Journal of Crop and Weed 7(2): 220- 223(2011)

Influence of maize cropping and levels of ammonium sulphate on different forms of inorganic N in an alluvial soil

S. P. VISTA, G. TAMANG AND D. SAHA

Department of Agricultural Chemistry and Soil Science, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal

Received:16.03.2011, Revised: 18.10.2011, Accepted : 15.11.2011

Key words: Ammonium sulphate, inorganic N, maize crop

Nitrogen is one of the major nutrients required by plants for growth and metabolic activities. The efficient utilization of N from native or applied sources depends on the clear understanding of N-transformation processes in soil. Nitrogen transformation processes may progress simultaneously and they interact in several ways in soil. Presence of plant changes the microenvironment in the soil. When the plants are growing, during respiration the roots are excreting exudates which are beneficial for microbial growth and their activities. This increased population of microbes due to the presence of crop, will promote mineralization of organic nitrogen present in the soil (Pal et al., 1986). With the age of crop, the uptake of nitrogen from the soil increases up to reproductive phase and then shows a decreasing trend. At reproductive phase extensive internal mobilization of nitrogen occurs from vegetative parts to fruits and seeds till the crop are harvested at maturity. A considerable variation occurs between and within plant species in pattern of uptake, assimilation and distribution of N within plants of different types and age. The present investigation was, therefore, conducted to study the influence of cropping on different fractions of inorganic N in soil at different growth stages of maize crop. This study was carried out in presence and absence of N in alluvial soil of West Bengal, India to make a relationship between the release patterns of different fractions of inorganic N from the soil at different growth stages of maize crop.

A green house experiment was conducted to study the effect of cropping and N fertilization on changes in different fractions of inorganic N in soil cropped with maize plant. Composite soil sample (Haplaquents, USDA, 1975, as shown in table- 1) collected from Chakdah, Nadia, West Bengal was used where 2 kg air-dried soil in each earthen pot was taken and 2 seeds of maize (var. A-de Cuba) were sown in each pot. Phosphorus and potassium were applied at 50kg P_2O_5 and 50kg K_2O ha^{-1} in the form of single super phosphate and murate of potash respectively to each pot as basal application. Altogether two sets were maintained for cropped and uncropped situation. All the treatments are replicated thrice. Three doses of inorganic N were applied viz., zero dose, 70mg N kg^{-1} and 100mg N kg^{-1} as basal application through ammonium sulphate. Soil samples were collected from both the uncropped and cropped pots on the 0^{th}, 30^{th}, 60^{th}, and 90^{th} day of the experiment and the soil were analysed periodically for exchangeable NH^+_4 and soluble NO^-_3 in soil (Bremner and Keeney, 1966)). Some of the relevant physical and chemical characteristics of the alluvial soil used for the investigation are presented in table- 1.

The results of the effect of cropping on changes in the amount of different forms of inorganic N in an alluvial soil at different growth stages of maize are presented in Tables 2 to 4. Perusal of the data (Table 2) reveals that irrespective of cropping and N-fertilization, the amount of exchangeable NH^+_4 decreased with increase in the period of investigation. Of the added inorganic N about 60 and 86 per cent were recovered as exchangeable NH^+_4 respectively in soils treated with 70 and 100 mg N kg^{-1} on 0-day. The decrease in exchangeable NH^+_4 with time is due to loss of nitrogen through volatilization as well as through denitrificaiton processes (Freny and Black, 1987; Groffman *et al.*, 1987).

The decrease in exchangeable NH^+_4 with the period of investigation is more in soils treated with higher dose of inorganic fertilizer N. The results (Table 2) further pointed out that irrespective of N-fertilization, at earlier stage of the experiment; the amount of exchangeable NH^+_4 is of lower order in soil cropped with maize than the uncropped system. This is due to utilization of a little amount of NH^+_4 from the soil by maize crop. However, at the later stage of investigation comparatively higher amount of exchangeable NH^+_4 was recorded in soils cropped with maize over the uncropped system. With time, the growth of roots of plants increases and liberation of higher amount of root exudates (Arshad and Frankenbergs, 1998) activates the activities and proliferation of microorganisms, which in turn promote the N-mineralization process of organic matter present in soil showing a net increase in exchangeable NH^+_4 in cropped systems.

Email: prasadvista@rediffmail.com

Table 1: Physical and Chemical Properties of the soils used for the investigation

	Soil Properties	Alluvial soil	Method adopted
1.	pH (1:2.5)	7.15	Glass electrode pH meter
2.	Mechanical separates		Hydrometer method
	Sand (%)	21.90	
	Silt (%)	34.00	
	Clay (%)	44.00	
3.	Textural class	Clay	
4.	EC (dsm^{-1})	0.35	Conductivity meter
5.	Water holding capacity (%)	49.53	Keen Rackzowski method (Piper, 1942)
6.	Oxidisable Organic carbon (%)	1.27	Walkley and Black (1934)
7.	Cation Exchange Capacity (cmol (P^+) kg^{-1})	2.448	Schollen berger and Simon (1945)
8.	Exchangeable NH^+_4-N (mg kg^{-1})	50.54	Bremner and Keeney (1996)
9.	Soluble NO^-_3-N (mg kg^{-1})	23.94	"
10.	Available N	74.48	"
11.	Bulk density (g cc^{-1})	1.21	Keen Rackzew
12.	P.D. (g cc^{-1})	2.3	Ski method (Piper, 1942)
13.	Pore space (%)	54.29	"
14.	Available K_2O(kg ha^{-1})	335.5	Jackson (1973)
15.	Available P_2O_5 (kg ha^{-1})	68.7	Jackson (1973)
16.	Fixed NH^+_4-N (mg kg^{-1})	806.4	Silva and Bremner (1996)
17.	Exchangeable Ca (mol kg^{-1})	13.05	Sparks *et al.* (1996)
18.	Total N (mg kg^{-1})	1694.4	Bremner (1996)
21.	C:N ratio	7.49 : 1	
22.	Nomenclature	Haplaquents	USDA (1975)

Changes in the amount of soluble NO^-_3-N in soil in presence and absence of cropping and N-fertilization are presented in Table 3. Perusal of the data reveals that irrespective of cropping and N-fertilization, the amount of soluble NO^-_3-N decreased sharply up to 30 day and then showed an increasing trend up to last stage of the experiment. The loss in NO^-_3-N at earlier stage of the investigation is due to loss of N through denitrification (Groffman et al., 1987). The loss of NO^-_3-N through denitrification process is of higher order in soil fertilized with higher dose of inorganic N. Present results find support of earlier investigation of Saha (2001). In general, comparatively lower amount of soluble NO^-_3-N was recorded in the cropped over the uncropped system up to 30 day of the experiment due to utilization of higher amount of NO^-_3-N by the maize crops. With increase in the period of investigation, irrespective of cropping and N-fertilization, the amount of soluble NO^-_3-N showed an increasing trend up to final stage of the investigation. The increase in soluble NO^-_3-N in soil is more pronounced at the later stage of the experiment. Again, the amount of increase in the amount of soluble NO^-_3 is more in cropped over the uncropped system.

The increase in soluble NO^-_3-N content with the advancement of time is due to production of NO^-_3-N in soil through nitrification which corroborates the findings of the decrease in the amount of exchangeable NH^+_4 presented in Table 2. Comparatively higher amount of soluble NO^-_3-N was recorded in cropped over the uncropped soil. The higher amount of decrease in exchangeable NH^+_4 and concomitant increase in soluble NO^-_3 in cropped over, the uncropped system pointed out that both the ammonification and nitrification processes are in operation during the growing period of maize crop.

Data in table-4 reveal that irrespective of cropping and N-fertilization, the amount of available N decreased with increase in the period of investigation. The decrease is more pronounced in the inorganic N added systems. Furthermore, the amount of decrease of available N is comparatively more in soil cropped with maize than the uncropped system. This observation is true for both the untreated and N-treated systems. However, irrespective of stages of sampling, comparatively higher amount of available N is accumulated in cropped over the uncropped system. This result is found in both in presence and absence of inorganic N. Presence of maize crop changes the micro-environment in soil particularly with respect to microbial population (Saha *et al.*, 1982). The congenial atmosphere created in the rhizosphere soil of maize due to secretion of root exudates (Arshad and Frankenberger, 1996) promotes the proliferation and activities of ammonifying and nitrifying organisms (Pate and Farquhar, 1987) which ultimately increased the available N content in cropped over the uncropped systems

Table 2: Effect of cropping and inorganic N on changes in the amount (mg kg^{-1}) of exchangeable NH^{+}_{4} in an alluvial soil

Cropping	N-Fertilization	Days after sowing 0	30		60		90	
			X	Y	X	Y	X	Y
	N0	53.97	57.50	+3.53	42.13	-11.84	39.63	-14.34
	N70	96.93	67.1	-29.83	41.67	-55.26	39.04	-57.89
Without	effect of N (+/-)	+42.96		+9.6		-0.46		-0.59
	N100	140.1	91.59	-48.51	61.99	-78.11	45.21	-94.89
	Effect of N (+/-)	+86.13		+34.09		+19.86		+5.58
	N0	53.97	56.70	+3.73	48.79	-5.18	42.93	-11.04
	N70	96.93	67.20	-29.73	63.00	-33.93	43.43	-53.5
With	effect of N (+/-)	+42.96		+10.5		+14.21		+0.5
	N100	140.1	90.90	-49.2	65.55	-74.55	46.92	-93.18
	Effect of N (+/-)	+86.13		+34.2		+16.76		+3.99
	N	NS	18.07		NS		NS	
LSD	C	NS	NS		NS		NS	
(0.05)	N x C	NS	NS		NS		NS	

Note: N0 = Zero dose of N, N70 = N added at 70ppm, N100 = N added at 100ppm, X = Amount in mg kg^{-1}, Y = Increase (+)/decrease (-) over zero day, N = Doses of nitrogen, C = Cropping, NS = Non significant

Table 3: Effect of cropping and inorganic N on changes in the amount (mg kg^{-1}) of soluble NO^{-}_{3} in an alluvial soil

Cropping	N-Fertilization	Days after sowing 0	30		60		90	
			X	Y	X	Y	X	Y
	N0	70.49	25.69	-44.8	36.21	-34.28	38.62	-31.87
	N70	72.33	39.64	-32.69	45.79	-26.54	45.21	-27.12
Without	effect of N (+/-)	+1.84	+13.95		+9.58		+6.59	
	N100	80.38	31.95	-48.43	42.68	-37.7	49.32	-31.06
	Effect of N (+/-)	+9.89	+6.26		+6.47		+10.7	
	N0	70.49	33.60	-36.89	47.76	-22.73	51.91	-18.58
	N70	72.33	38.85	-33.48	38.11	-34.22	52.91	-19.42
With	effect of N (+/-)	+1.84	+5.25		-9.65		+1	
	N100	80.38	38.35	-42.03	41.67	-38.71	59.85	-20.53
	Effect of N (+/-)	+9.89	+4.75		-6.09		+7.94	
	N	NS	8.11		NS		NS	
LSD	C	NS	NS		NS		NS	
(0.05)	N x C	NS	NS		NS		NS	

Irrespective of cropping and N fertilization, the amount of exchangeable NH^{+}_{4} in alluvial soil decreased with increase in the period of investigation. The exchangeable NH^{+}_{4} is of lower order in soil cropped with maize than the uncropped system. Irrespective of cropping and N fertilization, the amount of soluble NO^{-}_{3}-N decreased sharply up to 30 day and then showed an increasing trend up to the last stage of the experiment. In general, comparatively lower amount of solube NO^{-}_{3}-N was recorded in the cropped over the uncropped system up to 30th day of the experiment due to utilisation of higher amount of NO^{-}_{3}-N by the maize crop. Irrespective of cropping and N fertilization, the amount of available N decreased with increase in the period of investigation. The decrease is more pronounced in the inorganic N added systems. Again, the amount of decrease of available N is comparatively more in soil cropped with maize than the uncropped system.

Table 4: Effect of cropping and inorganic N on changes in the amount (mg kg^{-1}) of available N in an alluvial soil

Cropping	N-Fertilization	Days after sowing						
		0	30		60		90	
			X	Y	X	Y	X	Y
	N0	124.46	83.19	-41.27	78.34	-46.12	78.25	-46.21
	N70	169.26	106.74	-62.52	87.46	-81.796	84.25	-85.006
Without	effect of N (+/-)	+44.8	+23.55		+17.12		+6	
	N100	220.48	123.54	-96.94	104.67	-115.81	94.53	-125.95
	Effect of N (+/-)	+96.02	+40.35		+26.33		+16.28	
	N0	124.46	90.30	-34.16	96.55	-27.91	94.84	-29.62
	N70	169.26	106.05	-63.21	101.11	-68.15	96.34	-72.919
With	effect of N (+/-)	+44.8	+15.75		+4.56		+1.5	
	N100	220.48	129.25	-91.23	107.22	-113.26	106.77	-113.71
	Effect of N (+/-)	+96.02	+38.95		+10.67		+11.93	
	N	71.62	23.22		NS		NS	
LSD	C	NS	NS		NS		13.73	
(0.05)	N x C	NS	NS		NS		NS	

REFERENCES

Arshad, M. and Frankenberger, W. T. J.1998. Plant growth regulating substances in the rhizosphere : microbial production and functions, *Adv. Agron.*, **62**: 45-51.

Bremner, J. M. 1996. Nitrogen total. *In: Methods of Soil Analysis* (Eds.), part 3 Soil Science Society of America Inc. and American Society of Agronomy Inc, Madison, Wisconsin, USA, pp. 1085-21.

Bremner, J. M. and Keeny, D. R. 1966. Determination of exchangeable ammonium nitrate and nitrite by extraction distillation methods. *Soils Sci. Soc. America Proc.*, **30**: 577-87.

Freny. J. R. and Black, A. S. 1987. Importance of ammonia volatilisasion as a loss process. *In : Advances in Nitrogen Cycling in Agricultural Ecosystem* (Ed. Wilson, J. R.), CAB International Wellington , UK, pp. 156-73.

Groffman, P.H., Tiedje, J.M., Robertson, G.P. and Christensen, S. 1987. Denitrification at different temporal and geographical scale : proximal and dismal control. *In: Advances in Nitrogen Cycling in Agricultural Ecosystem* (Ed. Wilson, J. R.), CAB International Wellington, UK, pp. 174-92.

Jackson, M. L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Keeney, D. R. and Bremner, J. M. 1966. Characterisation of mineralizable nitrogen in soils. *Soils Sci. Soc. America Proc.*, **30**: 714-19.

Pal, S. K., Saha, D. and Mukhopadhyay, A. K. 1986. Influence of cropping and N-fertilization on inorganic and organic nitrogen changes in an alluvial soil. *Pl. and Soil*, **101**: 137-39.

Pate, J.S. and Farquhar, G.D. 1987. Role of the crop plant is cycling of nitrogen, *In: Advances in Nitrogen Cycling in Agricultural Ecosystem* (Ed. Wilson, J. R.), CAB International Wellington, UK, pp. 23-45.

Piper, C. S. 1942. *Soil and Plant Analysis*. University of South Australia.

Saha, D. 1999. N-transformation in a cropped and uncropped soil as influenced by nitrogen fertilization and temperature regimes, *Indian Agril.*, **43**: 71-78.

Saha, D. 2001. Soluble NO3—N accumulation in soils under different moisture regimes in presence and absence of different amendments. *J. Interacad.*, **5**: 330-39.

USDA. 1975. *Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Survey*. Agriculture Handbook, US Government Printing Office, Washington DC, USA, pp. 436.