1-1-1922

Tests with Nitrate of Soda for Cotton and Corn at Scott, Mississippi

Early C. Ewing

PART III

Tests With Nitrate of Soda For Cotton and Corn at Scott, Mississippi.

By E. C. EWING

Collaborator Mississippi Experiment Station

Experimental Department, Delta and Pine Land Company of Mississippi

Introduction

Investigations at the Delta Experiment Station during the past fifteen years, as well as trials elsewhere, have indicated that nitrogen is the only essential plant food element which has become deficient in the soils of the Mississippi Delta, and that the use of commercial nitrogenous fertilizers is often profitable practice. The following is an account of certain experiments which have been made, under plantation conditions, on the estate of the Delta and Pine Land Company of Mississippi, in Bolivar County, to determine what gains in the crop are to be expected from the use of nitrate of soda. This record is submitted for publication with the hope that it will be of interest and benefit to other Delta planters.

While we have used the technique of experiment stations and taken every reasonable precaution to obtain as high a degree of accuracy as possible, the cultivation of our plats has not been better than good cultivation as practiced on a well worked plantation. We believe, therefore, that our results are applicable generally to plantation conditions where average to good farming is done.

Nitrate of Soda On Cotton

Plan of Experiments.—In all our tests the nitrate of soda has been used on cotton as side application.

In laying out these experiments the plan has been to use a number of test plats lying side by side for the different fertilizer treatments, the same treatment being repeated several times on similar plats. Each treatment was used from three to six times on these parallel plats. In 1916, when these experiments were begun, we had only three plats representing each fertilizer treatment. The plan finally adopted in later tests has been to use

six replicate series of three plats to the series, the three classes of plats being treated as follows:

Check plats, receiving no fertilizer.

100 pounds of nitrate of soda per acre.

150 pounds of nitrate of soda per acre.

Accordingly, plat No. 1 is a check plat; No. 2 gets 100 pounds of nitrate of soda per acre; No. 3, 150 pounds of nitrate of soda per acre; then the same order of treatment is repeated five times, No. 4 being a check plat, and so on. In addition to the six plats of each class, an additional check plat, No. 19, is added at the end.

The two general classes of Delta soil, loam and buckshot, have been represented in our tests.

Short staple cotton has been planted in all but the 1916 test. With that exception, Wannamaker Cleveland has been the variety grown.

Time of Application.—In the later experiments the effort has been made to distribute the fertilizer as soon as possible after the cotton was chopped out. The date of application has varied in our tests from May 31 in the case of test No. 4 to June 23 and 24 in test No. 5, the average date of application being June 14. Since moisture is necessary to dissolve the salt and make it available after it reaches the soil, the date on which the nitrate is put down is not so important as the date of the first soaking rain thereafter. The average date of such a rain has been June 20, and this may, therefore, be considered the average effective date of application of the fertilizer.

Tests made at the Alabama Station* indicate that on an average the most effective time of application is at the time of chopping and dirting up, and that practice is to be recommended, in our opinion, on loam soils in the Delta. It is important to get the nitrate on the land early enough to insure its being made available by rains early in the growing season, and as soon as the cotton can be cleaned out, the nitrate should be applied.

On buckshot land, which is generally freer from grasses than the loam land, it would seem that there can be no objection to putting out nitrate of soda at planting time. Apparently little is leached out during the season and, since cotton so often fails to grow off well in June on buckshot soil, the very early use of nitrate of soda may be of considerable benefit in starting growth. However, we can never tell until cotton is chopped out what sort of stand we will get. It is not profitable to fertilize a poor stand of cotton, and the possibility of such a condition is to be considered.

Boll Weevil Damage.—The cotton used for these fertilizer tests has been protected more or less from boll weevil damage since 1918. In some cases this has resulted from dusting the plats with calcium arsenate. In other

*Cauthen, E. F. Time of Applying Nitrate of Soda to Cotton, Ala. Sta. Bul. 209, 1920.

cases the plats in question were not dusted but other cuts badly infested on the plantations were dusted and this, by delaying the infestation benefited the test plats indirectly. In no case have the fertilizer plats had one hundred per cent protection, though in some cases damage has been almost entirely prevented.

Loam and Buckshot Soils Both Represented.—These tests have been conducted on a productive type of silt loam soil, lying near Lake Bolivar and Deer Creek. It is typical of the better class of "front lands" common along the streams throughout the Delta, which have long been in cultivation. With the exception of the 1917 test, all of these trials on loam land have been conducted in a field used exclusively for experimental purposes. The 1917 test was located in an adjoining field worked by a negro tenant.

As the experimental field at Scott contains no buckshot soil, it has been necessary to use cotton growing elsewhere on the plantations for making the tests on buckshot soil. For this purpose plats have been staked off in tenants' crops. The nitrate was applied in the same way, however, and the same plan of arrangement and replication of plats that was followed in the experimental field was used in these plantation tests. Otherwise the cotton was cultivated by the tenant in the ordinary way. In choosing the crops for these tests, however, care has been taken to locate where they would be well cultivated and on land that was as uniform in soil fertility, soil type, drainage, and the stand of cotton as possible, in order to secure uniformity in our results.

It has not been possible to conduct these plantation tests with quite the same precision as has been attained in tests conducted in the experimental field. This is shown by the fact that the probable errors of the results from buckshot soil are higher than the probable errors of the results from loam soil. Nevertheless, the fact that these tests were made under actual normal plantation conditions gives a good indication of the possibilities of the fertilizer under those conditions.

Discussion of Results.—In table I below are compiled the results of the several fertilizer tests which have been carried through on similar lines at Scott. During the five years from 1917 to 1921 we have completed seven of these tests, four on loam and three on buckshot soil, to determine the effect of 100 pounds of nitrate of soda and 150 pounds of nitrate of soda. The plats so fertilized have been compared with identical plats receiving no fertilizer. In the table are shown the principal results of each test, viz., in the third column the mean or average yield per acre of the unfertilized check plats with the probable error of this mean. For example, in the first test this is 1575 pounds of seed cotton per acre plus or minus 20 pounds, the latter figure being the probable error of the former. In the second column is shown the mean percentage gain from the use of 100 pounds of nitrate of soda. In test one this increase is 10.8 plus or minus 4.0 per cent. In the

third column is shown the percentage gain from 150 pounds of nitrate p acre, viz., as in test 1, 15.6 plus or minus 1.1 per cent.

The probable error is computed for each figure to show its degree accuracy. or rather the degree of confidence to be placed in the results. all experimental work a certain amount of experimental error is necessari involved. This is illustrated by the fact, so familiar to investigators, th it is almost impossible to obtain exactly the same result twice in successi by repeating any field experiment. In spite of precaution to select for exp imental purposes the most uniform land to be had, natural soil differenc in the several plats especially affect their production. This illustrates o of the causes of variation in experimental results, one of the sources of e perimental error.

The probable error is computed by a standard formula. Its magnitu depends both on the variation in yield between the several plats averag and on the number of plats. Therefore, the best way to reduce the probab error and increase the precision of our results is to provide as uniform s and other experimental conditions as possible and to repeat the number trials as many times as possible, or in other words, to employ as many pla as practicable to represent each treatment.

If there were no uncontrollable sources of error, the yield found for a particular treatment could be accepted with absolute confidence. but r such conditions are possible. Consequently there is necessarily a degree uncertainty about the application of our results, and the probable error provided to serve as a measure of the confidence to be placed in them. is implied in this case that it is an even chance that the true yield li within the limits set by the probable error. In test one, for example, w are justified in assuming that the chances are even that the correct yie of the check plats lies somewhere between 1555 and 1595.

Likewise we may say that the data from test 4, for example, indica an even chance that the following results may be expected, namely, that th increased yield produced by 100 pounds of nitrate should be between 13 per cent and 20.5 per cent, or 16.9 ± 3.6 per cent, and that 150 pounds shou increase the crop somewhere from 19.1 per cent to 26.1 per cent. Thi roughly, is the significance of the probable error as used here.

Combining the results of all tests, we find that the average yield o tained without fertilizer has been 1300 pounds of seed cotton per acr Where 100 pounds of nitrate of soda per acre has been used, the averag increase was 15.0 per cent, or 195 pounds of seed cotton per acre. Th average increase from 150 pounds of nitrate per acre has been 20.6 per cen or 268 pounds of seed cotton..

TABLE 1.

Cotton Fertilizer Tests, 1917 to 1921, Seed Cotton.

LOAM SOIL.

Test	Year	No Fertilizer Yield Seed Cotton per Acre	Increase 100 lbs.	Increase 150 lbs.
1	1917	1575±20 lbs.	10.8±4.0 per cent	15.6±1.1 per cent
2	1918	1421±21 lbs.	14.2±1.7 per cent	15.5±2.0 per cent
3	1920	918±17 lbs.	12.7±2.1 per cent	25.9±2.8 per cent
4	1921	1418±31 lbs.	16.9±3.6 per cent	22.6±3.5 per cent
Averages Loam		1333 lbs.	13.6 per cent	19.9 per cent

BUCKSHOT SOIL.

5	1919	1976±90 lbs.	17.7±6.2 per cent	22.9±5.7 per cent
6	1920	1096±21 lbs.	16.6±2.4 per cent	20.8±3.6 per cent
7	1921	713±30 lbs.	16.0±5.2 per cent	20.6±5.6 per cent
Averages Buckshot		1253 lbs.	16.8 per cent	21.4 per cent
Gen. Averages		1300 lbs.	15.0 per cent	20.6 per cent

We have found that the use of nitrate of soda slightly lowers the lint percentage, or gin turn out.

The plats having no fertilizer have shown a higher lint percentage than the fertilized plats in all cases where we have made ginning tests on the cotton produced. There has not been much difference, however, between the effect of 100 pounds and the effect of 150 pounds of nitrate on the lint percentage.

Unfortunately we have made no ginning tests on the cotton grown on buckshot soil and are obliged to use results obtained from three of the tests on loam soil as the nearest approximation for determining the average lint yields of all tests.

The average lint turnout of the cotton grown without fertilizer has been 34.96 per cent; that grown with 100 pounds of nitrate of soda, 34.57 per cent; and with 150 pounds of nitrate, 34.60 per cent. This difference in lint percentage of only about four-tenths has considerable effect on the lint production. It makes sufficient difference to reduce the gain due to 100 pounds of nitrate from 15.0 per cent as seed cotton down to 13.6 per cent when the comparison is made on a lint basis.

TABLE 2.

Comparison of Yields of Seed Cotton and Lint

	Check Plats.	Plats Receiving 100 lbs. Nitrate per Acre.	Plats Receiving 150 lbs. Nitrate per Acre.
Pct. increase, seed cotton.		15.0%	20.6%
Yield Seed Cotton per acre	1300 lbs.	1495 lbs.	1568 lbs.
Mean lint per cent	34.96%	34.57%	34.60%
Mean yield lint	455 lbs.	517 lbs.	545 lbs.
Increase in yield of lint		62 lbs. or 13.6%	88 lbs. or 19.3%

The increases secured on buckshot soil have been slightly greater than those obtained on loam soil. In all cases, however, the buckshot land used has been rather well drained and has had as favorable a chance to make a full crop as the average loam land. These results prove that the buckshot soil may become as deficient in nitrogen as the loam soil, and that under favorable conditions the use of commercial nitrogen will pay as well on buckshot land as on loam. Still it must be recalled that the black land as a rule is not as well drained as the loam land and that cotton develops slower on buckshot land. For this reason, as well as others, cotton is more subject to severe boll weevil damage on buckshot soil. Of course, with heavy weevil damage most of the effect of the fertilizer will be lost.

1916 Test.—The first fertilizer test in this series of experiments was made in 1916. Here only one rate of application, 125 pounds of nitrate of soda per acre, was tried in comparison with untreated check plats. This rate of application is different from that used in the seven later tests, and a different variety of cotton, Express, was planted that year. For these two reasons, this test is not directly comparable with the subsequent trials. On this account the results are not included in the summary. The detailed results are shown in the following table.

TABLE 3.

Cotton Fertilizer Test 1916, Loam Soil, Express.

	Yield Seed Cotton per acre pounds.	Lint Percentage.	Lint per Acre Pounds.	Seed Percentage.	
Check plats .....1090±47		25.36	276±12	73.47	801±30 lbs.
125 lbs. Nitrate 1312±40		24.28	319±10	74.63	979±30 lbs.

Increase from nitrate 222±62 lbs. seed cotton per acre or 20.4±5.7 per cent
Increase from nitrate 42±16 lbs. lint cotton per acre or 15.2±5.8 per cent
Increase from nitrate 178±46 lbs. seed per acre or 22.2±5.7 per cent

Little Gain From Fertilizer Where Cultivation Is Poor.—The results of this test are published merely to show that profitable returns cannot be secured from the use of nitrate of soda on cotton unless the crop is well cultivated. In 1919 the cotton used for the regular test with nitrate of soda on loam soil was very poorly worked. It got in the grass early and was never kept clean after that. In the first place, the nitrate of soda was not put out until July 1, the application having been delayed in the hope that the cotton could first be cleaned of grass. However, it was never got even fairly clean and never got much work until late in the season. The yields from this test are shown in the following table:

TABLE 4.

Cotton Fertilizer Test, Loam Soil, 1919.

	Yields of Seed Cotton per Acre Pounds	Difference in Pounds per Acre.	Percentage Differences.
Check plats .....1016±34 lbs.			
100 lbs. Nitrate .....1029±21 lbs.		13±40 lbs.	1.3±3.9 per cent
150 lbs. Nitrate .....1145±78 lbs.		129±85 lbs.	12.7±8.4 per cent

The plats fertilized at the rate of 100 pounds of nitrate per acre yielded only 1.3±3.9 per cent more than the unfertilized plats. This difference

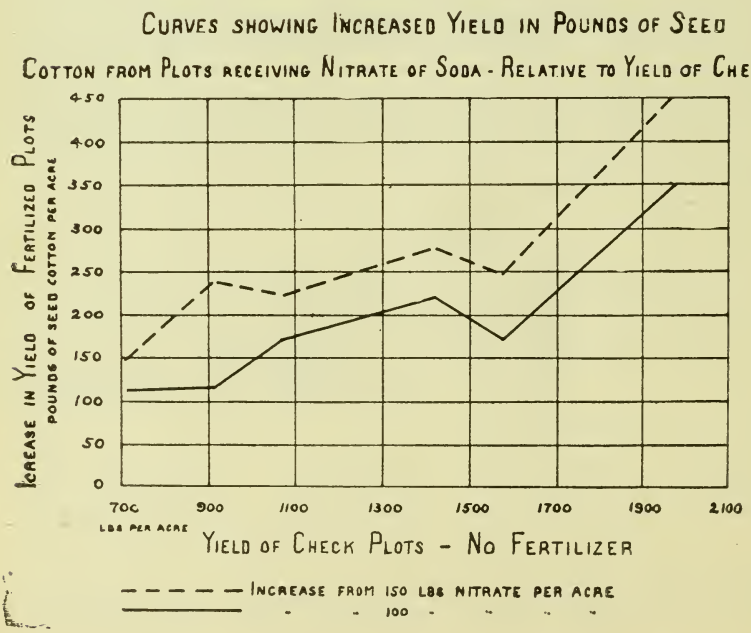
being less than the probable error has no significance, so there is no indication that any gain whatever was secured. It is apparent that the plats receiving 150 pounds per acre did not do very much better when we consider that the gain of 12.7 per cent is only one-half greater than its probable error.

Judging from these figures, one might say that apparently the grass got practically all the value of the 100 pounds of nitrate of soda and that it took as much as 150 pounds of nitrate to produce an apparent gain, which is itself even doubtful. It is clear that in order to be certain of a profit from the use of nitrate of soda on cotton, good cultivation must be given the crop. If it is not reasonably certain that the crop will be well worked, it is best to leave off the fertilizer. The results of this test are published to emphasize that point.

This test is an exceptional case and is not included in the summary, which is intended to show the possibilities of the fertilizer under good farming methods.

Practical Application of Results.—The results of our nitrate of soda tests have followed the general rule that where fertilizer is used on more productive land the increase, when measured in pounds per acre, is greater than

Figure 1,

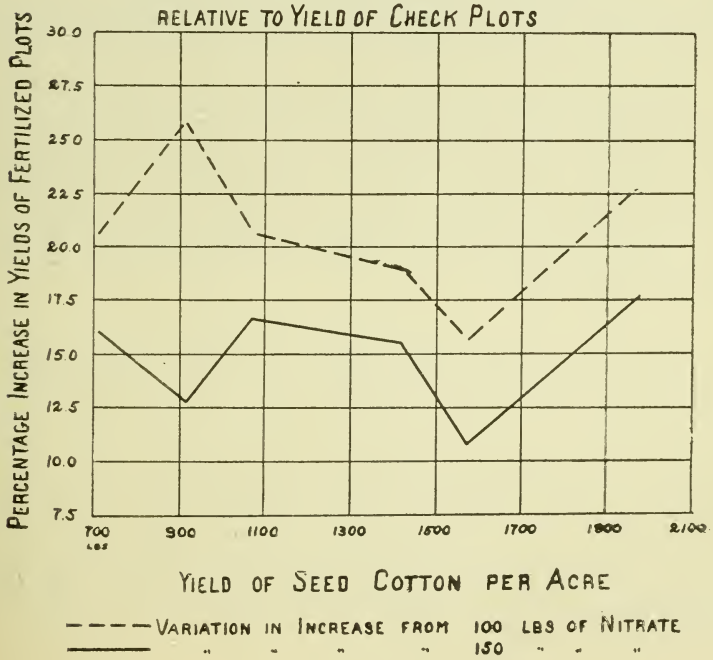


on less productive land. For example, in test 7, where the yield of seed cotton was 713±30 pounds per acre without fertilizer, 100 pounds of nitrate increaced the yield by only 114±37 pounds of seed cotton per acre and 150 pounds of nitrate gave an increase of only 147±40 pounds. In test 5, where the yield was 1976±90 pounds of seed cotton per acre without nitrate, the increases were 350±123 and 452±113 pounds of seed cotton per acre, respectively, from the application of 100 pounds and 150 pounds of nitrate of soda per acre.

This relationship is illustrated graphically in figure 1. In this diagram the yield of seed cotton per acre from the unfertilized cotton in each of our tests is represented on the scale at the bottom of the figure. The two curves show the increase in seed cotton from 100 pounds and 150 pounds of nitrate of soda, respectively, corresponding to different yields obtained without fertilizer in each test.

In only one case, that of test 1 (1917), where the unfertilized check

Figure 2



plats yielded 1575 pounds of seed cotton per acre, do the curves dip dow

In one case we have combined figures from two tests into one for th purpose, so there are only six points instead of seven to each curve. In te 2, where the yield of the check plats was 1421 pounds and in test 4, whe it was 1418 pounds of seed cotton per acre, we have averaged these two fi ures at 1420 pounds, with a corresponding average increase of 221 pound from 100 pounds of nitrate and 270 pounds from 150 pounds of nitrate.

Figure 2 illustrates graphically another aspect of these same result Here the increases produced by the fertilizer are considered as percentage of the yields of the unfertlilzed check plats in their respective tests.

Figure 2 is a graphic representation of the data in table 1. There i perhaps, a slight though not pronounced downward trend to these tw curves, this tendency being more noticeable in the upper than in the low curve.

It is probable, therefore, that we should expect a slightly higher pe centage increase from nitrate of soda on poor land than on rich land, oth things being equal. However, it is almost certain that a greater actual i crease in pounds and a greater profit from the investment will be made fertilizer is put on the more productive land. This statement is in line wi the generally recognized principle that fertilizers will pay best on good lan

The use of nitrate of soda on new grounds or on lands made excessive rich, of course, is not recommended, but it is very evident that if one has limited amount of money to invest in nitrate of soda, the most profitab returns will be secured by using it on land which can be depended on productive. This, of course, means land of fair natural fertility, land th is well drained and will be well cultivated. The crop must also have a fa chance with the boll weevil, the greater the weevil damage the smaller t fertilizer profit will be.

If these conditions are provided, we consider it safe to count on average increase of about 15 per cent in seed cotton from 100 pounds nitra and about 20 per cent from 150 pounds, or if we figure in terms of lint, t corresponding increases would be 13.6 per cent and 19.3 per cent. If assume a uniform rate of increase, the following table would assist in es mating the probable amount of increase to be expected where a certain yi is obtained without fertilizer. In order to judge whether it will be profital to use nitrate of soda and in what amounts under these conditions, we wo use this table in figuring the cost of the fertilizer against the probable pr of cotton. It may be assumed that the percentage increase will, perhaps, somewhat higher on poorer lands and somewhat lower on richer lands th the table would indicate.

TABLE 5.

Table Showing Increased Yields of Lint to Be Expected from Nitrate of Soda Corresponding to Various Yields Which Would Be Secured

Yield Without Fertilizer Lint per Acre.	Increase from 100 lbs. Nitrate Lint per Acre.	Increase from 150 lbs. Nitrate Lint per Acre.
100 lbs.	13.6 lbs.	19.3 lbs.
200 lbs.	27.2 lbs.	38.6 lbs.
300 lbs.	40.8 lbs.	57.9 lbs
400 lbs.	54.4 lbs.	77.2 lbs.
500 lbs.	68.0 lbs.	96.5 lbs.

The increase in yield of seed is also to be considered as an additional profit. On the other hand, as the yield of lint and seed increase, the cost of picking, ginning and handling the increased yield is to be taken into account in estimating profits.

Nitrate of Soda on Corn.

Nitrate of Soda On Corn.—Table 5 shows a summary of results with nitrate of soda as a top dressing, or side application for corn. All trials have been made with one hundred pounds and one hundred and fifty pounds of nitrate per acre. Only one of these tests, No. 3, 1921, was made in the field of the Experimental Department mentioned in connection with the cotton experiments. The other five were made in connection with some of the regular corn crops of the plantations.

In laying out the plats for the corn work, the same plan which was explained as having been used in the cotton experiments has been followed. All of the corn fields, as well as the test in the experimental field, have been planted in check rows. Equal areas have been staked off in these fields for the several plats and have been handled as replicate parallel series of three plats to the series, just as in the case of the cotton experiments. We have finally adopted the same system of using six plats to represent each treatment, with an extra check plat, or nineteen in all.

The corn has always been planted in March and given average cultivation. The fertilizer has usually been put out when the corn stalks averaged about shoulder high at about June 10. We have not made any investigations with reference to the time of application. We have tried to put the nitrate out in time to get the benefit of sufficient rain to make a large part of the salt available before the corn plants matured. In this we have not always been entirely successful and had more rain occurred after the application of the nitrate we would, no doubt, have secured larger gains. On the other hand, we did not apply the nitrate earlier for fear that the effect of the fertilizer would go into the production of a large stalk at the expense of ear development. In the light of our experience we would rather risk earlier applications as we think the danger from the latter source is more remote than the possibility of poor results due to dry weather. The earlier the nitrate is applied after cultivation is well started, the surer it will be dissolved and ready for the plants when needed.

In the case of March planted corn, we would advise the distribution of nitrate about the 15th to the 20th of May, or when the plants are about knee high.

The average yield for the six sets has been 23.9 bushels per acre without fertilizer. One hundred pounds of nitrate of soda have produced an average gain of 31.2 per cent, equivalent to 7.5 bushels per acre, and one hundred and fifty pounds gave an average gain of 40.1 per cent, or 9.6 bushels per acre.

TABLE 6.

Corn Fertilizer Tests, Summary 1917-1921.

Test No.	Year	Yield Check Plats No Fertilizer	Increase from 100 lbs. Nitrate per acre	Nitrate per acre Increase from 150 pounds	of Land Character
1	1918	19.2±0.6 bu. per acre	4.8±0.8 bu. ar 25.1±4.1 per cent	6.2±1.8 bu. or 32.3±5.6 per cent	Loam
2	1919	22.4±1.4 bu. per acre	9.4±1.9 bu. or 42.0±8.6 per cent	13.0±2.2 bu. or 50.8±8.7 per cent	Loam
3	1921	35.2±1.2 bu. per acre	8.4±1.6 bu. or 23.8±4.4 per cent	12.9±1.6 bu. or 36.6±4.5 per cent	Loam
4	1917	25.1±0.8 bu. per acre	9.1±1.0 bu. or 36.1±4.0 per cent	11.3±1.3 bu. or 44.9±5.0 per cent	Buckshot
5	1918	22.1±0.4 bu. per acre	7.0±1.9 bu. or 31.6±8.3 per cent	7.4±1.3 bu. or 33.6±5.8 per cent	Buckshot
6	1919	19.4±0.3 bu. per acre	5.5±0.5 bu. or 28.5±2.3 per cent	8.3±0.5 bu. or 42.5±2.5 per cent	Buckshot
Averages		23.9 bu. per acre	7.4 bu. or 31.2 per cent	9.8 bu. or 40.1 per cent	

In all tests but one, cow peas have been sown in the corn middles at the last working. No apparent effect to the peas resulted from the nitrate of soda.

At the present prices of nitrate of soda and of corn, very little profit, if any at all, is to be expected from the use of this fertilizer in the ordinary corn culture as practiced on the average Delta plantation. Normally the corn crop is cheaply grown and its cultivation is rather indifferent. Furthermore the crop is usually planted on rather thin land with the intention of improving the land with peas, sown in the middles, for the benefit of subsequent cotton crops. As a matter of fact, our average yield without fertilizer has been higher than the normal yield for this section and with no better cultivation the gain in bushels from the use of nitrate would probably be lower on the average plantation than the average gains reported here. However, where corn is planted on good land and is well worked, nitrate of soda can be used profitably, because a greater increase in yield is to be expected; or even on poor land with careful and clean cultivation higher yields than the averages indicated here could very probably be the result. If the cost of the fertilizer should decline and the price of corn advance somewhat, the use of nitrate of soda for corn would become profitable even under average conditions.