab]				
Hancock	.96[ab]				
DPL 45A	.95[ab]				
Aub M	.92[ab]				
DPL 16	.91[ab]				
DK 11	.90[ab]				
Rex SL	.88[ab]				
AC 1517D	.85[b]				
ST 213	.81[b]				

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 14

TISSUE MAGNESIUM CONCENTRATIONS OF TEN COTTON CULTIVARS FROM COMBINED ANALYSIS OF SIX LOCATIONS[1] AND THE FIRST TWO GROWTH STAGES

Cultivars	% Mg[2]
Coker 417	.86[a]
DK 11	.85[a]
[3]ST 508	.84[a]
Rex SL	.84[ab]
DPL 45A	.82[ab]
Hancock	.82[b]
Aub M	.78[b]
AC 1517D	.78[b]
DPL 16	.77[bc]
ST 213	.70[c]

[1]Does not include Lawrence County.

[2]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

[3]ST 603 replaced ST 508 in 1970 and both were analyzed as the same cultivar.

Data in Table 29, Appendix C, showing the combined analysis for each year separately, indicates that highly significant differences were found between locations, cultivars, stages, and location x growth stage interactions. In 1970 there were also differences among location x cultivar interactions.

When both years were included in the same combined analysis (Table 30, Appendix C), additional significant differences were found between years and among several of the interactions involving years.

When locations and stages were combined in separate analyses for each cultivar, some cultivars (Table 31, Appendix C) had differences among growth stages and interactions while others did not. Rex Smooth Leaf and Auburn M were the only cultivars which did not have differences among growth stages in either year.

Figures 12 and 13 and Table 15 show the Mg concentrations for each location, year, and growth stage as an average of all cultivars. Figures 12 and 13 show significant differences among growth stages while Table 15 shows statistical differences among locations.

Significant differences were found among growth stages at all locations in both of the two years. In 1969 the growth stage was higher in Mg concentration than the second at only two locations. In 1970 the first growth stage was higher than the second at three locations. The third growth stage was higher than the first and second at two locations.

Cotton plants at the first growth stage had the highest Mg concentrations at Lauderdale County in 1969 and at Henderson County in 1970. Henderson in 1969 and Hardeman in 1970 had the highest

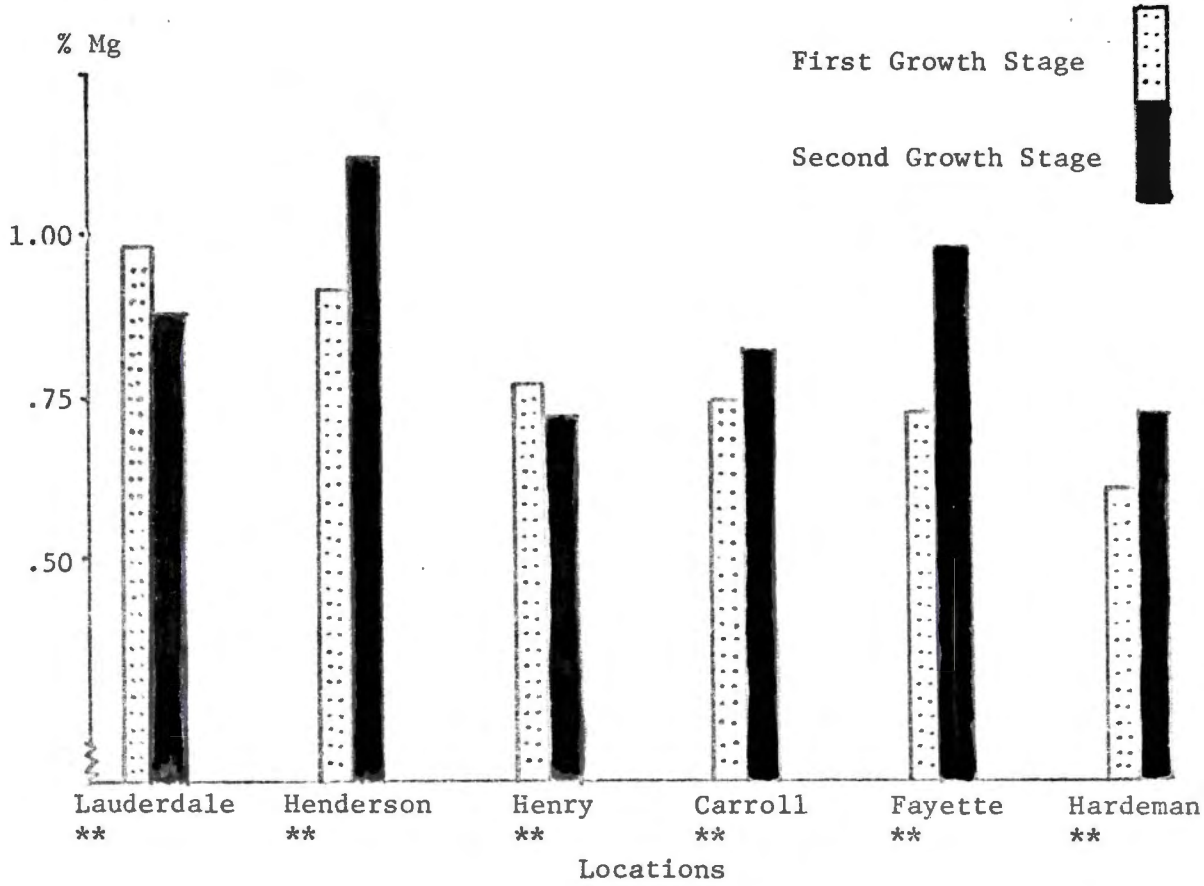

Figure 12. Mean concentrations of magnesium in cotton petioles sampled at first (early bloom) and second growth stages (mid bloom) at six locations in 1969.

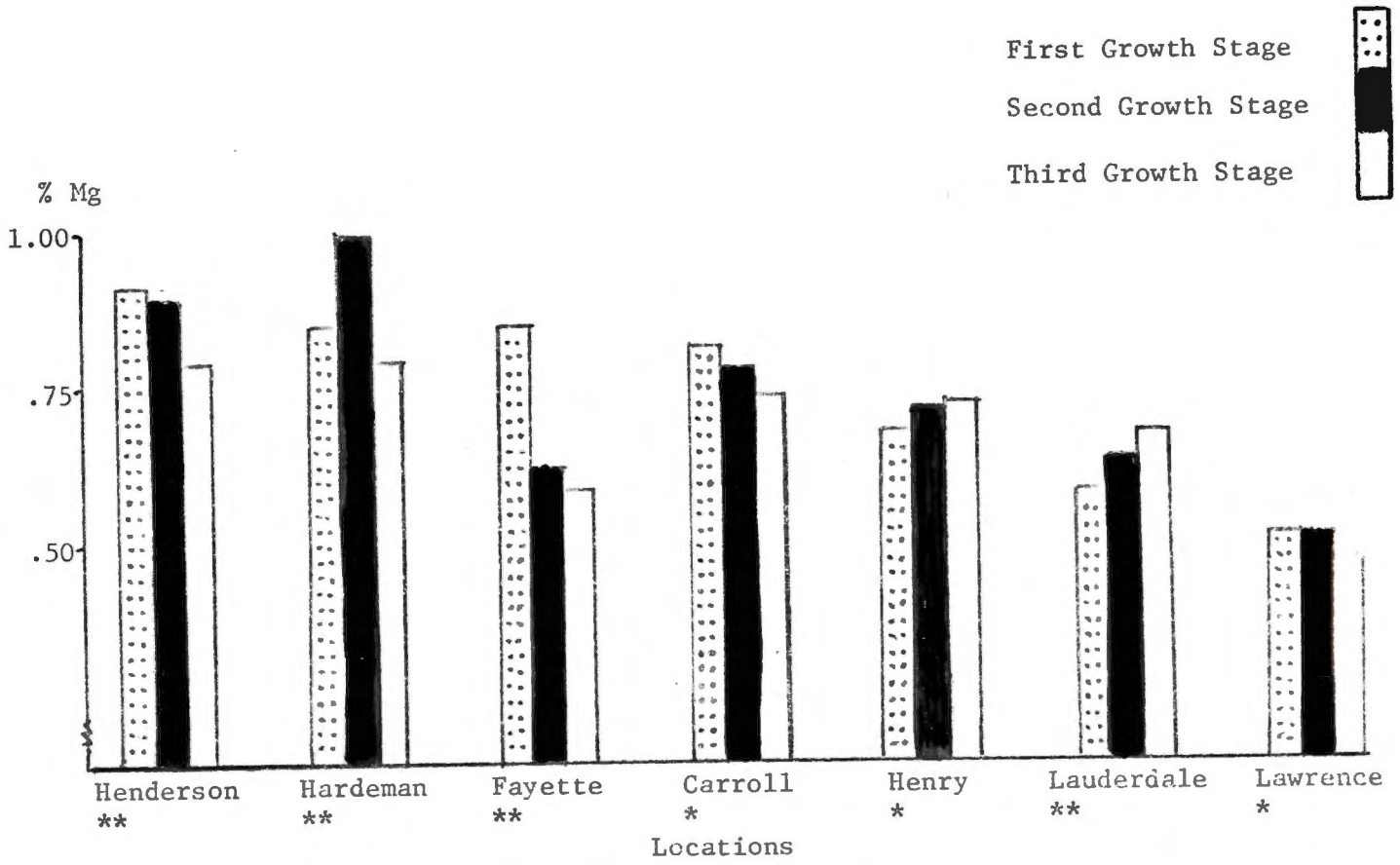

Figure 13. Mean concentrations of magnesium in cotton petioles sampled at first (early bloom), second (mid bloom) and third growth stages (late bloom) at seven locations in 1970.

TABLE 15

MEAN CONCENTRATIONS OF MAGNESIUM FOR DIFFERENT GROWTH STAGES AT SEVEN LOCATIONS

Stage 1		Stage 2		Stage 3	
Locations	% Mg[1]	Locations	% Mg[1]	Locations	% Mg[1]
1969					
Lauderdale	.99^{a}	Henderson	1.12^{a}		
Henderson	.93^{ab}	Fayette	.98^{ab}		
Henry	.78^{bc}	Lauderdale	.88^{bc}		
Carroll	.74^{bc}	Carroll	.82^{bc}		
Fayette	.73^{c}	Hardeman	.72^{c}		
Hardeman	.61^{c}	Henry	.72^{c}		
Mean	.80		.87		
1970					
Henderson	.90^{a}	Hardeman	1.00^{a}	Henderson	.79^{a}
Hardeman	.85^{ab}	Henderson	.89^{ab}	Hardeman	.79^{a}
Fayette	.85^{ab}	Carroll	.78^{abc}	Carroll	.74^{ab}
Carroll	.83^{ab}	Henry	.72^{bc}	Henry	.73^{ab}
Henry	.68^{bc}	Lauderdale	.64^{cd}	Lauderdale	.68^{ab}
Lauderdale	.59^{c}	Fayette	.62^{cd}	Fayette	.59^{bc}
Lawrence	.51^{c}	Lawrence	.51^{d}	Lawrence	.47^{c}
Mean	.74		.74		.68

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

concentration at the second. Henderson and Hardeman Counties had the highest Mg concentration at the third growth stage. On the average Mg concentrations were higher in 1969 than in 1970.

Tissue Potassium Concentration

Potassium concentrations differed significantly among cultivars at different growth stages at some locations. Table 28, Appendix C, lists the growth stages and locations for each year and indicates where significant differences among cultivars occurred. More differences occurred among cultivars at the second growth stage than any others. There were four differences at the second growth stage while only one in the first stage in both years. In 1970 there were two differences among cultivars for the third growth stage compared to three at the second and none in the first.

Results from analyses of covariance show that significant regression ($P \leq 0.10$) occurred at 22 of the 33 tests. There was a greater number of positive regression tests at the first growth stage than at the others.

There were seven of 33 tests which had differences among cultivars as indicated by analysis of variance, but use of the analysis of covariance revealed that cultivar adjusted mean values were different in three additional tests. This brought the total to 11 tests which had differences among cultivars.

Table 16 shows that while Deltapine 45A was generally low in K concentration, Stoneville 508 and 603 were usually high. This was also the same for the adjusted means shown in Table 17.

TABLE 16

MEAN POTASSIUM CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AT SEVEN LOCATIONS IN 1969 AND 1970

Stage 1		Stage 2		Stage 2	
Cultivars	% K[1]	Cultivars	% K[1]	Cultivars	% K[1]
		1969 Fayette County			
ST 508	2.63	DK 11	1.81		
Coker 417	1.37	AC 1517D	1.67		
DK 11	2.35	ST 213	1.37		
Hancock	2.28	Coker 417	1.37		
AC 1517D	2.24	ST 508	1.31		
DPL 16	2.20	Aub M	1.28		
ST 213	2.16	Hancock	1.26		
Aub M	2.14	DPL16	1.25		
DPL 45A	2.09	Rex SL	.98		
Rex SL	2.08	DPL 45A	.95		
Mean	2.25		1.33		
		1970 Fayette County			
ST 603	4.40	ST 603	3.06	ST 603	2.72
Aub M	4.08	ST 213	3.03	Coker 417	2.46
Rex SL	3.79	Rex SL	3.00	Rex SL	2.42
Coker 417	3.73	DK 11	2.95	ST 213	2.41
ST 213	3.70	Coker 417	2.90	DPL 45A	2.37
AC 1517D	3.66	AC 1517D	2.78	AC 1517D	2.37
DPL 45A	3.66	Aub M	2.77	DPL 16	2.21
DPL 16	3.61	DPL 45A	1.69	Aub M	2.20
DK 11	3.40	DPL 16	2.68	Hancock	2.16
Hancock	3.37	Hancock	2.65	DK 11	2.08
Mean	3.74		2.85		2.34
		1969 Henry County			
DPL 16	5.21	ST 508	3.04		
ST 508	5.01	Aub M	2.96		
ST 213	4.90	ST 213	2.83		
Rex SL	4.80	Coker 417	2.75		
Coker 417	4.77	DK 11	2.70		
Hancock	4.75	Hancock	2.61		
AC 1517D	4.48	DPL 16	2.56		
Aub M	4.45	Rex SL	2.46		
DK 11	4.43	AC 1517D	2.29		
DPL 45A	4.03	DPL 45A	1.99		
Mean	4.68		2.62		

TABLE 16 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% K[1]	Cultivars	% K[1]	Cultivars	% K[1]
		1970 Henry County			
Coker 417	4.42	Coker 417	2.89	Coker 417	2.33
ST 603	4.12	AC 1517D	2.81	ST 603	2.30
ST 213	3.89	ST 603	2.80	Hancock	2.27
DPL 45A	3.88	DK 11	2.79	AC 1517D	2.24
DK 11	3.74	Hancock	2.75	DPL 45A	2.02
Hancock	2.65	ST 213	2.75	DK 11	1.92
DPL 16	3.52	DPL 45A	2.57	ST 213	1.91
Aub M	3.40	Rex SL	2.33	Rex SL	1.89
AC 1517D	3.24	DPL 16	2.31	Aub M	1.80
Rex SL	3.17	Aub M	2.30	DPL 16	1.75
Mean	3.70		2.63		2.04
		1969 Hardeman County			
Rex SL	4.60	DK 11	3.89		
ST 213	4.40	Coker 417	3.31		
Hancock	4.37	Hancock	3.20		
AC 1517D	4.14	DPL 16	3.18		
ST 508	4.09	Rex SL	3.16		
DK 11	4.03	ST 213	3.14		
DPL 45A	3.94	ST 508	3.03		
Aub M	3.87	DPL 45A	3.00		
DPL 16	3.85	AC 1517D	2.94		
Coker 417	3.73	Aub M	2.93		
Mean	4.10		3.08		
		1970 Hardeman County			
ST 203	3.95	Coker 417	2.17	ST 603	2.42
ST 213	3.28	DPL 45A	1.75	Hancock	2.41
DK 11	3.15	Rex SL	1.58	AC 1517D	2.39
Coker 417	3.02	ST 213	1.51	DK 11	2.33
AC 1517D	3.00	Hancock	1.43	ST 213	2.27
DPL 16	2.95	DPL 16	1.42	Aub M	2.17
Aub M	2.92	DK 11	1.26	Coker 417	2.07
Rex SL	2.91	AC 1517D	1.16	Rex SL	1.96
DPL 45A	2.87	Aub M	1.12	DPL 45A	1.88
Hancock	2.84	ST 603	1.11	Dpl 16	1.73
Mean	3.09		1.45		2.16

TABLE 16 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% K[1]	Cultivars	% K[1]	Cultivars	% K[1]
		1969 Henderson County			
Hancock	4.09[a]	Hancock	2.75[a]		
Aub M	4.01[ab]	ST 213	2.65[ab]		
Rex SL	4.00[ab]	Rex SL	2.64[ab]		
AC 1517D	3.92[abc]	Aub M	2.58[ab]		
ST 213	3.84[bcd]	Coker 417	2.40[ab]		
DK 11	3.80[cd]	DPL 45A	2.38[abc]		
DPL 45A	3.79[cd]	AC 1517D	2.29[abc]		
ST 508	3.76[cd]	DK 11	2.28[abc]		
Coker 417	3.73[d]	ST 508	2.18[bc]		
DPL 16	3.54[e]	DPL 16	1.94[c]		
Mean	3.85		2.41		
		1970 Henderson County			
DPL 16	4.11	ST 603	3.19[a]	ST 603	2.56[a]
Hancock	4.00	AC 1517D	2.59[b]	Aub M	2.32[ab]
ST 603	3.87	ST 213	2.57[b]	AC 1517D	2.29[ab]
Coker 417	3.86	Coker 417	2.33[b]	ST 213	2.15[b]
DK 11	3.76	DK 11	2.30[b]	Coker 417	2.15[b]
ST 213	3.74	Aub M	2.28[b]	DK 11	2.12[b]
Aub M	3.64	DPL 16	2.27[b]	DPL 45A	2.12[b]
DPL 45A	3.48	Hancock	2.26[b]	DPL 16	2.08[b]
AC 1517D	3.37	DPL 45A	2.19[b]	Hancock	2.05[b]
Rex SL	3.00	Rex SL	2.18[b]	Rex SL	2.04[b]
Mean	3.68		2.41		2.19
		1969 Carroll County			
ST 508	4.80	ST 213	3.45		
ST 213	4.70	Hancock	3.17		
Rex SL	4.58	Aub M	3.06		
DK 11	4.48	DPL 45A	3.01		
AC 1517D	4.25	Rex SL	2.96		
DPL 45A	4.04	DK 11	2.94		
Aub M	4.02	AC 1517D	2.91		
Coker 417	4.01	ST 508	2.89		
DPL 16	3.71	Coker 417	2.82		
Hancock	3.60	DPL 16	2.76		
Mean	4.22		3.00		

TABLE 16 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% K[1]	Cultivars	% K[1]	Cultivars	% K[1]
		1970 Carroll County			
ST 603	5.09	ST 603	3.53	ST 603	3.37
ST 213	4.75	AC 1517D	3.25	Rex SL	3.27
Aub M	4.67	Hancock	3.24	Aub M	2.85
Hancock	4.55	Aub M	3.14	Hancock	2.85
DPL 16	4.11	ST 213	3.14	ST 213	2.77
Coker 417	4.06	Coker 417	3.13	Coker 417	2.72
Rex SL	3.92	Rex SL	3.06	DK 11	2.51
DK 11	3.89	DPL 45A	2.93	DPL 16	2.47
AC 1517D	3.60	DK 11	2.88	DPL 45A	2.43
DPL 45A	3.29	DPL 16	2.59	AC 1517D	2.25
Mean	4.20		3.09		2.75
		1969 Lauderdale County			
AC 1517D	3.71	DK 11	2.86		
DK 11	3.66	ST 508	2.76		
Rex SL	3.65	Coker 417	2.69		
ST 508	3.51	Aub M	2.63		
Hancock	3.43	Rex SL	2.56		
Coker 417	3.35	ST 213	2.49		
Aub M	3.33	DPL 45A	2.47		
ST 213	3.28	Hancock	2.35		
DPL 16	3.24	DPL 16	2.33		
DPL 45A	3.11	AC 1517D	2.27		
Mean	3.43		2.54		
		1970 Lauderdale County			
ST 603	3.35	ST 603	3.06^{a}	DK 11	3.09
DK 11	3.07	ST 213	2.64^{ab}	DPL 16	3.01
Aub M	3.06	DK 11	2.56^{ab}	ST 603	2.98
AC 1517D	3.03	Rex SL	2.55^{ab}	Coker 417	2.89
ST 213	3.01	Aub M	2.49^{b}	Rex SL	2.87
DPL 45A	3.01	Hancock	2.38^{b}	ST 213	2.82
Rex SL	2.98	Coker 417	2.37^{b}	Aub M	2.78
Hancock	2.91	DPL 16	2.22^{b}	DPL 45A	2.76
DPL 16	2.90	AC 1517D	2.16^{b}	Hancock	2.62
Coker 417	2.72	DPL 45A	1.99^{b}	AC 1517D	2.61
Mean	3.00		2.44		2.84

TABLE 16 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% K[1]	Cultivars	% K[1]	Cultivars	% K[1]
		1970 Lawrence County			
DK 11	4.63	Coker 417	4.36^{a}	DK 11	3.75^{a}
Coker 417	4.44	ST 603	3.91^{ab}	Rex SL	3.67^{a}
Hancock	4.37	ST 213	3.82^{ab}	ST 603	3.59^{ab}
ST 213	4.36	Hancock	3.63^{bc}	ST 213	3.56^{ab}
Rex SL	4.34	Aub M	3.63^{bc}	AC 1517D	3.46^{ab}
DPL 45A	4.32	DPL 45A	3.61^{bc}	Coker 417	3.38^{abc}
DPL 16	4.16	DPL 16	3.75^{bc}	DPL 45A	3.34^{abc}
AC 1517D	4.14	Rex SL	3.51^{bc}	Hancock	3.34^{abc}
ST 603	3.91	DK 11	3.42^{bc}	DPL 16	3.17^{bc}
Aub M	3.68	AC 1517D	3.10^{c}	Aub M	2.90^{c}
Mean	4.23		3.66		3.42

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 17

POTASSIUM CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AND LOCATIONS IN 1969 AND 1970 ADJUSTED FOR SOIL POTASSIUM CONTENT

Stage 1		Stage 2		Stage 3	
Cultivars	% K[1]	Cultivars	% K[1]	Cultivars	% K[1]
		Henderson County			
		1969		1970	
		Rex SL	2.73^{a}	ST 603	2.60^{a}
		Hancock	2.71^{a}	ST 603	2.60^{ab}
		ST 213	2.65^{a}	Aub M	2.22^{ab}
		ST 213	2.65^{ab}	AC 1517D	2.22^{ab}
		Aub M	2.55^{ab}	DPL 45A	2.19^{ab}
		Coker 417	2.41^{ab}	ST 213	2.18^{ab}
		AC 1517D	2.33^{ab}	Coker 417	2.15^{b}
		ST 508	2.26^{ab}	DK 11	2.09^{b}
		DPL 45A	2.24^{ab}	Hancock	2.08^{b}
		DK 11	2.22^{ab}	Rex SL	2.07^{b}
		DPL 16	1.98^{b}	DPL 16	2.05^{b}
1970 Hardeman County		1969 Henry County			
ST 603	3.85^{a}	Coker 417	3.21^{a}		
ST 213	3.30^{ab}	ST 508	2.81^{b}		
DK 11	3.10^{ab}	DPL 16	2.73^{bc}		
AC 1517D	3.09^{ab}	ST 213	2.63^{c}		
Rex SL	3.01^{b}	DK 11	2.63^{c}		
DPL 16	3.01^{b}	Aub M	2.63^{c}		
Coker 417	2.95^{b}	AC 1517D	2.52^{cd}		
Hancock	2.89^{b}	Hancock	2.38^{d}		
DPL 45A	2.85^{b}	Rex SL	2.36^{d}		
Aub M	2.83^{b}	DPL 45A	2.27^{d}		
1970 Carroll County		1970 Lauderdale County			
ST 603	5.18^{a}	ST 603	2.82^{a}		
ST 213	4.99^{a}	ST 213	2.66^{ab}		
Aub M	4.39^{ab}	DK 11	2.65^{ab}		
Hancock	4.29^{ab}	Rex SL	2.54^{ab}		
DPL 16	4.21^{ab}	Aub M	2.53^{ab}		
Rex SL	4.18^{ab}	Hancock	2.47^{ab}		
Coker 417	4.04^{ab}	Coker 417	2.34^{ab}		
DK 11	3.99^{ab}	DPL 16	2.20^{ab}		
AC 1517D	3.35^{b}	DPL 45A	2.17^{ab}		
DPL 45A	3.33^{b}	AC 1517D	2.03^{b}		

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

Analysis of each location separately revealed that in 1969 Hardeman County and in 1970 Fayette County were the only locations where there was a significant stage x cultivar interaction.

Results of the combined analysis of two growth stages, six locations and both years (Table 18) indicated that Stoneville 508 and Stoneville 603 contained the highest concentration of K while Deltapine Smooth Leaf contained the lowest.

Table 29, Appendix C, with combined analyses for 1969 and 1970 separately indicates that highly significant differences were found between locations, growth stages, and location x stage interactions in both years.

When both years were included in the same combined analysis in Table 30, Appendix C, a significant difference was found between years. The location x year interaction was also significant.

Table 31, Appendix C, reveals that differences among growth stages and locations were highly significant for all cultivars when locations and growth stages were combined in separate analyses for each cultivar. All cultivars except Rex Smooth Leaf 66, Hancock and Deltapine 45A had significant location x stage interactions in either one or two years.

Figures 14 and 15 and Table 19 show the K concentrations for each location, year, and growth stage as an average of all cultivars. Figures 14 and 15 show significant differences among growth stages while Table 19 shows statistical differences among locations.

Significant differences were found among growth stages at all locations in both years. The first growth stage had a higher K

TABLE 18

TISSUE POTASSIUM CONCENTRATIONS OF TEN COTTON CULTIVARS FROM COMBINED ANALYSIS OF SIX LOCATIONS AND THE FIRST TWO GROWTH STAGES

Cultivars	% K[1]
[2]ST 508	3.47[a]
ST 213	3.26[ab]
Rex SL	3.14[b]
Aub M	3.10[b]
Coker 417	3.09[bc]
Hancock	3.08[bc]
AC 1517D	3.03[bc]
DK 11	3.02[c]
DPL 16	2.97[c]
DPL 45A	2.87[c]

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

[2]ST 603 replaced ST 508 in 1970. The two cultivars are analyzed as one in combined analysis.

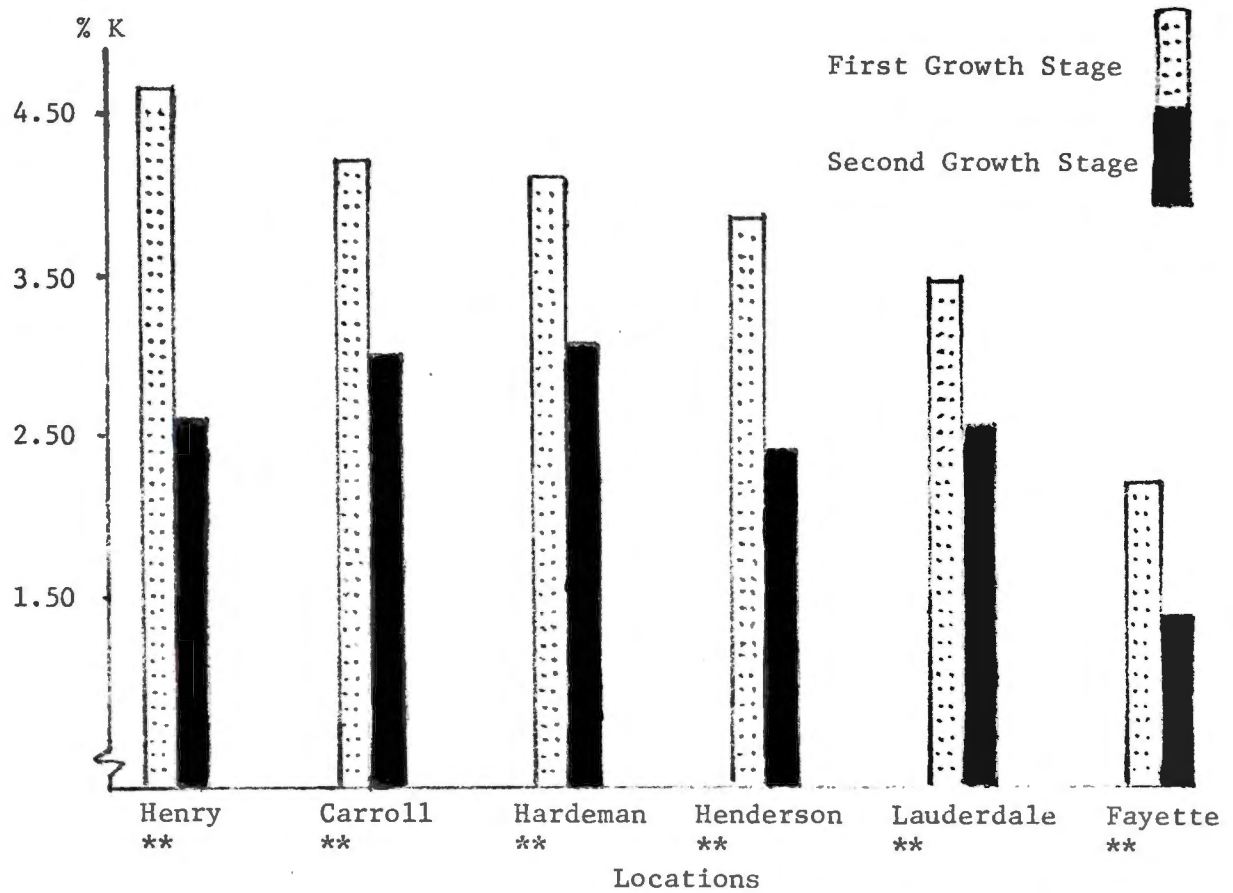

Figure 14. Mean concentrations of potassium in cotton petioles sampled at first (early bloom) and second growth stages (mid bloom) at six locations in 1969.

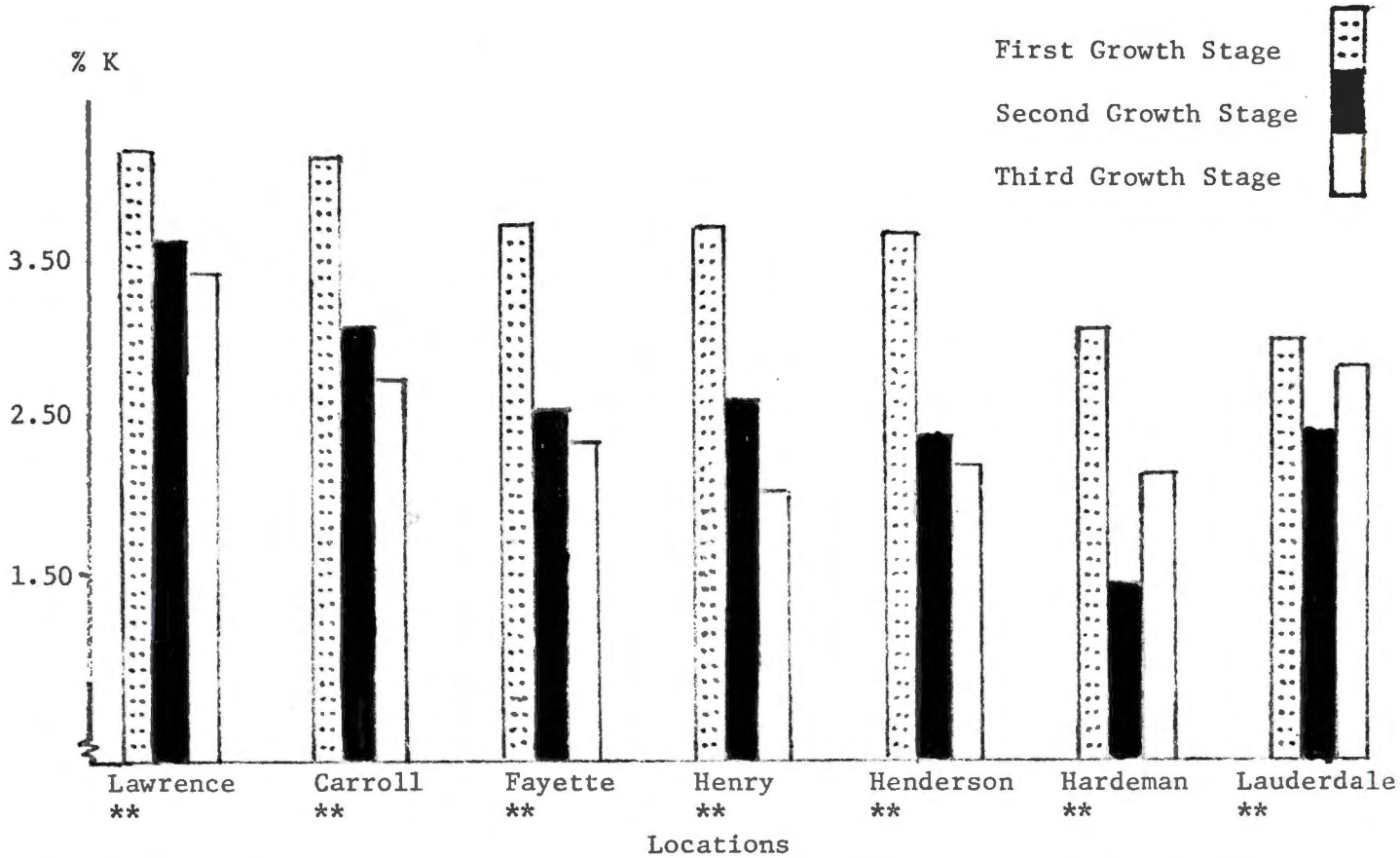

Figure 15. Mean concentrations of potassium in cotton petioles sampled at first (early bloom), second (mid bloom) and third growth stages (late bloom) at seven locations in 1970.

TABLE 19

MEAN POTASSIUM CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AND LOCATIONS IN 1969 AND 1970

Stage 1		Stage 2		Stage 3	
Location	% K[1]	Location	% K[1]	Location	% K[1]
1969					
Henry	4.68^{a}	Hardeman	3.08^{a}		
Carroll	4.22^{ab}	Carroll	3.00^{a}		
Hardeman	4.10^{ab}	Henry	2.62^{a}		
Henderson	3.85^{ab}	Lauderdale	2.54^{a}		
Lauderdale	3.43^{b}	Henderson	2.41^{a}		
Fayette	2.25^{c}	Fayette	1.33^{b}		
Mean	3.75		2.50		
1970					
Lawrence	4.23^{a}	Lawrence	3.66^{a}	Lawrence	3.42^{a}
Carroll	4.20^{a}	Carroll	3.09^{ab}	Lauderdale	2.84^{ab}
Fayette	3.74^{ab}	Fayette	2.85^{b}	Carroll	2.75^{abc}
Henry	3.70^{ab}	Henry	2.63^{b}	Fayette	2.34^{bc}
Henderson	3.68^{ab}	Lauderdale	2.44^{b}	Henderson	2.19^{bc}
Hardeman	3.09^{b}	Henderson	2.41^{b}	Hardeman	2.16^{bc}
Lauderdale	3.00^{b}	Hardeman	1.45^{c}	Henry	2.04^{c}
Mean	3.66		2.65		2.54

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

concentration than the second at all locations in both 1969 and 1970. The third growth stage was higher than the second at Hardeman and Lauderdale Counties.

Cotton plants at the first growth stage had the highest K concentration at Henry County in 1969 and at Lawrence County in 1970. Hardeman in 1969 and Lawrence in 1970 had the highest concentration at the second. Lawrence County had the highest K concentration at the third growth stage.

On the average, K concentrations at the first growth stage were higher in 1969 than in 1970. However, at the second growth stage, 1970 was higher than 1969.

Tissue Phosphorus Concentrations

Phosphorus concentrations differed significantly among cultivars at different growth stages at some locations. Table 28, Appendix C, lists the growth stages and locations for each year and indicates where significant differences among cultivars occurred. More differences among cultivars occurred in the second growth stage than any other stage. There were three differences at the first growth stage and four at the second in the two years. In 1970 there were three differences at the third stage.

Results from analyses of coveriance show that significant regression ($P \leq 0.10$) occurred at ten of 33 tests.

There were ten of 33 tests which had significant differences among cultivars as indicated by analysis of variance, but the analysis of covariance revealed that cultivar adjusted mean values were different

in one additional test. This brought the total to 11 tests which had significant differences among cultivars.

Table 20 shows that while Deltapine 45A was generally low in P, Acala 1517D was usually high. This was also the same for the adjusted means shown in Table 21.

Analysis of each location separately revealed that in 1969 and 1970 no growth stage x cultivar interactions were significant.

Results of combined analysis of two growth stages, six locations, and both years, shown in Table 22, indicate that Acala 1517D had the highest concentration of P and Deltapine Smooth Leaf the lowest.

Table 29, Appendix C, with a combined analysis for each year separately indicates that there were significant differences between locations, cultivars, growth stages, and locations x growth stages in both years. In 1970 the cultivar x growth stage interaction was significant. Additional significant interactions (Table 30, Appendix C) were locations x years, growth stages x years, and cultivars x years.

Table 31, Appendix C, reveals that locations were significant for all cultivars when locations and growth stages were combined in separate analyses for each cultivar. In 1969 all cultivars had differences between growth stages but not in 1970. Those cultivars which had significant growth stage x location interactions in 1969 did not in 1970.

Figures 16 and 17 and Table 23 show the P concentrations for each location, year, and growth stage as an average of all cultivars. Figures 16 and 17 show significant differences among growth stages while Table 23 shows statistical differences among locations.

TABLE 20

MEAN PHOSPHORUS CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AT SEVEN LOCATIONS IN 1969 AND 1970

Stage 1		Stage 2		Stage 3	
Cultivars	% P[1]	Cultivars	% P[1]	Cultivars	% P[1]
		1969 Fayette County			
ST 508	.14	AC 1517D	.11[a]		
AC 1517D	.13	Hancock	.10[ab]		
DK 11	.13	Rex SL	.09[abc]		
Coker 417	.12	DPL 16	.09[abc]		
Aub M	.12	ST 508	.09[abc]		
Rex SL	.12	DK 11	.09[abc]		
Hancock	.11	ST 213	.08[abc]		
ST 213	.11	Aub M	.08[bc]		
DPL 45A	.11	DPL 45A	.08[c]		
DPL 16	.10	Coker 417	.08[c]		
Mean	.12		.09		
		1970 Fayette County			
Aub M	.16[a]	ST 603	.18[a]	AC 1517D	.23
ST 603	.15[ab]	AC 1517D	.17[a]	ST 603	.21
Rex SL	.15[abc]	Rex SL	.17[a]	Aub M	.21
AC 1517D	.15[abc]	DK 11	.17[ab]	Rex SL	.21
DK 11	.14[abcd]	Hancock	.16[abc]	ST 213	.20
ST 213	.13[bcde]	ST 213	.15[abcd]	DPL 45A	.20
Hancock	.13[cde]	Coker 417	.15[abcd]	Coker 417	.19
Coker 417	.13[de]	Aub M	.14[bcd]	Hancock	.18
DPL 16	.13[de]	DPL 45A	.13[cd]	DK 11	.18
DPL 45A	.12[de]	DPL 16	.12[d]	DPL 16	.17
Mean	.14		.15		.20
		1969 Henry County			
ST 213	.21	Aub M	.12		
DPL 16	.21	AC 1517D	.12		
Rex SL	.19	Rex SL	.11		
AC 1517D	.19	DK 11	.11		
DK 11	.18	ST 508	.10		
ST 508	.17	ST 213	.10		
Aub M	.17	DPL 45A	.10		
DPL 45A	.16	Hancock	.10		
Coker 417	.16	Coker 417	.09		
Hancock	.15	DPL 16	.09		
Mean	.18		.10		

TABLE 20 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Pl	Cultivars	% Pl	Cultivars	% Pl
		1970 Henry County			
Coker 417	.14	ST 213	.14	AC 1517D	.16[a]
Aub M	.14	Rex SL	.13	ST 603	.16[ab]
ST 213	.14	Aub M	.13	Rex SL	.15[abc]
Rex SL	.13	ST 603	.13	DK 11	.15[abcd]
DPL 45A	.13	Coker 417	.13	Coker 417	.15[abcd]
Hancock	.13	ST 213	.12	Hancock	.14[bcd]
AC 1517D	.13	DK 11	.12	Aub M	.14[bcd]
ST 603	.12	Hancock	.12	ST 213	.14[bcd]
DK 11	.11	DPL 16	.11	DPL 45A	.14[cd]
DPL 16	.11	DPL 45A	.11	DPL 16	.13[d]
Mean	.13		.13		.15
		1969 Hardeman County			
AC 1517D	.16	AC 1517D	.08		
DK 11	.16	DK 11	.08		
Aub M	.16	Aub M	.08		
ST 213	.15	ST 508	.08		
Rex SL	.15	DPL 16	.08		
Hancock	.15	ST 213	.07		
ST 508	.14	DPL 45A	.07		
DPL 45A	.14	Rex SL	.07		
DPL 16	.13	Hancock	.07		
Coker 417	.12	Coker 417	.06		
Mean	.15		.07		
		1970 Hardeman County			
DK 11	.14	Coker 417	.11	ST 213	.13
Rex SL	.13	Rex SL	.11	Aub M	.13
DPL 16	.13	DPL 45A	.10	AC 1517D	.13
ST 603	.13	Hancock	.10	Rex SL	.12
Aub M	.12	Aub M	.10	DK 11	.12
ST 213	.12	DK 11	.09	ST 603	.12
AC 1517D	.12	AC 1517D	.09	Coker 417	.10
Hancock	.12	ST 603	.09	DPL 16	.10
DPL 45A	.11	DPL 16	.09	Hancock	.09
Coker 417	.11	ST 213	.07	DPL 45A	.08
Mean	.12		.10		.11

TABLE 20 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Pl	Cultivars	% Pl	Cultivars	% Pl
		1969 Henderson County			
AC 1517D	.16	AC 1517D	.07		
Aub M	.16	Aub M	.07		
Rex SL	.15	Rex SL	.06		
ST 213	.14	ST 213	.06		
DK 11	.14	DK 11	.06		
DPL 16	.14	DPL 16	.06		
Coker 417	.13	Coker 417	.06		
DPL 45A	.13	DPL 45A	.06		
Hancock	.12	Hancock	.06		
ST 508	.12	ST 508	.06		
Mean	.14		.06		
		1970 Henderson County			
DK 11	.17	AC 1517D	.14[a]	AC 1517D	.13[a]
Hancock	.15	ST 603	.14[a]	Aub M	.11[ab]
DPL 16	.14	DK 11	.12[ab]	ST 603	.11[ab]
ST 213	.14	Rex SL	.12[ab]	Hancock	.11[ab]
Rex SL	.13	Aub M	.12[ab]	DK 11	.11[abc]
Aub M	.13	Hancock	.11[ab]	Rex SL	.10[abc]
ST 603	.13	ST 213	.11[b]	ST 213	.10[bc]
DPL 45A	.13	DPL 45A	.10[b]	DPL 45A	.10[bc]
Coker 417	.12	Coker 417	.10[b]	Coker 417	.10[bc]
AC 1517D	.12	DPL 16	.10[b]	DPL 16	.09[c]
Mean	.14		.12		.11
		1969 Carroll County			
Aub M	.19	DK 11	.09		
AC 1517D	.19	Rex SL	.09		
DK 11	.19	ST 508	.07		
ST 508	.18	Hancock	.07		
Hancock	.17	AC 1517D	.07		
Rex SL	.16	Coker 417	.07		
Coker 417	.16	DPL 16	.07		
DPL 16	.15	Aub M	.07		
ST 213	.15	ST 213	.07		
DPL 45A	.15	DPL 45A	.07		
Mean	.17		.07		

TABLE 20 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% Pl	Cultivars	% Pl	Cultivars	% Pl
		1970 Carroll County			
ST 603	.12[a]	Rex SL	.12	Rex SL	.14
Rex SL	.12[ab]	AC 1517D	.12	ST 213	.11
Aub M	.11[ab]	Hancock	.11	DPL 16	.11
DK 11	.11[abc]	ST 603	.11	Coker 417	.11
AC 1517D	.10[bcd]	Coker 417	.11	DK 11	.10
Coker 417	.10[bcd]	DPL 45A	.10	DPL 45A	.10
Hancock	.10[cd]	Aub M	.10	AC 1517D	.10
ST 213	.10[d]	ST 213	.10	Hancock	.09
DPL 16	.09[d]	DK 11	.10	ST 603	.09
DPL 45A	.09[d]	DPL 16	.09	Aub M	.08
Mean	.11		.11		.10
		1969 Lauderdale County			
AC 1517D	.24[a]	AC 1517D	.19[a]		
Rex SL	.21[b]	DK 11	.15[b]		
Aub M	.20[bc]	Rex SL	.14[bc]		
Coker 417	.19[bc]	Aub M	.14[bc]		
DPL 16	.19[bc]	DPL 45A	.14[bc]		
DK 11	.19[bc]	Coker 417	.14[bc]		
Hancock	.19[bc]	ST 508	.13[bc]		
DPL 45A	.18[bc]	DPL 16	.12[bc]		
ST 213	.18[bc]	Hancock	.12[bc]		
ST 508	.17[c]	ST 213	.11[c]		
Mean	.19		.14		
		1970 Lauderdale County			
Aub M	.16	Coker 417	.15	AC 1517D	.17
ST 603	.16	Hancock	.15	ST 213	.17
ST 213	.15	Rex SL	.14	ST 603	.17
DPL 45A	.15	DPL 45A	.13	Rex SL	.16
Rex SL	.14	DPL 16	.13	Coker 417	.14
Hancock	.14	ST 603	.13	DPL 16	.14
Coker 417	.14	ST 213	.12	Hancock	.13
AC 1517D	.13	AC 1517D	.12	DK 11	.13
DPL 16	.12	Aub M	.11	Aub M	.12
DK 11	.12	DK 11	.10	DPL 45A	.12
Mean	.14		.13		.15

TABLE 20 (continued)

Stage 1		Stage 2		Stage 3	
Cultivars	% P[1]	Cultivars	% P[1]	Cultivars	% P[1]
		1970 Lawrence County			
AC 1517D	.11	AC 1517D	.10	AC 1517D	.16[a]
Aub M	.11	Aub M	.08	Aub M	.14[ab]
DPL 45A	.11	Coker 417	.08	DK 11	.14[ab]
ST 603	.11	ST 603	.08	ST 213	.14[bc]
Hancock	.10	Hancock	.08	ST 603	.13[bc]
DK 11	.10	DK 11	.08	Rex SL	.13[bc]
ST 213	.10	ST 213	.08	Hancock	.13[bc]
Rex SL	.10	Rex SL	.08	Coker 417	.13[bc]
Coker 417	.09	DPL 45A	.07	DPL 45A	.12[c]
DPL 16	.08	DPL 16	.07	DPL 16	.12[c]
Mean	.10		.08		.13

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 21

PHOSPHORUS CONCENTRATIONS OF TEN COTTON CULTIVARS AT SELECTED GROWTH STAGES AND LOCATIONS IN 1969 AND 1970 ADJUSTED FOR SOIL PHOSPHORUS CONTENT

Stage 1		Stage 2		Stage 3	
Cultivars	% P[1]	Cultivars	% P[1]	Cultivars	% P[1]
		Henry County			
		1969		1970	
		AC 1517D	.13^{a}	AC 1517D	.16^{a}
		Aub M	.11^{ab}	ST 603	.16^{ab}
		DK 11	.11^{ab}	Rex SL	.15^{ab}
		Rex SL	.11^{ab}	DK 11	.15^{abc}
		DPL 45A	.11^{ab}	ST 213	.14^{abc}
		Coker 417	.10^{b}	Aub M	.14^{abc}
		DPL 16	.10^{b}	Coker 417	.14^{bc}
		ST 213	.10^{b}	Hancock	.14^{bc}
		Hancock	.10^{b}	DPL 16	.14^{c}
		ST 518	.09^{b}	DPL 45A	.14^{c}
		Henderson County			
				1970	
				AC 1517D	.13^{a}
				Aub M	.11^{ab}
				Hancock	.11^{abc}
				ST 603	.11^{abc}
				Rex SL	.11^{abc}
				DK 11	.11^{abc}
				Coker 417	.10^{abc}
				DPL 45A	.10^{bc}
				ST 213	.09^{bc}
				DPL 16	.09^{c}
		Fayette County			
1970		1969			
Aub M	.16^{a}	AC 1517D	.10^{a}		
Rex SL	.15^{ab}	Hancock	.10^{ab}		
ST 603	.15^{abc}	Rex SL	.09^{ab}		
AC 1517D	.14^{abc}	DK 11	.09^{ab}		
DK 11	.14^{abc}	DPL 16	.09^{ab}		
Coker 417	.13^{abc}	ST 508	.09^{ab}		
DPL 16	.13^{abc}	ST 213	.09^{ab}		
ST 213	.13^{bc}	Aub M	.08^{b}		
Hancock	.13^{bc}	DPL 45A	.08^{b}		
DPL 45A	.12^{c}	Coker 417	.08^{b}		

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 22

TISSUE PHOSPHORUS CONCENTRATIONS OF TEN COTTON CULTIVARS FROM COMBINED ANALYSIS OF SIX LOCATIONS[1] AND FIRST TWO GROWTH STAGES

Cultivars	% P[2]
AC 1517D	.136[a]
Rex SL	.133[ab]
DK 11	.129[abc]
Aub M	.128[abc]
[3]ST 508	.126[abc]
ST 213	.122[bc]
Hancock	.122[bc]
Coker 417	.122[bc]
DPL 16	.116[c]
DPL 45A	.116[c]

[1]Fayette, Henry, Hardeman, Henderson, Carroll, and Lauderdale Counties.

[2]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

[3]ST 603 replaced ST 508 in 1970. Both cultivars were analyzed as one.

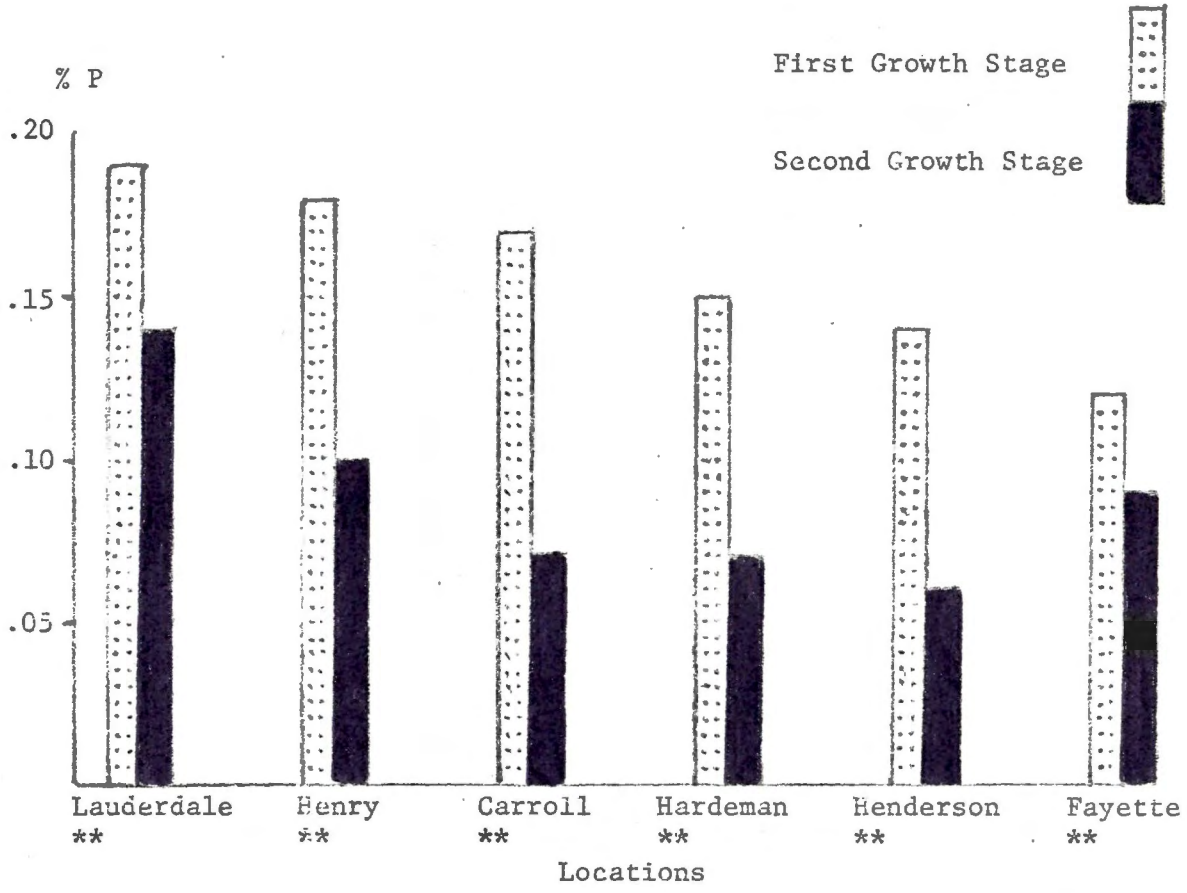

Figure 16. Mean concentrations of phosphorus in cotton petioles sampled at first (early bloom), second (mid bloom) and third growth stages (late bloom) at six locations in 1969.

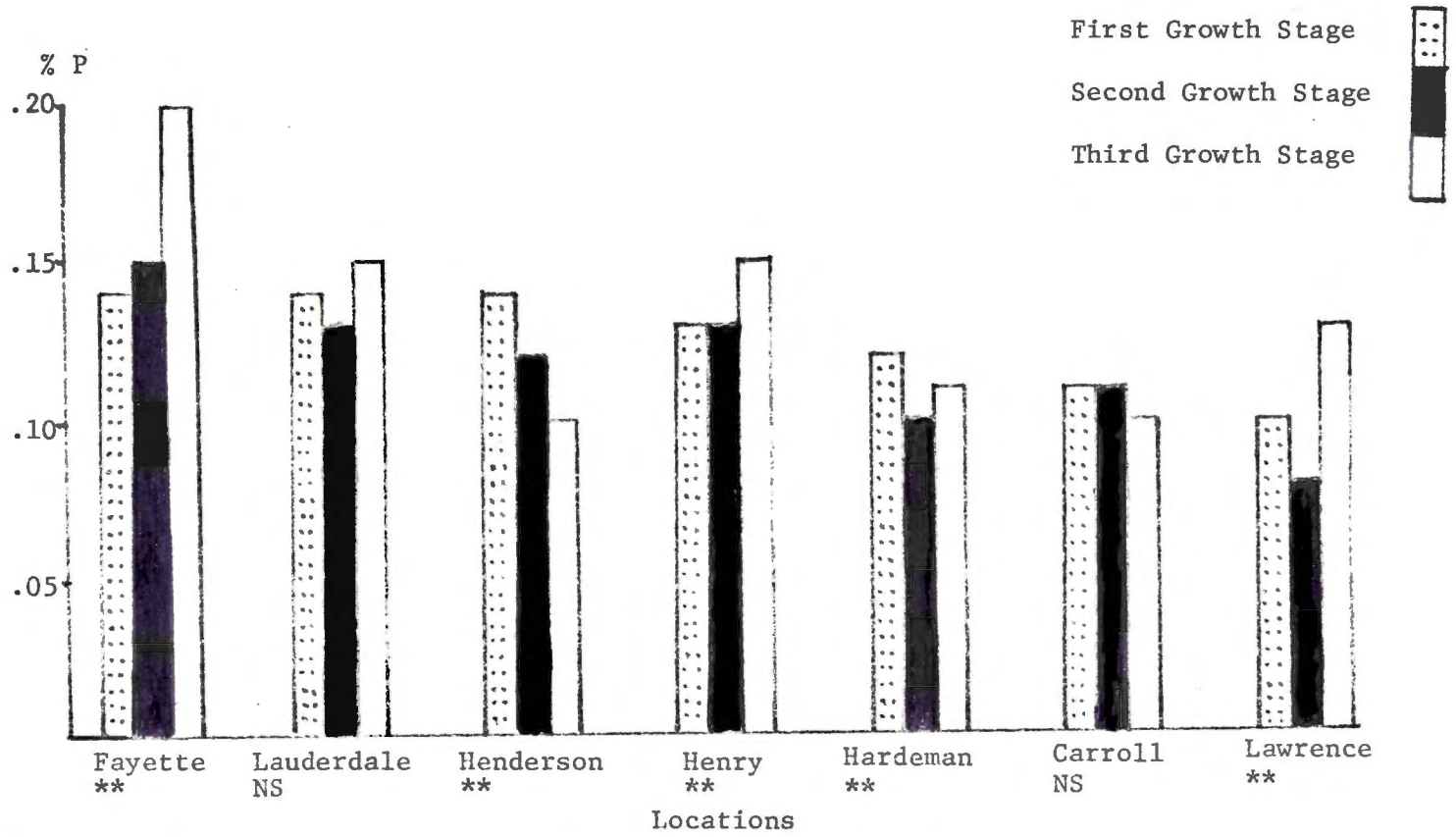

Figure 17. Mean concentrations of phosphorus in cotton petioles sampled at first (early bloom), second (mid bloom) and third growth stages (late bloom) at seven locations in 1970.

TABLE 23

MEAN CONCENTRATIONS OF PHOSPHORUS FOR DIFFERENT GROWTH STAGES AT SEVEN LOCATIONS

Stage 1		Stage 2		Stage 3	
Locations	% P[1]	Locations	% P[1]	Locations	% P[1]
1969					
Lauderdale	.19^{a}	Lauderdale	.14^{a}		
Henry	.18^{ab}	Henry	.10^{b}		
Carroll	.17^{ab}	Fayette	.09^{bc}		
Hardeman	.15^{bc}	Hardeman	.09^{c}		
Henderson	.14^{bc}	Carroll	.07^{c}		
Fayette	.12^{c}	Henderson	.06^{c}		
Mean	.16		.09		
1970					
Lauderdale	.14^{a}	Fayette	.15^{a}	Fayette	.20^{a}
Fayette	.14^{a}	Lauderdale	.13^{ab}	Henry	.15^{b}
Henderson	.14^{ab}	Henry	.13^{ab}	Lauderdale	.15^{b}
Henry	.13^{ab}	Henderson	.12^{b}	Lawrence	.13^{b}
Hardeman	.12^{ab}	Carroll	.11^{bc}	Hardeman	.11^{b}
Carroll	.11^{ab}	Hardeman	.10^{bc}	Henderson	.11^{b}
Lawrence	.10^{b}	Lawrence	.08^{c}	Carroll	.10^{b}
Mean	.13		.12		.14

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

Significant differences were found among growth stages at all locations except Lauderdale County in 1970. In 1969 the first growth stage was higher in P concentration than the second at all locations. However, in 1970 the first growth stage was higher than the second at only four locations. The third growth stage was higher than the first and second at four locations.

Cotton plants at the first growth stage had the highest P concentrations at Lauderdale County in 1969 and 1970. Lauderdale in 1969 and Fayette in 1970 had the highest concentration at the second. Fayette County at the third growth stage had the highest P concentration.

On the average P concentrations at the first growth stage were higher in 1969 than in 1970. At the second growth stage 1970 was higher than 1969.

Soil and Tissue Correlations

Table 24 shows correlation values between soil nutrient test levels and cotton petiole concentrations of four elements at the various growth stages in 1969 and 1970. Potassium had the highest degree of correlation at all growth stages in both years. Phosphorus also had highly significant positive correlations at all growth stages but the values were somewhat lower than for K. Soil Ca and Mg did not correlate as well with petiole concentrations as did K and P. Although the Ca correlation was highly significant in 1970 at the first growth stage, the value was negative. In 1969 Ca had highly significant correlations in both growth stages but there was little correlation in 1970. For Mg there was significant correlation in 1970 at all growth stages but not in 1969.

TABLE 24

CORRELATION VALUES BETWEEN SOIL AND TISSUE NUTRIENTS OF FOUR ELEMENTS AT VARIOUS GROWTH STAGES IN 1969 AND 1970

Stages	Ca	K	Mg	P
		1969		
Stage 1	.38 **	.62 **	.27 **	.35 **
Stage 2	.30 **	.70 **	.01 NS	.55 **
		1970		
Stage 1	-.15 **	.42 **	.12 *	.22 **
Stage 2	.07 NS	.57 **	.28 **	.20 **
Stage 3	.18 **	.59 **	.25 **	.25 **

Considering K, the third growth stage gave the highest correlation, followed by the second. In 1969 P correlation values were highest in the second growth stage. In 1970 there was no appreciable difference among growth stages.

Comparison of Elements

Results of this experiment indicate that Ca and K concentrations in cotton petioles were almost always above 1 while P and Mg concentrations were below 1.0 percent. Potassium concentrations were higher than Ca concentrations in 87 percent of the samples while Mg concentrations were always higher than P.

Yields

Table 25 shows cotton cultivar yields of lint produced at seven locations. Stoneville 213 was a consistent high yielding entry at all locations in 1969 and 1970 while Acala 1517D produced the lowest. The combined analysis of all locations and two years (Table 26) revealed similar results.

Table 32, Appendix C, shows the combined analysis of yields from six locations in 1969 and 1970. Differences in locations, cultivars, and years were highly significant.

Yields produced at different locations are shown in Table 27. Henry County produced the highest yields in 1969 and Henderson County in 1970. Yields produced at Hardeman County were rather consistent from year to year while yields at Carroll County showed wide variation. Generally yields were higher in 1970 than in 1969.

TABLE 25

MEAN LINT YIELD[1] OF TEN COTTON CULTIVARS AT SEVEN LOCATIONS IN 1969 AND 1970

1969		1970	
Cultivars	Yield Kg/Ha[2]	Cultivars	Yield Kg/Ha[2]
	Fayette County		
ST 508	756[a]	ST 213	1011[a]
Hancock	738[a]	ST 603	1004[a]
DPL 16	724[a]	DPL 45A	991[ab]
DK 11	709[a]	Aub M	900[ab]
ST 213	686[ab]	DPL 16	885[abc]
DPL 45A	640[ab]	Hancock	873[bc]
Aub M	636[ab]	Coker 417	846[c]
Coker 417	626[b]	DK 11	831[c]
AC 1517D	573[b]	Rex SL	787[cd]
Rex SL	569[b]	AC 1517D	696[d]
Mean	666		883
	Henry County		
Hancock	1188[a]	ST 213	1121[a]
ST 213	1163[a]	DPL 45A	1047[ab]
DK 11	1151[a]	Coker 417	995[ab]
DPL 16	1136[a]	Rex SL	966[ab]
Coker 417	1112[a]	DPL 16	947[ab]
Rex SL	975[ab]	DK 11	934[b]
DPL 45A	968[b]	ST 603	924[b]
Aub M	968[b]	Aub M	921[b]
AC 1517D	955[b]	Hancock	918[b]
ST 508	904[b]	AC 1517D	754[c]
Mean	1052		953
	Hardeman County		
ST 213	1028[a]	ST 603	1056[a]
Rex SL	967[ab]	Hancock	1007[a]
Aub M	942[abc]	DK 11	987[a]
DK 11	927[abc]	Coker 417	983[a]
Hancock	925[abc]	DPL 16	945[ab]
DPL 45A	924[abc]	ST 213	940[ab]
DPL 16	882[bcd]	Rex SL	924[ab]
Coker 417	875[cd]	DPL 45A	898[ab]
ST 508	825[cd]	Aub M	811[b]
AC 1517D	761[d]	AC 1517D	517[c]
Mean	906		907

TABLE 25 (continued)

1969		1970	
Cultivars	Yield Kg/Ha[2]	Cultivars	Yield Kg/Ha[2]
	Henderson County		
ST 213	815[a]	ST 213	1277[a]
DPL 16	736[ab]	ST 603	1196[ab]
DPL 45A	731[ab]	Coker 417	1156[abc]
Aub M	691[bc]	DK 11	1141[abcd]
ST 508	690[bc]	DPL 45A	1120[bcd]
Hancock	681[bcd]	Hancock	1119[bcd]
DK 11	672[bcd]	Aub M	1079[bcde]
Coker 417	662[cd]	DPL 16	1055[cde]
AC 1517D	601[d]	Rex SL	1018[de]
Rex SL	599[d]	AC 1517D	982[e]
Mean	688		1114
	Carroll County		
ST 213	799[a]	ST 213	1151[a]
DPL 45A	741[ab]	DPL 16	1129[a]
DPL 16	718[ab]	Aub M	1127[a]
Aub M	641[abc]	ST 603	1096[a]
Hancock	638[bc]	DPL 45A	1078[a]
Coker 417	624[bc]	Hancock	1077[a]
ST 508	620[bc]	DK 11	1068[a]
DK 11	598[cd]	Coker 417	1055[a]
AC 1517D	505[cd]	Rex SL	864[b]
Rex SL	466[d]	AC 1517D	831[b]
Mean	635		1048
	Lauderdale County		
ST 213	764[a]	DK 11	970[a]
DPL 45A	757[a]	ST 213	917[ab]
ST 508	751[a]	DPL 16	865[ab]
Coker 417	751[a]	DPL 45A	833[ab]
DPL 16	750[a]	Hancock	809[b]
Hancock	718[a]	Coker 417	776[b]
Rex SL	708[a]	Rex SL	776[b]
DK 11	702[a]	ST 603	760[b]
AC 1517D	553[b]	Aub M	752[b]
Aub M	525[b]	AC 1517D	624[c]
Mean	698		808

TABLE 25 (continued)

1969		1970	
Cultivars	Yield Kg/Ha[2]	Cultivars	Yield Kg/Ha[2]
		Lawrence County	
		ST 603	869[a]
		Coker 417	861[a]
		Hancock	859[a]
		Aub M	856[a]
		Rex SL	836[a]
		DK 11	808[ab]
		ST 213	791[ab]
		DPL 16	717[b]
		DPL 45A	713[b]
		AC 1517D	600[b]
Mean			791

[1]Yield in lint per hectare.

[2]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 26

LINT YIELDS FROM COMBINED LOCATIONS AND YEARS OF TEN COTTON CULTIVARS

Cultivars	Yield[1] Kg/Ha
ST 213	983[a]
ST 508	910[ab]
DPL 45A	910[ab]
DPL 16	908[ab]
Hancock	907[ab]
DK 11	888[abc]
Coker 417	883[bc]
Aub M	857[bc]
Rex SL	816[c]
AC 1517D	708[d]

[1]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

TABLE 27

LINT YIELD[1] OF TEN COTTON CULTIVARS AT SEVEN LOCATIONS FOR EACH YEAR SEPARATELY

1969		1970	
Locations	Yield Kg/Ha[2]	Locations	Yield Kg/Ha[2]
Henry	1052[a]	Henderson	1114[a]
Hardeman	906[a]	Carroll	1048[ab]
Lauderdale	698[b]	Henry	953[abc]
Henderson	688[b]	Hardeman	907[bc]
Fayette	666[b]	Fayette	883[bc]
Carroll	635[b]	Lauderdale	808[c]

[1]Total yield lint per Hectare.

[2]Superscripts indicate level of significance on Duncan's Multiple Range calculated at 0.05 level.

CHAPTER V

DISCUSSION

Soil Test Values

Calcium, Mg, and pH values (Figure 2, page 24, Figure 3, page 25, and Table 7, page 23) were slightly lower in 1970 than in 1969 where plots remained in the same field in both years of the experiment. This could be attributed to leaching of the basic cations, Ca and Mg, because all plots were limed as needed in the spring of 1968. The Ca, Mg, and pH values at Hardeman County were higher in 1970 than in 1969, whereas at Fayette they were only slightly lower. At these two locations the 1970 plots were moved to new fields which were limed just prior to planting the 1970 corp. Phosphorus and K, unlike lime, were applied each year and soil test values varied only slightly between years except at Hardeman and Fayette Counties. There was more variation from 1969 to 1970 in P and K at Fayette County than at Hardeman.

Comparing locations, there was a greater variation with P levels than with the other elements. The P level (Figure 4, page 26) at Lauderdale was very high. Relatively high annual applications of P fertilizer coupled with the nutrients added by the flooding Mississippi River, low P leaching and crop removal losses might explain the unusually high available soil P level. The P values at Henderson County were low in 1969. The pH values were also low at this location and this may have caused the P to be less available.

The low soil test values of P at Hardeman County both years were the result of inadequate fertilizer application (Table 3, page 15).

Lauderdale County was especially high in soil P and Mg and was also high in K. However, all locations except Fayette in 1969 were high in soil K.

Where the farmer applied small amounts of P, small amounts of N and K were also applied and this resulted in a rather even balance, nutrientwise.

Soil Types

There were two major groups of soils, upland and bottom. Robersonville, Morganfield, Alder, Collins, and Falaya are bottom soils, whereas Memphis, Lexington, Pembroke, and Crider are upland soils. Alder and Falaya were the only soils with drainage problems but there were only a few plots on these soils. All of these soils are commonly used for cotton production.

All soils were classed as silt loams. Memphis, Collins, and Robersonville are deeper and have greater water holding capacity than do the other soils and were expected to produce greater yields.

Yields

Stoneville 213, irrespective of location or year, was one of the highest yielders while Acala 1517D was consistently one of the lowest. Location influenced yield as much as did cultivar. These cultivars which were high at all other locations. This is further demonstrated from the data in Table 32, Appendix C, which show cultivar x location and cultivar x year interactions to be non-significant.

Evidently environment had little effect on determining the rank of cultivar yeilds in this experiment. A positive relationship was found between average July rainfall and yields at each location. For example, Henry County in 1969 had rather high amounts of July rainfall and produced high yields. Carroll County, in 1969, had low amounts of July rainfall and produced low yields. At most locations in 1970, total precipitation during the growing season was greater than in 1969. This is demonstrated by the yield increases from 1969 to 1970.

Another important factor affecting yield was weed control. At most locations weeds were controlled rather well except at Hardeman County where johnsongrass in both years caused yield reductions. Cockleburs at Fayette County and nutsedge at Lauderdale reduced yields of some plots but not others.

Cotton yields on bottom soils should have been higher than on the upland soils. Where prepipitation was low at both locations the bottom soil did produce higher yields. For example, in 1969, Carroll and Lauderdale Counties had equal amounts of July rainfall (Figure 6, page 29) and the bottom soils at Lauderdale produced higher yields (Table 27, page 89) than the upland soil at Carroll. However, this did not occur in 1970 because although the July rainfall was about equal, the June and August rainfall at Carroll County was greater than at Lauderdale.

Cultivars

Highly significant differences in nutrient concentrations were found among various cultivars. Most cultivars tested in this experiment

were developed in the southeastern United States and are genetically related. However, Acala 1517D was developed under the climatic and soil conditions of California and has a different genetic background from the others. It produced the most vegetative growth of any cultivar in this experiment and was the latest in maturity. Acala 1517D is better adapted to the hot irrigated regions of the West where the growing season is longer than in Tennessee. Under western conditions Acala 1517D while generally producing higher yields also has a higher quality fiber. In this experiment, Acala 1517D not only had the highest Ca and P concentrations but also produced the highest amount of dry matter, giving it the highest total Ca and P uptake.

Because Acala 1517D is a later maturing cultivar, there were no flowers at the first sampling date and very few at the second. Therefore, the nutrient concentration would be expected to be higher than in the other cultivars since nutrient concentration decreases as the cotton plant matures. Acala 1517D had high concentrations of Ca and P but was relatively low in Mg and K. Potassium shows the greatest dilution effect. If high concentrations of Ca and P were due to the earlier sampling, Acala also should have had a high concentration of K, but this was not the case.

Just the opposite situation occurred with Stoneville 213: K was high while Ca and P were relatively low. Other cultivars ranged between the extremes of Acala 1517D and Stoneville 213.

The Stoneville and Deltapine cultivars had similar P and K concentrations. This might be due to genetic similarity as they were all developed by the same plant breeders in the southeastern United

States. Their Ca and Mg concentrations, however, were not similar in spite of their close genetic relationship.

Petiole Nutrient Concentrations

In this experiment petiole concentrations of K at most locations were lower at the first sampling date (early bloom) than the 4.5 percent. Stromberg (49) proposed as an ideal concentration for cotton at early bloom in California. He suggested that cotton petioles at 130 days after planting should contain 1.0 percent K. In this experiment at late bloom (approximately 110 days after planting), the petioles contained over 2.0 percent K in 1970. In 1969 Fayette County (Table 19, page 69) had a very low concentration of K at mid bloom. It is possible that a K deficiency was present, but no symptoms were observed.

Magnesium concentrations were always above the 0.1 to 0.2 percent critical level set by Page and Bingham (42). Although Ca and P critical levels for cotton have yet to be determined, the concentrations in this experiment were equal to those reported in the literature by Joham (27) and are not believed to be below the critical level. No deficiency symptoms of these elements were observed in the field.

The dilution effect was found at all locations for K but there were many instances where Ca, Mg, and P concentrations increased rather than decreased as the plant matured. Similar results have been reported by other researchers (1), (4), (12). Obviously the plants accumulated these nutrients later in the growing season, whereas most of the K was taken up early.

If available soil moisture was limited early in the growing season, then less nutrient uptake occurred and less dry matter was produced. Greater amounts of available soil moisture usually resulted in higher nutrient concentrations overcoming even the dilution effect. Lauderdale County, which had the highest soil test values of P, also produced the highest petiole P concentrations of any location during both years. The Mg soil test was also highest at Lauderdale and the concentrations in the petioles were high in 1969. But in 1970 the petiole concentrations were about equal to those at other locations. Henderson County in 1970 had the highest Mg petiole concentrations, perhaps due to the favorable high July rainfall.

There were highly significant differences of nutrient concentrations among locations as shown by the combined analyses (Table 29, Appendix C). Henry County had the highest tissue concentrations of Ca and K of any location at the first growth stage in 1969. Soil Ca and K levels at Henry were also high which combined with high amounts of available soil moisture to produce the high concentrations. More significant differences among cultivar Mg, K, and P concentrations were found in the second growth stage than in any other. But for Ca, more differences were found in the first growth stage. If petiole analysis is to be used to determine nutrient deficiencies, it is necessary to know which cultivar is being analyzed especially if the plants are sampled in mid bloom.

Interactions

While some cultivars consistently contained high concentrations of Ca, Mg, K, and P at all locations, other cultivars had low

concentrations of these elements. However, in the 1970 combined analysis, Mg location x cultivar interactions were significant.

Growth stage x cultivar interactions in the combined analyses indicated that while some cultivars were high in nutrients at all growth stages other cultivars were consistently low.

Year x cultivar interactions (Table 30, Appendix C) in the combined analyses indicated that cultivars reacted the same in both years for Ca and K but not for Mg and P.

Location x growth stage interactions were highly significant for Ca, Mg, K, and P. In 1969 the first growth stage had higher concentrations than the second at all locations for K and P again because of the dilution effect.

Analysis of Covariance

Analysis of variance revealed significant differences among cultivars at some locations and at some growth stages but not at others. Perhaps this was due to lack of nutrient uniformity within locations. Analysis of covariance was used therefore to analyze and adjust the nutrient composition of cultivars for differences in soil mutrient content which existed at each location. Analysis of covariance tended to equalize the plot nutrient levels within each location. Not all locations had wide nutrient variation among plots. Thus, a regression test was first calculated at each location to determine if the variation within plots was great enough to use the analysis of covariance. When this analyiss was used, nine additional differences (Table 28, Appendix C) were found among cultivars. More

additional differences were found for Mg and P than for Ca and P. This was due not only to the greater variation within locations for soil Mg and K levels but also because K had a greater correlation between soil levels and concentrations in the petioles.

Generally the cultivar adjusted mean tended to rank in the same order as the unadjusted means. By calculating the analysis of covariance additional information was discovered which otherwise would have been lost.

CHAPTER VI

SUMMARY

During the 1969 and 1970 growing seasons, cotton cultivar performance experiments were conducted at seven Tennessee locations.

Petioles from the most recently matured leaf were collected at two stages of growth in 1969 and at three in 1970. The samples were digested by the wet ash nitric-perchloric method and analyzed with the Technicon AutoAnalyzer for Ca, Mg, K, and P.

Available Ca, Mg, K, and P were extracted from soil samples with a double acid solution (North Carolina method) and analyzed with the AutoAnalyzer. Soil pH values were also determined.

Cultivar nutrient concentrations were analyzed statistically using the analysis of variance and covariance. Significant differences were found among cultivars, growth stages, locations, and between years. Significant differences were found among location x growth stage, location x years, and growth stage x year interactions.

Generally, the greatest number of differences in nutrient concentration among cultivars occurred at the second sampling stage or at mid bloom. Therefore, cotton should be sampled for tissue analysis at this stage of maturity.

Generally Acala 1517D was higher in Ca and P concentrations than any of the nine other cotton cultivars. Coker 417 was generally higher in Mg while Stoneville 213 was consistently low in Ca and Mg.

Stoneville 213, Stoneville 508 and Stoneville 603 had high K concentrations. These cultivars had similar P concentrations.

Deltapine 16 and Deltapine 45A had low K and P concentrations.

Those cultivars which produced high yields often had low nutrient concentrations.

Wide differences occurred throughout the experiment in the nutrient concentration of these cultivars, although no nutrient deficiencies were known to be manifest. This suggests the need to know the cultivar being sampled if an accurate diagnosis of the nutrient status of the cotton plant is desired.

Rainfall and cultivar differences were more important in influencing yield levels than were soil pH, soil type, soil nutrient level, or tissue nutrient concentration in this experiment.

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LITERATURE CITED

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APPENDIXES

APPENDIX A

Procedure for the aluminum heating block method of wet ashing of plant tissue for Ca, Mg, K, and P analysis:

1. Weight 0.5000 gm of each oven dry, ground sample into a 50 ml tube containing two small glass beads.

2. Add three ml of concentrated nitric acid to each sample, and place a small glass funnel in the mouth of each tube to act as a condenser. Allow the samples to pre-digest at room temperature overnight in the aluminum heating block.

3. Place the heating block on hotplate, heat to 150° C, and digest at this temperature for one hour. Allow samples to cool to room temperature.

4. Add two ml of 60 to 70 percent perchloric acid to each tube through the funnel, and digest at 235° C for two hours or until the liquid in each sample is clear. Remove funnels and allow to cool to room temperature.

5. Add one ml of hydrochloric acid, and digest at 150° C for 15 to 20 minutes.

6. Transfer the cooled samples to 100 ml volumetric flasks and bring to volume with distilled water.

7. Shake flasks to mix contents, and let stand overnight before analysis on the AutoAnalyzer.

APPENDIX B

I. Simultaneous determination of Ca, K, Mg, and P concentrations by Autoanalysis.

A. The instrumentation for the Technicon AutoAnalyzer employed consisted of 14 separate modules as follows: small automatic sampler equipped with a liquid wash system; meters equipped with continuous tubular flow cells; and dual-channel flame photometer; two two-pen recorders; two voltage stabilizers; one time-delay coil; and two range expanders.

B. Calcium and potassium determinations were made by using the Technicon III dual-channel flame photometer. Lithium nitrate (.525 g in one liter of water) is used as an internal standard and lanthanum chloride (five gm in one liter of water) is used to increase the calcium flame response. The proportioning-pump manifold designed to supply the correct volume of sample, $LiNO_3$ and $LaCl_3$ to the dual-channel flame photometer is used.

C. Magnesium concentrations were determined in a colorimeter by a modified lake procedure in which $Mg(OH)_2$ is precipitated in an alkaline solution and Magnesium Blue dye (.02 percent) is adsorbed on the $Mg(OH)_2$ in the presence of a detergent (.05 percent Brij 35 in water) and a suspending material (two gm EGTA and two gm polyvinyl alcohol in one liter H_2O). The proportioning-pump manifold designed to supply the correct volumes of sample, PVA-EGTA, Magnesium Blue, and NaOH (2N) to the flow cell of the colorimeter is used. The colorimeter

used in this procedure was equipped with a 630 mμ filter.

D. Phosphorus determinations were made using a colorimeter. The sample is first diluted with .05N HCl. The diluted sample stream is then joined by a stream of ammonium vanadate (25 gm ammonium molybdate in 400 ml of H_2O mixed with an equal volume of a solution of 1.25 gm ammonium metavanadate in 300 ml of water with a few drops of concentrated NH_4OH and 250 ml of concentrated HNO_3). The stream then passes through the colorimeter, equipped with a 420 mμ filter, where phosphorus is determined as PO_4^{-3}. The proportioning-pump manifold designed to supply the correct volumes of sample, HCl, and ammonium vanadate to the colorimeter is used.

APPENDIX C

TABLE 28

LEVELS OF STATISTICAL DIFFERENCE AMONG CULTIVAR MEANS AND ADJUSTED MEANS WHERE ANALYSES OF VARIANCE, REGRESSION AND COVARIANCE WERE CALCULATED FOR CALCIUM, MAGNESIUM, POTASSIUM AND PHOSPHORUS AT DIFFERENT GROWTH STAGES IN 1969 AND 1970.

Locations	Stage 1			Stage 2			Stage 1			Stage 2			Stage 3		
	Cov[1]	Reg	Var	Cov[1]	Reg	Var	Cov[1]	Reg	Var	Cov[1]	Reg	Var	Cov[1]	Reg	Var
	Calcium 1969						Calcium 1970								
Fayette	--	NS	NS	--	NS	NS	--	NS	NS	--	NS	NS	--	*	NS
Henry	--	NS	**	*	*	NS	--	NS	*	--	*	NS	--	NS	NS
Hardeman	NS	Sig	NS	--	NS	NS	--	NS	NS	--	NS	NS	--	NS	NS
Henderson	NS	Sig	NS	--	NS	*	--	NS	**	--	NS	NS	--	NS	*
Carroll	**	Sig	**	--	NS	*	*	**	*	--	NS	**	--	NS	NS
Lauderdale	--	NS	**	--	NS	NS	*	**	NS	--	NS	**	--	NS	NS
Lawrence							--	NS	**	--	NS	NS	--	NS	**
	Magnesium 1969						Magnesium 1970								
Fayette	--	NS	*	--	NS	*	--	NS	NS	--	NS	**	--	NS	*
Henry	--	NS	NS	--	NS	NS	NS	*	NS	NS	*	NS	NS	*	NS
Hardeman	**	**	**	**	*	**	--	NS	NS	--	NS	NS	--	NS	NS
Henderson	**	**	NS	--	NS	**	NS	*	NS	--	NS	NS	--	NS	**
Carroll	**	*	**	*	*	**	*	**	NS	--	NS	*	*	*	*
Lauderdale	**	**	NS	NS	**	NS	--	NS	NS	--	NS	NS	--	NS	NS
Lawrence							--	NS	NS	--	NS	NS	--	NS	*

TABLE 28 (continued)

Locations	Stage 1			Stage 2			Stage 1			Stage 2			Stage 3		
	Cov[1]	Reg	Var	Cov[1]	Reg	Var	Cov[1]	Reg	Var	Cov[1]	Reg	Var	Cov[1]	Reg	Var
	Potassium 1969						Potassium 1970								
Fayette	NS	*	NS	--	NS	NS	--	NS	NS	--	NS	NS	--	NS	NS
Henry	NS	**	NS	*	**	NS	NS	**	NS	NS	**	NS	NS	**	NS
Hardeman	NS	*	NS	--	NS	NS	*	**	NS	--	NS	NS	--	NS	NS
Henderson	--	NS	*	*	Sig	*	NS	*	NS	--	NS	**	**	**	*
Carroll	NS	**	NS	NS	**	NS	*	**	NS	NS	**	NS	NS	*	NS
Lauderdale	NS	**	NS	NS	**	NS	NS	**	NS	*	**	*	NS	**	NS
Lawrence							NS	Sig	NS	--	NS	*	--	NS	**
	Phosphorus 1969						Phosphorus 1970								
Fayette	NS	Sig	NS	**	Sig	*	**	Sig	**	--	NS	**	**	NS	NS
Henry	--	NS	NS	**	**	NS	--	NS	NS	NS	Sig	NS	**	**	*
Hardeman	--	NS	NS	--	NS	NS	NS	**	NS	--	NS	NS	--	NS	NS
Henderson	--	NS	NS	--	NS	NS	NS	Sig	NS	--	NS	*	**	*	*
Carroll	--	NS	NS	--	NS	NS	--	NS	**	--	NS	NS	--	NS	NS
Lauderdale	--	NS	**	--	NS	**	--	NS	NS	NS	Sig	NS	--	NS	NS
Lawrence							--	NS	NS	--	NS	NS	--	NS	**

[1]If regression was not significant analyses of covariance was not calculated.

Cov = Analyses of covariance; Reg = Regression test; Var = Analyses of variance; NS = Not significant at 0.05 level; * = Significant at 0.05 level; ** = Significant at 0.01 level; Sig = Significant regression coefficient at 0.10 level.

TABLE 29

LEVELS OF STATISTICAL DIFFERENCE AND MEAN SQUARES OF CALCIUM, MAGNESIUM, POTASSIUM AND PHOSPHORUS CONCENTRATIONS FROM THE COMBINED ANALYSES OF VARIANCE FOR EACH YEAR SEPARATELY

Source	Significance Level	Mean Square	Significance Level	Mean Square
	Calcium 1969[1]		Calcium 1970[2]	
Locations	**	5.910	**	4.520
Cultivars	**	0.370	**	0.920
Stages	**	2.360	**	9.330
Location x Stage	**	3.120	**	1.490
Locations x Cultivars	NS		NS	
Cultivars x Stages	NS		NS	
Location x Cultivars x Stages	NS		NS	
	Magnesium 1969		Magnesium 1970	
Locations	**	1.880	**	3.220
Cultivars	**	0.250	**	0.140
Stages	**	0.880	**	0.460
Locations x Stages	**	0.570	**	0.330
Locations x Cultivars	NS		NS	
Cultivars x Stages	NS		NS	
Locations x Cultivars x Stages	NS		NS	
	Potassium 1969		Potassium 1970	
Locations	**	58.760	**	41.540
Cultivars	NS		**	2.440
Stages	**	261.000	**	152.000
Locations x Stages	**	5.880	**	6.500
Locations x Cultivars	NS		NS	
Cultivars x Stages	NS		NS	
Locations x Cultivars x Stages	NS		NS	

TABLE 29 (continued)

Source	Significance Level	Mean Square	Significance Level	Mean Square
	Phosphorus 1969		Phosphorus 1970	
Locations	**	0.073	**	0.080
Cultivars	**	0.005	**	0.006
Stages	**	0.698	**	0.045
Locations x Stages	**	0.014	**	0.016
Locations x Cultivars	NS		NS	
Cultivars x Stages	NS		*	0.001
Locations x Cultivars x Stages	NS		NS	

[1]Analyses included two growth stages in 1969 and three in 1970.

[2]Analyses included Fayette, Henry, Hardeman, Henderson, Carroll, Lauderdale and Lawrence Counties in 1970. Lawrence was not included in 1969.

NS = Nonsignificant at 0.05 level.

* = Significant at 0.05 level.

** = Significant at 0.01 level.

TABLE 30

LEVELS OF STATISTICAL DIFFERENCE AND MEAN SQUARES OF CALCIUM, MAGNESIUM, POTASSIUM AND PHOSPHORUS CONCENTRATIONS FROM THE COMBINED ANALYSES OF VARIANCE FOR 1969 AND 1970 COMBINED

Source	Significance Level	Mean Square
	Calcium 1969 and 1970[1]	
Cultivars	**	0.810
Stages	**	6.130
Locations	**	5.510
Years	**	11.580
Locations x Cultivars	*	
Locations x Stages	**	1.790
Locations x Years	**	1.470
Stages x Years	*	0.400
Cultivars x Years	NS	
Cultivars x Stages	NS	
Cultivars x Stages x Locations	NS	
Cultivars x Stages x Years	NS	
Cultivars x Years x Locations	NS	
Cultivars x Stages x Years x Locations	NS	
	Magnesium 1969 and 1970	
Cultivars	**	0.220
Stages	**	0.326
Locations	**	1.098
Years	**	0.757
Locations x Stages	**	0.168
Locations x Years	**	1.518
Locations x Cultivars	**	0.034
Stages x Years	**	0.330
Cultivars x Years	**	0.083
Cultivars x Stages	NS	
Cultivars x Stages x Locations	NS	
Cultivars x Stages x Years	NS	
Cultivars x Years x Locations	NS	
Cultivars x Stages x Locations x Years	NS	

TABLE 30 (continued)

Source	Significance Level	Mean Square
	Potassium 1969 and 1970	
Cultivars	**	2.590
Stages	**	334.000
Locations	**	23.380
Years	**	8.850
Locations x Stages	**	3.000
Locations x Years	**	31.090
Locations x Cultivars	NS	
Stages x Years	NS	
Cultivars x Years	NS	
Cultivars x Stages	NS	
Cultivars x Stages x Locations	NS	
Cultivars x Stages x Years	NS	
Cultivars x Years x Locations	NS	
Cultivars x Stages x Locations x Years	NS	
	Phosphorus 1969 and 1970	
Cultivars	**	0.004
Stages	**	0.338
Locations	**	0.041
Years	NS	
Locations x Stages	**	0.010
Locations x Years	**	0.028
Locations x Cultivars	NS	
Stages x Years	**	0.192
Cultivars x Years	*	0.002
Cultivars x Stages	*	0.002
Cultivars x Stages x Locations	NS	
Cultivars x Stages x Years	NS	
Cultivars x Years x Locations	NS	
Cultivars x Stages x Locations x Years	NS	

[1]Analysis included Fayette, Henry, Hardeman, Henderson, Carroll, and Lauderdale Counties with the first two growth stages.

NS = Nonsignificant at 0.05 level.

* = Significant at 0.05 level.

** = Significant at 0.01 level.

TABLE 31

1969 AND 1970 ANALYSES OF VARIANCE LEVELS OF STATISTICAL DIFFERENCE AMONG GROWTH STAGES, LOCATIONS AND INTERACTIONS FOR EACH CULTIVAR CALCULATED SEPARATELY FOR THE FOUR NUTRIENT CONCENTRATIONS

Cultivar	Stages	Locations[1]	Stage x Locations[2]	Stages	Locations	Stage x Locations
		Calcium 1969			Calcium 1970	
AC 1517D	NS	**	**	*	**	**
Coker 508	*	**	NS	**	**	**
ST 508	NS	**	**			
ST 603				NS	**	*
DPL 16	NS	**	**	**	**	*
Hancock	**	**	**	**	**	*
DK 11	**	**	**	**	**	**
Aub M	NS	**	**	**	**	NS
ST 213	NS	**	**	NS	**	*
DPL 45A	*	**	**	**	**	NS
Rex SL	**	**	**	*	**	**
		Magnesium 1969			Magnesium 1970	
AC 1517D	*	**	*	*	**	*
ST 508	*	**	**			
ST 603				NS	**	**
DPL 16	NS	**	*	**	**	**
Hancock	**	**	**	NS	**	NS
DK 11	*	**	*	NS	**	**
Aub M	NS	**	**	NS	**	NS
ST 213	NS	**	NS	*	**	NS
DPL 45A	*	**	**	*	**	**
Rex SL	NS	**	**	NS	**	**
Coker 417	NS	**	*	**	**	NS
		Potassium 1969			Potassium 1970	
AC 1517D	**	**	NS	**	**	*
Coker 417	**	**	NS	**	**	**
ST 508	**	**	*			
ST 603				**	**	**
DPL 16	**	**	*	**	**	**
Hancock	**	**	NS	**	**	NS
DK 11	**	**	NS	**	**	**
Aub M	**	**	NS	**	**	**
ST 213	**	**	NS	**	**	**
DPL 45A	**	**	NS	**	**	NS
Rex SL	**	**	NS	**	**	NS

TABLE 31 (continued)

Cultivar	Stages	Locations[1]	Stage x Locations[2]	Stages	Locations	Stage x Locations
	Phosphorus 1969			Phosphorus 1970		
AC 1517D	*	**	*	**	**	*
Coker 417	**	**	NS	NS	**	*
ST 508	**	*	NS			
ST 603				NS	**	*
DPL 16	**	**	**	**	**	**
Hancock	**	**	*	NS	**	*
DK 11	**	**	NS	*	**	**
Aub M	**	**	**	**	**	**
ST 213	**	**	**	**	**	*
DPL 45A	**	**	NS	NS	**	**
Rex SL	**	**	*	NS	**	NS

[1]Analyses included two growth stages in 1969 and three in 1970.

[2]Analyses included Fayette, Henry, Hardeman, Henderson, Carroll and Lauderdale Counties in 1969. In 1970 Lawrence County was included.

NS = Nonsignificant at 0.05 level.

* = Significant at 0.05 level.

** = Significant at 0.01 level.

TABLE 32

LEVELS OF STATISTICAL DIFFERENCE AND MEAN SQUARES OF YIELDS FROM THE COMBINED ANALYSES OF VARIANCE FOR 1969 AND 1970 COMBINED

Source	Significance Level	Mean Square
Locations	**	583,074
Cultivars	**	256,265
Years	**	4,275,492
Locations x Cultivars	NS	
Locations x Years	**	955,671
Cultivars x Years	NS	

NS = Not significant at 0.05 level.

** = Significant at 0.01 level.

APPENDIX D

I. Preparation of extracting reagent (0.05N HCl and 0.02N H_2SO_4) for "North Carolina" extraction method.

A. Add separately 73 ml of concentrated HCl and 12 ml of concentrated H_2SO_4 to approximately ten liters of distilled water.

B. Dilute to 18 liters with distilled water, and mix thoroughly.

II. Extraction of exchangeable ions by "North Carolina" method.

A. Weigh 5.0 g of soil into a container, and add 20 ml of the above extracting solution.

B. Shake the soil extracting solution mixture (1:4 soil-solution ratio) in a mechanical shaker for five minutes, and filter immediately through retentive filter paper into an appropriate container.

VITA

Marshall Clayton Smith was born June 3, 1943, in Memphis, Tennessee. He lived on a farm and attended Grand Junction High School where he graduated in May 1962.

He attended The University of Tennessee at Martin, completing his Bachelor of Science degree in General Agriculture in 1968. He then attended The University of Tennessee at Knoxville, and worked as an Assistant in Agronomy, receiving his Master's degree in Agronomy in March 1972.