Proceedings of the Iowa Academy of Science

Volume 36 | Annual Issue Article 14

1929

The Effects of Some Nitrogen Fertilizers on Nitrification

Ray A. Pendleton
Iowa State College

P. E. Brown
Iowa State College

F. B. Smith
Iowa State College

THE EFFECTS OF SOME NITROGEN FERTILIZERS ON NITRIFICATION

RAY A. PENDLETON, P. E. BROWN AND F. B. SMITH

A number of investigations have shown the effects of certain nitrogen fertilizers on the nitrification process and it has generally been noted that nitrates would stimulate the production of nitrates. The work of Coleman,[1] Brown and Gowda [2] and Greaves [3] may be referred to in this connetion.

In order to determine what the effect of several nitrogenous materials would be when applied to a typical Carrington loam, the following experiment was carried out in the greenhouse.

On March 26, 1928, a quantity of soil was secured and placed in pots in the greenhouse. The soils received the following treatments:

POT NO.	FERTILIZER USED	GRAMS PER POT	POUNDS PER ACRE	POUNDS NITROGEN PER ACRE
1 and 2	Sodium Nitrate	0.625	100.0	15.24
3 and 4	Ammonium Sulfate	0.467	74.7	15.24
5 and 6	Urea	0.207	33.1	15.24
7 and 8	Leunasalpeter	0.3488	55.8	15.24
9 and 10	Nitrophoska	0.5776	92.4	15.24
11 and 12	Check	-----	----	----

Where convenient, the fertilizers were applied in solution, otherwise they were well mixed with the dry soil. The soil in all the pots was made up to and maintained at the optimum, 26 percent moisture.

Samples for analysis were taken from each pot during the first month of the experiment at weekly intervals and later at more infrequent intervals until July 12, when the last sampling was made. Determinations were made for the nitrate production, and the nitrifying power.

1 Coleman, D. A. 1917. The Influence of Sodium Nitrate Upon Nitrogen Transformations in Soils with Special Reference to Its Availability and That of Other Nitrogenous Fertilizers. Soil Science 4: 345.

2 Brown, P. E. and Gowda, R. N. 1924. The Effect of Certain Fertilizers on Nitrification. Jour. Amer. Soc. Agron. 16: 137.

3 Greaves, J. E. 1916. The Influence of Salts on the Bacterial Activities of the Soil. Soil Science 2: 443.

NITRATE PRODUCTION

The nitrate accumulation in the soils is shown in table I. As there was no leaching from the pots and probably no denitrification, whatever increases occurred in the nitrate content of the soil would be shown quite clearly by the data. The average nitrate content of the sodium nitrate treated soils was approximately

Table I — Nitrate Production in Carrington Loam in Pots in the Greenhouse with Various Nitrogen Fertilizers

Pot No.	Mgm. Nitrate Nitrogen Per 100 Grams Soil at Different Dates of Sampling							Increase in Last Sampling Over Original Content	
	Mar. 27	April 7	April 13	April 24	June 1	July 12	Aver. for Six Determinations	Individual	Average
1	2.40	4.28	4.39	5.72	6.67	8.80	5.04	6.40	4.99
2	2.65	4.61	3.94	6.00	5.82	6.24	4.88	3.59	
3	2.57	3.50	2.22	3.75	3.40	4.38	3.30	1.81	3.69
4	2.33	3.97	3.12	4.73	5.65	7.90	4.61	5.57	
5	2.94	4.60	3.52	4.96	4.70	7.14	4.64	4.20	3.85
6	2.75	4.05	3.62	3.75	4.25	6.25	4.11	3.50	
7	2.55	4.44	3.91	4.65	7.14	5.80	4.75	3.25	3.93
8	2.12	4.22	3.79	4.80	6.00	6.74	4.61	4.62	
9	2.20	2.56	4.00	5.27	5.44	6.82	4.38	4.62	4.78
10	2.84	3.80	3.06	3.85	4.27	7.79	4.27	4.95	
11	2.04	2.61	2.48	3.55	3.85	6.18	3.45	4.14	2.80
12	2.76	2.46	2.56	2.77	2.99	4.23	2.96	1.47	

trebled during the period from March 27 to July 12. This treatment brought about a larger increase in nitrate content than any of the others. The nitrophoska treatment, (pots 9 and 10) gave the second largest increase. The untreated soils contained the smallest amounts of nitrates at each sampling and showed the smallest increase in nitrates. Averaging the results secured from the duplicate pots, the urea and leunasalpeter had about equal effects on the nitrate accumulation and the ammonium sulfate had the least influence. The differences between the results for the duplicate soils were rather large in some cases; the greatest difference being shown between the two ammonium sulfate treated soils.

As the nitrogen added in the fertilizers was only 7.67 ppm., and was, therefore, rather insignificant when compared to the increase in nitrates, it is evident that the various nitrogenous materials brought about a distinct stimulation in the nitrification of the soil nitrogen. Averaging the results for the duplicate soils, this increase amounted to 2.19 mgm. of nitrogen per 100 grams of soil in the case of the nitrate treated soils; 0.89 mgm. for the ammonium sulfate treatment; 1.05 mgm. for the urea treatmet; 1.13

mgm. for the leunasalpeter treatment; and 1.98 mgm. for the nitrophoska treatment. Assuming an efficiency rating of 100 for sodium nitrate in stimulating nitrification in the soil, nitrophoska would rate 90.5 leunasalpeter 51.7, urea 47.9 and ammonium sulfate 40.6.

The nitrate content of the soils at the second sampling on April 7, indicates that sodium nitrate, urea and leunasalpeter had about equal effect on nitrate accumulation, while nitrophoska had the least influence.

The nitrate content of the soils at the third sampling on April 13, shows a slight drop in nitrate accumulation for all treatments except the nitrophoska and the checks. These soils show only a slight gain. With the exception of this unaccountable depression in the nitrate content on April 13, all treatments gave a gradual increase in nitrate content up to the last sampling on July 12.

The average nitrate production with the various treatments for the six determinations was 4.96 mgm. of nitrogen per 100 grams of soil for the sodium nitrate treatment; 4.68 mgm. for the leunasalpeter treatment; 4.37 mgm. for the urea treatment; 4.32 mgm. for the nitrophoska treatment; 3.95 mgm. for the ammonium sulfate treatment; and 3.20 mgm. for the checks. Based on these data, the nitrate of soda was superior to any of the other treatments, with leunasalpeter a close second, nitrophoska and urea about equal and ammonium sulfate least effective. However, it would seem that the data based on the increase due to the fertilizers are most accurate as a rating basis.

NITRIFICATION

The data secured in the determination of the nitrifying power of the soils are given in table II. At the first two samplings, three series of tests were run; (1) with soil alone, (2) with 30 mgm. of nitrogen as ammonium sulfate and (3) with 30 mgm. of nitrogen as ammonium sulfate plus 210 mgm. of lime. At the third sampling series (1) and (2) were used.

In the test using soil alone, the data secured at the first sampling showed the highest nitrifying power for the sodium nitrate treatment followed closely by the nitrophoska treatment. The ammonium sulfate treatment stimulated the nitrifying power the least. At both the June and July samplings, there was no regularity in the results using the soil alone. Possibly this was due to toxic effects from the nitrate accumulated or to nitrate assimilation.

As with the soil alone, the highest nitrifying power in the test

Table II — Nitrification Tests in Carrington Loam in Pots in the Greenhouse with Various Fertilizer Treatments

Pot No.	Mgm. Nitrogen Nitrified Per 100 Gm. Soil by Different Methods Used							
	April 7-25 Days Incubation			June 1-23 Days Incubation			July 13-21 Days Incubation	
	Soil Alone	$(NH_4)_2SO_4$	$(NH_4)_2SO_4 + CaCO_3$	Soil Alone	$(NH_4)_2SO_4$	$(NH_4)_2SO_4 + CaCO_3$	Soil Alone	$(NH_4)_2SO_4 + CaCO_3$
1	2.42	11.90	18.50	1.81	9.87	23.12	–0.60	19.75
2	2.09	10.20	19.00	3.20	5.33	13.88	1.22	18.69
3	1.00	13.20	16.50	6.41	2.97	----	0.67	19.45
4	0.73	7.30	20.30	–0.90	8.55	12.25	–0.65	21.25
5	0.40	15.50	18.90	1.80	10.86	18.50	1.19	20.11
6	1.45	13.80	19.50	2.42	6.58	17.63	–0.08	19.78
7	1.09	12.35	21.10	–1.22	6.58	9.43	0.74	19.06
8	1.98	12.60	11.80	0.00	8.94	15.79	0.40	18.31
9	2.14	9.60	7.90	–0.23	6.29	13.19	0.32	16.76
10	1.50	12.20	23.80	–0.56	----	9.04	–1.08	16.10
11	1.00	10.30	14.80	1.15	----	10.22	0.32	17.20
12	1.09	11.75	19.35	0.58	5.08	7.78	0.39	17.43

using ammonium sulfate was shown at the first sampling. There was no great difference between the effects of the various treatments. At the second sampling the soils showed a lower nitrifying power and wide variations among the duplicate soils but no significant difference between the various treatments.

With the ammonium sulfate and calcium carbonate method, the results secured at the first and third samplings were quite similar; and a slightly lower nitrifying power was found at the second sampling. However, there was no correlation between these results and the nitrate content of the soils. Except that the check soils showed the lowest nitrifying power at the second sampling, there was no indication that the various treatments or the nitrate content of the soils were correlated with the nitrifying power of the soils as tested with ammonium sulfate and lime.

These results indicate that the additions of the various fertilizers all increased the nitrate content of the soils. Sodium nitrate was superior in this respect to all the other fertilizers used.

The treatments also stimulated the nitrifying power of the soil, the sodium nitrate showing the greatest effect when the soil alone was used in the tests. When ammonium sulfate was used in the test, the various fertilizers all stimulated nitrification but there were no definite differences between the various materials. The results were very similar in the test where ammonium sulfate and calcium carbonate were employed. Apparently in the amounts used here all the fertilizers increased nitrification but the effects were very similar from the different materials.

IOWA STATE COLLEGE,
AMES, IOWA.