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NITRIFICATION PATTERN IN A LATERITE SOIL

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Abstract: An investigation was conducted at the College of Horticulture, Vellanikkara, Trichur during 1984-85 with typical laterite soil collected from Vellanikkara to study the nitrification pattern in the soil and to examine the effect of various factors on nitrification. The rate of nitrification in the soil was found to be naturally low. Attempts were made to locate the factors responsible for the low rate of nitrification. Factors like build up of ammoniacal nitrogen to values around 100 ppm, pH, organic matter content, cropping history, moisture level of incubation, source of fertiliser nitrogen and lack of microbial population were not indicated as responsible for the naturally low rate of nitrification.

INTRODUCTION

When amide and ammoniacal forms of fertilisers are applied to soil, it is converted to nitrate form by the action of nitrifying organisms. The process of nitrification is influenced by a host of factors. Hence, soils differ in their ability to nitrify added ammonium compounds even under similar conditions of temperature, moisture and level of added ammonium. An attempt was made to study the nitrification pattern in laterite soils of Kerala and the factors affecting it.

MATERIALS AND METHODS

The investigation was conducted at the College of Horticulture, Vellanikkara, Trichur during 1984-85 with typical laterite soil collected from Vellanikkara. Separate incubation studies were conducted to study the nitrification pattern in the soil and to examine the effect of various factors on nitrification.

Expt. No.1

The objective of this experiment was to study the nitrification pattern in the soil. Soil samples (1 kg) passing through 2 mm sieve were mixed with 100 ppm N supplied through urea. Appropriate quantity of distilled water was added to bring the moisture level to 65 per cent of field capacity. From this, 10 g soil was transferred to 250 ml conical flasks and the mouths of the flasks were plugged with cotton. Samples were drawn at five days intervals for one month and ammoniacal and nitrate nitrogen were determined by steam distillation method suggested by Bremner (1965).

Expt. No.2

This experiment was aimed at studying the effect of different doses of ammoniacal nitrogen on nitrification. Soil samples were incubated with urea to supply 10, 25, 50 and 75 ppm nitrogen and estimations of ammoniacal nitrogen were done 2, 5, 11, 18 and 21 days after incubation.

Expt. No. 3

The aim of this experiment was to study the effects of involvement of organic matter content of soil, cropping history and pH on nitrification. Soil samples were collected from an area which was comparatively low in organic matter content as well as from an area rich in organic matter and which was under an existing crop of rubber. Both these soils were incubated with and without lime after addition of 100 ppm nitrogen in the form of urea. Ammoniacal nitrogen contents were determined at five days intervals till 20th day after incubation.

Expt. No.4

The objective of this experiment was to study the effect of varying moisture levels on nitrification. Soil was incubated with 100 ppm nitrogen as urea at different moisture levels, namely 25, 50, 75 and 100 per cent of field capacity. Ammoniacal nitrogen contents were estimated, 1, 3, 4, 5, 6, 9 and 11 days after incubation.

Expt. No.5

This incubation study was carried out to find the effect of inhibiting materials like biuret contained in the urea fertiliser on nitrification. To assess this, separate incubation studies were conducted with addition of 100 ppm nitrogen supplied through urea and ammonium sulphate. Samples for estimations of ammoniacal nitrogen were drawn 1, 4, 7, 14 and 21 days after incubation.

Expt. No.6

The objective of this experiment was to study the effect of liming and inoculation with red (Alfisol) and black (Vertisol) soils on nitrification of urea added to laterite soil. The rates were compared with those of red and black soils collected from Coimbatore. Treatments were as follows (pH values of the respective treatments are given in brackets).

1 Laterite soil - unlimed (5.15)
2 Laterite soil - limed (6.35)
3 Red soil (7.5)
4 Black soil (7.9)
5 Laterite soil unlimed + red soil mixed in 9:1 ratio (5.5)
6 Laterite soil unlimed + black soil mixed in 9:1 ratio (5.55)
7 Laterite soil limed + red soil mixed in 9:1 ratio (6.4)
8 Laterite soil limed + black soil mixed in 9:1 ratio (6.55)

Treatments were replicated thrice. Estimations of ammoniacal nitrogen were carried out 5, 10, 15, 25 and 30 days after incubation.

RESULTS AND DISCUSSION

Results of the experiment to study the nitrification pattern in the soil are shown in Table 1. The data showed appearance of appreciable quantities of ammoniacal nitrogen from the amide form applied even at the very first sampling, five days after incubation, the quantity being 69.2 ppm. With advancing periods of incubation, there was a slight increase in the content. Even up to the last stage of estimation (30 days after incubation), there was no indication of any decrease in the ammoniacal nitrogen content. The content of nitrate nitrogen was comparatively low during the entire period of study. The conclusion from the substantial build up and maintenance of ammoniacal nitrogen up to the last stage and the lack of any substantial quantity of nitrate nitrogen in the soil is that the rate of nitrification in the soil was very low and that there were probably strong inhibiting factors for nitrification in the soil naturally. Selvaseelan (1981) and Thomas (1981) have reported low nitrification rate in laterite soils.

Subsequent experiments were to study the effects of various factors on nitrification.

Results of the experiment No.2 (Table 2) to study whether build up of large quantities of ammoniacal nitrogen consequent to the addition of urea at 100 ppm N was the factor for the noted

inhibition of nitrification revealed that once the hydrolysis was over, no appreciable change in ammoniacal nitrogen content occurred at any of the rates of N supply. The whole of added nitrogen remained mainly in the ammoniacal form itself even after 20 days of incubation. Hence, the quantity of fertiliser nitrogen added (up to 100 ppm nitrogen) did not appear to be a factor resulting in the low rate of nitrification. Stojanovi and Alexander (1958) have reported that the inhibition of nitrification occurs only when ammoniacal nitrogen content in the soil is 250 ppm or above; at rates lower than this, there was no depression of nitrate nitrogen formation.

Experiment No.3 was aimed at studying the mineralisation pattern of urea in soils collected from two locations and the effect of liming them to bring the pH to a favourable value of 6.2 to 6.7. The results (Table 3) showed that difference between soils was not appreciable. Also, liming led to no consistent effect. Hence, the conclusion was that pH, organic matter content and cropping history did not appear to be important factors deciding the rate of nitrification in the soil under study. This is in contrast to the observations of Alexander (1976) who reported that nitrification in acid soils is usually markedly enhanced by liming. Also, Stepanova (1961) observed that nitrification was greater under cultivated crops than under other crops and the dynamics of nitrate accumulation was affected by the preceding crop.

The main objective of experiment No.4 was to assess whether soil aeration was a limiting factor in nitrification at the level of moisture at which the soil samples were maintained (65 per cent field moisture capacity). The results (Table 4) showed that irrespective of the moisture contents at which soil samples were maintained, there was no indication of a decrease in ammoniacal nitrogen content after a peak which shows that further conversion of ammoniacal to nitrate form did not occur at any of the moisture contents. There are reports that nitrification rate is not much affected between moisture levels 0.1 bar tension to 7 bar (Tisdale and Nelson, 1975).

Experiment No. 5 was aimed at studying the effect of different sources of nitrogen, namely urea and ammonium sulphate on nitrification in the soil. Results (Table 5) showed that irrespective of whether the fertiliser was urea or ammonium sulphate, the rate of nitrification of added urea was quite low. As the contents of ammoniacal nitrogen were comparable in the soils treated with the two fertilisers and as the values remained nearly the same or were showing progressive increase with advancing stage, it was presumed that inhibitors in urea were not involved in the nitrification inhibition.

The results of the experiment to study the effect of liming and inoculation of laterite soil with soils having high nitrification rates, namely red and black soils of Coimbatore are given in Table 6. Appreciable decrease in ammoniacal nitrogen content of red and black soils was observed with advancing stages of estimation. But in laterite soil samples which were also set for incubation under the same conditions during the same period, the peak value of ammoniacal nitrogen content noted after five days of incubation remained nearly the same. Mixing the soil with red or black soil to supply inoculum of nitrifying organism that was probably lacking and liming to a favourable pH of 6.2 to 6.7 were not found to result in appreciably higher rate of nitrification in laterite soil.

Table 1. Mineralisation pattern of urea (contents of NH_4^+ - N and NO_3 - N ppm)

	Days after incubation				
	5	10	15	20	30
NH_4^+ - N	69.20	76.33	79.13	83.80	89.07
NO_3^- - N	1.87	6.60	7.80	8.53	6.07

(Means of three replications)

Table 2. Mineralisation pattern of urea applied at different doses (content of NH_4^+ - N ppm)

Amount of N added (ppm)	Days after incubation				
	2	5	11	18	21
10	28.62	31.80	33.39	30.21	33.39
25	46.11	46.13	49.29	41.34	59.59
50	58.83	68.37	69.96	65.19	71.92
75	58.83	85.86	98.58	96..32	96.58

Table 3. Mineralisation pattern of urea in soils collected from two locations and the effect of liming (content of NH_4^+ - N ppm)

Treatments	Days after incubation			
	5	10	15	20
Soil from crop museum				
Control - without lime	3.18	4.77	1.59	1.59
Control - with lime	1.59	3.18	1.59	2.90
Urea - unlimed	82.68	103.35	87.45	89.04
Urea - limed	98.58	98.58	93.81	93.81
Soil from rubber plantation				
Control - without lime	1.59	3.18	1.59	2.06
Control - with lime	6.36	6.36	5.20	1.59
Urea - unlimed	90.63	73.14	76.78	77.91
Urea - limed	82.68	90.60	80.60	95.70

Table 4. Mineralisation pattern of urea at varying moisture levels (content of NH_4^+ - N ppm)

Moisture level	Days after incubation						
	1	3	4	5	6	9	11
*25% FC	25.92	31.68	15.84	18.72	20.16	28.80	24.48
50% FC	27.54	32.13	26.01	26.01	30.60	45.90	47.43
75% FC	39.75	55.65	58.83	62.01	79.50	114.48	108.12
100% FC	47.18	94.36	102.78	99.42	90.99	97.73	102.78

*FC = Field capacity

Table 5. Mineralisation pattern of urea and ammonium sulphate (contens of NH_4^+ N ppm)

Treatments	Days after incubation				
	1	4	7	14	21
Urea	23.85	53.99	66.98	97.78	99.70
Ammonium sulphate	82.68	82.68	77.91	94.60	95.40

(Mean of two replications)

Table 6. Effect of liming and/or addition of red soil or black soil on the mineralisation pattern of urea in laterite soil (content of NH4 - N ppm)

Treatments	Days after incubation				
	5	10	15	25	30
1 (Laterite soil, unlimed)	127.20	118.30	121.10	119.00	116.20
2 (Laterite soil, limed)	121.80	115.50	118.30	119.00	118.30
3 (Red soil)	89.90	70.70	54.60	37.80	33.60
4 (Black soil)	98.00	72.80	43.40	26.60	16.10
5 (1+3 in 9:1 ratio)	124.60	119.70	124.60	119.00	126.00
6 (1+4 in 9:1 ratio)	119.70	114.80	117.60	120.40	114.80
7 (2+3 in 9:1 ratio)	120.40	115.50	116.90	110.60	95.20
8 (2+4 in 9:1 ratio)	116.20	113.40	107.80	100.80	92.40
CD (0.05)	8.16	7.61	11.27	8.54	24.82
SEm t	2.50	2.33	3.46	2.62	7.61

The results of the above incubation studies thus showed that laterite soil did not favour appreciable nitrification. The various factors like organic matter content, pH, cropping history, ammoniacal nitrogen build up to 100 ppm, supply of nitrifying population etc. did not appear affect nitrification in the soil substantially. It appears that it is probably a combination of few factors that can bring about an improvmement in the rate of nitrification in the laterite soil under study. Involvement of factors other than those included in this study also cannot be excluded.

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