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NITRATE OF SODA AS A FERTILIZER FOR CORN

By

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SUMMARY

1. **Character of Soil.**—A soil of good depth, with subsoil readily penetrated so as to be "drouth resistant", can be expected to respond well to nitrate, provided phosphate and potash are adequate. A poor Lintonia silt loam at the West Tennessee Station proved highly responsive, making average yield increases for 14 years of nearly 12 bushels of corn per acre from annual applications of 100 pounds of nitrate. In a series of trials running 10 years the increase from 120 pounds of nitrate was 12.3 bushels; and from 160 pounds, 15.3 bushels.

A series on poor land at Middle Tennessee Teachers College, Murfreesboro, made an average increase for 8 years of only 3 bushels from 120 pounds of nitrate and 3½ bushels from 200 pounds. The low increases were attributed to subsoil conditions which made the soil "drouthy."

2. **Recently Cleared Land on Cumberland Plateau.**—Although the soils proved of low productivity, there was little response to nitrating at either a 100- or a 200-pound rate the first year. There was some response, as a rule, the second year, especially at the higher rate. The third year, responses at both rates were excellent.

3. **Seasonal Conditions.**—At the Middle Tennessee Station, near Columbia, responses were good in only 1 year out of 3. Lack of response in the 2 years was attributed to dry weather.

4. **Rate-of-Nitrating.**—Two rates, 120 and 160 pounds per acre, continued for 10 years at the West Tennessee Station, indicated that 160 pounds might be the limit of profitable application. Similar results were obtained elsewhere.

5. **Time-of-Application.**—Data were secured from 4 series of experiments in which 100 pounds of nitrate per acre was applied as a top-dressing over the rows at each of 5 stages of growth: at planting, just up, knee-high, waist-high, and at tasseling. Results were fairly uniform. The lowest average increase, 5.3 bushels per acre, came from the application made when the plants were about to tassel. The next lowest, 6.7 bushels, was from the application immediately after planting. When the plants were just up to about 3 inches in height, the average increase was 7.5 bushels. The largest increases, 9.5 and 9.1 bushels, followed the knee-high and waist-high applications. The knee-high stage is recommended.

6. **General Observations.**—The profitable use of nitrate is controlled by a number of factors other than prices, especially rainfall and character of soil. Adequate supplies of both phosphate and potash are important. Careful attention, of course, should be given to variety and to cultural methods. Adjustment to the proper stand is important. For example, 3500 plants per acre is about right for an expectancy yield of 30 bushels of corn. If fertilizer or manure is used to such extent that an increased yield of 15 bushels can be expected, in an average season, then the number of plants should be increased to 5000.

If the responsiveness of the soil is in doubt, it might be well to use nitrate experimentally for a few years. On most Tennessee soil, only a light application, 100 to 150 pounds per acre, seems advisable.

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INTRODUCTION

Corn is the most extensively grown harvested crop in Tennessee. The 1940 census reports 203,768 farms growing corn on 2,583,607 acres. This is nearly 41 percent of all the land used for harvested crops in the State. The average yield is about 22 bushels per acre. On the more fertile uplands, 35 bushels is often considered satisfactory. Under especially good farm practices, which include a clover-and-grass rotation, as in the Belvedere section of Franklin County, a yield of from 40 to 60 bushels is expected.

Well-drained bottom lands in the past gave the highest yields of corn; but their productivity has been greatly reduced by continuous cropping, so that now 45 bushels per acre is a good average yield where formerly far more was obtained.

FACTORS LIMITING THE YIELD OF CORN

RAINFALL

Under the most fertile soil conditions, the possible average yield of corn is controlled by the rainfall of the growing season. July in particular is a critical month in Tennessee, because in that month corn is in tassel. In exceptional years July is so dry that pollination is greatly reduced. As a result, on good upland the yield may be only 10 or 15 bushels per acre. Even when pollination is not affected by dry weather, the seasonal rainfall may be such as to allow only a 20-, 30-, or 40-bushel crop on a fertile soil capable of producing 60 bushels or more to the acre. The yield that the average-expectancy rainfall will allow varies with the character of the soil and can be only approximated from the experimental evidence at hand. At the West Tennessee Station, on highly responsive upland, which received 5 tons of manure, 200 pounds of 16-percent superphosphate, 50 pounds of muriate of potash, and 100 pounds of nitrate of soda per acre every year, the average yield of corn grown continuously for 33 years was 51.2 bushels per acre, compared with 24.6 bushels where neither manure nor fertilizer was applied. With the same treatments except that the nitrate of soda was increased to 200 pounds per acre, the yield was 51.6 bushels, being unchanged by the doubling of the nitrate. The results indicate that for this particular soil the point may have been reached where the rainfall was the limiting factor. During the 33-year period the highest yield for any single year was 85.0 bushels and the lowest, 16.4 bushels. In this connection it may be mentioned that in a 10-year period, 1931 to 1940, inclusive, an average yield of 62.5 bushels per acre was obtained where manure and the 200-pound application of nitrate were used. But during the next 4 years the average yield was only 43.1 bushels. Results like these illustrate the seasonal uncertainties, not only from year to year, but over periods lasting several years. Also because of rainfall limitation it is obvious that the greater the soil fertility the less is the possible increase from fertilizer of any kind.

SOIL ADAPTABILITY

More than 70 soil types have been found and described in the Tennessee soil survey. These soil types differ materially, but for the present purpose the harvested croplands may be placed in 3 large groups, as follows:

1. Well-drained friable soils of good depth, standing drouth well and responding readily to any needed manurial treatment. They are well suited to a large variety of crops, including corn.

2. Soils somewhat poorly drained because of either a clay pan too near the surface or their extra-high content of silt, causing the soil to become "drouthy" in dry weather.

3. Shallow soil, 1 to 2 feet from limestone or other rock.

The last two groups usually are "drouthy", but often are planted to corn in spite of low yields. They cover large areas in all three divisions of the State.

NEW LAND ON THE CUMBERLAND PLATEAU

With respect to the effects of an application of nitrate of soda on the corn crop, recently cleared land on the Cumberland Plateau appears to be in a special group, deserving separate attention, because of the little response obtained on a soil which after a few years in cultivated crops becomes highly responsive.

SOIL SUPPLY OF PLANT NUTRIENTS

The soil supply of various important plant nutrients is a major factor limiting the yield of corn. Over roughly three-fourths of the State, phosphate is so deficient that its omission as a fertilizer is a serious mistake. Potash sometimes is needed, especially where annual lespedeza has been grown several years for hay. Nitrogen deficiency is characteristic of the great majority of soils the State over. Only by the production of a legume, such as red clover, alfalfa, or the like, together with the careful saving and use of farmyard manure, can a good nitrogen supply in the soil be maintained. Liming is important in this connection; nearly everywhere it increases the yield of corn.

This bulletin deals primarily with the practical use of nitrate of soda as a fertilizer source of nitrogen for the corn crop.

LONG-TIME EXPERIMENTS UNDER FAVORABLE SOIL CONDITIONS

At the West Tennessee Station, two series of experiments have been carried out for a number of years, the results of which illustrate the increased yield of corn obtainable from the application of nitrate of soda as a fertilizer under favorable soil conditions. In each series the corn was grown continuously on the same land.

SOIL DESCRIPTION

The soil was Lintonia silt loam, a type naturally fertile, well drained, and well adapted to a wide range of both field and garden crops. The surface soil is grayish-brown and the subsoil yellowish-brown. The particular soil used had become much reduced in productivity by long-continued crop removal with little return of the fertilizer elements. In particular it was poor in nitrogen, but had little need of either phosphate or potash. Both soil and subsoil were in good mechanical condition, the latter being friable and rather readily penetrated by the roots of most crops.

Memphis silt loam, which covers a large area in West Tennessee, resembles Lintonia silt loam and would be expected to respond to nitrating in a similar manner. Both Richland and Olivier silt loam as found at the West Tennessee Station are similar to Lintonia, and in long-time trials have responded fully as well.

SERIES 1

The trials of series 1 were continued for 14 years, 1931 to 1944, inclusive. The annual yields, as given in table 1, are averages from 4 replications of both the nitrated and unnitrated plots.

It should be stated that in order to insure an ample supply of phosphate and potash, 200 pounds of 16-percent superphosphate and 50 pounds of muriate of potash per acre were applied annually to all plots.

Table 1—*Acre yields of nitrated and unnitrated corn grown continuously on the same plots at the West Tennessee Station for* 14 *years,* 1931-1944.

Soil: Lintonia silt loam.

Figures represent averages from 4 replications.

Year	Plots 8W-11W		Plots 8E-11E		Gain from nitrate	
	No nitrate		100 pounds nitrate per acre			
	Grain	Stover	Grain	Stover	Grain	Stover
	Bushels	Tons	Bushels	Tons	Bushels	Tons
1931	24.3	1.28	38.8	1.44	14.5	0.16
1932	17.3	1.06	35.1	1.23	17.8	.17
1933	24.3	.75	32.4	.99	8.1	.24
1934	14.5	1.12	26.5	1.42	12.0	.30
1935	16.5	.69	25.4	1.10	8.9	.41
1936	17.3	.74	27.7	.81	10.4	.07
1937	21.5	.88	39.5	1.15	18.0	.27
1938	17.5	.70	27.2	1.09	9.7	.39
1939	16.1	1.17	21.6	1.44	5.5	.27
1940	16.0	1.13	32.0	1.36	16.0	.23
1941	13.6	.82	25.7	1.17	12.1	.35
1942	22.0	1.00	35.4	1.27	13.4	.27
1943	10.4	.77	20.6	.83	10.2	.06
1944	9.7	.69	17.6	.80	7.9	.11
Average	17.2	.91	29.0	1.15	11.8	.24

DISCUSSION OF DATA OF TABLE 1

The data of table 1 show that the average increase attributable to the annual 100-pound application of nitrate of soda for the 14-year period is 11.8 bushels of corn and .24 ton of stover. Yields were not maintained under either condition, but decreased appreciably. Without nitrate the average yields for the first 7 years were 19.4 bushels of corn and .93 ton of stover. The second 7 years the averages were only 15.0 bushels of corn and .90 ton of stover. The application of nitrate for the first 7 years resulted in average yields of 32.2 bushels of corn and 1.16 tons of stover. For the second 7 years the average yields were only 25.7 bushels of corn and 1.14 tons of stover. The increased yield from nitrate varied greatly in different years. The lowest increase was 5.5 bushels per acre, in the poor season of 1939. The highest increase was 18.0 bushels, in the favorable season of 1937.

SERIES 2

The trials of series 2 were continued for 10 years. They were located on a different range not far removed from series 1, but on soil that proved somewhat more productive. Series 2 differed from series 1 chiefly in that it included 2 rates of nitrating, 120 and 160 pounds per acre (table 2).

Table 2—*Acre yields of corn at each of two rates of nitrating in trials at the West Tennessee Station continued for ten years*, 1927-1936.

Soil: Lintonia silt loam.

Year	No nitrate		120 pounds nitrate per acre		160 pounds nitrate per acre		Increase from— 120 pounds nitrate		Increase from— 160 pounds nitrate	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
	Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons
1927	19.3	1.39	24.4	1.70	32.1	1.72	5.1	0.31	12.8	0.33
1928	28.3	1.60	39.3	1.97	43.8	2.05	11.0	.37	15.5	.45
1929	28.6	1.58	45.9	1.70	49.1	2.30	17.3	.12	20.5	.72
1930	14.1	1.30	20.5	1.50	25.9	1.60	6.4	.20	11.8	.30
1931	22.0	1.56	32.6	1.72	36.6	1.92	10.6	.16	14.6	.36
1932	25.4	1.36	45.5	1.75	46.4	1.52	20.1	.39	21.0	.16
1933	24.6	.97	37.5	1.30	39.3	1.32	12.9	.33	14.7	.35
1934	16.4	1.45	31.3	1.60	32.1	1.65	14.9	.15	15.7	.20
1935	11.7	1.44	23.2	1.62	22.8	1.52	11.5	.18	11.1	.08
1936	24.0	.95	37.1	1.12	38.8	1.05	13.1	.17	14.8	.10
Average	21.4	1.36	33.7	1.60	36.7	1.67	12.3	.24	15.3	.31

DISCUSSION OF DATA OF TABLE 2

The average yields per acre without nitrate of soda were 21.4 bushels of corn and 1.36 tons of stover. Where 120 pounds of nitrate was applied annually the average yields were 33.7 bushels of corn and 1.60 tons of stover. Where 160 pounds of nitrate was applied annually the average yields were 36.7 bushels of corn and 1.67 tons of stover. The average acre increase from 120 pounds of nitrate, therefore, was 12.3 bushels of corn and .24 ton of stover; and an additional 40 pounds of nitrate gave a further increase of 3 bushels of corn and .07 ton of stover per acre.

In this set of experiments 160 pounds of nitrate per acre is indicated as nearly or quite the limit of profitable application.

LONG-TIME EXPERIMENTS UNDER UNFAVORABLE SOIL CONDITIONS

SERIES 1

ON SOIL OF MODERATE PRODUCTIVITY

Trials with nitrate of soda at different rates of application were conducted for 8 years at the Teachers College farm, Murfreesboro on a gray-colored soil containing an evident amount of "buckshot", or small, roundish iron and manganese concretions, which indicate that this soil at some time, probably remote, was poorly drained. The subsoil is light red in color, but too compact for ready root penetration by crops or for drouth resistance. The surface drainage was good, but subsurface drainage was slow. The soil productivity probably was fair originally, but had been greatly reduced by long cropping in corn and cotton. In fact, the area was recognized as poor land and naturally inferior to the "red" land (Decatur) found over the major portion of the farm.

All plots received a basic application of 200 pounds of 16-percent superphosphate and 50 pounds of muriate of potash per acre.

Table 3 gives the rates of nitrating per year and the yields. The experimental series was replicated 3 times.

DISCUSSION OF DATA OF TABLE 3

This soil unfertilized proved a little more productive than the soils used in the experiments at the West Tennessee Station. Without fertilizer of any kind the average yields per acre for the 8-year period were 24.0 bushels of corn and .65 ton of stover. The annual application of phosphate and potash without nitrate raised the yields to 27.8 bushels of corn and .78 ton of stover. The application of 80 pounds per acre of nitrate increased the yield of corn only 1.5 bushels. The highest averages were 31.9 bushels of corn and .83 ton of stover, where the annual application of nitrate was 160 pounds per acre. Like yields were obtained from the 200-pound application of nitrate. The responses to nitrate were too small to be profitable.

Table 3—*Acre yields from rate-of-nitrating experiments conducted at the Middle Tennessee Teachers College farm for eight years*, 1920-1927.

Annual applications per acre to all plots: 200 pounds 16-percent superphosphate and 30 pounds muriate of potash.

Year	No nitrate		80 pounds nitrate		120 pounds nitrate		160 pounds nitrate		200 pounds nitrate	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
	Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons
1920	38.3	1.09	44.5	1.19	42.9	1.12	45.5	1.26	44.9	1.31
1921	33.2	.93	30.0	.95	36.7	1.07	37.7	.94	32.7	1.06
1922	28.6	.83	28.5	.70	30.6	.77	26.2	.68	33.8	.94
1923	16.9	.60	16.0	.57	17.3	.66	20.0	.76	20.3	.86
1924	28.8	.69	34.7	.78	33.2	.77	33.7	.77	32.7	.66
1925	25.7	.90	22.8	.81	25.7	.86	29.1	.94	27.8	.97
1926	27.7	.72	29.3	.66	30.8	.81	32.2	.75	29.2	.68
1927	23.1	.48	28.5	.56	28.8	.53	30.9	.55	28.6	.53
Average	27.8	.78	29.3	.78	30.8	.82	31.9	.83	31.3	.88
	Average gain		1.5	.00	3.0	.04	4.1	.05	3.5	.10

SERIES 2
ON UPLAND OF ABOVE-AVERAGE FERTILITY

1. On Decatur silt loam at Teachers College, Murfreesboro.—The soil used was the typical brownish-red limestone soil found over large areas in Rutherford County. It is by nature one of the better upland types in the State, but is deficient in phosphate, and under the usual system of farming becomes more or less depleted in nitrogen.

Table 4—*Fertilizer experiments with corn following clover and grass, on Decatur silt loam.*

1. AT TEACHERS COLLEGE FARM, MURFREESBORO.

A 4-year average.

Series	Fertilizer per acre		Average yields per acre of four crops of corn	
	Kind	Amount	Grain	Stover
		Pounds	Bushels	Tons
1	No fertilizer	....	39.0	1.24
2	16-percent superphosphate	200	46.3	1.25
3	16-percent superphosphate Nitrate of soda	200 100	46.6	1.27
4	16-percent superphosphate Muriate of potash	200 25	44.8	1.29
5	16-percent superphosphate Muriate of potash Nitrate of soda	200 25 100	45.2	1.47

2. RATE-OF-NITRATING TRIALS ON RED LAND OF LIMESTONE ORIGIN NEAR McMINNVILLE.

A single year's trial.

Series	Nitrate of soda per acre	Average yields per acre		Increase from nitrate	
		Grain	Stover	Grain	Stover
	Pounds	Bushels	Tons	Bushels	Tons
1	None	22.2	1.03	....	....
2	80	27.4	1.07	5.2	0.04
3	160	34.4	1.16	12.2	.13
4	240	37.9	1.21	15.7	.18
5	320	37.9	1.17	15.7	.14

In this experimental series, 4 crops of corn were grown in a 5-year rotation of corn, soybeans, wheat, and clover and grass for 2 years. Without fertilizer of any kind the average yields were 39.0 bushels of corn and 1.24 tons of stover. The annual application of 200 pounds of 16-percent superphosphate and 25 pounds of muriate of potash without nitrate increased the average yields to 44.8 bushels of corn and 1.29 tons of stover per acre. With the same application of phosphate and potash and 100 pounds of nitrate of soda in addition, the average yields were 45.2 bushels of corn and 1.47 tons of stover, or essentially the same yield of grain as where no nitrate was applied but with an increase of 360 pounds of stover per acre. Even 200 pounds of nitrate per acre under otherwise identical conditions failed in this series to make any further increase.

In this case the chief limiting factor appeared to be rainfall.

That this type of soil is at least moderately responsive to nitrating is indicated by the results reported in part 2 of table 4.

2. That an upland soil producing 45 bushels of corn per acre without nitrate may respond well to nitrating is illustrated in table 5. Where 44.7 bushels of corn per acre was obtained without nitrate, an application of 80 pounds per acre increased the yield 5.8 bushels, and 160 pounds increased the yield 13 bushels. But such increases are not the rule under Tennessee conditions, largely because of the limiting factor of rainfall.

Table 5—*Rate-of-nitrating on gray-colored soil near Smithville, DeKalb County.*

A single year's trial, 1912.

Series	Nitrate of soda per acre	Average yields per acre		Increase from nitrate	
		Grain	Stover	Grain	Stover
	Pounds	Bushels	Tons	Bushels	Tons
1	None	44.7	1.60	....	....
2	80	50.5	1.71	5.8	0.11
3	160	57.7	1.70	13.0	.10
4	240	59.5	1.87	14.8	.27

MISCELLANEOUS FERTILIZER EXPERIMENTS

The experimental data in tables 1 to 5 were obtained on soil types of Middle and West Tennessee. Table 6 shows results of 5 other series from these sections, and in addition the average of 20 miscellaneous series conducted over a 5-year period on various soil types of East Tennessee.

All of the 25 series were on soils poor in phosphate, with the exception of series 3 and 5, which were conducted on soils naturally rich in both phosphate and potash.

Omitting series 3 and 5, the most striking results common to all is the increase from the "minerals"—phosphate and potash mixture—the average being 11 bushels per acre. The increase from the nitrate of soda was only 4 bushels, which happens to be practically the average increase from 100 pounds of nitrate of soda in the 20 series on East Tennessee soils. Only under unusual conditions, such as are brought about by war or by a great reduction in the price of nitrate, could the application be considered profitable for the general run of soils.

In series 3, on Grenada silt loam, the increase attributable to 100 pounds of the nitrate is only 3.6 bushels. Since this soil type is considered to be highly responsive, the low increase is assumed to be due to inadequate moisture supply.

Series 5 was carried out on an excellent type of soil, richly supplied with phosphate. In the 1941 series the nitrate may be said to have produced no noticeable effects at either the 75- or the 150-pound rate of application. In 1942, with a more favorable season, the responses at both rates were excellent, as would be expected. In the dry season of 1944 the results were like those for 1941, no response being obtained from nitrate.

Table 6—*Miscellaneous experiments with fertilizer for corn.*

Series	Year	Locality and soil	Fertilizer per acre	Yield per acre		Increase per acre from fertilizer	
				Grain	Stover	Grain	Stover
				Bushels	Tons	Bushels	Tons
1	1912	Near Crab Orchard, Cumberland Plateau. Hartsells soil.	None.	14.3	0.76	....	....
			300 lbs. 16% superphosphate, 50 lbs. muriate of potash.	27.2	1.37	12.9	0.61
			300 lbs. 16% superphosphate 50 lbs. muriate of potash. 160 lbs. nitrate of soda.	29.5	1.55	15.2	.79
2	1914	Near Burrville, Morgan County, Cumberland Plateau.	None.	14.3	.71	....	....
			300 lbs. 16% superphosphate, 50 lbs. muriate of potash.	26.9	.81	12.6	.10
			300 lbs. 16% superphosphate, 50 lbs. muriate of potash. 80 lbs. nitrate of soda.	25.1	.81	10.8	.10
3	1931	At Junior College farm, Martin. Grenada silt loam. (Corn followed crimson clover turned under).	None.	40.1	....	....	....
			200 lbs. 16% superphosphate, 50 lbs. muriate of potash.	41.2	....	1.2	....
			200 lbs. 16% superphosphate 50 lbs. muriate of potash. 100 lbs. nitrate of soda.	44.8	....	4.8	....
4	1908	Near Baxter, Putnam County. Gray-colored soil of Eastern Highland Rim.	None.	7.0	.57	....	....
			300 lbs. 16% superphosphate, 100 lbs. muriate of potash.	25.1	1.02	18.1	.45
			300 lbs. 16% superphosphate, 100 lbs. muriate of potash. 160 lbs. nitrate of soda.	33.1	1.35	26.1	.78
5	1941	At Middle Tennessee Station. Maury silt loam.	None.	30.0	.97	....	....
			75 lbs. nitrate of soda.	31.0	.96	1.0	None
			150 lbs. nitrate of soda.	27.9	.98	None	.01
	1942		None.	24.6	1.03	....	....
			75 lbs. nitrate of soda.	33.5	1.06	8.9	.03
			150 lbs. nitrate of soda.	38.5	1.24	13.9	.21
6 to 26	1935 to 1939	An average of 20 miscellaneous series during a 5-year period on various common soil types of East Tennessee.	None.	24.4	....	....	....
			200 lbs. 16% superphosphate, 30 lbs. muriate of potash.	34.9	....	10.5	....
			200 lbs. 16% superphosphate, 30 lbs. muriate of potash. 100 lbs. nitrate of soda.	39.0	....	14.6	....

EXPERIMENTS ON NEWLY CLEARED LAND ON THE CUMBERLAND PLATEAU

As previously indicated, newly cleared land on the Cumberland Plateau deserves special consideration. This is true from a very practical point of view—because of the large area of undeveloped but promising agricultural land involved.

The experiments reported in table 7 were carried out by J. J. Bird at the Cumberland Homesteads, near Crossville, in connection with a Station project on Home Production of Food Supplies.

The trials were made chiefly on Hartsells fine sandy loam, which is widely distributed and is considered the most desirable upland type of this region.

The data are divided into 3 series. Series 1 gives the results from the first crop after the land was cleared; series 2 gives the results from the second crop, and series 3 gives the results under 5 miscellaneous conditions. In series 1, experiments were made on each of 4 farms, 1 each for the years 1935 and 1937 and 2 for 1936. Without nitrate but with 200 pounds of common superphosphate and 30 pounds of muriate of potash per acre, the average yield for the 4 sets was 26.5 bushels per acre. Where the same amounts of phosphate and potash were applied and in addition 100 pounds of nitrate of soda, the average yield was 26.8 bushels, showing no significant increase. Where the nitrate was increased to 200 pounds, the average yield was 28.5 bushels, an increase of only 2 bushels. The detailed yields given in the table show increases from only 2 of the 8 nitrate applications.

In series 2, similar experiments were made, but corn followed corn for the second year after clearing. Without nitrate the average yield of the 7 sets was 28.6 bushels per acre. With the 100-pound application of nitrate the average yield of corn was 31.6 bushels, an increase of 3 bushels. With a 200-pound application of nitrate, the average yield was 33.9 bushels, an increase of 5.3 bushels. Out of the 7 trials, 5 gave appreciably increased yields from the 200-pound application of nitrate. In short, the response from nitrate was more evident the second year than the first.

In series 3, there was an appreciable response to the 200-pound application of nitrate in 4 of the 5 sets. In particular was the response significant in trial 8, where the third crop after clearing was grown.

SUMMARY OF THE PLATEAU EXPERIMENTS ON NEWLY CLEARED LAND

1. Nitrate for corn as the first crop after land clearing is of doubtful value and cannot be advised from the evidence obtained in these experiments.

2. Second-year corn, following corn as the first year's crop, responded appreciably to the 200-pound application of nitrate in 5 of the 7 trials. Where the 100-pound application was made, the response was profitable in only 2 of the 7 sets.

Table 7—*Experiments with nitrate of soda for corn on new land of the Cumberland Plateau.*

Applications per acre to all plots: 200 pounds of 15-percent superphosphate and 30 pounds of muriate of potash.

Soil type: Hartsells fine sandy loam.

Each yield is the average of 4 replications.

Trial No.	Year land cleared	Year of trial	Preceding crop	Rate of nitrating and yield per acre						Increase per acre from—			
				No nitrate		100 pounds		200 pounds		100 pounds		200 pounds	
				Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
				Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons
				Series 1—First crop on land after clearing									
1	1935	1936	None	15.9	0.79	22.6	1.20	18.6	1.18	6.7	0.41	2.7	0.39
6	1936	1937	None	38.9	....	31.0	....	36.5	....	0.	....	0.	....
7	1936	1937	None	33.1	1.12	35.4	1.07	40.6	1.24	2.1	—.05	7.5	.12
10	1937	1938	None	18.2	.63	18.3	.56	18.1	.58	.1	—.07	0.	—.05
				Series 2—Second crop on land after clearing									
4	1935	1937	Corn	31.5	....	43.4	....	40.9	....	11.9	....	9.4	....
5	1936	1938	Corn	30.3	....	32.5	....	40.2	....	2.5	....	9.9	....
9	1936	1938	Corn	38.4	.75	42.2	.81	47.4	.83	3.8	.06	9.0	.08
11	1936	1938	Corn	25.2	.75	27.2	.77	30.0	.84	2.0	—.02	4.8	.09
12	1936	1938	Corn	21.0	.74	19.3	.65	18.8	.68	....	—.09	0.	—.06
13	1936	1938	Corn	30.3	.71	29.0	.69	26.7	.73	0.	—.02	0.	.02
15	1937	1939	Corn	23.4	....	27.6	....	33.1	....	6.2	....	9.7	....
				Series 3—Miscellaneous									
2	1935	1936	Potatoes	42.9	1.11	42.9	1.30	53.3	1.54	0.	.19	10.4	.43
3	1935	1936	Potatoes	22.4	.89	22.4	1.15	26.0	1.16	0.	.26	3.6	.27
8	1935	1938	Corn (2 yrs.)	26.3	.99	37.2	1.14	44.9	1.12	10.9	.15	18.6	.13
14	1936	1939	None 1937 Corn 1938	24.4	....	30.3	....	34.5	....	5.9	....	10.1	....
16	1936	1939	None 1937 None 1938	25.8	....	27.9	....	33.8	....	2.1	....	8.0	....
Average, all trials				28.0	.85	30.6	.93	33.9	.99	3.4	.08	6.5	.14

3. In 5 miscellaneous sets of experiments the 100-pound rate was excellent in one set, No. 8, where corn had been grown for the 2 previous years following clearing. A moderate increase, 5.9 bushels per acre, was obtained where corn followed corn that was preceded by fallow.

Appreciable increases were obtained from the 200-pound application of nitrate in 4 out of the 5 trials.

TIME OF APPLICATION OF NITRATE

Table 8 gives the yields obtained in 4 sets of experiments with regard to the effect of time of application of 100 pounds per acre of nitrate of soda. The experiments were made on representative uplands, 2 in West and 2 in Middle Tennessee. In all 4 sets, phosphate and potash were applied to all plots alike prior to planting so that the full effect of nitrating would be brought out. All applications of nitrate were made as surface dressings over the rows in strips about 2 feet in width—that is, extending 1 foot on each side of the corn row—and were left to be carried into the soil by rain. The dates and the intervals between nitrating were approximately as follows:

Time of planting, April 26
Corn ankle-high, May 9, 2-week interval
Corn knee-high, June 6, 6-week interval
Corn waist-high, June 21, 8-week interval
Corn about to tassel, July 5, 10-week interval

DISCUSSION OF THE RESULTS

All of the soils used gave good response to the nitrate—an important item in a trial of this kind, in which sharply defined results are desired.

The average acre yields of the 4 sets without nitrate were 19.2 bushels of corn and 1.12 tons of stover. Where the nitrate was applied at time of planting, the average yields were 25.9 bushels of corn and 1.24 tons of stover, an increase of 6.7 bushels of grain and 240 pounds of stover. When the application was made about 2 weeks later the yields were 26.7 bushels of grain and 120 pounds of stover, or practically the same as those obtained when the application was made at time of planting. The knee-high time of application made a better showing, averaging 2.8 bushels more than was obtained from the application at time of planting. A similar increase resulted from the waist-high application made 8 weeks after planting. Only when the application was delayed almost until the beginning of tasseling, or 10 weeks after planting, was the response appreciably lower. Although the differences in yield are not great, significance is attached to the fact that the late applications—when the plants were knee-high to waist-high—agreed in giving higher yields than either of the earlier applications and much higher than the latest application, made nearly 10 weeks after planting.

Application of nitrate when the plants are about knee-high is recommended.

Table 8—*Time-of-application experiments with nitrate of soda for corn—yields per acre without nitrate and with 100 pounds of nitrate applied at various stages of growth—all plots fertilized alike with phosphate and potash.*

Series	Place	Year	Yield of grain at stage applied						Yield of stover					
			No nitrate	At planting	Just up	Knee-high	Waist-high	At tasseling	No nitrate	At planting	Just up	Knee-high	Waist-high	At tasseling
			Bushels	Bushels	Bushels	Bushels	Bushels	Bushels	Tons	Tons	Tons	Tons	Tons	Tons
1	W. T. Sta. (R10)	1914	16.6	21.9	24.5	27.0	26.2	21.1	1.74	1.86	1.88	1.79	1.85	1.93
2	W. T. Sta. (R04)	1921	23.3	31.1	34.1	38.9	37.9	35.2	1.11	1.33	1.30	1.41	1.19	1.21
3	Near Daylight, Warren County	1913	25.0	32.9	31.4	32.9	28.6	24.3	.80	.88	.80	.84	.68	.70
4	Near McMinnville Warren County	1913	11.9	17.5	16.8	16.1	20.4	17.5	.83	.90	.72	.82	.80	.83
	Average yield		19.2	25.9	26.7	28.7	28.3	24.5	1.12	1.24	1.18	1.22	1.13	1.17
	Average increase		....	6.7	7.5	9.5	9.1	5.3	....	.12	.06	.10	.01	.05

GENERAL DISCUSSIONS

POSSIBLE INCREASE PER POUND OF NITROGEN FROM NITRATE OF SODA

Only a general answer can be made to the question of possible increase per pound of nitrogen from an application of nitrate of soda. In the experiments reported, 100 pounds of nitrate contained approximately 16 pounds of nitrogen. In an investigation made at this Station, mature corn plants grown on fertile soil were found to contain 1.26 pounds of nitrogen per bushel of corn. The distribution of the nitrogen was .94 pound in the grain and .32 pound in the other above-ground parts of the plant. On the basis of 1.26 pounds of nitrogen per bushel of grain, 100 pounds of nitrate contains enough nitrogen for 12.7 bushels, if all were taken up by the growing plants. As a matter of fact, all is not taken up; some escapes the roots and is lost by leaching. In field-placed cylinder experiments at this Station, using good soils but moderately deficient in nitrogen, a recovery of 80 percent of the applied nitrogen was obtained from millet, which was sown to a full and practically perfect stand. Where much poorer soils were used and much less growth was obtained, both with and without nitrate, the resultant recovery of nitrogen was only 52 percent.

Nitrate nitrogen is very readily soluble and, as indicated, if not absorbed by plants is lost by leaching. Leaching of course is quicker from some soils than from others. In an extremely sandy soil, a single heavy rain may leach nearly all away. Tennessee soils are silt loams for the most part, and loss by leaching is much more gradual. But the data from the time-of-application experiments, in which best results were obtained when the nitrate was applied from the time the plants were knee-high to waist-high, are best explained on the assumption that greater loss by leaching resulted from the earlier applications. The larger plants, with their much more extensive root systems, were able to hold more of the nitrogen, with a resultant better yield.

Turning under nitrate obviously hastens loss by leaching.

COMPARATIVE VALUE OF DIFFERENT SOURCES OF FERTILIZER NITROGEN

The question naturally arises as to the comparative value of equal quantities of fertilizer nitrogen from different sources. The experimental findings in this bulletin are limited to nitrate of soda, the nitrogen of which is rated as 100-percent available. At the West Tennessee Station a comparative trial of different carriers was continued for a 10-year period and included 4 different crops—corn, cotton, tomatoes, and sweetpotatoes. With all crops except sweetpotatoes, the nitrogen of nitrate of soda proved the most effective. Ammonium sulfate was second best. Cyanamid ranked third and cottonseed meal fourth. Sweetpotatoes responded nearly or quite as well to nitrogen from cyanamid or cottonseed meal as from nitrate of soda.

KNOWLEDGE OF THE SOIL OF FOREMOST IMPORTANCE

The responses obtained in the experiments show that knowledge of the soil, with special regard to drouth resistance, is of great importance in determining the possible value of a nitrate application. Some soils undoubtedly are unresponsive, though impoverished by crop removal, so that nitrating may be unprofitable even when corn is selling at a high price. On the other hand, there are responsive soils on which nitrate can be used to much advantage. The farmer must be governed by the conditions in determining whether or not to use nitrate.

Other experiments at the West Tennessee Station showed that calcium nitrate and ammonium nitrate could be classed with nitrate of soda in effectiveness.

In connection with this subject, cost of materials must be taken into consideration. Ammonium sulfate is a cheaper source of nitrogen than nitrate of soda, so that often its lower availability is considered as being offset by the lower cost. It is used a good deal in commercial fertilizer mixtures, which frequently include the much more expensive organic nitrogen, because organic materials have a good effect on the mechanical condition of the fertilizer. Of course all the materials differ in percentage content of nitrogen. Ammonium nitrate, for instance, contains nearly twice as much nitrogen as nitrate of soda.