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Corn Fertilization In The Yazoo-Mississippi Delta

By

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CURRENT FERTILIZER RECOMMENDATIONS FOR CORN IN THE YAZOO-MISSISSIPPI DELTA

1. Apply 90 to 100 pounds of nitrogen per acre.
2. Place nitrogen as deep as practical with present equipment. In case anhydrous ammonia is used as the source of nitrogen, place at least 6 inches deep.
3. Apply nitrogen prior to planting or as a side dressing when corn is small.
4. Leave 8,000 to 12,000 corn plants per acre. If corn is planted in checks, leave two to three stalks per hill; or if corn is drilled, leave corn spaced 12 to 15 inches apart in 40-inch rows.
5. Apply phosphate and potash where deficiences have been previously determined.

Corn Fertilization in the Yazoo-Mississippi Delta

By PERRIN H. GRISSOM[1] [2]

Corn occupies approximately one-fifth of the total cultivated acreage in the Yazoo-Mississippi Delta. With over 400,000 acres planted annually, corn is second only to cotton in acreage. Because the average yield is only about 20 bushels per acre, the crop does not contribute proportionately to the total farm income. Since corn production and harvesting can be completely mechanized, and because Delta farmers are faced with an increasingly acute labor shortage, it is reasonable to expect that a relatively large acreage of corn will continue to be planted each year. However, acre yields must be increased if corn production is to be a profitable farm enterprise.

Many factors have contributed to the low yields of corn in the Delta. Poor management practices, coupled with low yielding varieties and hybrids, have certainly played important roles. Inadequate and ineffective fertilization can also claim a major share of the credit for the low corn yields. Some of the most important requirements for successful corn production that can be controlled by the farmers are:

1. Good seedbed preparation,
2. Use of adapted varieties or hybrids,
3. Proper fertilization in conjunction with an adequate number of plants per acre,
4. Early planting,
5. Adequate weed control,
6. Good management practices.

Much could be said concerning each of these items. This discussion, however, will be devoted to the third requirement —proper fertilization in conjunction with an adequate number of plants per acre.

The first corn fertility investigations were begun at the Delta Branch Experiment Station in 1921 when two experiments were initiated to study the influence of sources of nitrogen and rates of nitrogen on the yield of corn. At that time, it was assumed that information related to nitrogen was needed most. Numerous tests since 1921 have confirmed the original assumption. From a soil fertility standpoint, nitrogen is the limiting factor in corn production in the Yazoo-Mississippi Delta. It is the purpose of this report to summarize the results of corn fertilization investigations conducted at Stoneville and on outlying fields with special reference to nitrogen.

Sources of Nitrogen

An experiment designed to study the effectiveness of different sources of nitrogen in increasing the yield of corn was initiated in 1921. Uniform rate of 30 pounds of nitrogen per acre from nitrate of soda, ammonium nitrate, cyanamid, ammonium sulphate, cottonseed meal, and one-half cottonseed meal and one-half nitrate of soda, have been applied for comparisons. A rotation of cotton-corn-oats has been practiced for most of the length of the test, with each plot receiving the same treatment year after year regardless of the crop being grown. The experiment has been conducted on a

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[2] The data included in this report have been collected by different individuals, including Mr. Roy Kuykendall, Superintendent of Coastal Plain Branch of the Mississippi Agricultural Experiment Station, located at Newton, and Dr. John B. Pitner, Soil Scientist, Rockefeller Foundation, Mexico City, Mexico, both formerly with the Delta Branch Experiment Station.

well-drained fine sandy loam soil. Continuation of the experiment affords an opportunity to study the long-time effect of the different sources of nitrogen on the soil.

The 27-year results of the sources of nitrogen test are reported in table 1. Ammonium nitrate has produced slightly greater increases in yield than the other sources and is followed by nitrate of soda, cyanamid, ammonium sulphate, one-half cottonseed meal and one-half nitrate of soda, and cottonseed meal. There has been no marked decline in the yield of corn resulting from the long duration of the experiment as indicated by the averages of the three 9-year periods. Cultural practices and varieties of corn have been modified as superior ones became known. This has tended to offset some of the ill effects to the soil by the cropping system. There were several unusually dry years during the second 9-year period which may partially account for the low average yields.

Since the beginning of this corn-fertilizer experiment, several other sources of nitrogen have been tested. In most of the experiments there have not been large differences between the effect upon yields of different sources of nitrogen when equal rates have been used for comparison. Individual preference and costs have been the chief determinants of the nitrogenous materials used on the farms of the area.

In keeping with the policy of testing new nitrogenous fertilizers and searching for cheaper nitrogen, an experiment was started in 1945 to study the effectiveness of anhydrous ammonia as a source of nitrogen for corn production. The anhydrous ammonia study was in cooperation with W. B. Andrews and F. E. Edwards, of the Central Station at State College. Forty- and 60-pound rates of nitrogen per acre from anhydrous ammonia have been compared with equal rates supplied by ammonium nitrate and nitrate of soda. Four methods of application have been used. The 3-year results of this experiment are listed in table 2. These results show no significant differences between the effectiveness of the three sources of nitrogen when measured in terms of increased yields.

As advantages, anhydrous ammonia af-

Table 2. Rates, methods of application, and sources of nitrogenous fertilizers for corn production: Delta Branch Experiment Station, 1945-47.

Treatment	Yield in bushels of corn per acre			
	1945	1946	1947	Average
A. Rates of application				
40 pounds of nitrogen	62.1	71.8	53.4	63.7
60 pounds of nitrogen	65.4	78.0	63.3	70.2
B. Methods of application				
Plow sole[1]	72.4	83.8	59.5	71.9
Deep[2]	62.2	76.5	66.9	68.5
Furrow[3]	60.2	66.3	49.0	58.5
Side dress[4]	60.1	73.1	58.1	63.7
C. Sources of nitrogen				
Anhydrous ammonia	62.3	74.8	58.9	65.3
Ammonium nitrate	63.4	73.8	58.5	65.2
Sodium nitrate	65.6	76.1	57.9	66.5
Yield of no nitrogen plots	54.7	38.7	25.8	39.7

[1] Fertilizer placed 5 to 6 inches deep in plow sole in bands 20 inches apart.

[2] Fertilizer placed 8 to 10 inches deep, directly underneath the row in bands 40 inches apart.

[3] Fertilizer placed in middle breaker furrow and bedded on.

[4] Fertilizer placed from 4 to 6 inches to the side of growing plant and 4 to 5 inches under the surface.

Table 1. The influence of sources of commercial nitrogen on the yield of corn: Delta Branch Experiment Station, 1921-1947

Treatment[1]	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
	Yield in bushels of corn per acre															
No nitrogen	34.7	29.5	25.8	22.1	29.8	23.3	28.1	32.6	16.8	10.0	45.3	17.4	16.0	11.5	15.3	9.7
Nitrate of soda	36.6	38.4	31.7	30.2	33.6	40.7	56.6	69.2	32.4	24.0	62.1	35.7	26.7	28.8	30.7	13.4
Ammonium nitrate	36.3	35.7	31.5	33.9	38.7	37.2	55.1	70.4	35.7	27.1	63.8	33.4	30.5	28.1	30.6	18.8
Ammonium sulphate	38.9	36.9	31.0	29.3	40.5	36.9	47.1	66.3	32.2	22.6	59.7	29.1	25.2	23.7	27.1	21.0
Cyanamid	38.4	36.0	33.9	26.3	42.5	36.5	43.7	66.9	29.6	19.2	55.5	28.3	23.4	24.9	29.4	18.7
Cottonseed meal	38.0	34.2	31.1	26.1	33.9	29.0	40.3	54.6	29.0	17.6	52.5	26.9	20.9	21.1	24.7	14.8
One-half cottonseed meal and one-half nitrate of soda	39.2	36.6	33.4	28.3	34.1	31.7	48.0	55.3	31.6	18.2	55.7	29.7	20.7	21.9	24.9	13.3

Treatment	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	Av. 1st 9 yrs.	Av. 2nd 9 yrs.	Av. 3rd 9 yrs.	Av. 27 yrs.	Increase over no nitrogen
No nitrogen	11.2	18.7	8.6	48.5	35.1	33.7	16.0	17.0	43.8	41.8	19.8	26.9	17.2	29.3	24.5	-----
Nitrate of soda	40.7	33.5	25.3	65.6	47.8	52.5	34.4	26.7	72.1	64.6	38.9	41.0	32.8	47.5	40.5	16.1
Ammonium nitrate	36.8	35.9	31.4	66.3	52.0	57.2	37.4	32.9	81.4	65.5	46.3	41.6	33.8	52.2	42.6	18.1
Ammonium sulphate	33.5	32.6	28.3	62.8	50.7	50.8	35.6	25.1	67.7	61.5	43.0	39.8	30.5	47.3	39.2	14.7
Cyanamid	30.7	34.1	25.9	60.7	52.7	59.1	36.8	28.5	73.7	64.6	46.2	39.3	29.3	49.8	39.4	14.9
Cottonseed meal	22.7	30.1	22.3	55.7	48.4	52.5	34.1	24.8	66.6	56.2	33.4	35.1	25.7	43.7	34.8	10.3
One-half cottonseed meal and one-half nitrate of soda	26.4	29.7	22.7	55.4	47.8	52.6	31.2	22.9	69.0	55.0	33.0	37.5	26.7	43.3	35.9	11.4

[1] Nitrogen applied at the rates of 30 pounds per acre.

fords a cheaper source of nitrogen, reduces the bulk to be handled by the farmer, and lends itself to placement at more desirable depths and locations. Partially offsetting some of the advantages are the relatively high initial cost of equipment for storage and handling, difficulty encountered on some soil types in securing adequate coverage, and the possible danger resulting from careless handling.

Rates of Nitrogen

Since nitrogen is the limiting fertility factor in the production of corn, it seems logical that the adjustment of the rates to provide the optimum amount affords the greatest opportunity, from a fertilizer standpoint, for raising the level of corn production in the Yazoo-Mississippi Delta.

The first rates of nitrogen experiment at the Delta Branch Experiment Station was begun also in 1921. The test is established adjacent to the nitrogen sources test described above, and the same cropping systems have been practiced on both experiments. Rates of nitrogen ranging from 7½ pounds per acre to 45 pounds per acre, in 7½ pound increments, have been compared with a no-nitrogen check.

The 27-year results of the rates of nitrogen experiment are reported in table 3. With very few exceptions, increases in yield have been produced by increasing the rate of nitrogen. The average yields for the duration of the test show smaller increases in yield per pound of nitrogen when the 37½- and 45-pound rates were applied when smaller amounts were added. This might be construed as an indication that maximum nitrogen efficiency was accomplished at the lower rates.

However, in 1945 and succeeding years, thicker stands of corn were left on the ground. With this practice there was no indication that a leveling-off point had been reached. The 3-year average (1945-47) shows increases in yield in bushels of corn per acre produced by successive increments of nitrogen from 7½- to 45-pound rate to be 3.3, 5.7, 4.6, 5.0, 5.4, and 4.2. It is evident that the rates of nitrogen used were not approaching the maximum that could have been utilized by the corn.

It has only been within the last few years that the potentialities of increasing corn yields with higher fertilization have been recognized and demonstrated. The work of agronomists in other areas has pointed the way. The general relationship between the amount of nitrogen that should be applied and number of corn plants per acre has also been rather definitely established. In 1943, Gull and Pitner (5) found that significant increases in yield of corn were produced by increasing the population to three plants per hill in 40-inch checks. Jordan (6), in experiments conducted in the hill sections of Mississippi, found that with higher rates of nitrogen, 12,000 plants per acre were superior to 4,000 plants per acre with the same rate of nitrogen. It should also be pointed out that with low rates of nitrogen there may be an adverse effect on the yield if a thick stand of corn is left on the ground.

In 1945, a rates and placement of nitrogen test was begun which compares six rates of nitrogen ranging from 20 pounds per acre to 120 pounds per acre applied at two depths—2 to 4 inches and 8 to 10 inches deep. The corn was planted in 40-inch checks and thinned to 3 plants per hill. Nitrate of soda was used as the source of nitrogen. The 1946 and 1947 results of this test are shown in table 4. There is a marked response to increased rates of nitrogen up to the 100-pound rate. There was a slight increase in yield produced by increasing the rate of nitrogen to 120 pounds per acre in 1947 but the difference is not statistically significant. There

Table 3. The influence of rates of nitrogen on the yield of corn: Delta Branch Experiment Station, 1921-1947

Pounds of nitrogen per acre[1]	Yield in bushels of corn per acre																	
	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
0	40.5	32.7	30.3	26.3	26.1	26.3	30.9	31.6	12.6	11.9	45.3	14.3	15.3	12.4	11.5	10.0	11.1	14.5
7.5	41.4	34.4	31.7	29.5	29.1	30.2	36.4	40.3	14.5	13.1	62.1	15.4	14.2	14.2	12.2	12.8	16.1	15.4
15.0	43.2	38.4	35.1	32.3	31.2	34.9	46.0	49.3	21.1	16.7	63.8	21.7	16.5	19.3	18.1	13.5	20.2	21.4
22.5	44.5	45.1	42.9	39.2	32.5	39.2	50.3	55.9	22.8	20.7	59.7	25.1	18.4	23.0	22.4	15.2	27.5	23.3
30.0	46.0	48.2	44.2	40.2	30.4	43.2	62.8	66.5	30.9	24.6	55.5	35.3	22.4	27.0	29.9	19.0	33.4	32.5
37.5	44.8	54.8	43.7	42.3	29.5	47.5	62.5	73.9	32.6	26.9	52.5	38.1	25.9	28.8	35.8	21.1	33.7	40.5
45.0	44.0	56.4	50.4	42.4	28.9	46.0	61.7	73.7	33.4	27.3	55.7	39.9	28.4	28.9	36.5	20.4	35.9	44.3
Pounds of nitrogen per acre	1939	1940	1941	1942	1943	1944	1945	1946	1947	Av. 1st 9 yrs.	Av. 2nd 9 yrs.	Av. 3rd 9 yrs.	Av. 27 yrs.	Increase over no nitrogen	Increase per pound nitrogen	Increase for each increment		
0	11.2	47.9	30.9	29.1	15.4	15.6	43.2	39.2	20.1	28.5	16.2	28.0	24.3	----	----	----		
7.5	14.8	49.3	32.4	34.4	20.1	15.7	48.9	39.6	24.0	31.9	19.5	31.0	27.5	3.2	.43	3.2		
15.0	17.7	52.9	39.2	43.2	25.2	16.9	55.8	44.9	28.8	36.8	23.4	36.0	32.1	7.8	.52	4.6		
22.5	21.8	57.9	41.7	47.4	30.6	23.1	65.6	55.1	32.6	41.3	26.2	41.7	36.4	12.1	.54	4.3		
30.0	25.9	61.4	43.5	54.3	34.6	24.3	67.1	62.3	39.1	45.8	31.0	45.8	40.9	16.6	.55	4.5		
37.5	28.7	63.8	45.8	57.9	33.9	23.9	74.6	67.3	43.8	47.9	33.7	48.8	43.5	19.2	.51	2.6		
45.0	30.5	67.2	50.3	62.5	38.9	22.1	77.8	72.1	48.5	48.5	35.2	51.9	45.3	21.0	.47	1.8		

[1] Nitrate of soda used as source of nitrogen.

Table 7. Fall versus spring application of nitrogen for corn: Delta Branch Experiment Station, 1937-1947.

Treatment	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	11 yr. Av.	Increase over no nitrogen
No nitrogen	18.1	21.7	6.2	49.2	30.3	27.7	18.5	15.5	38.6	40.4	19.2	25.9	------
Nitrate of soda, fall	40.4	32.9	26.7	63.6	32.9	51.9	38.2	19.5	71.9	61.6	23.6	42.1	16.2
Nitrate of soda, spring	39.9	40.1	26.1	61.9	33.9	49.4	33.2	21.6	68.4	55.5	24.5	41.3	15.4
Ammonium sulphate, fall	32.6	36.6	24.1	62.8	40.8	50.8	38.9	23.0	69.0	59.2	31.9	42.7	16.8
Am. sulphate, spring	35.7	41.7	23.9	59.9	42.0	46.6	39.3	21.0	64.2	55.6	37.8	42.5	16.6
Cyanamid, fall	32.0	35.1	19.7	59.6	39.2	50.9	35.4	23.4	71.8	54.5	36.3	41.6	15.7
Cyanamid, spring	39.3	38.0	20.8	61.2	38.7	47.6	41.4	22.5	70.9	62.3	37.6	43.7	17.8

is little doubt that on this soil type 90 to 100 pounds of nitrogen per acre is desirable.

An experiment was conducted at Stoneville in 1947 to study the influence of four rates of nitrogen ranging from 60 to 150 pounds per acre, on the yield of corn. Ammonium nitrate was used to supply the nitrogen and was applied prior to planting. Stands of corn consisting of three plants per hill and four plants per hill were compared. Table 5 lists the data obtained in the test.

The 150-pound rate of nitrogen produced the highest increase in yield. However, due to the small increase over the 90-pound rate, it is questionable whether rates in excess of 90 to 100 pounds per acre can be recommended until further experimental information is available. There was no significant difference between the two plant populations.

Fertilizer Responses by Soil Types

It is a well known fact that all soil types do not perform alike. In the Yazoo-Mississippi Delta there is a wide range of soil types. This divergence of types naturally means that there is considerable difference in the capability and productive capacity of these soils. In order to obtain more concrete information on the performance and fertilization requirements of the predominant soil types, a series of tests with different crops was begun in 1946. These experiments are located on Roundaway Plantation south of Clarksdale, Mississippi

Table 4. The effect of six rates of nitrogen applied at two depths on the yield of corn: Delta Branch Experiment Station, 1946-1947.

Rate in pounds of nitrogen per acre[1]	Depth of placement	Yield in bushels of corn per acre		
		1946	1947	Average
20	ordinary	54.5	37.1	45.8
20	deep	61.6	44.0	52.8
40	ordinary	73.5	59.0	66.2
40	deep	79.0	60.1	69.5
60	ordinary	82.0	65.5	73.7
60	deep	93.9	77.1	85.5
80	ordinary	91.3	77.1	84.2
80	deep	85.6	85.9	85.8
100	ordinary	101.2	88.7	95.0
100	deep	100.8	93.3	97.1
120	ordinary	99.6	90.9	95.3
120	deep	98.8	98.1	98.5
Rates of nitrogen				
20		58.0	40.6	49.3
40		76.1	59.6	67.9
60		87.9	71.3	79.6
80		88.4	81.5	85.0
100		101.0	91.0	96.0
120		99.2	94.5	96.9
Difference in yield between rates for significance		5.8	5.6	5.0
Difference in yield between rates for high significance		8.0	7.7	6.7
Depth of placement				
Ordinary		79.8	69.7	74.7
Deep		82.9	76.4	79.7
Difference required for significance		4.3	3.2	2.1
Difference required for high significance		6.0	4.2	2.8

[1] Nitrate of soda used as source of nitrogen.

and on Prairie Plantation near Tutwiler, Mississippi.

The three soil types on which the tests are located are (1) Bosket fine sandy loam, a low terrace soil with very good internal drainage; (2) Sharkey clay, a low bottom soil with poor internal drainage, commonly referred to as "buckshot" soil; (3) Forestdale silty clay loam, a grayish white low terrace soil with poor internal drainage.

Ammonium nitrate was used as the source of nitrogen and application was made prior to planting in the middlebreaker furrow and the land rebedded. Data obtained to date on corn tests included in this series are presented in table 6. Two of the tests were not harvested in 1946.

The results of the test conducted on the Bosket soil show an average of 12.6 bushels increase in the corn yield produced by each 30 pounds of nitrogen added and indicate that 90 pounds of nitrogen was definitely superior to the lower rates of application. It appears quite possible that higher rates may be profitable, particularly if corn prices are at high levels. There was no difference between the average yields produced

Table 5. The influence of rates of nitrogen on the yield of corn: Delta Branch Experiment Station, 1947.

	Bushels of corn per acre: Yield	Bushels of corn per acre: Increase over no nitrogen
A. Rates of nitrogen[1]		
0 pounds of nitrogen per acre	41.5	-----
60 pounds of nitrogen per acre	75.5	34.0
90 pounds of nitrogen per acre	94.1	52.6
120 pounds of nitrogen per acre	95.4	53.9
150 pounds of nitrogen per acre	101.4	59.9
Difference required to be:		
Significant	5.6	
Highly significant	7.7	

[1] Ammonium nitrate used as source of nitrogen.

Table 6. The influence of rates of nitrogen, corn population, and phosphate and potash on the yields of corn on three soil types: 1946-1947.

Treatment	Yield in bushels of corn per acre: Bosket 1946	Bosket 1947	Sharkey 1947	Forestdale 1947
A. Rates of nitrogen[1]				
0 pounds per acre	33.0	39.8	5.9	9.9
30 pounds per acre	45.6	54.6	19.6	14.6
60 pounds per acre	57.4	70.7	28.3	16.0
90 pounds per acre	69.4	79.0	35.5	16.9
Difference in yield required to be:				
Significant	4.9	2.7	2.4	
Highly significant	7.4	3.7	3.2	
B. Corn population[2]				
2 plants per hill	57.1	64.0	24.1	14.7
3 plants per hill	57.8	64.2	25.3	15.2
C. Phosphorus and potash[3]				
Nitrogen alone	57.9	66.7	27.2	15.9
Nitrogen with phosphorus and potash	57.0	68.5	28.4	15.8

[1] Ammonium nitrate used as source of nitrogen.

[2] Corn planted in 40-inch checks.

[3] Phosphorus and potash applied at the rate of 40 pounds of P_2O_5 and 40 pounds of K_2O per acre.

where two plants per hill in 40-inch checks were left on the ground and where three plants per hill were used.

Although the highest plot yields were obtained where the highest rate of nitrogen was used in conjunction with phosphate and potash, the increase in yield was not enough to indicate a significant response to these minerals.

The response of corn to nitrogen applications on the Sharkey soil was similar to that found on the Bosket soil. However, there was considerable difference in the total yield produced on the two soils. There was no benefit in these experiments resulting from the addition of phosphate and potash, nor was there any difference in yield produced by the two plant populations.

The response of corn to nitrogen applications on the Forestdale soil was very slight. This is one of the problem soils of the Delta. The physical condition is such that effective utilization of commercial nitrogen has not been possible. There is considerable doubt whether row crops can be produced profitably on this soil type unless some means of improving the physical condition can be devised. Although the corn was not harvested in 1946, it was evident that the yields were no better than those produced in 1947.

Time of Applying Nitrogen

Experimental findings indicate that the time of applying nitrogen is not nearly as important as the amount applied. However, if high rates of nitrogen are applied, it will certainly be desirable to make the applications at the time when the greatest efficiency can be obtained. Table 7 shows the results of a test begun in 1937 to compare fall and spring application of equal rates of nitrate of soda, cyanamid and ammonium sulphate. The different sources were applied at the rate of 30 pounds of nitrogen per acre.

In this experiment the dates of applying nitrogen have affected the yield of corn very little. It would be dangerous to reason that similar results will be obtained on all Delta soil conditions, particularly on deep sandy soils where leaching might be a greater problem with the fall application.

The question has been asked many times whether all of the nitrogen should be applied prior to planting, or all of it as a side-dressing, or whether a split application may give the best result. The experimental information related to these questions is inadequate. As shown in table 2, the nitrogen applied as a side-dressing gave a greater increase in yield than did a pre-planting application made in the middlebreaker furrow, although both dates of application proved effective. Variations in the yield of corn obtained with different methods of placement detract from the value of the experiment and the differences are greater than would normally be expected. Service Sheet 195, published by the Mississippi Agricultural Experiment Station, shows a very slight increase in yield results from applying a part of the nitrogen before planting and a part as a side-dressing as compared with all applied in one application.

In an experiment in 1947, there was no increase in yield produced by applying nitrogen as a side-dressing because of insufficient moisture to render the nitrogen available. Generally, the weather will be the real determinant of the effectiveness of the time of application. To eliminate partially the element of risk it will probably prove desirable to apply the nitrogen either prior to planting or as a side-dressing at an early stage of growth. Observations have indicated that at least one cultivation may be eliminated by applying high rates of nitrogen prior to planting.

There is a possibility that with the higher rates of nitrogen a split-application may be profitable. The fact that anhydrous ammonia may be applied as a side-dressing in conjunction with a regular cultivation, thus eliminating an extra operation, introduces another factor to be considered in the application of nitrogen fertilizers. In this case, the small increase in yield that might be obtained by splitting the application of nitrogen could be profitable.

Placement of Nitrogen Fertilizer

It has been stated with regard to the application of fertilizer in general, that the most efficient and most effective placement is that which provides for a sufficient supply of soluble nutrients in a well aerated zone of moist soil occupied by actively absorbing plant roots at periods of growth when the demands of the plant are most acute (3). In the case of nitrogenous fertilizers for corn, optimum placement will depend largely upon the type of soil, the nitrogen material used, and the amount and distribution of rainfall. For the nitrogen to be utilized most efficiently, it must either be applied in the root zone or be moved down into the root zone by water. The latter is true where "on the surface" applications are made.

In the case of materials such as nitrate of soda containing only nitrate nitrogen, the nitrogen is free to move with the soil moisture. When nitrogen is added in the ammonium form, as in the case of anhydrous ammonia and ammonium sulphate, it is absorbed or held by the clay particles of the soil so that it is not free to move with soil moisture. Over a period of time, depending upon temperature, moisture, and soil acidity, the ammonium nitrogen will be converted to the nitrate form. As long as the nitrogen remains in the ammonium form it is not subject to leaching; conversely if placed near the surface it is not free to move down into the root zone until it is converted. In heavy clay soils the absorption of ammonium nitrogen will be greater than in sandy soils. This will also affect the movement of nitrogen within the soil.

An experiment was initiated in 1945 to compare the effect of two depths of placement on the yield of corn. Prior to this time Pitner (9) had shown a beneficial effect resulting from deep application of nitrogen for corn at three rate levels.

The data, showing six rates of nitrogen applied in the middlebreaker furrow compared with the same rates applied deep, are given in table 4. The ordinary application, applied to the middlebreaker furrow, enabled the nitrate of soda to be placed 2 to 4 inches beneath the surface of the soil. The deep application was made by applying the nitrate of soda on the bottom of a furrow made by a subsoil plow. In this case the fertilizer was applied 8 to 10 inches below the surface.

In 1946, there was no signfiicant difference between the two methods of application. The amount and distribution of rainfall during the growing season was sufficient to meet the needs of the crop at all times. In 1947, there were highly significant increases resulting from the deeper application of the nitrogen. An average of all rates show an increase of 6.7 bushels per acre by applying the nitrogen 8 to 10 inches deep. Although the total rainfall was about normal in 1947 (table 8) the distribution was such that many crops suffered severely from lack of moisture. This was true generally for corn. The ground was wet only once between June 25 and September 20.

It was observed that on the plots where the fertilizer was applied deep the corn fired much less than where equal rates were applied at the ordinary depth. The data obtained in this experiment would indicate that it is desirable to have the nitrogen placed deeper when moisture deficiencies develop. Apparently no detrimental effects occurred when the fertilizer was applied during years that adequate moisture was available. The data presented in table 2 tend to confirm the beneficial effect of deep application of nitrogen in dry years.

It should be pointed out that at the present time there are no practical means of applying solid fertilizers 8 to 10 inches deep. This depth of placement may be feasible where anhydrous ammonia is used as the source of nitrogen. In heavy clay soils, depth of placement will be limited by the depth that fertilizer applicators can penetrate.

Before making general recommendations that fertilizer be applied deeper than 6 inches it seems advisable to have added experimental results, particularly those embracing different soil conditions.

Phosphate and Potash

Only a limited number of experiments have been conducted in the Mississippi Delta in which the response of corn to phosphate and potash has been studied. The tests that have been made have failed to show significant response. The data presented in table 5 do not indicate significant responses to the addition of these minerals. These data are in agreements with previous experiments conducted at the Delta Branch Experiment Station.

Normally, deficiencies in these plant nutrients will be manifested in other crops before symptoms appear in corn. Since there have been only a few areas in the Delta where any crops have responded to the addition of phosphate and potash it is probable that the number of soils on which corn will respond to applied phosphate and potash are even fewer. That the soils are either well supplied in available phosphate and potash or possess the ability to release these nutrients in an available form is confirmed by the maintenance of yield levels in the tests reported in tables 1 and 3.

Regardless of the present level of these minerals, however, it is not unreasonable to expect deficiences to develop if enough nitrogen is applied to produce yields of corn that appear possible.

Summary

1. The 27-year results of a source of nitrogen experiment conducted at the Delta Branch Experiment Station show that the greatest increase in corn yields has been produced by ammonium nitrate. Nitrate of soda, cyanamid and ammonium sulphate follow in order of decreasing effectiveness. The differences among the four sources of nitrogen, however, are very small.

2. In tests where anhydrous ammonia has been compared with ammonium nitrate and nitrate of soda, no significant differences in yield increases have resulted due to the source of nitrogen.

3. There has been little difference between fall applications of three sources of nitrogen and spring application of the same nitrogenous materials. These results may not apply to all soil conditions.

4. Nitrogen fertilizers have been equally effective when applied prior to plant-

Table 8. Rainfall in inches at Stoneville in 1945, 1946, and 1947 compared with 1915-1945 average.

Month	1945	1946	1947	Average 1915-1945
April	4.83	2.03	7.16	5.10
May	3.30	7.10	5.58	4.23
June	3.53	6.98	5.79	3.32
July	7.42	3.75	2.13	3.53
August	2.34	2.31	.91	3.01
September	5.09	.62	2.30	2.54
6-month total	26.51	22.79	23.87	21.75

ing or as a side-dressing, except when extremely dry weather followed the side-dressing application. Pre-planting application will eliminate the risk of an ineffective side-dressing application resulting from inadequate moisture.

5. There are indications that at least one cultivation may be eliminated if high rates of nitrogen are applied prior to planting.

6. Pronounced increases in corn yields have resulted from the application of up to 90 pounds of nitrogen per acre when 8,000 to 12,000 plants per acre have been left on the ground. In one experiment, highly significant increases resulted from the application of up to 100 pounds of nitrogen per acre.

7. In one experiment on a poorly drained soil there was very little response to fertilization, indicating that the efficiency of applied fertilizer is directly related to the physical condition of the soil associated with poor drainage.

8. There have been no differences in the yields of corn produced where two plants per hill have been compared with three plants per hill in 40-inch checks.

9. Increased corn yields resulted from deep application of nitrogen with dry weather conditions. When adequate moisture was available there were no significant differences in favor of deep application.

10. There has been no significant response of corn to the addition of phosphate and potash in the experiments conducted in the Yazoo-Mississippi Delta.

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