

MINERALISATION PATTERN OF APPLIED UREA IN RICE SOILS

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Abstract: A laboratory incubation study was conducted to find out the pattern of transformation and mineralisation of applied urea under submerged condition in the three major rice soils of Kerala. The hydrolysis of urea to ammonium was influenced by the soil reaction and organic matter content. The formation of oxidised N products like nitrate and nitrite was meagre due to lack of adequate oxygen to carry out the process of nitrification. This avoided the chances of N loss through denitrification in the waterlogged rice soils.

INTRODUCTION

Urea, the high analysis N fertilizer is being increasingly used in the wetland rice production. The mineralisation pattern of applied urea significantly influences the fertilizer use efficiency. When highly water soluble non-polar urea is applied to soil, enzymatic hydrolysis converts it to ammonium; oxidation of ammonium leads to the formation of nitrate and nitrite and reduction of nitrate to nitrogenous gases under suitable conditions. Mohapatra *et al* (1983) reported that hydrolysis of urea was completed within two days of its application in flooded soil. Hydrolysis of urea is faster in soils having high pH and high organic matter (Sahrawat, 1980). Rapid hydrolysis of urea in flooded soil has been reported to increase the pH, bicarbonate and ammonium-nitrogen concentrations in flood water resulting in higher loss of N through volatilization. The present study was taken up with a view to determine the extent of mineralisation of urea in flooded rice soils with varying physico-chemical properties.

MATERIALS AND METHODS

The laboratory incubation study was conducted at the Regional Agricultural Research Station, Pattambi,

during 1988-'89 using three major rice soil types of Kerala viz., laterite, kari and poonthalpadam. Soil samples were collected from the surface (0- 15 cm) shortly before the study and were air dried and ground to pass through a 2 mm sieve. The physico-chemical properties of the soils (Table 1) showed wide variation in texture, pH, cation exchange capacity, organic carbon, total N and ammoniacal N.

The study was conducted in plastic containers of 18 litre capacity with a tap fitted at the bottom. The bottom layer was packed up with acid washed gravel and sand to a thickness of 5 cm. Afterwards 10 kg each of soil samples was transferred to these containers. The soils were kept under 5 cm submergence for two weeks. Two N doses viz., zero and 90 kg N/ha were superimposed over the soil types with three replications. Calculated quantity of urea was surface applied. Soil samples were drawn from each pot by the funnel method (Abichandani and Patnaik, 1957) and soil solutions were collected with the help of tap provided at the bottom of the container in alternate days up to 15 days and thereafter at 10 days interval up to 65 days after urea application. Samples were analysed for ammoniacal N (Jackson, 1958), nitrate N (Sims and Jackson, 1971) and nitrite N (Barnes and Folkard, 1951).

RESULTS AND DISCUSSION

Ammoniacal nitrogen content

There was wide variation between soils in the hydrolysis of urea as evidenced by the data on the concentration of the mineralised N products (Table 2). The data from the fertilized pots indicated that at 65 days after urea application poonthalpadam soil contained 81.4 ppm $\text{NH}_4\text{-N}$, whereas the contents in laterite and kari soils were 31.6 and 62.1 ppm respectively. This revealed that poonthalpadam soils with high pH and organic carbon content retained more $\text{NH}_4\text{-N}$ content in soil and soil solution than other soil types. Sahrawat (1980) reported that hydrolysis of urea is faster in soils having high pH and organic matter content. The $\text{NH}_4\text{-N}$ content in soil reached its peak five days after urea application, after which there was a gradual decrease. In the case of soil solution, the peak was attained nine days after application and decreased thereafter due to leaching and volatilization losses. According to Mohanty and Mandal (1989) rapid hydrolysis of urea might increase the pH and cause a higher N loss through volatilization. The mean contents of $\text{NH}_4\text{-N}$ in soil and soil solution were 51.8 and 4.01 ppm more in the fertilized treatment than in the unfertilized treatment, respectively.

Nitrate nitrogen content

The values of $\text{NO}_3\text{-N}$ content in soil was not appreciable and did not show significant variation between fertilized and non-fertilized treatments in different soil types under study at different periods after urea application. It gives an indication that the formation of oxidised N products was meagre due to the lack of adequate oxygen. However, $\text{NO}_3\text{-N}$

content in soil solution was significantly influenced by the soil types and varied considerably at different periods after urea application. Maximum content of $\text{NO}_3\text{-N}$ was observed in poonthalpadam soil whereas kari soil recorded the lowest value. The nitrification rate is very slow in soils with pH less than 5.0 and the rate increased with increase in soil pH from 5.0 to 10.0 (Mohanty and Mandal, 1989). Kari soil with low pH did not favour nitrate production. The nitrate ions that were formed in the soil were progressively leached down to the soil solution and the maximum concentration was recorded on the 35th day.

Nitrite nitrogen content

The analysis of both the soil and soil solution indicated the presence of $\text{NO}_2\text{-N}$ only in traces, irrespective of the application of urea or otherwise. The values ranged from 0.01 ppm for laterite soil to 0.05 ppm for kari soil.

Irrespective of the type of soil, addition of urea and period of observation, the production of $\text{NO}_3\text{-N}$ and $\text{NO}_2\text{-N}$ through the hydrolysis of urea was found to be negligible and was mostly in traces only. The substantial build up of $\text{NH}_4\text{-N}$ following the application of urea might have resulted in the inhibition of nitrifying organisms which has been reported to be a main cause for the lower nitrate and nitrite production in the soils of Kerala (Mathew, 1986) and also due to lack of adequate oxygen under waterlogged condition and absence of rice crop.

The study clearly indicated that the denitrification losses of applied urea is very meagre in the waterlogged rice soils of Kerala due to the very little formation of the oxidised N products. This agrees with the findings of Hulm and Killham (1988)

Table 1. Physico-chemical properties of the soil

	Soil types		
	Laterite	Kari	Poonthalpadam
Particle size distribution, %			
Coarse sand	46.84	49.64	24.46
Fine sand	27.84	16.62	25.10
Silt	fi.46	11.81	13.93
Clay	19.08	19.87	34.25
pH	5.17	3.61	7.74
CEC, me/100 g soil	6.34	9.96	18.13
Organic C, %	1.13	2.43	2.44
Total N, %	0.13	0.14	0.21
Ammoniacal N, ppm	5.78	6.28	8.92
Nitrate N, ppm	0.98	0.81	0.78

Table 2. Ammoniacal, nitrate and nitrite nitrogen of soil and soil solution at different period of incubation, ppm

	Soil			Soil solution		
	NH ₄ - N	NO ₃ - N	NO ₂ - N	NH ₄ - N	NO ₃ - N	NO ₂ - N
Soil type						
Laterite	36.7	1.28	0.01	1.33	0.79	0.01
Kari	34.2	1.62	0.05	7.35	0.18	0.00
Poonthalpadam	111.7	0.40	0.03	10.47	0.83	0.02
CD (0.05)	2.5	N.S.	0.01	0.47	0.03	0.003
N dose, kg/ha						
0	35.0	1.10	0.03	4.38	0.60	0.05
90	86.8	1.09	0.03	8.3.9	0.61	0.06
CD (0.05)	2.0	N.S.	N.S.	0.38	N.S.	0.002
Days after urea application						
3	61.3	1.30	0.04	5.88	0.74	0.04
5	78.0	1.14	0.08	7.48	0.59	0.04
7	71.1	1.18	0.04	7.64	0.48	0.05
9	68.9	1.11	0.04	8.87	0.62	0.06
11	64.3	1.02	0.02	5.11	0.71	0.06
13	67.4	1.02	0.02	8.57	0.81	0.05
15	72.1	1.09	0.02	7.30	0.82	0.06
25	63.1	0.97	0.02	3.74	0.82	0.06
35	53.5	0.62	0.01	4.69	0.87	0.06
45	44.4	0.59	0.02	5.40	0.33	0.06
55	45.2	1.70	0.02	5.11	0.23	0.06
65	41.3	1.35	0.02	3.81	0.18	0.05
CD (0.05)	5.0	N.S.	0.03	0.94	0.07	0.005

who reported that the total N loss through denitrification was not more than 0.05 per cent of added fertilizer N in waterlogged rice soils.

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