

THE EFFECT OF FERTILIZER SALTS ON
GERMINATION AND SEEDLING
GROWTH OF COTTON

By

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
LITERATURE REVIEW	3
MATERIALS AND METHODS	8
RESULTS	11
Effect of Mono-Calcium-Phosphate on Cottonseed Germination	12
Effect of a Mixed Fertilizer 10-20-0 on Cottonseed Germination.	12
Effect of a Mixed Fertilizer 10-20-10 on Cottonseed Germination.	15
Effect of Ammonium Nitrate on Cottonseed Germination.	17
Effect of Sodium Nitrate on Cottonseed Germination.	17
Effect of a Mixed Fertilizer 10-20-20 on Cottonseed Germination.	19
Effect of Potassium Chloride on Cottonseed Germination.	21
Analysis of Variance Tables.	28
Multiple Range Tables.	30
SUMMARY AND CONCLUSIONS	33
LITERATURE CITED.	36
APPENDIX.	38

LIST OF FIGURES

Figure	Page
1. The growth of cotton fourteen days after planting with check and mono-calcium-phosphate (0-20-0) plots at 100 pound per acre rate	13
2. The growth of cotton fourteen days after planting with check and mono-calcium-phosphate (0-20-0) plots at 150 pounds per acre rate	13
3. The growth of cotton fourteen days after planting with check and 10-20-0 plots at 100 pounds per acre rate	14
4. The growth of cotton fourteen days after planting with check and 10-20-0 plots at 150 pounds per acre rate	14
5. The growth of cotton fourteen days after planting with check and 10-20-10 plots at 100 pounds per acre rate	16
6. The growth of cotton fourteen days after planting with check and 10-20-10 plots at 150 pounds per acre rate	16
7. The growth of cotton fourteen days after planting with check and ammonium nitrate plots at 100 pounds per acre rate	18
8. The growth of cotton fourteen days after planting with check and ammonium nitrate plots at 150 pounds per acre rate	18
9. The growth of cotton fourteen days after planting with check and sodium nitrate plots at 100 pounds per acre rate	20
10. The growth of cotton fourteen days after planting with check and sodium nitrate plots at 150 pounds per acre rate	20

LIST OF FIGURES (Continued)

Figure		Page
11.	The growth of cotton fourteen days after planting with check and 10-20-20 plots at 100 pounds per acre rate	22
12.	The growth of cotton fourteen days after planting with check and 10-20-20 plots at 150 pounds per acre rate	22
13.	The growth of cotton fourteen days after planting with check and potassium chloride plots at 100 pounds per acre rate	23
14.	The growth of cotton fourteen days after planting with check and potassium chloride plots at 150 pounds per acre rate	23
15.	Root growth of cotton fourteen days after planting in the check plots of the 100 pounds per acre rate	24
16.	Root growth of cotton fourteen days after planting with a mixed fertilizer (10-20-10) at 100 pounds per acre rate	24
17.	Root growth of cotton fourteen days after planting with (0-20-0) at 100 pounds per acre rate	25
18.	Root growth of cotton fourteen days after planting with mixed fertilizer (10-20-10) at 100 pounds per acre rate	25
19.	Root growth of cotton fourteen days after planting with ammonium nitrate at 100 pounds per acre rate	26
20.	Root growth of cotton fourteen days after planting with a mixed fertilizer (10-20-20) at 100 pounds per acre rate	26
21.	Root growth of cotton fourteen days after planting with sodium nitrate at 100 pounds per acre rate	27
22.	Root growth of cotton fourteen days after planting with potassium chloride at 100 pounds per acre rate	27

LIST OF TABLES

Table	Page
1. Varieties of cotton used in experiment. . . .	8
2. Fertilizer treatments used in the experiment.	9
3. Analysis of variance for seedling emergence when fertilizer treatments were placed in direct contact with the seed at the 50 pound rate	28
4. Analysis of variance for seedling emergence when fertilizer treatments were placed in direct contact with the seed at the 100 pound rate.	29
5. Analysis of variance for seedling emergence when fertilizer treatments were placed in direct contact with the seed at the 150 pound rate .	29
6. Multiple range test for relative effect of fertilizer on seedling emergence when the fertilizer treatments were placed in direct contact with the seed at the 50 pound rate (Fertilizer Ranked Means)	30
7. Multiple range test for relative ranking of varietal effect on seedling emergence when the fertilizer treatments were placed in direct contact with the seed at the 50 pound rate (Variety Ranked Means)	30
8. Multiple range test for relative ranking of varietal effect on seedling emergence when the fertilizer treatments were placed in direct contact with the seed at the 100 pound rate (Fertilizer Ranked Means)	31
9. Multiple range test for relative ranking of varietal effect on seedling emergence when the fertilizer treatments were placed in direct contact with the seed at the 100 pound rate (Variety Ranked Means)	31

LIST OF TABLES (Continued)

Table	Page
10. Multiple range test for relative ranking of varietal effect on seedling emergence when the fertilizer treatments were placed in direct contact with the seed at the 150 pound rate (Fertilizer Ranked Means)	32
11. Multiple range test for relative ranking of varietal effect on seedling emergence when the fertilizer treatments were placed in direct contact with the seed at the 150 pound rate (Variety Ranked Means)	32
12. Germination percentage of the varieties obtained in the 'Stultz Germinator'	39
13. The germination counts obtained on cotton varieties grown on check plots in the greenhouse	40
14. Effect of mono-calcium-phosphate (0-20-0) upon germination and emergence of cotton varieties when applied in direct contact with the seed	41
15. Effect of a mixed fertilizer (10-20-0) upon germination and emergence of cotton varieties when applied in direct contact with the seed.	42
16. Effect of a mixed fertilizer (10-20-10) upon germination and emergence of cotton varieties when applied in direct contact with the seed.	43
17. Effect of ammonium nitrate upon germination and emergence of cotton varieties when applied in direct contact with the seed	44
18. Effect of sodium nitrate upon germination and emergence of cotton varieties when applied in direct contact with the seed	45
19. Effect of a mixed fertilizer (10-20-20) upon germination and emergence of cotton varieties when applied in direct contact with the seed.	46
20. Effect of potassium chloride upon germination and emergence of cotton varieties when applied in direct contact with the seed	47

LIST OF TABLES (Continued)

Table	Page
21. Germination counts of seedlings in all check plots 4, 5, 6, and 14 days after planting.	48
22. Seedling growth 14 days after planting. . . .	49

INTRODUCTION

One of the major factors contributing to successful cotton production is the fertility of the soil on which cotton is grown. Many of the soils in Oklahoma on which cotton is grown need additional fertilizer elements above that supplied by the soil. If production is to be maintained or increased on these soils at a level which will give the farmers a reasonable income, then commercial fertilizers must be applied.

According to recent estimates, approximately 30 percent of the cotton acreage in Oklahoma is fertilized and this acreage on the average receives only two-thirds of the recommended rate. Some observers feel that approximately 80 percent of the land on which cotton is grown in Oklahoma can be profitably fertilized.

One of the big problems in the use of commercial fertilizer in cotton production is the placement of fertilizer in proper relation to the seed. The principles of proper placement have been studied for many years, yet serious concern has not been given to proper placement by many farmers. However, those farmers who were concerned with proper placement, in most instances, did not have adequate machinery for proper fertilizer application. As a result of this inadequacy, many farmers are still placing commercial fertilizer

in contact with the cottonseed. This method in many cases is injurious to seedlings, and results in poor stands, lower yields, and, as a consequence, they are often forced to replant.

The purpose of this study was as follows:

- (1) To evaluate the placement of fertilizer salts in contact with the cottonseed.
- (2) To study the effect of fertilizer placement on germination, emergence, and growth of cotton.
- (3) To study the effect of fertilizer salts on varieties of cotton commonly grown in Oklahoma.

LITERATURE REVIEW

There has been more work done on fertilizer placement on cotton than any other crop in the south, and principles of placement have been known for many years. Loss of stand and yield reduction have invariably followed when fertilizer was placed either in contact with the seed or directly below the seed, and in some instances several inches below the seed.

A number of investigators have studied the effects of fertilizer upon the germination of seed. A study of the effect of various fertilizer materials, at varying rates, on germination of corn, cotton, buckwheat, wheat, and soybeans was made by Coe (7). He found that when fertilizer materials were placed in contact with the seed, under dry field conditions, that an Ammo-phos' (13-48-0) and potassium chloride combination was more toxic to plants than the other materials studied. The apparent limit of tolerance for germination of cottonseed when 'Ammo-phos' was placed in contact with the seed was 20 pounds per acre. Other fertilizer materials affecting germination of cottonseed to a lesser extent at the 20 pounds per acre rate were the following: 'Ammo-phos' (13-48-0) in combination with potassium chloride, acid phosphate in combination with potassium chloride, and acid phosphate alone. Coe found that 60 pounds of potassium chloride per acre was required to affect seriously the germination of cottonseed. The fertilizer materials having the least effect were

sodium nitrate, acid phosphate, potassium chloride, and 80 pounds per acre of a mixture of the three salts. Coe also showed that the closer the fertilizer was to cottonseed the quicker the seeds germinated when fertilizer salts were applied at low rates. This was also shown by Buffun (6) who applied small quantities of certain salts such as sodium sulphate, sodium chloride, magnesium sulphate, and sodium carbonate, and found that all had a beneficial effect upon germination of seeds and growth of plants. He stated that large amounts of salts retarded and reduced germination of seeds in direct proportion to the osmotic pressure of the salt solution. Rusche (4) demonstrated the effect of salts upon seed germination, and he found that all phosphate salts were injurious, especially ammonium phosphates.

On Norfolk sandy loam soil in North Carolina, Collings, et al. (8) obtained a 20 percent stand of cotton when 800 pounds of 4-8-4 was applied per acre in contact with the seed.

Jackson (12) studied the effect of fertilizer salts on germination of sorghums. He found that the emergence of seedlings was not significantly affected by 25 pound per acre rates of several fertilizer materials. Germination was retarded and reduced by calcium nitrate, sodium nitrate, ammonium nitrate, and potassium chloride at the 50 and 100 pound rates. The germination of all varieties of grain and forage sorghums with the mixed fertilizer (5-10-5) treatments at all rates of application was as good as or better than the no fertilizer treatments. He found that ammonium nitrate

and potassium chloride severely inhibited seedling emergence at the 100 pound per acre rate. He concluded that germination varied with the kind and amount of fertilizer applied. Hobbs (11) studied the effect of fertilizer on emergence of Redlan sorghum seed. He reported that ammonium nitrate, superphosphate, muriate of potash, ammonium nitrate plus superphosphate, ammonium nitrate plus muriate of potash, and superphosphate plus muriate of potash all retarded germination at seven days. Hobbs applied nitrogen (N), phosphate (P_2O_5), and potassium (K_2O) at the rate of 30 pounds per acre in rows spaced 20 inches apart. The fertilizer was placed in the bottom of the furrows and the sorghum seed placed on top of the fertilizer. He found that, eighteen days after planting, seed that had been treated with superphosphate germinated as well as or better than those that had not been in contact with fertilizer. The other materials delayed the emergence of sorghum seedlings and decreased the number of seedlings that emerged.

Sherwin (17) studied the effect of fertilizers on the germination of corn and cotton. He showed that the class of soil was not related to the effect of the fertilizer. Allison (1) showed that on the basis of the amount of nitrogen present, the depression in germination and early growth due to ammonium phosphate was equivalent to ammonium sulphate. Ammonium phosphate was less toxic than sodium chloride and ammonium chloride. He also reported that the heavier the soil the larger the amount of fertilizer required to affect seed germination. He pointed

that under ordinary field conditions, soluble salts were washed down to the subsoil and could be brought back to the surface by capillarity very readily, but that lateral diffusion was almost negligible. This was also shown by Coe (7), Sayre and Clark (16) and other workers.

The effects of soil reaction upon seed germination were reported by Salter and McIlvaine (15). They concluded that the process of seed germination was not readily susceptible to injury from soil acidity, but that soil acidity probably affected subsequent processes of plant growth.

The anion, or acid radical, and not the cation or base radical determines the toxicity of alkali salts in soil according to studies made by Harris (9). He reported on several acid radicals and concluded that the chloride ion was more toxic than the other anions and that sodium was the most toxic metal studied. He also found that the germination period was lengthened by soluble salts in the soil, and that the injurious action of alkali salts was not in all cases proportional to the osmotic pressure of the salts.

Hicks (10) reported that fertilizer salts affected seed germination and summarized his results as follows: (a) Chemical fertilizers should not be placed in contact with germinating seeds. (b) Muriate of potash and sodium nitrate used as fertilizers in strengths of one percent or more were detrimental to germination of seeds, whether applied directly or mixed with the soil. (c) The chief injury to germination from chemical fertilizers was to young sprouts after they left

the seed coat and before they emerged from the soil, while seeds themselves were injured only slightly or none at all. Knight and Moudy (13) concluded that the absorption of salts by seeds was roughly in direct proportion to the mobility of the ions.

In recent years much good work has been done on the salt tolerance of varieties of vegetables and some work has been reported on field crop varieties. Ayers (2) studied the germination and emergence of 30 varieties of barley in salinized soil cultures. He showed that there were marked differences in the germination of barley varieties in saline soils. Bernstein and Ayers (2) studied the salt tolerance of green beans and reported significant differences among varieties. Two levels of salinity, 3000 ppm and 6000 ppm of equal parts of sodium chloride and calcium chloride were tried on six varieties of green beans. Bernstein and Ayers (4) also studied the salt tolerance of five varieties of carrots. Irrigation water was salinized and applied with 3000 ppm, 6000 ppm, and 9000 ppm of equal parts sodium chloride and calcium chloride 35 days after five varieties of carrots were planted. They reported no significant differences in mean total yields among varieties except on the high salt plot. Bernstein, Wadleigh, and Ayers (5) studied salt tolerance of six varieties of lettuce, but reported no significant differences among varieties.

METHODS AND MATERIALS

The effect of fertilizer salts, placed in contact with cottonseed, on the emergence and germination was studied in the greenhouse. Since adequate space was not available in the greenhouse to initiate the entire experiment at one time, it was necessary to complete the 50 pound per acre rate in 1955 and the 100 and 150 pound per acre rates in 1956.

Cotton varieties selected were representative of those commonly grown in Oklahoma. The varieties used and a brief description of each is given in Table I.

TABLE I

COTTON VARIETIES USED IN THE EXPERIMENT

Variety	Boll Size	Plant Size	Size of Seed	Maturity	Staple
Stoneville 62	Medium	Medium	Average	Early	15/16-1"
Deltapine 15	Small	Large	Small	Med-Late	1"-1 1/16
Parrott	Medium	Medium	Small	Early-Med	15/16-31/32
Lankart 57	Large	Medium	Large	Medium	15/16-1"
Northern Star	Med-Large	Medium	Av-Large	Early-Med	15/16-1"
Lockett No.1	Medium	Medium	Average	Medium	29/32-15/16

A preliminary germination check of the varieties used was made in 'The Stultz Germinator'.

The fertilizer treatments used are given in Table II.

TABLE II
FERTILIZER TREATMENTS USED IN EXPERIMENT

Treatment No.	Treatment
1	Check, no fertilizer
2	Mixed fertilizer (10-20-10)
3	Calcium phosphate (monobasic)
4	Mixed fertilizer (10-20-0)
5	Ammonium nitrate
6	Sodium nitrate
7	Potassium chloride
8	Mixed fertilizer (10-20-20)

Commercial fertilizers were used in all treatments except for sodium nitrate, which was a chemically pure reagent.

Fertilizer treatments were applied at 50, 100, and 150 pound per acre rates, with the assumption that the rows were 42 inches apart, and that a layer of fertilizer two inches wide would normally be placed in contact with the seed under field conditions. The 50 pound per acre treatments were planted June 8, 1955 and the 100 and 150 pound per acre treatments were planted June 3, 1956. Each rate and each fertilizer treatment was replicated three times in a split plot randomized block design. One row each of all varieties was planted per 14 by 24 inch flat, with 10 seed planted per row. The location of varieties in the flats and the location of each

treatment on the greenhouse bench were decided by random selection.

Port very fine sandy loam soil was obtained from the Lake Carl Blackwell area. This soil series is well suited to cotton production. The soil was soaked with distilled water immediately before planting. The seed was planted in rows four inches apart and spaced at 1.4 inch intervals in the row. The fertilizer was applied with a small sieve in direct contact with the seed in a two-inch band the length of the row. After the fertilizer was applied, approximately one-half inch of soil and a three-fourths inch layer of vermiculite were placed over the seed and then the whole flat was lightly sprinkled with distilled water. Only distilled water was used in the experiment and flats were watered lightly to keep them moist.

Seedling counts were made daily on all treatments on the 4th through the 14th days after planting. Only live seedlings were counted.

Photographs were made of selected treatments 14 days after planting. Root growth examination and photographs were made 14 days after planting on the 100 pound rate. Growth measurements (seedling height) were taken 14 days after planting on all rates.

RESULTS

The live seedling counts are given in Table XIII. The number of emerged seedlings for all varieties except Deltapine 15 was lower on the 50 pound per acre check plots than the 100 and 150 pound rate check plots. Low greenhouse temperatures resulting from adverse weather conditions in 1955 (cool, cloudy, rainy weather), may have contributed to this difference in germination of check plots. Weather conditions in 1956 were more favorable during the period of early seedling emergence with the 100 and 150 pound per acre rates. This was reflected in the quicker emergence of seedlings of all varieties in check plots of the 100 and 150 pound rates as compared to check plots on the 50 pound rate. The earliest emerging varieties were Parrott, Lockett No. 1 and Deltapine 15. Seedling growth of check plots on the 100 and 150 pound rate treatments 14 days after planting is shown in Figures 1 and 2. The root growth 14 days after planting for the check plot of the 100 pound per acre rate is shown in Figure 15. The rate and percentage germination of varieties in check plots are shown in Table XIII. The germination percentage obtained for each variety in 'The Stultz Germinator' is given in Table XII.

Effect of Mono-Calcium Phosphate on Cottonseed Germination

The emergence of varieties was slightly retarded or reduced by all fertilizers at 50 pound per acre rates except mono-calcium phosphate (Table XIV). Seedling growth 14 days after planting showed that these seedlings were 0.5 inch taller than the checks (Table XXII).

The emergence of all varieties was reduced and retarded by the mono-calcium phosphate at the 100 and 150 pound rates. Seedling growth 14 days after planting at the 100 pound rate showed that seedlings averaged 1.1 inches less ^{than} height than the checks. All evidence obtained indicates that Lankart 57 is a slow germinator. Reduced percentage and retardation of germination was noted with Lankart 57 as compared to other varieties (See Figures 1 and 2, and Table XIV). The root system for all varieties was examined and found to be more extensive in check plots than in plots treated with 100 and 150 rates 14 days after planting (See Figures 15 and 17). Root growth of seedlings with the 50 pound rate was not retarded.

Effect of A Mixed Fertilizer (10-20-0) on Cottonseed Germination

The germination of all varieties was unaffected by the 50 pound rate; however, emergence was slightly delayed (Table XIV). Measurement of seedling height 14 days after planting showed that the 50 pound rate gave an average increase in height of 1.1 inches over the check.

Figure 1. The growth of cotton fourteen days after planting with check and 0-20-0 plots at 100 pound per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
2	Deltapine 15	4	Lankart 57
5	Northern Star	6	Lockett No. 1
3	Parrott	1	Stoneville 62

Figure 2. The growth of cotton fourteen days after planting with check and 0-20-0 plots at 150 pound per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
6	Lockett No. 1	2	Deltapine 15
5	Northern Star	4	Lankart 57
1	Stoneville 62	3	Parrott

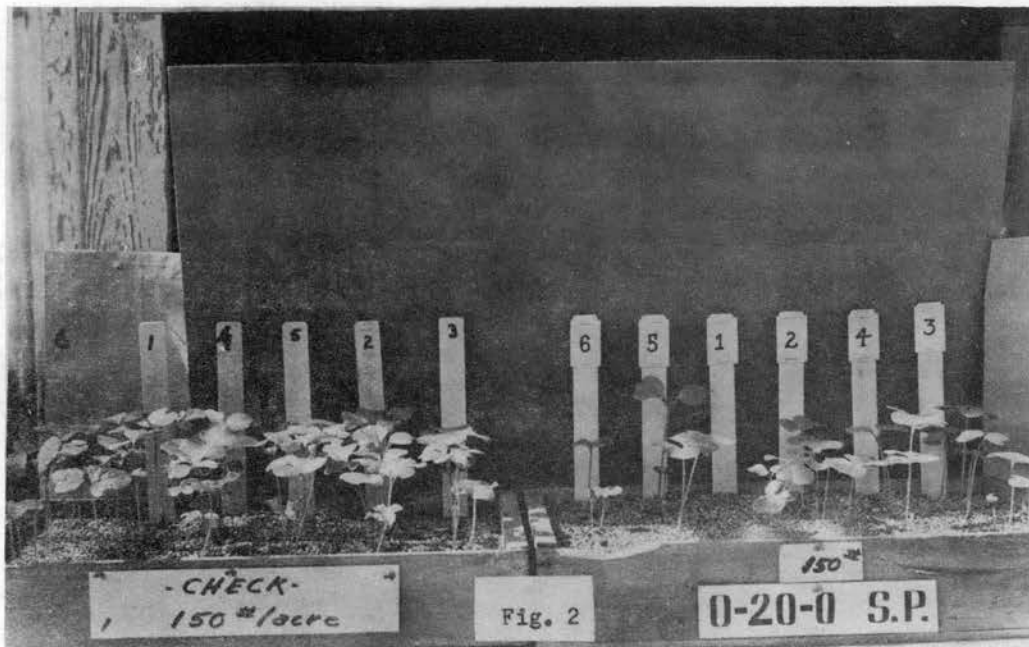
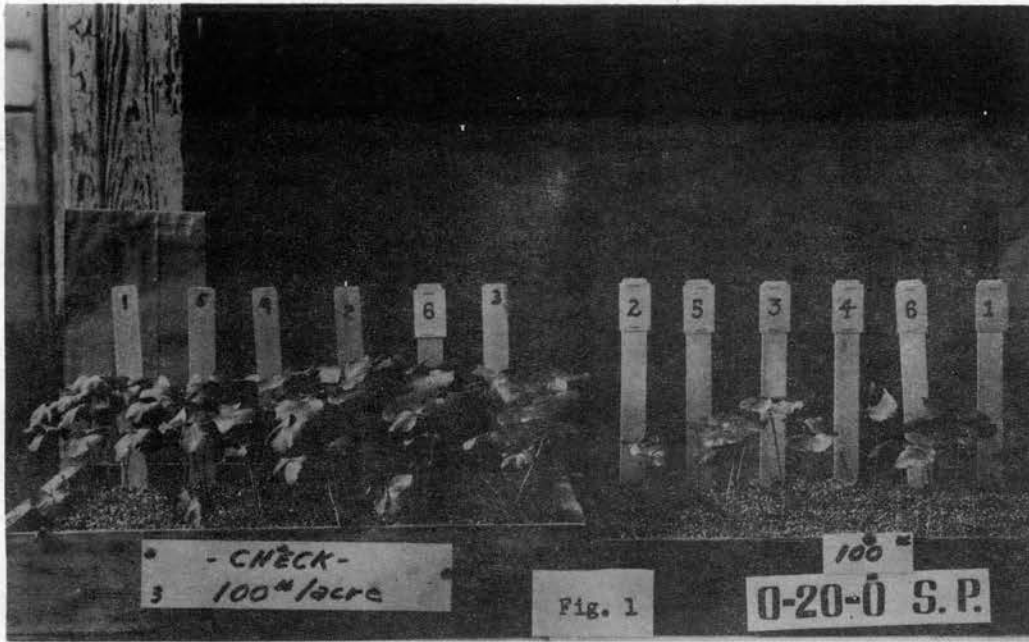
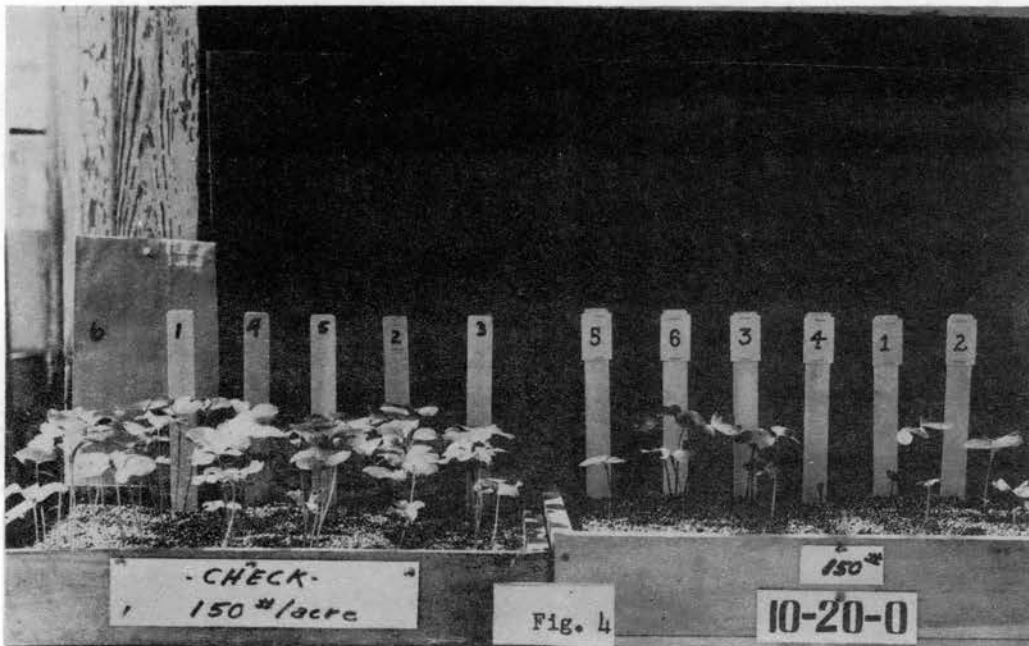
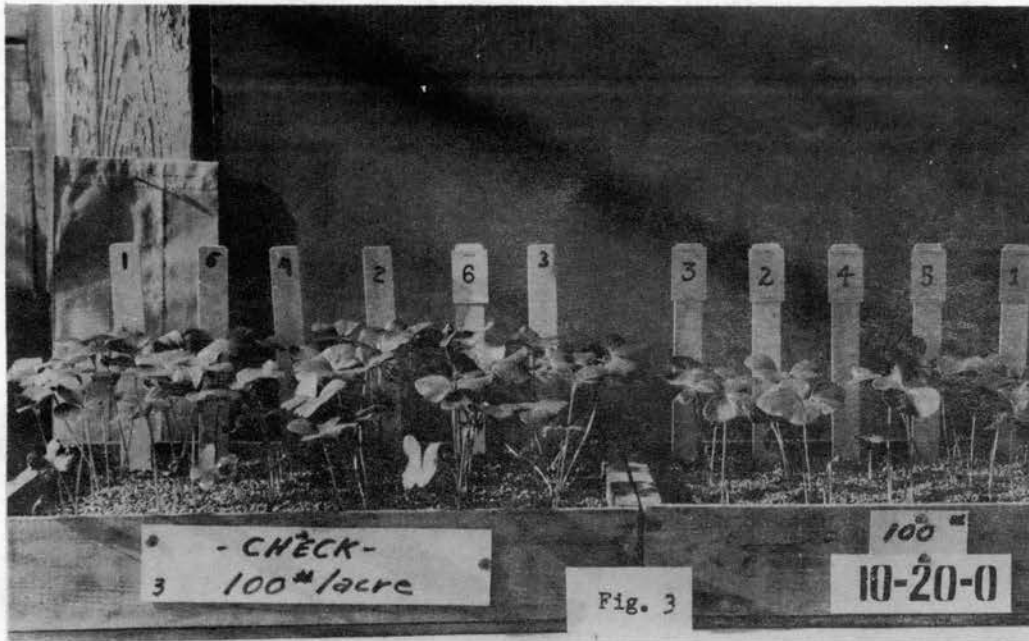


Figure 3. The growth of cotton fourteen days after planting with check and 10-20-0 plots at 100 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
3	Parrott	5	Northern Star
2	Deltapine 15	1	Stoneville 62
4	Lankart 57	6	Lockett No. 1

Figure 4. The growth of cotton fourteen days after planting with check and 10-20-0 plots at 150 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
5	Northern Star	4	Lankart 57
6	Lockett No. 1	1	Stoneville 62
3	Parrott	2	Deltapine 15



The germination of all varieties except Northern Star was reduced at the 100 pound rate, and germination of all varieties was reduced at the 150 pound rate.

Emergence was retarded markedly at the 100 pound rate and severely retarded at the 150 pound rate (Table XV).

Seedling growth of all varieties was reduced considerably at the 100 and 150 pound rates. Measurements taken 14 days after planting showed average height of seedlings to be 2.8 inches on the 100 pound per acre rate plots as compared to 5.9 inches for check plots (Figures 3 and 4 and Table XXIII).

Root growth and development at the 100 and 150 pound rates was severely retarded (Figure 18).

Effect of A Mixed Fertilizer (10-20-10) on Cottonseed Germination

Germination was not reduced but emergence of all varieties was slightly delayed. At the 100 pound rate germination was slightly less than the check plots and emergence was slightly delayed, while at the 150 pound rate germination was severely reduced and emergence markedly delayed (Table XVI).

Seedling growth of all varieties was reduced at the 100 pound rate and the seedlings averaged 1.8 inches less in height than varieties in check plots 14 days after planting (Figure 5 and 6 and Table XXII).

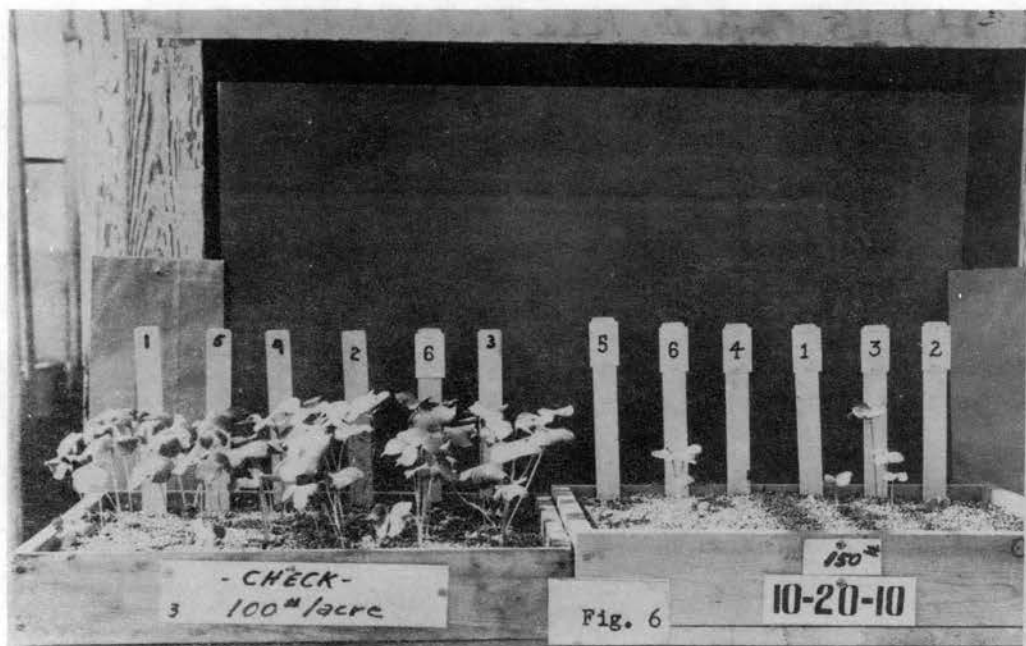
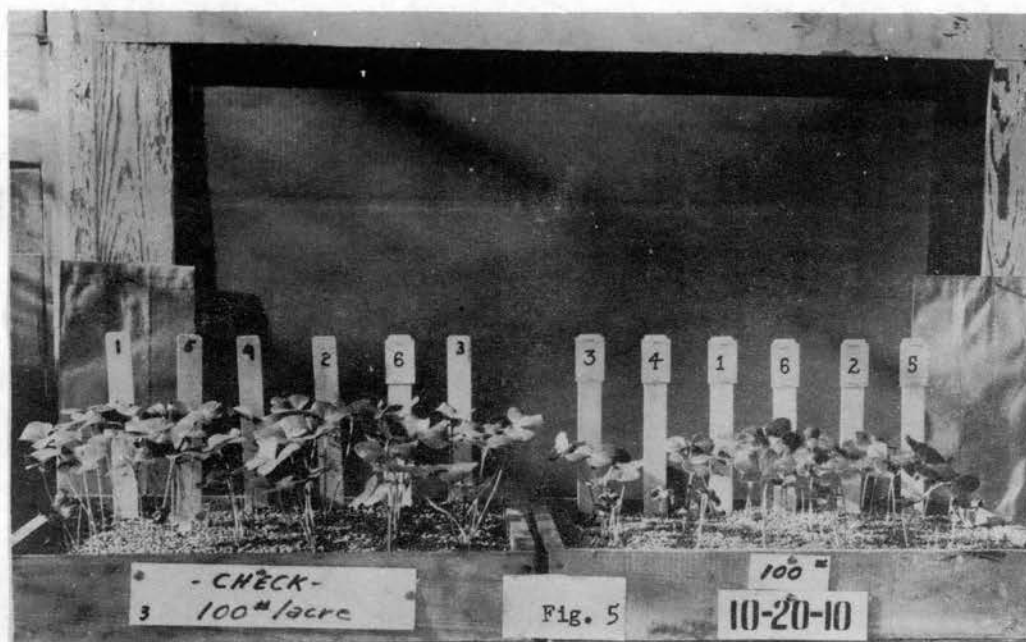
Root growth was less extensive for all varieties with the 100 pound rate as compared with check plots (Figure XVI).

Figure 5. The growth of cotton fourteen days after planting with check and 10-20-10 plots at 100 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
3	Parrott	6	Lockett No. 1
4	Lankart 57	2	Deltapine 15
1	Stoneville 62	5	Northern Star

Figure 6. The growth of cotton fourteen days after planting with check and 10-20-10 plots at 150 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
5	Northern Star	4	Lankart 57
6	Lockett No. 1	1	Stoneville 62
3	Parrott	2	Deltapine 15



Effect of Ammonium Nitrate on Cottonseed Germination

The germination of all varieties except Stoneville 62 and Parrott was reduced by the 50 pound rate of ammonium nitrate, and emergence was delayed in all varieties (See Table XVII). Seedling height 14 days after planting was 0.5 inches less than in the check plots.

Germination of all varieties was severely reduced and emergence drastically delayed by the 100 and 150 pound per acre rates. Seedling growth at the 100 and 150 pound rates was severely reduced. Measurements of seedlings 14 days after planting showed the height to be 1.3 inches less than seedlings in check plots at the 100 pound rate. Lankart 57 seedlings showed less growth 14 days after planting than did other varieties which may be attributed in part to its normally slow emergence (Table XXII).

It was found that roots of seedlings of all varieties were less extensive at the 100 pound rate than in the check plots.

Effect of Sodium Nitrate on Cottonseed Germination

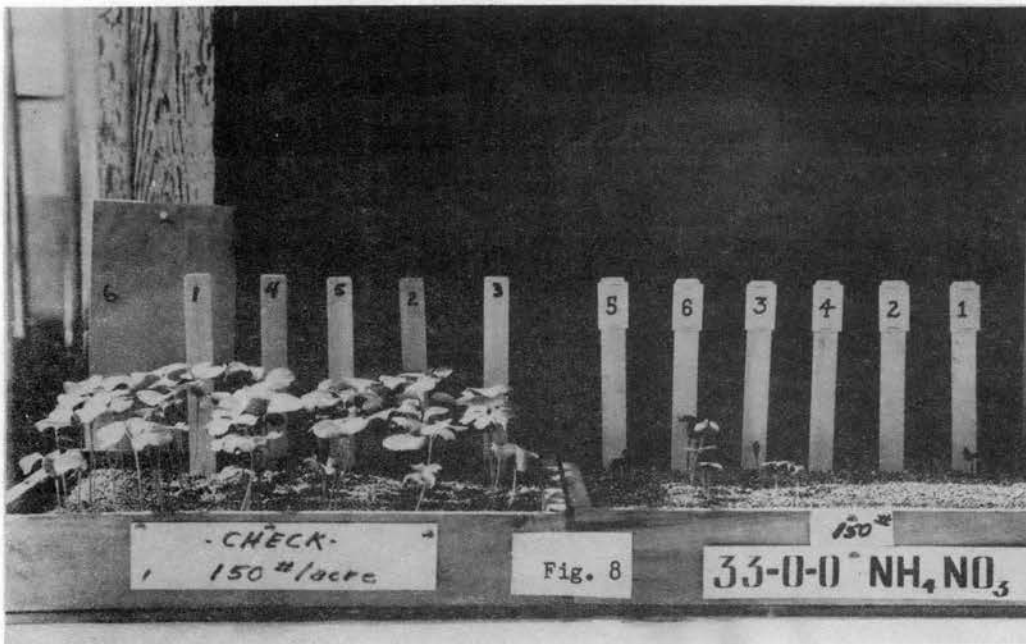
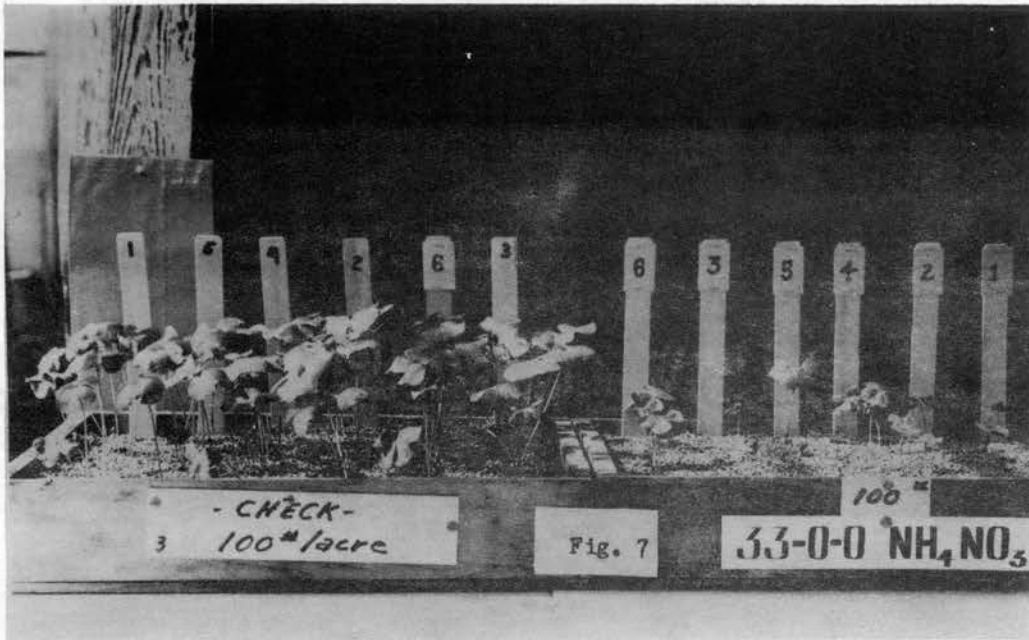
The germination of all varieties except Lankart 57 and Lockett No. 1 was reduced by sodium nitrate at the 50 pound per acre rate (Table XVIII); emergence was delayed in all varieties. Seedling growth was less with sodium nitrate at the 50 pound rate than with any of the other fertilizer salts (See Table XXII).

Figure 7. The growth of cotton fourteen days after planting with check and ammonium nitrate plots at 100 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
6	Lockett No. 1	4	Lankart 57
3	Parrott	2	Deltapine 15
5	Northern Star	1	Stoneville 62

Figure 8. The growth of cotton fourteen days after planting with check and ammonium nitrate plots at 150 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
5	Northern Star	4	Lankart 57
6	Lockett No. 1	2	Deltapine 15
3	Parrott	1	Stoneville 62



The emergence of all varieties was severely reduced and delayed by sodium nitrate at the 100 and 150 pound rates (Table XVIII). Seedling growth was drastically reduced with sodium nitrate at the 100 and 150 pound rates. Measurement of seedling height 14 days after planting showed the 100 pound rate seedling height to be 2.7 inches less than seedling height in check plots (Figures 9 and 10, and Table XXII). Root growth was also much less extensive with the 100 and 150 pound rates than with the 50 pound rate and check plots (Figure 22).

Effect of A Mixed Fertilizer (10-20-20) on Cottonseed Germination

The emergence of all varieties at the 50 pound rate of 10-20-20 varied only slightly from check plots, however, emergence was slightly delayed (Table XIX). Seedling growth was more vigorous at the 50 pound rate than on check plots (Table XXII).

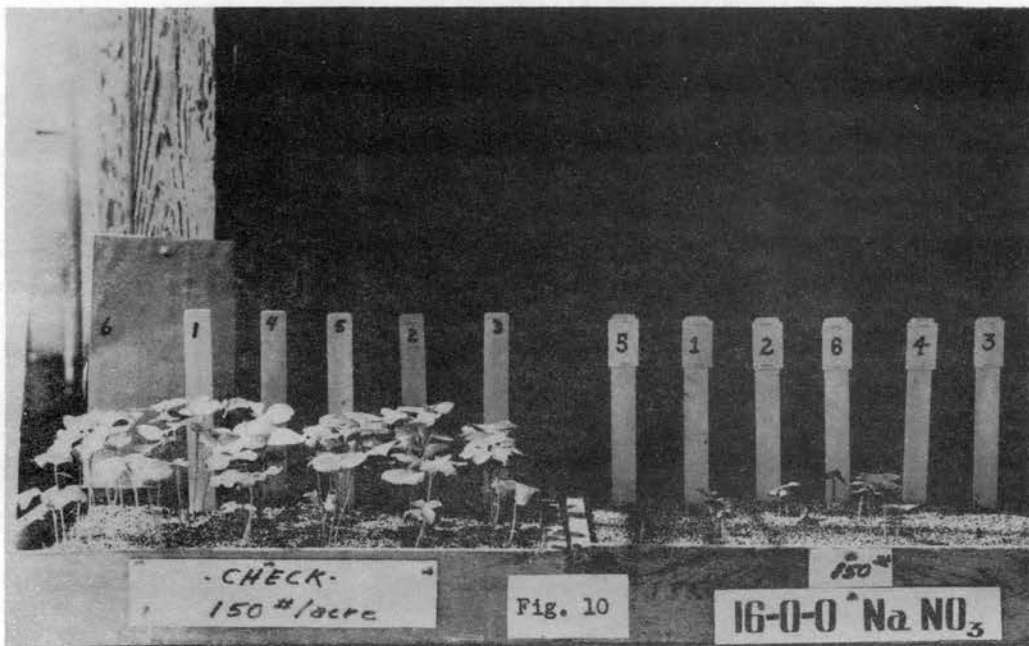
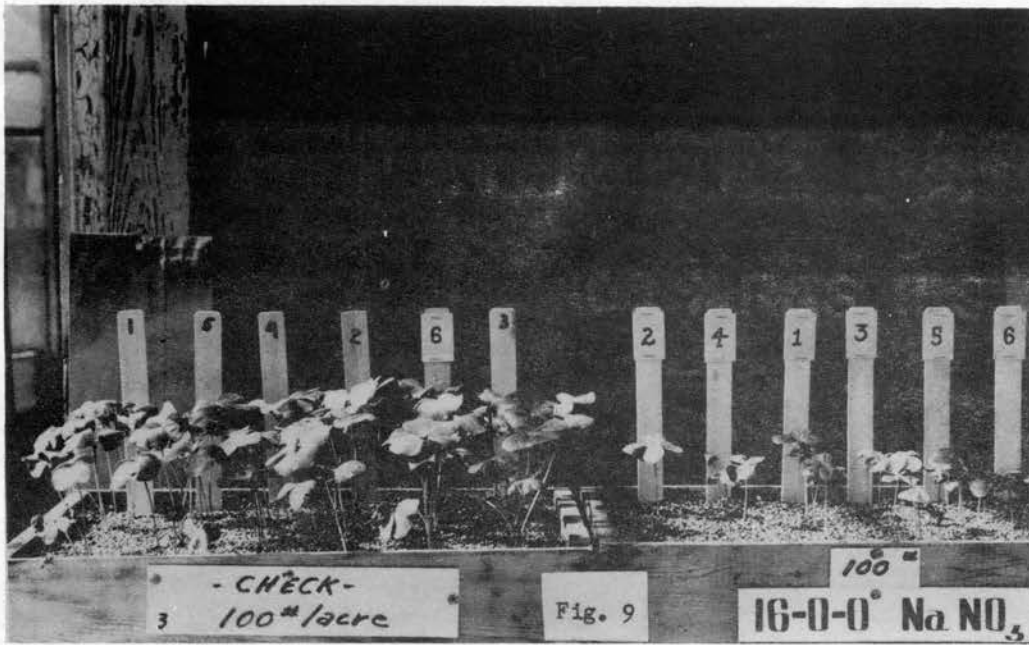
The emergence of all varieties was delayed and germination severely affected at the 100 and 150 pound rates (Figures 11 and 12 and Table XIX). Seedling growth was more depressed with 100 pound 10-20-20 treatment than any of the other fertilizer treatments except for ammonium nitrate. Seedling height measured 14 days after planting showed the average height of seedlings on 100 and 150 pound treatments to be 2.7 inches less than the average on check plots (See Table XXII). Root development was severely reduced at the 100 pound rate (Figure 20).

Figure 9. The growth of cotton fourteen days after planting with check and sodium nitrate plots at 100 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
2	Deltapine 15	3	Parrott
4	Lankart 57	5	Northern Star
1	Stoneville 62	6	Lockett No. 1

Figure 10. The growth of cotton fourteen days after planting with check and sodium nitrate plots at 150 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
5	Northern Star	6	Lockett No. 1
1	Stoneville 62	4	Lankart 57
2	Deltapine 15	3	Parrott



Effect of Potassium Chloride on Cottonseed Germination

The emergence of all varieties was unaffected by potassium chloride at the 50 pound rate, but the higher rates of 100 and 150 pounds severely reduced emergence. The germination of all varieties was retarded by all treatments, but at the 50 pound rate, the effect was slight. (Figure 13 and 14 and Table XX).

Measurements made 14 days after planting showed that at the 50 pound rate seedling height exceeded the check by 0.4 inches and at the 100 pound rate seedling height was 2.1 inches less than the check (Table XX). Root growth was reduced at rates above 50 pounds of potassium chloride (Figure XXII).

Figure 11. The growth of cotton fourteen days after planting with check and 10-20-20 plots at 100 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
1	Stoneville 62	2	Deltapine 15
4	Lankart 57	6	Lockett No. 1
5	Northern Star	3	Parrott

Figure 12. The growth of cotton fourteen days after planting with check and 10-20-20 plots at 150 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
6	Lockett No. 1	3	Parrott
4	Lankart 57	1	Stoneville 62
2	Deltapine 15	5	Northern Star

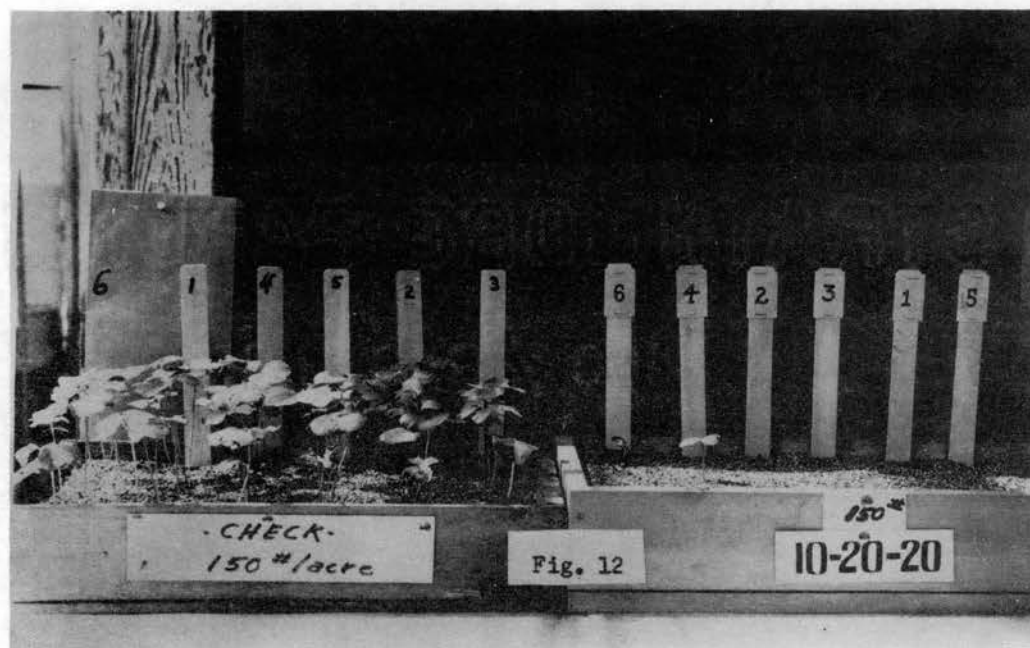
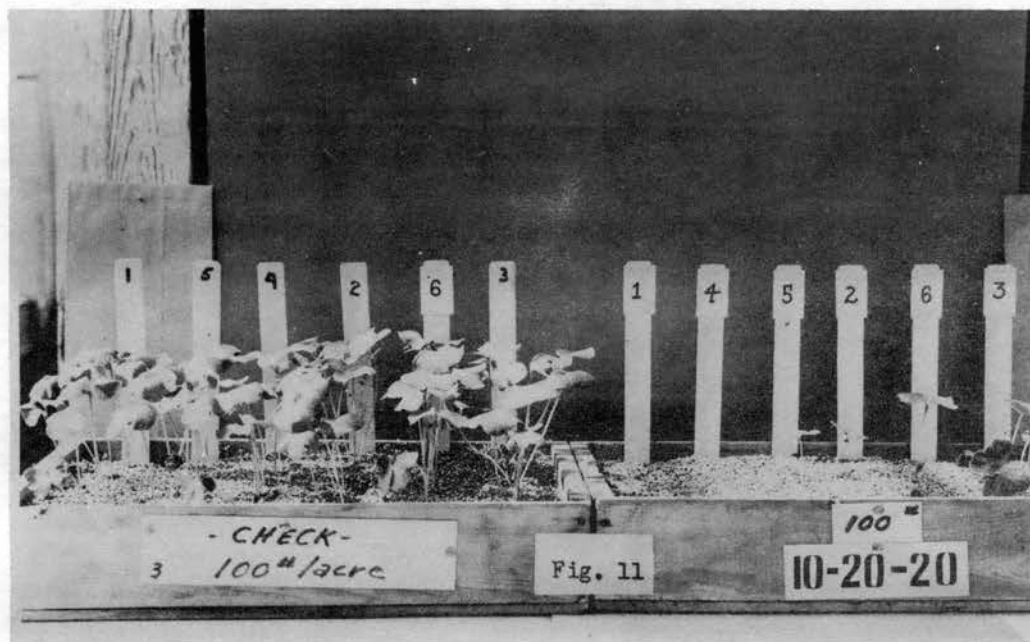


Figure 13. The growth of cotton fourteen days after planting with check and potassium chloride plots at 100 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
5	Northern Star	6	Lockett No.1
1	Stoneville 62	3	Parrott
2	Deltapine 15	4	Lankart 57

Figure 14. The growth of cotton fourteen days after planting with check and potassium chloride plots at 150 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
3	Parrott	2	Deltapine 15
6	Lockett No. 1	5	Northern Star
1	Stoneville 62	4	Lankart 57

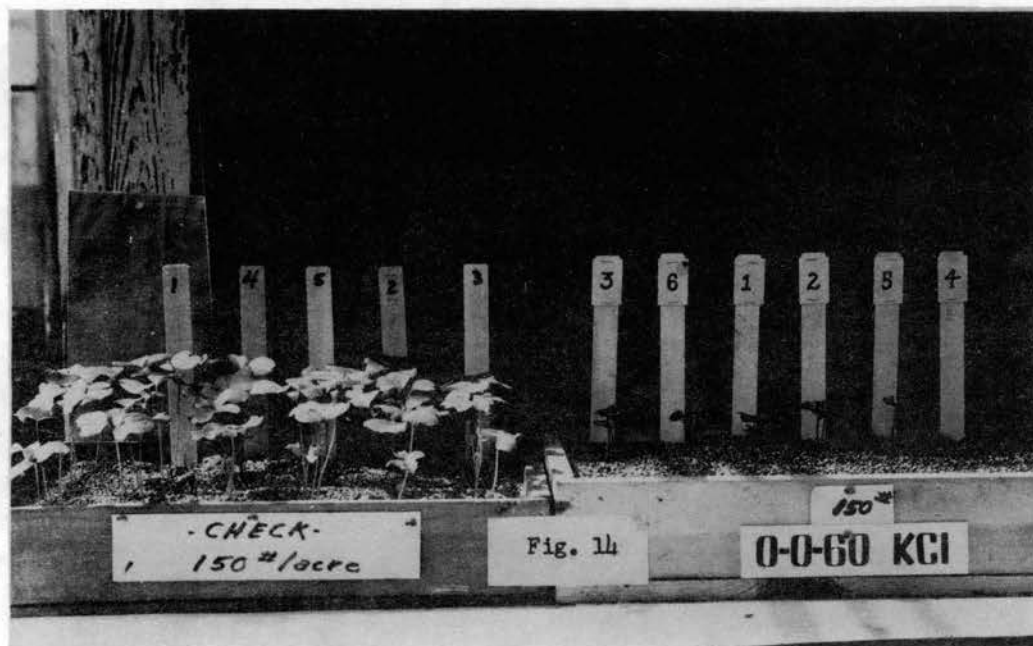
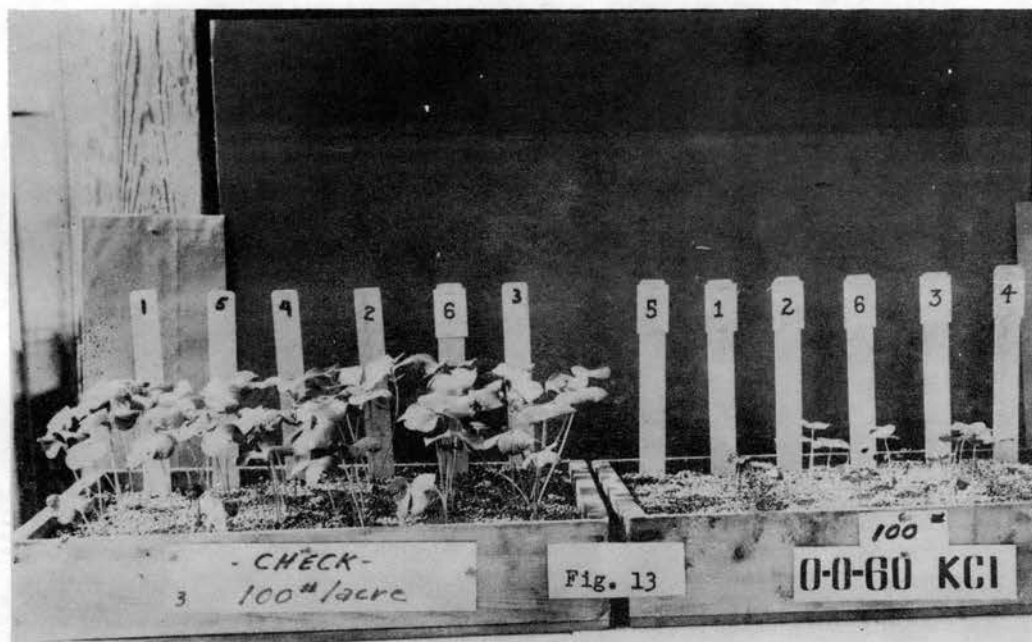


Figure 15. Root growth of cotton fourteen days after planting in the check plots of the 100 pounds per acre rate. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
1	Stoneville 62	2	Deltapine 15
5	Northern Star	6	Lockett No. 1
4	Lankart 57	3	Parrott

Figure 16. Root growth of cotton fourteen days after planting with a mixed fertilizer (10-20-10) at 100 pounds per acre. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
3	Parrott	6	Lockett No. 1
4	Lankart 57	2	Deltapine 15
1	Stoneville 62	5	Northern Star

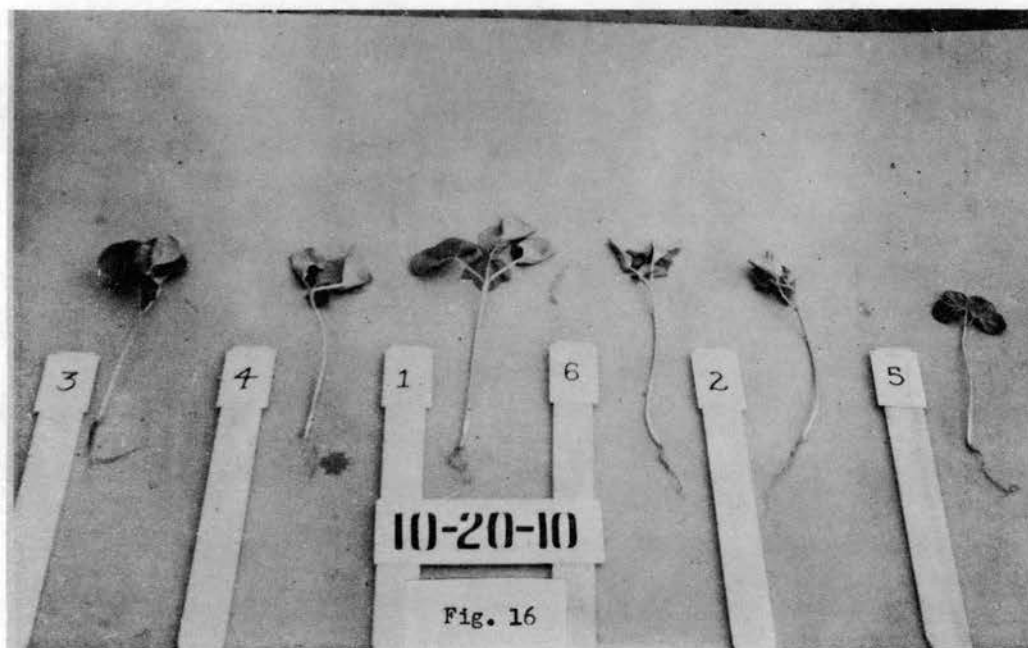
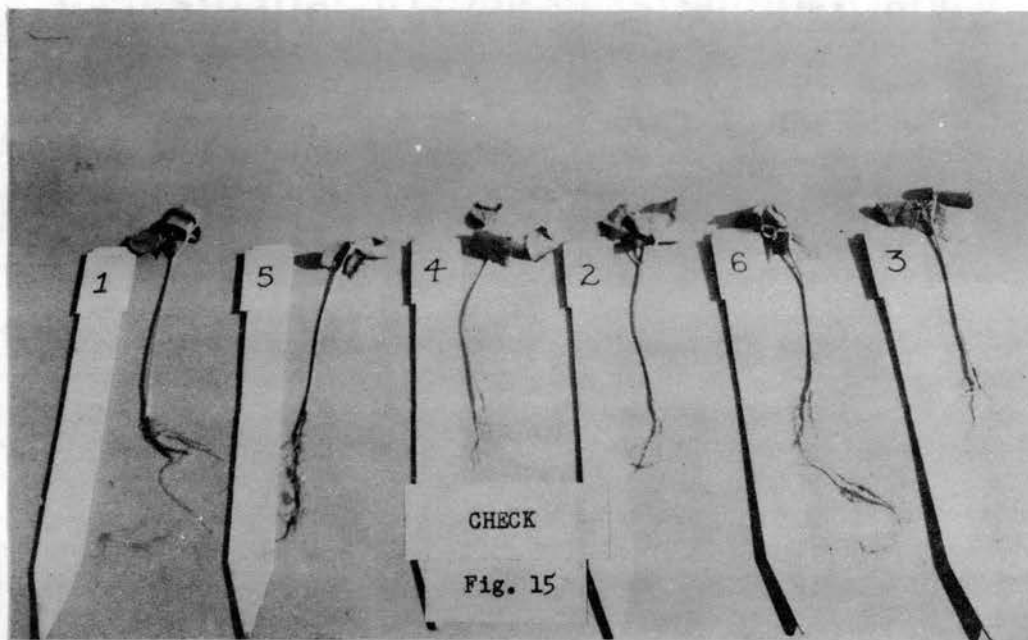


Figure 17. Root growth of cotton fourteen days after planting with (0-20-0) at 100 pounds per acre. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
2	Deltapine 15	3	Parrott
5	Northern Star	4	Lankart 57
6	Lockett No. 1	1	Stoneville 62

Figure 18. Root growth of cotton fourteen days after planting with a mixed fertilizer (10-20-0) at 100 pounds per acre. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
3	Parrott	5	Northern Star
2	Deltapine 15	6	Lockett No. 1
4	Lankart 57	1	Stoneville 62

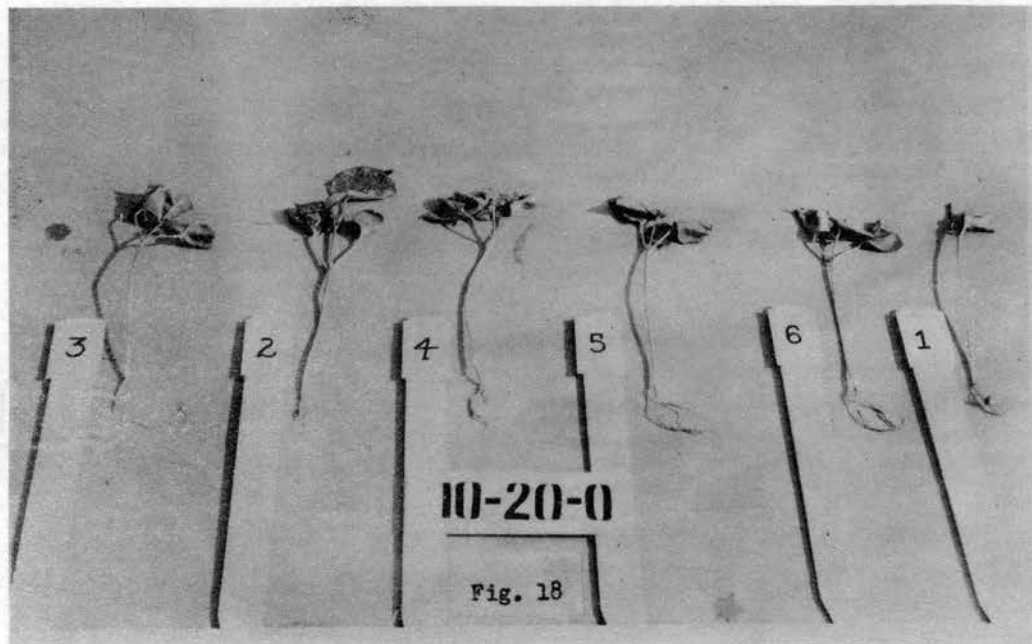
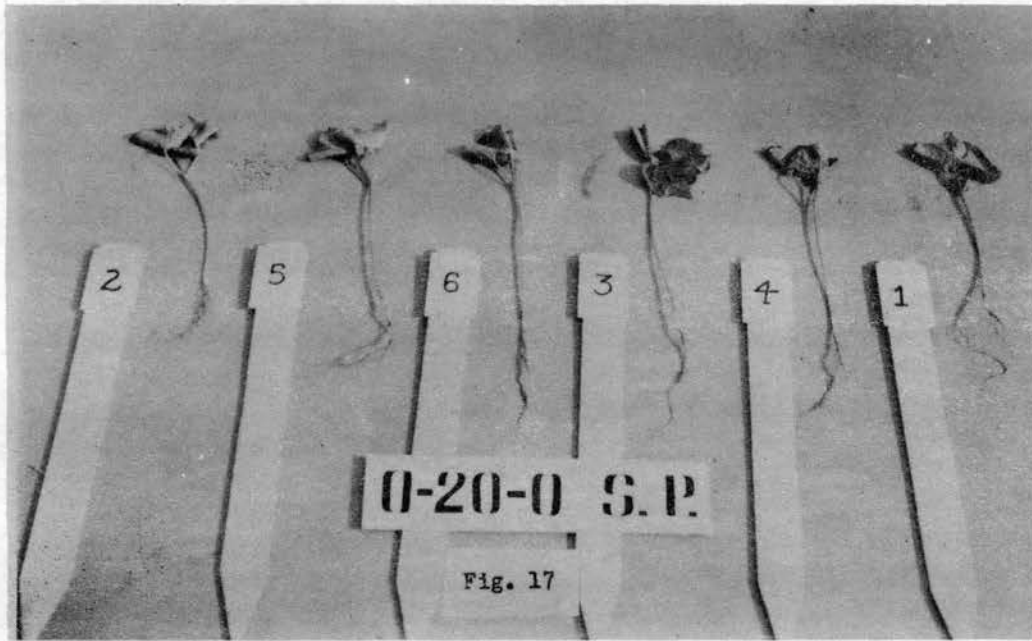


Figure 19. Root growth of cotton fourteen days after planting with ammonium nitrate at 100 pounds per acre. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
6	Lockett No. 1	4	Lankart 57
3	Parrott	2	Deltapine 15
5	Northern Star	1	Parrott

Figure 20. Root growth of cotton fourteen days after planting with a mixed fertilizer (10-20-20) at 100 pounds per acre. (Variety identity number given below.)

Row No.	Variety	Row No.	Variety
1	Stoneville 62	2	Deltapine 15
4	Lankart 57	6	Lockett No. 1
5	Northern Star	3	Parrott

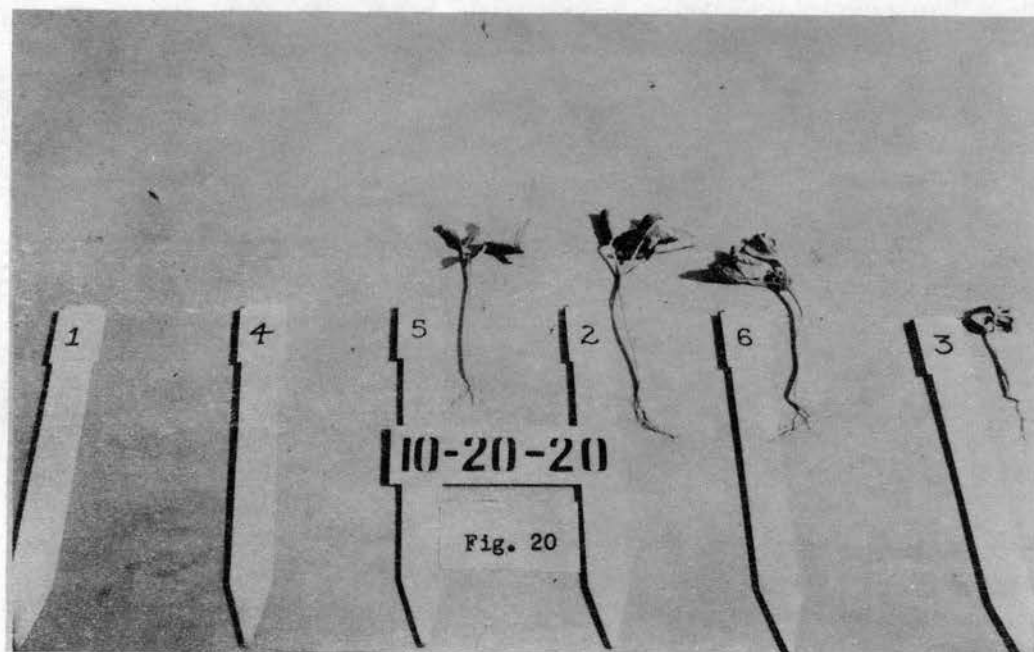
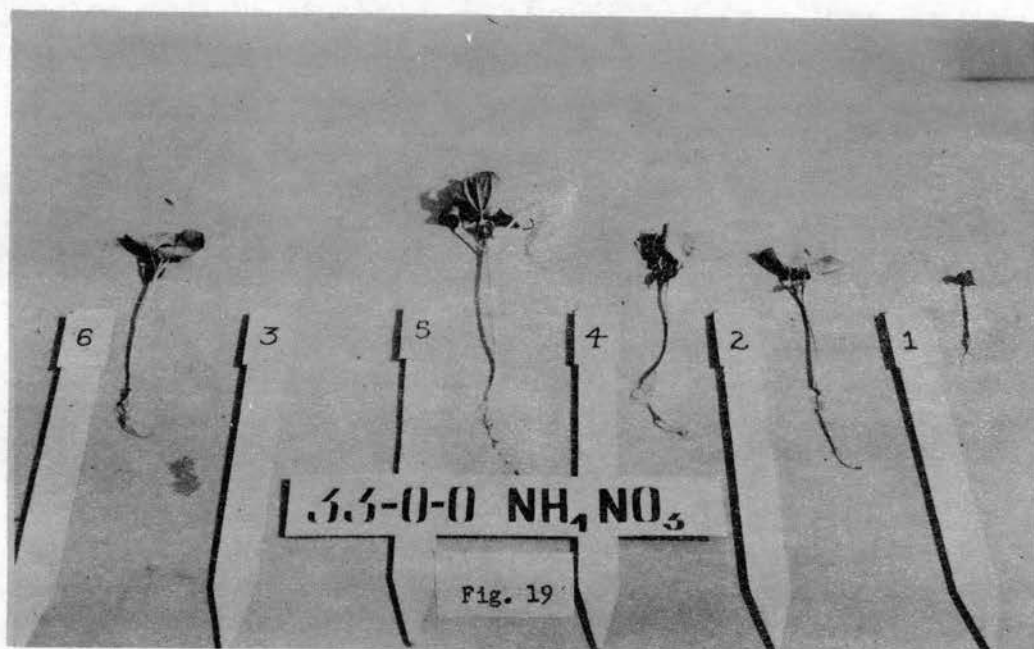
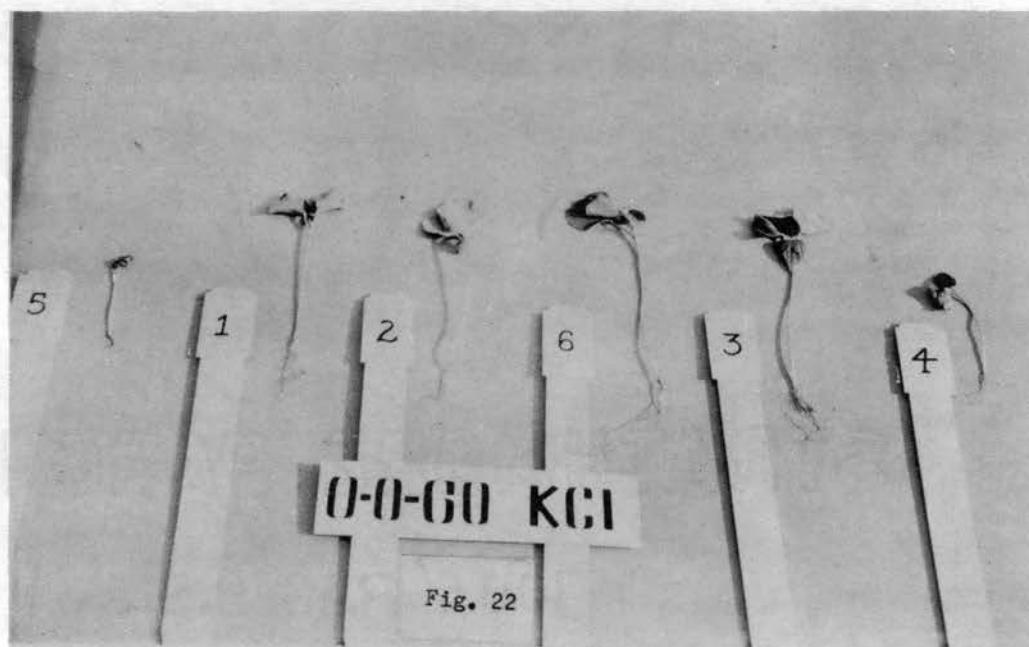
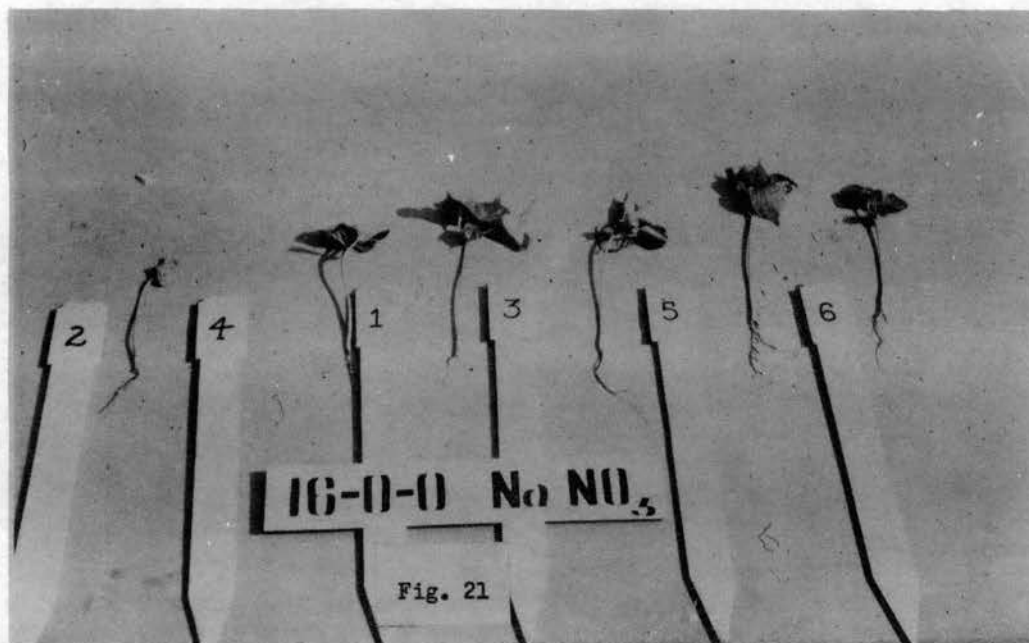


Figure 21. Root growth of cotton fourteen days after planting with sodium nitrate at 100 pounds per acre.
(Variety identity number given below.)

Row No.	Variety	Row No.	Variety
2	Deltapine 15	3	Parrott
4	Lankart 57	5	Northern Star
1	Stoneville 62	6	Lockett No. 1

Figure 22. Root growth of cotton fourteen days after planting potassium chloride at 100 pounds per acre.
(Variety identity number given below.)

Row No.	Variety	Row No.	Variety
5	Northern Star	6	Lockett No. 1
1	Stoneville 62	3	Parrott
2	Deltapine 15	4	Lankart 57



ANALYSIS OF VARIANCE TABLES

The statistical significance of the results obtained 14 days after planting is indicated in the following analysis of variance tables.

TABLE III

ANALYSIS OF VARIANCE FOR SEEDLING EMERGENCE WHEN FERTILIZER TREATMENTS WERE PLACED IN DIRECT CONTACT WITH THE SEED AT THE 50 POUND RATE. SEEDLING COUNTS WERE MADE 14 DAYS AFTER PLANTING

Source	df	SS	MS	F	5%F	1%F
Total	143	382.94	----	----	----	----
Replication	2	13.32	6.66	4.53*	3.74	6.51
Fertilizer	7	53.94	7.71	5.25**	2.28	3.20
Error A	14	21.68	1.47	----	----	----
Variety	5	26.40	5.28	2.39*	2.33	3.25
Variety x Fert.	35	92.16	2.63	1.19	1.57	1.89
Error B	80	176.44	2.21	----	----	----

*Significant at the 5% level. **Significant at the 1% level

TABLE IV

ANALYSIS OF VARIANCE FOR SEEDLING EMERGENCE WHEN
FERTILIZER TREATMENTS WERE PLACED IN DIRECT
CONTACT WITH THE SEED AT THE 100 POUND
RATE. SEEDLING COUNTS WERE MADE
14 DAYS AFTER PLANTING

Source	df	SS	MS	F	5%F	1%F
Total	143	869.31	----	----	----	----
Replication	2	2.86	1.43	.24	3.74	6.51
Fertilizer	7	542.30	77.47	13.06**	2.28	3.20
Error A	14	83.03	5.93	----	----	----
Variety	5	70.50	14.10	14.10**	2.33	3.25
Variety x Fert.	35	90.41	2.58	2.58**	1.57	1.89
Error B	80	80.21	1.00	----	----	----

**Significant at the 1% level.

TABLE V

ANALYSIS OF VARIANCE FOR SEEDLING EMERGENCE WHEN
FERTILIZER TREATMENTS WERE PLACED IN DIRECT
CONTACT WITH THE SEED AT THE 150 POUND
RATE. SEEDLING COUNTS WERE MADE
14 DAYS AFTER PLANTING

Source	df	SS	MS	F	5%F	1%F
Total	143	1267.66	----	----	----	----
Replication	2	13.01	6.50	1.53	3.74	6.51
Fertilizer	7	749.38	107.05	25.30**	2.28	3.20
Error A	14	67.53	4.23	----	----	----
Variety	5	67.12	13.42	3.43**	2.33	3.25
Variety x Fert.	35	57.72	1.65	.42	1.19	1.57
Error B	80	312.90	3.91	----	----	----

**Significant at the 1% level.

TABLE VI

MULTIPLE RANGE TEST FOR RELATIVE EFFECT OF FERTILIZERS ON SEEDLING EMERGENCE WHEN THE FERTILIZER TREATMENTS WERE PLACED IN DIRECT CONTACT WITH THE SEED AT THE 50 POUND RATE. SEEDLING COUNTS WERE MADE 14 DAYS AFTER PLANTING.

Multiple range test at 1% level.

<u>Fertilizer</u>	<u>Ranked Means</u>
Potassium chloride (0-0-60)	8.8
10-20-10	8.5
0-20-0	8.1
Check	7.8
10-20-20	7.8
10-20-0	7.6
Ammonium nitrate (33-0-0)	7.1
Sodium nitrate	6.9

TABLE VII

MULTIPLE RANGE TEST FOR RELATIVE RANKING OF VARIETAL EFFECT ON SEEDLING EMERGENCE WHEN THE FERTILIZER TREATMENTS WERE PLACED IN DIRECT CONTACT WITH THE SEED AT THE 50 POUND RATE. SEEDLING COUNTS WERE MADE 14 DAYS AFTER PLANTING.

Multiple range test at 5% level.

<u>Variety</u>	<u>Ranked Means</u>
Parrott	8.5
Deltapine 15	8.3
Lockett No. 1	7.7
Lankart 57	7.7
Northern Star	7.5
Stoneville 62	6.9

TABLE VIII

MULTIPLE RANGE TEST FOR RELATIVE EFFECT OF FERTILIZERS ON SEEDLING EMERGENCE WHEN THE FERTILIZER TREATMENTS WERE PLACED IN DIRECT CONTACT WITH THE SEED AT THE 100 POUND RATE. SEEDLING COUNTS WERE MADE 14 DAYS AFTER PLANTING.

Multiple range test at the 1% level.

<u>Fertilizer</u>	<u>Ranked Means</u>
Check	8.9
10-20-0	7.4
10-20-10	7.3
0-20-0	6.4
Potassium chloride (0-0-60)	6.2
Sodium nitrate	5.9
Ammonium nitrate (33-0-0)	4.3
10-20-20	2.1

TABLE IX

MULTIPLE RANGE TEST FOR RELATIVE RANKING OF VARIETAL EFFECT ON SEEDLING EMERGENCE WHEN THE FERTILIZER TREATMENTS WERE PLACED IN DIRECT CONTACT WITH THE SEED AT THE 100 POUND RATE. SEEDLING COUNTS WERE MADE 14 DAYS AFTER PLANTING.

Multiple range test at the 1% level.

<u>Variety</u>	<u>Ranked Means</u>
Lockett No. 1	7.2
Deltapine 15	6.6
Parrott	6.2
Northern Star	5.8
Lankart 57	5.4
Stoneville 62	5.2

TABLE X

MULTIPLE RANGE TEST FOR RELATIVE EFFECT OF FERTILIZERS ON SEEDLING EMERGENCE WHEN THE FERTILIZER TREATMENTS WERE PLACED IN DIRECT CONTACT WITH THE SEED AT THE 150 POUND RATE. SEEDLING COUNTS WERE MADE 14 DAYS AFTER PLANTING.

Multiple range test at the 1% level.

<u>Fertilizer</u>	<u>Ranked Means</u>
Check	9.1
10-20-0	5.9
10-20-10	4.6
10-20-0	4.4
Sodium nitrate	3.8
Ammonium nitrate (33-0-0)	3.2
Potassium chloride (0-0-60)	3.0
10-20-20	0.6

TABLE XI

MULTIPLE RANGE TEST FOR RELATIVE RANKING OF VARIETAL EFFECT ON SEEDLING EMERGENCE WHEN THE FERTILIZER TREATMENTS WERE PLACED IN DIRECT CONTACT WITH THE SEED AT THE 150 POUND RATE. SEEDLING COUNTS WERE MADE 14 DAYS AFTER PLANTING.

Multiple range test at the 1% level.

<u>Variety</u>	<u>Ranked Means</u>
Deltapine 15	5.3
Parrott	4.6
Lockett No. 1	4.6
Northern Star	4.3
Stoneville 62	4.0
Lankart 57	3.1

SUMMARY AND CONCLUSIONS

- (1) Statistical analysis of the data obtained showed that rates and kinds of fertilizers were highly significant affecting germination at all levels of treatment.
- (2) Varieties were significantly different at the one percent level at all levels of treatment except the 50 pound rate, which showed significance at the five percent level.
- (3) Variety x fertilizer interaction was highly significant at the 100 pound per acre rate, but was not significant at the one or five percent level for the 50 and 150 pound rates. This behavior was probably due to the fact that the 50 pound rate was not high enough to produce large differences in germination among varieties as compared to the 100 pound rate, while the 150 pound rate was too high to show differences among varieties. In other words varieties acted more nearly alike in regard to salt tolerance at the 50 and 150 pound rates even though varieties at these two levels of treatment were significantly different.
- (4) At the 50 pound rate all fertilizers except sodium nitrate and ammonium nitrate stimulated seedling growth. At the 100 and 150 pound treatments, all fertilizers severely retarded seedling growth and caused some seedlings to die a few days after emerging.

- (5) Emergence of all varieties was retarded slightly at the 50 pound rate except the mono-calcium phosphate treatment. Emergence of all varieties was severely retarded at the 100 and 150 pound per acre treatments.
- (6) At the 50 pound per acre rate, replications were significant at the five percent level. This was attributed to a leak in the greenhouse which permitted rain water to enter, thus resulting in considerable disturbance to germination of seedlings in several flats most of which represented the second replication.
- (7) At the 100 pound per acre treatment, 10-20-20 reduced germination of all varieties more than any other treatment except ammonium nitrate. Ammonium nitrate and 10-20-20 were not significantly different at the one percent level. At the 150 pound rate, the 10-20-20 treatment significantly reduced germination more than any other treatment.
- (8) Parrott, Deltapine 15, and Lockett No. 1 appeared to be more tolerant of fertilizer salts than other varieties at all levels of treatment. At the 100 pound rate, Lockett No. 1 and Deltapine 15 were not significantly different in tolerance to fertilizer salts. At the 150 pound rate Deltapine 15, Parrott, and Lockett No. 1 were not significantly different in tolerance to fertilizer salts. At the 150 pound rate of fertilizer treatment, less difference was noted among varieties in tolerance to fertilizer salts.

- (9) Growth of seedlings of all varieties was stimulated by all fertilizers at the 50 pound rate except sodium nitrate and ammonium nitrate. Growth of all varieties was stunted by all fertilizers at the 100 and 150 pound rates. In fact, some seedlings died a few days after emerging.
- (10) Relative root growth was closely correlated with seedling growth at all levels of treatment.

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APPENDIX

TABLE XII

GERMINATION PERCENTAGES OF THE VARIETIES OBTAINED
IN 'THE STULTZ GERMINATOR'.

Variety	% Germination
Stoneville 62	87
Parrott	87
Northern Star	85
Lankart 57	86
Deltapine 15	85
Lockett No. 1	82

TABLE XIII

THE GERMINATION COUNTS OBTAINED ON COTTON
VARIETIES GROWN ON CHECK PLOTS
IN THE GREENHOUSE

Variety	Date Planted	Seedlings Days After Planting										
		4	5	6	7	8	9	10	11	12	13	14
Stoneville 62	*	0	5	19	20	20	20	20	20	20	20	20
	**	21	25	26	26	26	26	26	26	26	26	26
	***	23	27	27	27	27	27	27	27	27	27	27
Deltapine 15	*	0	7	26	28	28	28	28	28	28	28	28
	**	22	22	23	23	23	23	23	24	25	25	25
	***	26	28	28	28	28	28	28	28	28	28	28
Parrott	*	0	8	25	24	26	26	26	26	25	25	25
	**	27	28	29	29	29	29	29	29	29	29	29
	***	22	25	26	27	28	28	29	29	29	29	29
Lankart 57	*	0	2	13	21	22	23	23	22	23	23	23
	**	14	20	22	26	26	26	26	27	27	27	27
	***	14	21	25	27	27	27	27	27	27	27	27
Northern Star	*	0	1	16	22	23	23	23	23	24	24	24
	**	18	24	25	25	25	25	25	25	25	25	25
	***	18	22	24	25	25	25	25	25	25	25	25
Lockett No. 1	*	0	10	20	20	20	20	20	20	20	20	20
	**	25	27	28	28	28	28	28	28	28	28	28
	***	26	28	27	27	27	27	27	27	27	27	27

* Planted June 8, 1955

** Planted June 3, 1956

*** Planted June 3, 1956

TABLE XIV

EFFECT OF 0-20-0 UPON GERMINATION AND EMERGENCE
OF COTTON VARIETIES WHEN APPLIED IN DIRECT
CONTACT WITH THE SEED

Variety	Pounds Per Acre	Seedlings Days After Planting										
		4	5	6	7	8	9	10	11	12	13	14
Stoneville 62	50	0	3	17	20	21	21	22	22	22	22	22
	100	0	7	10	12	12	12	13	13	13	14	14
	150	1	6	9	11	14	15	15	17	17	17	17
Deltapine 15	50	0	7	26	27	27	27	27	27	27	27	27
	100	2	7	11	12	12	12	12	15	16	16	16
	150	0	2	14	16	18	20	20	22	22	23	23
Parrott	50	0	9	25	27	28	28	28	28	28	28	28
	100	0	14	17	18	19	19	19	21	22	23	23
	150	2	5	11	11	13	13	13	17	18	17	17
Lankart 57	50	0	0	14	19	22	23	23	23	23	21	21
	100	0	6	12	12	12	12	12	17	17	17	17
	150	0	4	8	9	9	9	9	12	14	14	13
Northern Star	50	0	5	17	23	23	23	23	23	23	23	23
	100	1	13	16	17	17	17	17	19	19	20	20
	150	1	5	9	11	13	17	18	20	20	20	20
Lockett No. 1	50	0	12	24	25	25	25	25	25	25	25	25
	100	4	14	23	25	25	25	24	25	25	25	25
	150	0	2	6	6	7	8	9	14	17	16	16

TABLE XV

EFFECT OF A MIXED FERTILIZER 10-20-0 UPON
GERMINATION AND EMERGENCE OF COTTON
VARIETIES WHEN APPLIED IN DIRECT
CONTACT WITH THE SEED

Variety	Pounds Per Acre	Seedlings Days After Planting											
		4	5	6	7	8	9	10	11	12	13	14	
Stoneville 62	50	0	3	23	24	24	24	24	24	24	24	24	24
	100	0	7	13	14	14	14	15	17	18	18	18	18
	150	0	2	7	8	8	8	9	9	10	10	10	11
Deltapine 15	50	0	3	21	24	26	26	26	26	26	27	27	27
	100	2	8	17	19	22	23	21	24	23	23	22	22
	150	0	2	5	7	9	10	13	17	17	17	18	18
Parrott	50	0	6	18	23	23	24	24	24	24	24	24	24
	100	2	13	17	20	21	21	20	25	24	24	24	24
	150	0	1	5	6	9	12	12	13	14	16	16	16
Lankart 57	50	0	1	12	17	17	19	19	20	19	20	20	20
	100	2	6	14	17	18	18	17	18	18	18	18	18
	150	0	0	3	4	5	4	5	5	4	4	4	4
Northern Star	50	0	2	18	23	24	25	25	24	24	23	23	23
	100	0	15	17	22	23	23	24	25	25	25	25	25
	150	0	1	4	8	9	10	10	13	13	14	13	13
Lockett No. 1	50	0	5	20	22	22	23	23	23	23	23	19	19
	100	2	8	18	22	25	26	26	26	26	26	26	26
	150	0	3	8	9	10	11	12	16	16	17	17	17

TABLE XVI

EFFECT OF MIXED FERTILIZER 10-20-10 UPON
GERMINATION AND EMERGENCE OF COTTON
VARIETIES WHEN APPLIED IN DIRECT
CONTACT WITH THE SEED

Variety	Pounds Per Acre	Seedlings Days After Planting										
		4	5	6	7	8	9	10	11	12	13	14
Stoneville 62	50	0	1	15	23	25	26	26	26	26	26	26
	100	0	5	11	14	17	18	20	21	21	21	22
	150	0	3	4	4	5	6	7	10	12	12	12
Deltapine 15	50	0	2	19	22	24	25	24	24	25	25	25
	100	0	7	10	17	22	22	22	22	22	23	25
	150	0	1	3	3	7	10	10	13	20	20	20
Parrott	50	0	3	25	25	27	28	28	28	28	28	28
	100	0	5	16	18	20	21	20	20	21	20	21
	150	0	3	4	8	9	10	12	14	14	14	14
Lankart 57	50	0	0	11	20	23	25	26	27	26	26	26
	100	0	1	11	11	15	17	18	20	20	20	21
	150	0	0	3	5	6	7	7	10	10	11	11
Northern Star	50	0	0	19	23	24	24	24	24	23	23	23
	100	0	2	8	9	12	17	17	18	18	18	18
	150	0	0	3	5	8	9	9	11	12	13	13
Lockett No. 1	50	0	3	24	25	25	25	25	25	25	25	25
	100	0	7	15	19	22	22	23	24	24	25	25
	150	0	1	2	6	7	8	11	12	12	13	13

TABLE XVII

EFFECT OF AMMONIUM NITRATE UPON GERMINATION AND
EMERGENCE OF COTTON VARIETIES WHEN APPLIED
IN DIRECT CONTACT WITH SEED

Variety	Pounds Per Acre	Seedlings Days After Planting										
		4	5	6	7	8	9	10	11	12	13	14
Stoneville 62	50	0	1	19	24	25	25	25	25	25	25	25
	100	0	0	2	5	6	10	11	11	11	10	11
	150	0	0	0	0	1	4	5	8	8	10	10
Deltapine 15	50	0	0	13	17	18	19	19	18	18	18	17
	100	0	0	0	2	5	10	12	18	18	20	20
	150	0	3	3	4	4	5	6	10	10	12	12
Parrott	50	0	1	19	25	25	27	26	26	26	26	26
	100	0	2	2	3	7	8	10	11	8	8	8
	150	0	1	3	4	5	8	8	8	7	9	9
Lankart 57	50	0	0	10	19	23	22	22	20	20	20	20
	100	0	0	2	3	6	7	7	9	9	9	10
	150	0	0	2	3	3	4	3	4	5	6	6
Northern Star	50	0	0	12	20	20	21	22	22	22	22	21
	100	0	1	1	1	3	5	8	12	12	11	11
	150	0	2	2	2	3	4	5	5	6	6	6
Lockett No. 1	50	0	4	19	24	26	23	22	21	20	19	19
	100	0	1	3	6	12	16	17	18	18	18	18
	150	0	0	2	5	6	12	12	14	14	14	14

TABLE XVIII

EFFECT OF SODIUM NITRATE UPON GERMINATION AND
EMERGENCE OF COTTON VARIETIES WHEN APPLIED
IN DIRECT CONTACT WITH THE SEED

Varieties	Pounds Per Acre	Seedlings Days After Planting											
		4	5	6	7	8	9	10	11	12	13	14	
Stoneville 62	50	0	1	13	20	22	23	23	17	15	14	14	
	100	0	1	5	6	10	12	14	14	14	15	15	
	150	0	0	1	1	3	5	6	9	10	10	10	
Deltapine 15	50	0	0	8	16	22	23	22	21	21	21	21	
	100	0	0	3	10	13	15	16	17	15	15	17	
	150	0	0	0	2	3	7	8	8	10	13	14	
Parrott	50	0	1	7	21	23	24	24	22	23	22	22	
	100	0	0	5	8	12	16	18	18	18	18	18	
	150	0	0	0	1	2	6	6	10	11	11	12	
Lankart 57	50	0	0	5	15	22	24	26	25	25	24	24	
	100	0	0	2	6	11	14	15	16	17	18	18	
	150	0	0	0	2	2	4	4	5	11	5	5	
Northern Star	50	0	0	4	12	19	20	19	18	18	18	18	
	100	0	1	7	8	11	17	19	21	21	21	21	
	150	0	1	1	1	4	10	11	12	12	13	13	
Lockett No. 1	50	0	1	16	26	26	27	27	27	26	26	26	
	100	0	0	1	4	7	9	13	16	17	17	18	
	150	0	0	1	2	5	11	12	15	15	14	15	

TABLE XIX

EFFECT OF A MIXED FERTILIZER 10-20-20 UPON GERMINATION
AND EMERGENCE OF COTTON VARIETIES WHEN APPLIED IN
DIRECT CONTACT WITH THE SEED

Variety	Pounds Per Acre	Seedlings Days after Planting										
		4	5	6	7	8	9	10	11	12	13	14
Stoneville 62	50	0	0	11	15	16	19	19	19	19	19	19
	100	0	0	2	2	1	2	2	2	2	2	2
	150	0	0	0	0	1	1	1	1	1	1	1
Deltapine 15	50	0	3	17	20	22	26	26	26	26	26	26
	100	0	2	5	5	7	6	7	8	9	9	10
	150	0	0	0	0	0	1	1	2	3	3	3
Farrott	50	0	4	17	24	24	24	24	24	24	24	24
	100	0	1	3	4	4	3	3	5	5	7	7
	150	0	0	0	0	0	0	0	1	1	2	2
Lankart 57	50	0	0	8	22	23	25	25	25	23	24	24
	100	0	1	1	1	2	2	2	3	2	2	3
	150	0	0	0	0	2	2	2	3	3	3	3
Northern Star	50	0	1	15	19	22	24	24	24	24	24	24
	100	0	2	3	3	4	4	5	6	6	6	6
	150	0	0	0	0	0	0	0	0	0	0	0
Lockett No. 1	50	0	4	17	19	20	22	22	23	23	23	23
	100	0	0	3	5	8	10	10	10	10	10	10
	150	0	0	0	0	2	2	2	2	2	3	2

TABLE XX

EFFECT OF POTASSIUM CHLORIDE UPON GERMINATION AND
EMERGENCE OF COTTON VARIETIES WHEN APPLIED IN
DIRECT CONTACT WITH THE SEED

Variety	Pounds Per Acre	Seedlings Days after Planting										
		4	5	6	7	8	9	10	11	12	13	14
Stoneville 62	50	0	4	17	26	27	27	27	27	27	27	27
	100	0	1	1	4	6	12	13	16	16	16	16
	150	0	0	0	0	3	4	4	8	8	8	8
Deltapine 15	50	0	1	13	21	26	27	27	27	27	28	28
	100	0	0	3	6	14	18	21	21	27	23	23
	150	0	0	0	0	1	4	4	7	8	9	10
Parrott	50	0	4	20	27	27	27	27	27	27	27	27
	100	0	1	1	5	10	11	15	15	17	17	17
	150	0	0	0	0	2	7	7	10	12	12	12
Lankart 57	50	0	0	10	20	24	27	27	27	27	27	27
	100	0	0	0	2	4	7	13	14	15	15	16
	150	0	0	0	0	0	0	0	1	3	5	5
Northern Star	50	0	0	12	17	20	21	23	23	23	23	23
	100	0	1	1	2	5	9	10	12	14	15	15
	150	0	0	1	1	3	3	5	10	13	13	13
Lockett No. 1	50	0	6	21	24	24	25	26	27	27	27	27
	100	0	0	1	6	16	20	21	23	24	24	24
	150	0	0	0	0	1	2	2	5	5	6	6

TABLE XXI

GERMINATION COUNTS OF SEEDLINGS IN ALL CHECK PLOTS
4, 5, 6, AND 14 DAYS AFTER PLANTING

Variety	Total No. of seedlings emerged after planting days				No. seedlings emerged between 6-14 days	% germination in greenhouse	% germination Stultz*
	4	5	6	14			
Lockett No. 1	51	65	75	75	0	83	82
Parrott	49	61	80	83	3	92	87
Deltapine 15	48	57	77	82	5	91	85
Stoneville 62	44	57	72	73	1	81	87
Northern Star	36	47	65	74	9	82	85
Lankart 57	28	43	60	77	17	85	86

*Germination of all varieties was obtained in 'Stultz Germinator'.

TABLE XXII

SEEDLING GROWTH 14 DAYS AFTER PLANTING

<u>Variety</u>	<u>Treatment</u>	<u>Average Seedling Height (inches)</u>	
		<u>50 lb.</u>	<u>100 lb.</u>
Stoneville 62	Check	6.0	5.7
"	Potassium Chloride	6.8	5.3
"	10-20-0	7.4	3.5
"	10-20-10	7.5	4.6
"	Calcium Monophosphate	6.9	4.1
"	Ammonium Nitrate	6.2	2.5
"	Sodium Nitrate	4.2	3.3
"	10-20-20	6.8	2.7
Deltapine 15	Check	6.2	5.8
"	Potassium Chloride	6.6	4.2
"	10-20-0	7.2	3.9
"	10-20-10	7.1	4.7
"	Calcium Mono-Phosphate	7.1	4.8
"	Ammonium Nitrate	5.2	2.8
"	Sodium Nitrate	5.2	3.3
"	10-20-20	7.5	3.3
Parrott	Check	6.5	5.7
"	Potassium Chloride	7.0	3.4
"	10-20-0	7.1	3.7
"	10-20-10	7.4	4.9
"	Calcium Mono-Phosphate	6.8	4.8
"	Ammonium Nitrate	6.7	2.8
"	Sodium Nitrate	5.3	2.6
"	10-20-20	7.6	3.5
Lankart 57	Check	5.9	5.0
"	Potassium Chloride	6.7	3.3
"	10-20-0	6.9	4.2
"	10-20-10	7.0	3.5
"	Calcium Mono-Phosphate	6.4	4.0
"	Ammonium Nitrate	5.7	3.0
"	Sodium Nitrate	5.0	3.3
"	10-20-20	6.7	2.0

Northern Star	Check	6.9	5.6
"	Potassium Chloride	6.7	2.8
"	10-20-0	7.1	4.8
"	10-20-10	7.1	4.3
"	Calcium Mono-Phosphate	6.8	5.1
"	Ammonium Nitrate	5.3	2.7
"	Sodium Nitrate	5.1	3.7
"	10-20-20	7.1	3.5
Lockett No. 1	Check	6.2	5.7
"	Potassium Chloride	6.6	3.7
"	10-20-0	7.3	4.7
"	10-20-10	7.7	5.3
"	Calcium Mono-Phosphate	6.7	5.2
"	Ammonium Nitrate	5.7	3.3
"	Sodium Nitrate	5.4	3.0
"	10-20-20	7.3	5.1

VITA

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