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TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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DIVISION OF AGRONOMY

The Effect of Time and Rate of Application of Nitrate of Soda on the Yield of Cotton

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Fertilizers increased the yield of cotton by producing larger plants which provided more space for more bolls and larger bolls and not by increasing the length of lint or percentage of lint, as shown in experiments at Nacogdoches and Troup, during four years ending 1930, to determine the best time and rate of application of nitrate of soda for cotton.

The application of 200 pounds of nitrate of soda furnished the optimum amount of nitrogen for cotton at Troup and 100 pounds gave the best results at Nacogdoches. These amounts of nitrate of soda (with superphosphate and muriate of potash) are roughly equal to 400 pounds of 8-12-4 and 4-12-4 fertilizer, respectively.

Side dressings of nitrate of soda on the Ruston and Orangeburg soils at Nacogdoches made an average yield of 203 pounds of lint per acre, which was 24 pounds, or 13.4 per cent, more than the yield where all of the nitrogen was applied before planting. However, on the Kirvin fine sandy loam at Troup, applications of nitrate of soda before planting produced slightly larger yields of cotton than side dressings. These differences in yield are probably caused by differences in the nature of the subsoils, the Ruston and Orangeburg soils having open friable clay subsoils and the Kirvin soil a less permeable subsoil. These results indicate that the practice of side dressing is satisfactory on soils with friable, permeable subsoils, especially where large amounts of nitrate of soda are used. On soils with less permeable subsoils all of the nitrogen may be applied before planting.

All of the fertilizers used increased yield, size of boll, number of bolls per plant, percentage of 5-lock bolls, size of plant, number of fruiting branches, and earliness. Fertilizers, however, did not increase the length of lint, nor the percentage of lint, nor did they reduce the amount of shedding.

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BULLETIN NO. 490 MARCH, 1934

THE EFFECT OF TIME AND RATE OF APPLICATION OF NITRATE OF SODA ON THE YIELD OF COTTON

E. B. Reynolds, P. R. Johnson, and B. C. Langley

The main object of the fertilizer work reported in this Bulletin was (1) to determine the most profitable amounts of nitrate of soda in combination with suitable amounts of phosphoric acid and potash for cotton and (2) to study the effect of time and rate of application of nitrate of soda on yield, length and percentage of lint, size of boll, shedding, and other characters of the cotton plant on the sandy soils of eastern Texas, as a basis for developing a more intelligent and profitable fertilizer practice for cotton in the region[1]

More fertilizer is used for cotton on the sandy soils in eastern and northeastern Texas than in any other section of the State. Many farmers in the region follow the practice of applying a complete fertilizer on the land before the cotton is planted and then applying a readily available nitrogenous fertilizer, such as nitrate of soda or sulphate of ammonia, as a side dressing soon after the cotton has been thinned to a proper stand. The practice of side dressing is based on the assumption (1) that part of the readily available nitrogen will be washed out of the soil by rains before it can be taken up by the young growing plants and (2) that if part of the nitrogen is applied to the soil after the plant has made some growth and can take up plant food more rapidly, extensive losses of nitrogen by leaching will be avoided. The losses of nitrogen by leaching are influenced largely by the kind of soil; the amount, intensity, and distribution of rainfall; and kind and age of plant.

The work reported here was planned to secure information that could be used in developing a better fertilizer practice, especially as related to best time of applying nitrogenous fertilizer as side dressings to cotton on different kinds of soil.

PLAN OF EXPERIMENT

Description of Soils Used

The fertilizer work was conducted on Kirvin fine sandy loam at Substation No. 2, Troup[2], and on land consisting of Ruston and Orangeburg fine sandy loams at Substation No. 11, Nacogdoches.

The Kirvin soils have grayish-brown or reddish-brown surface soils underlain by a heavy, red clay subsoil. The surface relief ranges from undulating to rolling or even hilly in places. These soils occur extensively in northeastern Texas and extend into Arkansas and Louisiana. The Kirvin soils are moderately productive and respond well to good methods of

[1]This work with nitrate of soda was made possible through a fellowship established at the Agricultural Experiment Station, A. & M. College of Texas, by the Educational Bureau, Chilean Nitrate of Soda, New York, N. Y.

[2]Substation No. 2 was removed from Troup to Tyler, Smith County, in 1931.

improvement. They are well suited to the general farm crops, fruits and vegetables grown in the region.

The Ruston and Orangeburg soils have grayish-brown or light-brown surface soils. The Ruston soils have friable, crumbly yellowish-red or reddish-yellow sandy clay subsoils. The subsoils of the Orangeburg soils are similar, except that they are deeper red in color. These soils are not so extensive as the Kirvin soils. They are moderately productive, respond well to good soil-improving practices, and are well adapted to the general farm crops, fruits, and vegetables.

Varieties of Cotton Used

The Mebane variety of cotton was grown in the experiment at Troup and the Acala variety at Nacogdoches because the results of the variety tests of cotton have shown that these varieties are well adapted to these parts of the State. The time and method of preparing the land, planting, and cultivating which have been found best by experience were adhered to in this work. The cotton was thinned to a stand of one plant every 12 inches in the row when the plants were four to six inches high.

The test was conducted on the same land each year at both Nacogdoches and Troup, the cotton being grown continuously without a winter cover crop. The several treatments occurred on the same plats each year.

Size of Plat

The plats consisted of four rows 3 feet wide and 132 feet long, comprising an area 2/55 of an acre in size. The two inside rows of each plat were used as the test part of the plat. The two outside rows served as guard rows to prevent the fertilizer treatment on one plat from influencing the yield on adjoining plats and were disregarded at picking time.

Fertilizer Treatments

There were two series of fertilizer treatments. In one series all of the fertilizer was applied about two weeks before the cotton was planted. In the other series, all of the phosphoric acid and potash and one-half of the nitrogen was applied about two weeks before planting and the other half of nitrogen was applied as a side dressing immediately after the cotton was thinned to the desired stand. Sixteen per cent superphosphate or equivalent amounts of higher grades of superphosphate were used in this work. The following treatments were included in the experiment at both Nacogdoches and Troup:

Fertilizer treatment		Approximately equal to 400 pounds of—
Pounds	Material	
No treatment		Check
100	nitrate of soda	4-12-0
300	superphosphate	

100	nitrate of soda	
300	superphosphate	4-12-4
30	muriate of potash	
80	sulphate of ammonia	
300	superphosphate	4-12-4
30	muriate of potash	
50	nitrate of soda	
100	cottonseed meal	
300	superphosphate	4-12-4
30	muriate of potash	
67	nitrate of soda	
70	cottonseed meal	
300	superphosphate	4-12-4
30	muriate of potash	
150	nitrate of soda	
300	superphosphate	6-12-4
30	muriate of potash	
200	nitrate of soda	
300	superphosphate	8-12-4
30	muriate of potash	
160	sulphate of ammonia	
300	superphosphate	8-12-4
30	muriate of potash	
250	nitrate of soda	
300	superphosphate	10-12-4
30	muriate of potash	
300	nitrate of soda	
300	superphosphate	12-12-4
30	muriate of potash	
300	nitrate of soda	
300	superphosphate	12-12-8
60	muriate of potash	
300	nitrate of soda	
450	superphosphate	8-12-4*
45	muriate of potash	

*This analysis was used at the rate of 600 pounds per acre.

EFFECT OF FERTILIZER ON YIELD OF COTTON

Yields were obtained from cotton that received (1) different rates of application of nitrate of soda, (2) side dressings of nitrate of soda, and (3) different nitrogenous fertilizers, at Nacogdoches and Troup, Texas.

Rates of Application of Nitrate of Soda

Nitrate of soda was used at the rates of 100, 150, 200, 250, and 300 pounds per acre in combination with superphosphate and muriate of potash. The several combinations of these materials are given in the first three columns of the tables and the approximate equivalents of these treatments, expressed as fertilizer analyses, are given in column four. This means, for example, that the treatment consisting of 100 pounds of nitrate of soda, 300 pounds of superphosphate, and 30 pounds of muriate of potash is approximately equal to 400 pounds of a 4-12-4 fertilizer.

Results Obtained at Troup: The average yield of cotton for the four years 1927-1930 gradually increased from 206 pounds of lint per acre from the use of 100 pounds of nitrate of soda to 228 pounds of lint where 300

pounds of nitrate of soda was used (Table 1). The first increment of 50 pounds of nitrate of soda—an increase from 100 to 150 pounds—increased the yield only 6 pounds of lint per acre; the second increment of 50 pounds of nitrate of soda, 14 pounds per acre; and the third and fourth increments, only 1 pound per acre. The application of 200 pounds of nitrate of soda, however, furnished the optimum amount of nitrogen, since larger applications produced only slight additional increases in yield.

The treatment consisting of 300 pounds of nitrate of soda, 450 pounds of superphosphate, and 45 pounds of muriate of potash, (which contained the same ratio of nitrogen, phosphoric acid, and potash but 50 per cent more plant food than the treatment of 200 pounds of nitrate of soda, 300 pounds of superphosphate, and 30 pounds of muriate of potash) made an average yield of 256 pounds of lint per acre, or 30 pounds of lint more than the latter treatment.

Potash produced only small increases in yield during the four years of the work. The use of 30 pounds of muriate of potash (with nitrate of soda and superphosphate) made an average yield of 206 pounds of lint per acre, or only 6 pounds more than the plats that received nitrogen and phosphate but no potash (Table 1). The application of 60 pounds of muriate of potash made a similar increase in yield.

The use of 160 pounds of sulphate of ammonia produced an average yield of 246 pounds of lint, or 20 pounds more than 200 pounds of nitrate of soda (Table 1).

Table 1. Effect of rate and time of application of nitrate of soda on the yield of cotton at Troup

Fertilizer treatments per acre				Pounds of lint per acre				
Nitrate of soda	Superphosphate 16%	Muriate of potash	Approximately equal to 400 pounds of—	1927	1928	1929	1930	Average
Pounds	Pounds	Pounds						
none	none	none		152	178	84	90	126
All nitrogen applied before planting								
100	300	0	4-12-0	161	270	207	160	200
100	300	30	4-12-4	215	236	211	163	206
150	300	30	6-12-4	201	251	219	178	212
200	300	30	8-12-4	209	287	238	170	226
250	300	30	10-12-4	206	286	253	163	227
300	300	30	12-12-4	204	288	246	173	228
300	300	60	12-12-8	240	294	240	164	235
300	450	45	8-12-4[b]	231	325	270	198	256
160[a]	300	30	8-12-4	261	274	273	176	246
One-half of nitrogen as side dressing								
150	300	30	6-12-4	209	251	228	163	213
200	300	30	8-12-4	220	258	224	161	216
250	300	30	10-12-4	194	269	223	142	207
300	300	30	12-12-4	233	265	264	153	229
300	300	60	12-12-8	237	266	259	190	238
300	450	45	8-12-4[b]	237	267	258	160	231
160[a]	300	30	8-12-4	204	268	241	160	218

[a]Sulphate of ammonia equivalent to 200 pounds of nitrate of soda
[b]600 pounds per acre.

The results obtained at Troup indicate that the use of about 200 pounds of nitrate of soda, 300 pounds of superphosphate, and 30 pounds of muriate of potash, a treatment that is roughly equivalent to 400 pounds of an 8-12-4 fertilizer, is good fertilizer practice. These results are in general agreement with the results obtained at Troup during the same years, and published in Bulletin 469 (1932).

Results Obtained at Nacogdoches: The application of 100 pounds of nitrate of soda made an average yield of 170 pounds of lint for the two years, 1927 and 1929, while the application of 150, 200, 250, and 300 pounds of nitrate of soda produced average yields of 172, 175, 168, and 169 pounds of lint per acre, respectively (Table 2). The application of 100 pounds of nitrate of soda apparently supplied enough nitrogen where 30

Table 2. Yield of cotton fertilized with nitrate of soda at different rates of application at Nacogdoches

Fertilizer treatments per acre				Pounds of lint per acre		
Nitrate of soda	Superphosphate 16%	Muriate of potash	Approximately equal to 400 pounds of—	1927	1929	Average
Pounds	Pounds	Pounds				
none	none	none		98	162	130
All nitrogen applied before planting						
100	300	0	4-12-0	141	212	177
100	300	30	4-12-4	158	181	170
150	300	30	6-12-4	126	218	172
200	300	30	8-12-4	149	201	175
250	300	30	10-12-4	140	195	168
300	300	30	12-12-4	142	196	169
300	300	60	12-12-8	168	213	191
300	450	45	8-12-4[b]	164	200	182
160[a]	300	30	8-12-4	167	220	194
One-half of nitrogen as side dressing						
150	300	30	6-12-4	229	179	204
200	300	30	8-12-4	218	147	183
250	300	30	10-12-4	220	174	197
300	300	30	12-12-4	203	161	182
300	300	60	12-12-8	272	152	212
300	450	45	8-12-4[b]	264	185	225
160[a]	300	30	8-12-4	251	188	220

[a]Sulphate of ammonia equivalent to 200 pounds of nitrate of soda
[b]600 pounds per acre

pounds of muriate of potash was used, for larger applications did not produce further increase in yield of cotton.

Increasing the amount of muriate of potash from 30 to 60 pounds per acre produced an average gain of 22 pounds of lint per acre, which apparently is a significant gain (Table 2).

Side Dressings of Nitrate of Soda

Nitrate of soda was applied at the rates of 150, 200, 250, and 300 pounds per acre (a) before planting and (b) one-half before planting

the cotton and one-half soon after the cotton was thinned to a stand. This work, as stated previously, was conducted on Kirvin fine sandy loam at Troup and on Ruston and Orangeburg fine sandy loams at Nacogdoches. The results obtained in individual years at Troup are given in Table 1, and at Nacogdoches in Table 2.

The average yields obtained during the four years of the experiment at both points are given in Table 3 for direct comparison. At Nacogdoches on Ruston and Orangeburg fine sandy loams, all of the treatments applied as side dressing produced somewhat larger yields than the same rates of nitrate of soda applied before planting. The largest average gain from side dressing, 43 pounds of lint per acre, was produced by 300 pounds of nitrate of soda. This fact probably indicates that a division of the nitrogenous fertilizer is more desirable with heavy applications than with lighter applications.

Somewhat different results were obtained at Troup on Kirvin fine sandy loam soil, which has a stiff plastic clay subsoil. Side dressing reduced the yield considerably in four of the treatments. The average decreases for the four years ranged from 10 pounds to 48 pounds of lint per acre, as shown in Table 3. Where nitrate of soda was used at the rates of 150 and 300 pounds per acre, there was practically no difference in yield where the material was applied before planting or as a side dressing.

The differences in results obtained at Nacogdoches and Troup are probably due to differences in the structure of the subsoil at the two points. The Ruston and Orangeburg soils have friable sandy, clay subsoils, while the Kirvin fine sandy loam has a more compact and less

Table 3. Yield of lint cotton per acre where all of the nitrate of soda was applied before planting and where one-half was applied as side dressing

Pounds of nitrate of soda per acre	Troup			Nacogdoches		
	Nitrogen applied before planting	One-half nitrogen applied as side dressing	Gain or loss for side dressing	Nitrogen applied before planting	One-half nitrogen applied as side dressing	Gain or loss for side dressing
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
150	212	213	1	172	204	32
200	226	216	—10	175	183	8
250	227	207	—20	168	197	29
300	228	229	1	169	182	13
300[a]	235	238	3	191	212	21
300[b]	279	231	—48	182	225	43
160[c]	246	218	—28	194	220	26

[a]With 60 pounds muriate of potash
[b]With 45 pounds muriate of potash
[c]Sulphate of ammonia equivalent to 200 pounds of nitrate of soda

permeable subsoil. The results of this work indicate that side dressing may be good farm practice on soils with friable, permeable subsoils. On soils with more compact and less permeable subsoils all of the nitrogen may be applied before the cotton is planted.

Comparison of Different Nitrogenous Fertilizers

Nitrate of soda, sulphate of ammonia, and cottonseed meal were compared on the basis of equivalent amounts of nitrogen as sources of nitrogen for cotton. One hundred pounds of nitrate of soda contains about 15 pounds of nitrogen, which is approximately equal to the nitrogen contained in 200 pounds of cottonseed meal or in 80 pounds of sulphate of ammonia. These nitrogenous fertilizers were used in combination with 30 pounds of muriate of potash and 300 pounds of 16 per cent superphosphate or an equal amount of phosphoric acid in other grades of superphosphate.

Results Obtained at Troup: The application of 100 pounds of nitrate of soda produced an average yield of 221 pounds of lint per acre, which was 27 pounds, or 14 per cent, more than the yield produced by 200 pounds of cottonseed meal (Table 4). On the other hand, 80 pounds of sulphate of ammonia made an average yield of 255 pounds of lint per acre, which was

Table 4. Yield of cotton fertilized with nitrate of soda, sulphate of ammonia, and cottonseed meal, applied at rates to supply approximately equal amounts of nitrogen

Amount and kind of nitrogenous fertilizer	Pounds of lint per acre at							
	Troup					Nacogdoches		
	1927	1928	1929	1930	Average 1927-29	1927	1929	Average
None	152	178	84	90	138	98	162	130
50 lbs. nitrate of soda 100 lbs. cottonseed meal	245	247	224	.....	239	143	211	177
67 lbs. nitrate of soda 70 lbs. cottonseed meal	234	235	211	.....	227	145	193	169
200 lbs. cottonseed meal	170	220	193	.....	194	205	.....	.....
100 lbs. nitrate of soda	215	236	211	163	221	158	181	170
80 lbs. sulphate of ammonia	268	256	240	179	255	143	197	170
160* lbs. sulphate of ammonia	261	274	273	176	269	167	220	194

*This treatment supplies twice as much nitrogen as the other treatments.

15 per cent more than the yield resulting from the nitrate of soda and 31 per cent more than the yield from 200 pounds of cottonseed meal. Stated in another way, the yield of the cottonseed meal was 100 per cent, nitrate of soda 114 per cent, and sulphate of ammonia 131 per cent.

The mixtures of (a) 50 pounds of nitrate of soda and 100 pounds of cottonseed meal and (b) 67 pounds of nitrate of soda and 70 pounds of cottonseed meal were slightly superior to the nitrate of soda alone. The first-named mixture produced an average yield of 239 pounds of lint, which was 18 pounds, or 8 per cent, more than the yield produced by 100 pounds of nitrate of soda.

Results Obtained at Nacogdoches: The work was conducted at Nacogdoches in 1927 and 1929, the results of which are reported in Table 4. There were no significant differences in the yields of cotton that received the different nitrogenous fertilizers and the mixtures composed of varying amounts of nitrate of soda and cottonseed meal.

A comparison of the results obtained at Nacogdoches and Troup indicates that soils may respond differently to various forms of nitrogen. On the Ruston and Orangeburg soils at Nacogdoches nitrate of soda, sulphate of ammonia, and mixtures of nitrate of soda and cottonseed meal gave almost identical average yields. On the Kirvin fine sandy loam at Troup, however, sulphate of ammonia was decidedly the best source of nitrogen, and the varying mixtures of nitrate of soda and cottonseed meal were somewhat better than either alone.

EFFECT OF FERTILIZERS ON THE CHARACTER OF LINT

The length and percentage of lint are important characters of cotton. The length of lint is involved in the quality of cotton and governs, to a large extent, the price of cotton. Consequently these characters are usually emphasized by cotton breeders.

Length of Lint

It is sometimes thought that application of fertilizers to soil will increase the length of lint. In order to show whether or not fertilizers affect this character, the cotton obtained from the variously treated plats was graded and the length of lint determined by a State licensed cotton grader for each year of the test at both Nacogdoches and Troup.

The average length of lint of the Mebane variety from each of the fertilizer treatments was 30/32 of an inch at Troup, as shown in Table 5. The length, however, varied somewhat from year to year, probably on account of differences in environmental conditions, although the seasonal differences in length are not shown in the table.

There was a slight variation of 1/32 of an inch in the length of lint among the several treatments at Nacogdoches (Table 5). Six of the eleven treatments produced lint 31/32 of an inch long, while the other five treatments yielded 30/32-inch lint. This variation apparently is the normal range in variation in the length of lint of the variety, or it may be caused by differences in soil moisture, since the unfertilized soil produced as long lint as any of the fertilizer treatments.

The results obtained at both Nacogdoches and Troup indicate that fertilizers had no effect on the length of lint. The Arkansas Agricultural Experiment Station (Bulletin 273) also found that fertilizers were not effective in increasing the length of lint when determined by the usual methods.

Percentage of Lint

The percentage of lint is largely a varietal character and consequently is inherited. The percentage of lint, however, may be influenced to a

small extent by seasonal conditions. The cotton grower usually considers the percentage of lint as a fixed character and has not been concerned with any effect the soil or fertilizers may have on this character. In this fertilizer work, however, it was deemed advisable to determine the percentage of lint at both Nacogdoches and Troup. As was mentioned previously, the Mebane variety of cotton was used in the work at Troup and the Acala variety at Nacogdoches.

The average percentage of lint of the Mebane variety was practically the same for each fertiiizer treatment at Troup, as shown in Table 5. Similar results were obtained with the Acala variety at Nacogdoches (Table 5). It will be noted that the Mebane variety has a somewhat higher percentage of lint than the Acala variety. There were, of course, some slight differences in the percentages of lint, which were probably due to slight

Table 5. Length and percentage of lint grown on soil which received different amounts of nitrate of soda

Pounds of nitrate of soda per acre	Average length of lint in thirty-seconds of an inch		Average percentage of lint	
	Troup 1927-1930	Nacogdoches 1927 and 1929	Troup 1927-1930	Nacogdoches 1927 and 1929
None	30	31	36.2	34.4
100[a]	30	31	36.6	34.3
100	30	31	36.9	34.7
100[b]	30	30	36.9	34.3
150	30	31	37.1	34.0
200	30	31	37.0	34.9
200[b]	30	30	36.9	33.4
250	30	31	37.0	34.3
300	30	30	36.9	33.8
300[c]	30	30	36.6	34.7
300[d]	30	30	36.6	34.6

[a]Nitrate of soda used with 300 pounds of superphosphate but no potash
[b]Sulphate of ammonia equivalent to amount of nitrate indicated
[c]With 60 pounds of muriate of potash
[d]With 450 pounds of superphosphate and 45 pounds of muriate of potash.

errors in weighing and ginning the seed cotton in the process of determining the percentage of lint and not to differences that could be ascribed to fertilizers. These results indicate that fertilizers had no appreciable effect on the percentage of lint.

Since the fertilizers had no appreciable effect on the length or percentage of lint, it will be necessary to select varieties of cotton that naturally have these desirable characters if one wishes to produce longer lint or higher percentage of lint.

SIZE OF BOLL

The size of boll is important only as it may influence the amount of cotton that may be picked in a day or other given time. A laborer usually can pick more cotton in a day from large bolls than from small bolls, and, consequently, the larger bolls are of economic importance to that extent.

The size of boll in this work is measured, or expressed, by the number of well-opened bolls required to make a pound of seed cotton. It is obvious that the larger the bolls the fewer will be required to make a pound.

In general all of the fertilized soil at Troup produced larger bolls than the unfertilized soil. During the four years, 1927-1930, 92 bolls were required to make a pound of seed cotton on the unfertilized soil and 80 to 87 bolls on the fertilized soil (Table 6). Apparently there was no consistent relation between the size of boll and the rate or time of application of nitrate of soda.

At Nacogdoches the fertilized soil produced larger bolls than the unfertilized soil. During the two years, 1927 and 1929, 103 bolls from the unfertilized soil and 88 to 97 bolls from the fertilized soil were required to make a pound of seed cotton (Table 6). Apparently the amounts of nitrate of soda had no significant effect on size of boll. In 1929, however, the size of boll was reduced markedly by the side dressings of

Table 6. Number of well-opened bolls in a pound of seed cotton at Troup and Nacogdoches

Fertilizer treatments per acre			Troup					Nacogdoches		
Nitrate of soda	Superphosphate 16%	Muriate of potash	1927	1928	1929	1930	Average	1927	1929	Average
Pounds	Pounds	Pounds								
None	None	None	93	87	105	83	92	97	108	103
All nitrogen applied before planting										
100	300	0	91	80	92	79	86	82	95	89
100	300	30	86	82	85	80	83	84	98	91
150	300	30	87	83	82	79	83	91	96	94
200	300	30	90	77	85	83	84	85	95	90
250	300	30	90	76	89	81	84	87	93	90
300	300	30	89	80	84	84	84	84	98	91
300	300	60	87	82	88	87	86	84	96	90
300	450	45	89	77	89	80	84	80	97	89
160[a]	300	30	87	74	81	77	80	80	95	88
80[b]	300	30	93	80	80	80	83	89	104	97
One-half of nitrogen as side dressing										
150	300	30	85	75	86	79	81	82	98	90
200	300	30	85	77	82	80	81	86	103	95
250	300	30	92	82	88	85	87	82	103	93
300	300	30	85	80	85	86	84	80	106	93
300	300	60	82	82	84	84	83	80	102	91
300	450	45	84	74	84	84	82	82	101	92
160[a]	300	30	90	79	87	85	85	80	96	88

[a]Sulphate of ammonia containing same amount of nitrogen as 200 pounds of nitrate of soda

[b]Sulphate of ammonia containing same amount of nitrogen as 100 pounds of nitrate of soda

nitrate of soda. As an average of the two years, where the cotton received a side dressing of nitrogen 92 bolls were required to make a pound of seed cotton, while with the corresponding treatments where all of the nitrogen was applied before planting, 90 bolls were required to make a pound.

The soil that received nitrate of soda at various rates also produced a larger percentage of 5-lock bolls than the unfertilized soil, as shown later in Table 7. This fact accounts in a large measure for the larger bolls on the fertilized soil, since in a given variety of cotton, 5-lock bolls are usually larger than 4-lock bolls.

EFFECT OF FERTILIZERS ON SIZE OF PLANTS

In areas where fertilizers are used profitably, well-fertilized soil usually produces larger plants than unfertilized soil. In this work, data on height of plants, number of fruiting branches, and number of bolls per plant were obtained from each fertilizer treatment in order to show any relation that these characters may have to the yield of cotton.

Height of Plants

The relative size of plants on fertilized and unfertilized soil is probably of importance only as size may be related to the quantity and quality of lint produced.

The average height of plants at Troup and Nacogdoches was about the same, as shown in Table 7. The unfertilized soil at Troup produced plants 21 inches high and the fertilized soil, plants 25 to 28 inches high. The largest application of fertilizer (300 pounds of nitrate of soda, 450 pounds of superphosphate, and 45 pounds of muriate of potash) produced the tallest plants, which were 28 inches high as an average for the four years. Somewhat similar results were obtained at Nacogdoches (Table 7).

Number of Fruiting Branches per Plant

The larger plants on the fertilized soil contained more fruiting branches and more bolls per plant than the plants on the unfertilized soil (Table 7). The number of fruiting branches per plant includes the fruiting branches on the main stem of the plant and the fruiting branches on the vegetative branches.

At Troup the number of fruiting branches ranged from 10.9 per plant on the unfertilized soil to 16.5 per plant on the soil which received 300 pounds of nitrate of soda, 450 pounds of superphosphate, and 45 pounds of muriate of potash (Table 7). In general, the number of fruiting branches increased as the amount of nitrate of soda was increased from 100 to 300 pounds per acre. As a rule the plants on fertilized soil produced more fruiting branches than plants on the untreated soil at Nacogdoches, but there was no consistent relation between the number of fruiting branches and the amount of nitrate of soda used.

Number of Bolls per Plant

The number of bolls per plant is a good indicator of yield and in fact is sometimes used as a basis of estimating yield of cotton before harvesting. The number of bolls per plant, together with the height of plant and number

of fruiting branches was obtained to show what relation these characters may have to yield.

At Troup the number of bolls per plant ranged from 3.2 on the untreated soil to 5.9 on the soil which received 160 pounds of sulphate of ammonia (equivalent to 200 pounds of nitrate of soda), Table 7. This is a difference of 2.5 bolls per plant, which is equal to 120 pounds of lint per acre, as may be seen by referring to Table 1. At Nacogdoches the plants on fertilized soil also produced more bolls than the plants on the unfertilized soil, but there appeared to be no correlation between the number of bolls and the amount of nitrate of soda (Table 7).

Percentage of 5-Lock Bolls

The percentage of 5-lock bolls frequently is emphasized because in a given variety of cotton the 5-lock bolls are usually larger than the 4-lock bolls. This character, however, is of importance mainly because a higher

Table 7. Height of plant, number of fruiting branches, number of bolls per plant, and percentage of 5-lock bolls on soil which received different amounts of nitrate of soda

Pounds of nitrate of soda per acre	Average height of plant in inches		Average number of fruiting branches per plant		Average number of bolls per plant		Percentage of 5-lock bolls	
	Troup 1927-1930	Nacogdoches 1927 and 1929	Troup 1927-1930	Nacogdoches 1927 and 1929	Troup 1927-1930	Nacogdoches 1927 and 1929	Troup 1927-1930	Nacogdoches 1927 and 1929
None	21	23	10.9	11.1	3.2	4.2	45	37
100[a]	26	25	13.7	11.3	4.7	4.6	54	44
100	25	24	12.9	10.6	4.7	4.7	59	47
100[b]	26	25	14.5		5.4		55	
150	25	26	13.9	12.0	4.7	4.3	59	47
200	27	25	14.5	11.7	5.1	5.2	60	48
200[b]	27	27	14.0		5.9		58	
250	27	26	14.8	12.0	5.4	4.4	57	52
300	27	26	14.8	12.2	5.4	4.3	59	51
300[c]	27	26	15.5	12.2	5.5	5.1	56	53
300[d]	28	27	16.5	12.2	5.7	4.9	59	49

[a]Nitrate of soda used with 300 pounds of superphosphate but no potash
[b]Sulphate of ammonia equivalent to amount of nitrate of soda indicated
[c]With 60 pounds of muriate of potash
[d]With 450 pounds of superphosphate and 45 pounds of muriate of potash

percentage of 5-lock bolls enables a laborer to pick slightly more cotton. The percentage of 5-lock bolls is a varietal character and is inherited, although it is influenced to some extent by environmental conditions.

All of the fertilized soil at both Troup and Nacogdoches produced a considerably higher percentage of 5-lock-bolls than the unfertilized soil. Considering all of the treatments as a whole, the fertilized soil produced 28 per cent more 5-lock bolls than the unfertilized soil at Troup and 32 per cent more at Nacogdoches (Table 7).

The results obtained on the size of plants show that fertilizer increased the yield of cotton by producing larger plants, which had more fruiting branches and more bolls, a higher percentage of 5-lock bolls and consequently larger bolls than plants grown on unfertilized soil.

EFFECT OF FERTILIZERS ON SHEDDING

The percentage of shedding was obtained in these experiments because it was desired to ascertain if various rates and time of application of nitrate of soda would reduce shedding.

By percentage of shedding we mean the percentage of the total number of blooms produced that do not form well-matured bolls. For example, if 1000 blooms were produced and 600 of these blooms did not result in mature bolls, there would be 60 per cent of shedding. This may be stated in another way by saying that of the 1000 blooms, only 400, or 40 per cent, developed into mature bolls.

The amount of shedding was obtained by counting the total number of blooms produced during the season and the total number of bolls picked on 50 average plants receiving the different fertilizer treatments. The

Table 8. Percentage of shedding as influenced by various fertilizer treatments at Troup and Nacogdoches

Fertilizer treatments pounds per acre			Percentage of shedding								
			Troup					Nacogdoches			
Nitrate of soda	Super-phosphate 16%	Muriate of potash	1927	1928	1929	1930	Average	1927	1928	1929	Average
Pounds	Pounds	Pounds									
None	None	None	61	38	38	20	39	61	34	62	52
All nitrogen applied before planting											
100	300	0	64	48	50	32	49	64	39	59	54
100	300	30	63	44	52	39	50	59	39	63	54
150	300	30	67	45	54	38	51	66	41	62	56
200	300	30	70	52	56	39	54	59	40	60	53
250	300	30	65	50	58	35	52	65	32	63	53
300	300	30	68	54	54	36	53	64	48	62	58
300	300	60	67	56	55	34	53	63	30	61	51
300	450	45	67	52	57	47	56	61	24	62	49
160[a]	300	30	63	49	54	44	53				
80[b]	300	30	56	48	52	36	48				
One-half of nitrogen as side dressing											
150	300	30	64	48	53	33	50	56	30	68	51
200	300	30	68	45	63	39	54	53	33	69	52
250	300	30	67	51	56	39	53	52	28	66	49
300	300	30	68	52	57	43	55	49	28	67	48
300	300	60	68	48	60	37	53	53	29	69	50
300	450	45	68	53	59	45	56	58	30	69	52
160[a]	300	30	64	50	59	44	54				

[a]Sulphate of ammonia equivalent to 200 pounds of nitrate of soda
[b]Sulphate of ammonia equivalent to 100 pounds of nitrate of soda

percentage of shedding was found by dividing the number of bolls picked by the total number of blossoms produced and multiplying by 100.

It will be observed in Table 8 that all of the fertilizers increased the percentage of shedding at Troup. The average amount of shedding was 39 per cent on the unfertilized soil and more than 50 per cent on almost

all of the fertilized soil. At Nacogdoches, however, the fertilizers did not appreciably affect shedding. There was a slight tendency for the amount of shedding to increase with the amount of fertilizer used at Troup, but no such tendency was apparent at Nacogdoches.

The side dressing apparently had a slight tendency to reduce shedding at Nacogdoches but had no appreciable effect at Troup.

EARLINESS

The length of the growing season is not a limiting factor in cotton production in eastern Texas unless planting is delayed far beyond the normal planting dates. Earliness, however, is important for several reasons: (1) the plant puts on more fruit during the usual favorable weather before the drouth periods that often occur during late summer, (2) insect damage, especially by boll weevils, almost invariably becomes greater as the season advances, and (3) an earlier crop is usually harvested during more favorable weather and escapes weather damage, resulting in a better grade of cotton. Under these conditions, any practice, such as the

Table 9. Effect of fertilizer on earliness of cotton as measured by the percentage of total yield of seed cotton harvested in the first three pickings at Troup and Nacogdoches

Fertilizer treatments per acre			Troup					Nacogdoches		
Nitrate of soda	Superphosphate 16%	Muriate of potash	1927	1928[c]	1929	1930	Average	1927	1929	Average
Pounds	Pounds	Pounds	P.ct.	P.ct.	P.ct.	P.ct.	P.ct	P.ct.	P.ct.	P.ct.
None	None	None	46	48	30	22	37	47	66	57
All nitrogen applied before planting										
100	300	0	58	57	57	45	54	69	69	69
100	300	30	53	62	65	54	59	69	64	67
150	300	30	57	63	59	56	59	72	68	70
200	300	30	52	61	62	68	61	75	65	70
250	300	30	45	61	66	64	59	73	66	70
300	300	30	42	65	65	62	59	76	65	71
300	300	60	48	59	60	59	57	76	68	72
300	450	45	44	54	60	64	56	82	69	76
160[a]	300	30	58	59	73	63	63	82	77	80
80[b]	300	30	65	58	71	59	63	82	71	77
50[d]	300	30	62	56	60		59	77	73	75
67[d]	300	30	63	57	56		59	68	71	70
300[e]	300	30	44	68	70		61			
One-half of nitrogen as side dressing										
150	300	30	52	65	67	52	59	65	79	72
200	300	30	50	65	69	53	59	64	74	69
250	300	30	46	69	70	66	63	64	77	71
300	300	30	49	65	75	64	63	55	87[a]	71
300	300	60	39	69	72	67	62	69	78	74
300	450	45	41	68	75	66	63	76	83	80
160[a]	300	30	48	68	76	78	68	75	82	79

[a]Sulphate of ammonia equivalent to 200 lbs. of nitrate of soda
[b]Sulphate of ammonia equivalent to 100 lbs. of nitrate of soda
[c]First two pickings in 1928
[d]With 100 lbs. and 70 lbs. of cottonseed meal, respectively
[e]Cottonseed meal

use of fertilizers, that will allow the cotton plant to put on more fruit early in the season and consequently produce an earlier and larger crop is good farm practice. Data were obtained to measure the effect of fertilizers on earliness.

Earliness in cotton may be measured or indicated by (1) the first bloom, (2) the peak of the blooming period, and (3) by the percentage of the total yield harvested in the first two, three, or four pickings. In these studies the cotton was picked at weekly intervals or as nearly at weekly intervals as conditions would permit, after the cotton began to open actively. The earliness was measured by the percentage of the total yield that was harvested in the first three pickings in 1927, 1929, and 1930, and in the first two pickings in 1928.

On the average all of the fertilized soil produced an earlier crop than the unfertilized soil. During the four years, 1927-1930, the unfertilized soil at Troup produced 37 per cent of its total yield at the first three pickings while the soil which received 150 pounds of nitrate of soda produced 59 per cent of the total yield at the first three pickings (Table 9).

There appeared to be no significant difference in the effect of different amounts of nitrate of soda on earliness. Sulphate of ammonia, however, hastened maturity more than nitrate of soda at both Nacogdoches and Troup (Table 9). As a whole, side dressing was conducive to earliness at Troup, but probably was not significant.

The results indicate that the use of a properly balanced fertilizer hastens the maturity of the cotton crop on the sandy soils of the region. Further, sulphate of ammonia made larger yields and a slightly earlier crop of cotton than nitrate of soda or varying mixtures of nitrate of soda and cottonseed meal on the Kirvin soils at Troup.

SUMMARY AND CONCLUSIONS

The main object of this fertilizer work was to secure information on the effect of the time and rate of application of nitrate of soda on the yield, length and percentage of lint, size of boll, shedding, and other characters of cotton that may be used in developing a more profitable fertilizer practice. The nitrate of soda was applied at the rates of 100, 150, 200, 250, and 300 pounds per acre in combination with suitable amounts of superphosphate and muriate of potash. Applications of nitrate of soda before planting were compared with side dressings applied when the cotton was thinned to a stand. The experiment was conducted on Kirvin fine sandy loam soil at Troup and on Ruston and Orangeburg fine sandy loams at Nacogdoches during the four years, 1927 to 1930.

The average yield of cotton increased as the rate of application of nitrate of soda was increased from 100 to 300 pounds per acre at Troup. The use of 200 pounds of nitrate of soda per acre, however, apparently furnished enough nitrogen, since larger applications produced only small additional increases in yield. At Nacogdoches the application of 100 pounds of nitrate of soda supplied enough nitrogen, for larger applications were only slightly more effective.

On the soils at Nacogdoches side dressings produced larger average yields of cotton than applications of all the nitrogen before planting. On Kirvin fine sandy loam at Troup, however, larger yields were obtained from the applications of nitrogen before planting. These differences in yields are probably due to the differences in structure of the soils at the two points. Ruston and Orangeburg soils have friable sandy clay subsoils while Kirvin fine sandy loam has a dense, compace subsoil which probably does not permit as much leaching of fertilizer as the more permeable subsoils of Ruston and Orangeburg soils. These results indicate that side dressing is good farm practice on soils with friable, permeable subsoils, especially where large amounts of fertilizer are usd. On soils with more compact and less permeable subsoils, all of the nitrogen may be applied before the cotton is planted.

Nitrate of soda, mixtures of nitrate of soda and cottonseed meal, and sulphate of ammonia were compared as sources of nitrogen. These materials produced practically the same yields of cotton on Ruston and Orangeburg soils at Nacogdoches. Sulphate of ammonia, however, was the best source of nitrogen on Kirvin fine sandy loam at Troup and produced a larger and earlier crop of cotton than nitrate of soda or mixtures of nitrate of soda and cottonseed meal.

In general, applications of fertilizers hastened maturity of cotton. For example, at Troup soil which received 150 pounds of nitrate of soda produced 59 per cent and the unfertilized soil, 37 per cent of its total yield, at the first three pickings. Apparently there was no consistent or significant difference in the effect of different amounts of nitrate of soda on earliness. Sulphate of ammonia, however, hastened maturity more than nitrate of soda.

The time and rate of application of nitrate of soda had no significant effect on the percentage of shedding at Nacogdoches. At Troup, however, there was a considerably higher percentage of shedding on the fertilized soil than on the unfertilized soil.

The various rates of application of nitrate of soda with phosphoric acid and potash had no effect on the length of lint, since the unfertilized soil produced just as long lint as the fertilized soil. In general fertilizers did not influence the percentage of lint, although at Troup the percentage of lint on the unfertilized soil was slightly lower than on the fertilized soil.

The fertilized soil produced larger plants with more fruiting branches and more bolls and larger bolls than the unfertilized soil. The fertilized soil also produced a higher percentage of 5-lock bolls than the unfertilized soil. This fact probably accounts in a large measure for the larger bolls on the fertilized soil, for in a given variety of cotton 5-lock bolls are generally larger (heavier) than 4-lock bolls.

From these results it is concluded that fertilizers increase the yield of cotton by producing larger plants which have more bolls and larger bolls than are produced on unfertilized soil and not by increasing the length of lint or the percentage of lint.