

TRANSFORMATION OF UREA UNDER SALINE CONDITION

J.P. SHARMA* AND R.P.S. CHAUHAN**

Department of Agricultural Chemistry and Soil Science
R.B.S. College, Bichpuri, Agra 283 105

ABSTRACT

An incubation study was carried out at 0, 50, 100, 150 and 200 ppm N applied to normal soil as well as saline soil of Agra region. Soil samples drawn at different intervals after incubation were analysed for urea -N, NO_2^- -N, NH_4^+ -N and NO_3^- -N. Salinity of soil delayed urea hydrolysis by two days as compared to normal soil and suppressed the nitrification rate but enhanced accumulation and persistence of nitrite in soil.

INTRODUCTION

Excessive salts in soil inhibit several microbial processes such as enzyme activity, mineralization and nitrification. The salt effect may modify the ionic concentration on the active sites of the enzyme protein and specific low toxicities cause nutritional imbalance for microbial growth and subsequent enzymes synthesis. Urea hydrolysis in soil is also an enzymatic process and is dependent on several factors among which salt concentration is most prominent one. Therefore, the present study was undertaken to determine the urea transformation in the saline soil.

MATERIAL AND METHODS

Normal and saline soils used in the present study were collected from the RBS College, Bichpuri farm from plough layer (0-15 cm). The physico chemical properties of these soils are presented in Table 1. One kg of each of the soil was treated

Table 1. Physico-chemical characteristics of the experimental soil

Characteristics	Soils	
	Normal	Saline
pH (1 : 2.5)	7.5	8.4
E _{Ce} (dSm ⁻¹)	1.0	7.6
CEC (mol (H) Kg ⁻¹)	13.5	14.0
Texture	SCL	SCL
Organic carbon (%)	0.26	0.12
ESP	11.1	14.3

Present address: *Division of Soil Science and Agricultural Chemistry, IARI, New Delhi-110012

**Department of Soil Science, N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U P.)

with 0, 50, 100, 150 and 200 ppm-N (applied as urea) and was incubated in 1.5 litre wide mouth plastic bottles for a period of 42 days after fertilizer application at $31 \pm 1^\circ\text{C}$. Moist wool was used to cover the mouth of each bottle to prevent the loss of moisture by evaporation and to allow free exchange of air from atmosphere. Sixty per cent of water holding capacity was maintained through out on weight loss basis. Samples from each bottles were drawn on 1, 2, 3, 4, 5, 6, 7, 8, 9, 14, 21, 28, 35 and 42 days after incubation for determining urea-N, $\text{NH}_4^+\text{-N}$, $\text{NO}_2^-\text{-N}$ and $\text{NO}_3^-\text{-N}$ content (ppm) by the methods as described by Bremner (1965).

RESULTS AND DISCUSSION

Effect of period of incubation and salinity

The data on the effect of period of incubation and soil salinity on changes in urea-N, $\text{NH}_4^+\text{-N}$, $\text{NO}_2^-\text{-N}$ and $\text{NO}_3^-\text{-N}$ are presented in Table 2. The entire quantity of urea applied got hydrolysed in normal soil within first five days after incubation and after that no urea-N was detectable irrespective of the nitrogen levels. In saline soil the hydrolysis of urea got delayed and it took seven days as against five days for normal soil. The percentage of urea hydrolysed by fifth day of incubation in normal and saline soils were 99.8 and 92.6, respectively. Thus hydrolysis of urea took place faster in normal than in saline soil. The maximum $\text{NH}_4^+\text{-N}$ content was obtained at 7th and 14th day after incubation in normal and saline soils respectively. The lowest values of $\text{NH}_4^+\text{-N}$ were observed at 42nd day in both the soils. The interaction between soil and time (S x I) was found to be significant. There was an enormous accumulation of $\text{NO}_2^-\text{-N}$ (44.3 ppm) in saline soil but $\text{NO}_2^-\text{-N}$ content in normal soil was of smaller magnitude. This shows that there can be sizeable accumulation of nitrite following urea application to a saline soil which may result in significant yield loss. $\text{NO}_2^-\text{-N}$ completely vanished after 28 days in case of normal soil but persisted upto 42 days in saline soil. The accumulation and large persistence of $\text{NO}_2^-\text{-N}$ in saline soil is likely due to high pH which might further accentuated by urea hydrolysis (Beri and Brar 1978, Christrenson et al 1979) and extreme salinity (Pal and Chhonkar 1979.) The decline in $\text{NO}_2^-\text{-N}$ is obviously due to its oxidation to $\text{NO}_3^-\text{-N}$ as is indicated by the data presented in Table 2 which further showed that the accumulation of $\text{NO}_3^-\text{-N}$ in normal and saline soil were 62.2 and 67.1 ppm respectively on 28th day after incubation. The normal soil exhibited higher values of $\text{NO}_3^-\text{-N}$ than saline soil throughout the experimental period.

Effect of soil salinity and N-levels

Urea was not detectable (Table 3) in control but treated soil urea concentration was found to be commensurate with the level of nitrogen application irrespective of the soil. The lower values of urea N in normal soil indicated its faster rate of hydrolysis. The highest concentration of urea-N was achieved at 200 ppm-N, in

Table 2. Effect of salt concentration and period of incubation on urea-N, NO_4^+ -N, NH_4^+ -N and NO_3^- -N content (ppm)

N-form	Soil	Incubation time in days										CD 5%	
		I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	I ₉			
Urea-N	Normal	50.2	36.8	25.2	11.9	5.8	O.O.	O.O.	O.O.	O.O.	O.O.	O.O.	I 0.7 S 0.4
	Saline	82.4	67.8	57.4	46.5	36.7	25.2	14.6	0.0	0.0	0.0	0.0	IxS 1.0
NH_4^+ -N	Normal	39.2	44.9	50.3	55.6	50.1	40.6	33.4	24.3	19.1	19.1	19.1	I 2.4 S 1.1
	Saline	33.8	38.0	43.4	46.2	49.3	36.6	26.8	20.1	15.1	15.1	15.1	IxS 3.4
NO_2^- -N	Normal	18.3	22.3	25.5	12.6	10.6	5.5	0.0	0.0	0.0	0.0	0.0	I 9.3 S 5.3
	Saline	21.3	27.4	30.9	35.9	33.9	29.2	24.4	16.3	8.7	8.7	8.7	IxS 13.1
NO_3^- -N	Normal	34.0	37.0	41.1	46.3	52.7	58.4	62.2	56.6	53.7	53.7	53.7	I 1.3 S 0.6
	Saline	30.2	34.1	37.9	41.8	47.5	44.4	57.1	51.6	42.6	42.6	42.6	IxS .8

Note : 1. Incubation period : I₁, I₂,.....,I₉=1, 2, 3, 4, 5, 6,.....,9 days for urea-N, whereas it was 1, 3, 5, 7, 14, 21, 28, 35, 42 days for NH_4^+ -N, NO_3^- -N and NO_2^- -N content.

both the soils. This observation is in accordance with the law of mass action which stated that rate of reaction is proportional to the concentration of substrate. Each successive addition resulted in significantly higher NH_4^+-N content over the preceding lower dose irrespective of the soil type. The higher values of NH_4^+-N in normal soil are confirmative of the faster rate of urea hydrolysis. The persistence of NO_2^--N was also observed from the Table 3. At lower level of urea application accumulation of NO_2^--N was lower as compared to highest N levels (Table 3). The alarmingly high NO_2^--N concentration at all levels of applied nitrogen was observed in saline soil.

Effect of incubation time and N-levels

The urea-N content increased linearly with the amount of nitrogen application (Table 4) irrespective of the soil type. As the incubation period increased, the urea-N content in both type of soil decreased. Upto 8th day of incubation no urea-N could be detected at any of the four levels. The concentration of ammoniacal-N increased upto first 14th days after incubation than gradually decreased with time. The highest NH_4^+-N content of 15.0, 35.9, 61.9, 70.7 and 76.0 ppm at 0, 50, 100, 150 and 200 ppm-N levels respectively, were recorded at 14 days of incubation after which the values dropped with time. As the time increased the values of NO_2^--N rose up significantly with nitrogen application upto 5th day of incubation and had declined thereafter. At lower level (50 ppm-N) NO_2^--N was not observed at 28th days after incubation, while at other levels it was observed at 35 days after incubation. The interaction effect between level and time in case of NO_2^--N was also significant. The concentration of NO_2^--N increased upto 28th day and declined thereafter irrespective of soil type. The highest value of NO_3^--N (85.7 ppm) was achieved with 200 ppm-N at 28th day of incubation. Correlation Table 3. Effect of salt concentration and N-levels on urea-N, NH_4^+-N , NO_2^--N and NO_3^--N content (ppm)

N form	Soil	N-levels (ppm)					CD	5%
		0	50	100	150	200		
Urea-N	Normal	0.0	10.8	20.9	31.4	43.3	S	6.4
							L	10.4
NH_4^+-N	Saline	0.0	26.7	52.6	71.6	86.6	SxL	14.2
	Normal	11.5	22.8	44.3	56.3	63.7	S	0.7
NO_2^--N	Saline	8.0	19.5	36.9	49.0	57.6	SxL	1.7
	Normal	0.0	6.2	11.2	20.9	28.4	S	1.2
NO_3^--N	Saline	0.0	17.1	23.2	36.6	41.8	SxL	2.6
	Normal	19.2	35.2	50.9	65.9	73.9	S	1.9
							L	3.0
	Saline	16.2	29.9	46.5	61.5	67.8	SxL	4.2

Table 4. Effect of incubation time and N-levels on urea-N, NH_4^+ -N, NO_2^- -N and NO_3^- -N content (ppm)

N form	N-levels (ppm.)	Period of incubation in days										CD, 5%		
		I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	I ₉				
Urea-N	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I	10.2
	50	24.2	21.4	18.9	12.8	8.7	6.0	3.0	3.0	3.0	0.0	0.0	L	9.1
	100	56.4	46.2	37.6	25.3	18.3	9.8	6.3	6.3	0.0	0.0	0.0	IxL	20.4
	150	83.5	60.7	49.3	33.1	25.6	13.1	9.3	9.3	0.0	0.0	0.0	I	5.2
	200	98.2	72.7	60.4	45.5	32.6	20.5	10.7	10.7	0.0	0.0	0.0	L	3.4
NH_4^+ -N	0	10.2	11.6	13.2	15.0	13.8	11.6	8.4	8.4	5.4	3.6	3.6	I	5.2
	50	18.8	22.1	33.3	35.9	34.8	16.1	13.2	13.2	7.2	5.4	5.4	L	11.7
	100	37.7	45.7	50.4	61.9	55.3	45.1	33.3	33.3	24.2	17.6	17.6	I	2.1
	150	55.0	60.0	64.8	70.7	69.2	56.1	43.0	43.0	30.5	24.1	24.1	L	2.0
	200	66.2	67.9	72.4	76.0	75.2	64.8	52.0	52.0	42.2	33.2	33.2	IxL	4.2
NO_2^- -N	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I	2.1
	50	9.8	12.3	16.6	14.2	10.4	6.6	3.0	3.0	0.0	0.0	0.0	L	2.0
	100	13.3	17.1	19.3	22.1	18.2	12.2	8.2	8.2	5.8	3.1	3.1	I	3.6
	150	26.7	32.4	34.2	31.2	25.4	22.1	17.1	17.1	12.6	5.6	5.6	L	2.7
	200	29.2	37.5	41.2	40.8	33.1	23.4	20.0	20.0	14.1	7.0	7.0	IxL	8.5
NO_3^- -N	0	8.4	10.3	12.4	15.7	18.8	20.5	22.0	22.0	20.2	14.2	14.2	I	3.6
	50	16.3	18.3	23.7	30.1	38.2	42.1	43.8	43.8	43.3	39.4	39.4	L	2.7
	100	31.4	35.1	39.2	45.3	53.3	60.0	67.5	67.5	57.3	49.2	49.2	I	3.6
	150	42.1	52.2	58.3	62.7	63.7	72.3	79.6	79.6	68.8	64.3	64.3	L	2.7
	200	57.3	61.2	63.9	65.9	67.7	80.2	85.7	85.7	76.6	72.3	72.3	IxL	8.5

between NO_2 -N accumulation and high pH, salinity, sodium sulphate, sodium chloride and calcium chloride are also reported by Pal and Chhonkar (1979).

The studies showed that in saline soils urea hydrolysis was retarded by 2 days and resulted in nitrite accumulation. It necessitates suitable management practices while using urea in saline soils, to avoid ammonia volatilisation due to prolonged hydrolysis.

REFERENCES

- Beri, V. and Brar, S. S. 1978. Urea activity in subtropical alkali soils of India. *Soil Science* 126 : 330
- Bremner, J. M. 1965. *Methods of soil analysis* Vol. 2. Ed. C. A. Black, American Society of Agronomy, Medison, Wisconsin, U.S.A.
- Christrenson, G. B., Heldon, R. B. and Cho, C. M. 1979. Loss of N from soil during nitrification of urea. *Canadian Journal of Soil Science* 59 : 147
- Pal, S. and Chhonkar, P. K. 1979. Thermal sensitivity and kinetic properties of soil urease. *Journal of the Indian Society of Soil Science* 27 : 243