Plant Archives Vol. 20 Supplement 1, 2020 pp. 2945-2948 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

IMPACT OF INTEGRATED NUTRIENT MANAGEMENT PRACTICES ON DISTRIBUTION OF NITROGEN FRACTIONS AND NITROGEN USE EFFICIENCY BY MAIZE CROP IN SOIL

S. Krishnaprabu

Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar-608 002 (Tamil Nadu) India.

Abstract

A field study was carried out at Experimental Farm, Annamalai University during 2016 to study the effect of integrated nutrient management practices on distribution of nitrogen fractions in soil. There were two levels of nitrogen applied through organics (FYM and vermicompost) and in-organics involving nine treatments combinations were tried in a RCBD with three replications. Significantly lower available nitrogen status was recorded in the treatments which received nitrogen only through fertilizers and without any organic matter application (196.00-200.50 kg ha^{-1}) including absolute control Compared to all other treatments (238.00-243.60 kg ha^{-1}). Except inorganic nitrogen fractions, organic nitrogen fractions were recorded high in integrated treatments compared to the treatment which received nitrogen only in the form of fertilizers. An agronomic nitrogen use efficiency was found highest (73.00) in the treatments involving package of practices compared to other treatments. However, nitrogen use efficiency was found to be more at lower level of nitrogen application and also in the integrated treatments compared to the treatments which received only NPK fertilizers.

Key words: Integrated nutrient management, inorganics, maize, organic matter, Vermicompost and Nitrogen use efficiency.

Introdcution

Maize has high genetic yield potential than other cereal crops. Hence it is called as 'miracle crop' and also as 'queen of cereals'. Being a C_4 plant, it is very efficient in converting solar energy in to dry matter. As heavy feeder of nutrients, maize productivity is largely dependent on nutrient management. Transformation of added nitrogen through fertilizers or manures into different forms of nitrogen in soil and their availability to crops depends on soil properties and nature of nitrogen sources added to soils. According to the research reports, more than 90 per cent of nitrogen in the soil is present in organic form and concentrations of inorganic form *viz*., nitrate nitrogen and ammonical nitrogen in soil at any given time is influenced by several soil factors. But, very little information is available with respect to the effect of integrated nutrient management practices on distribution of different forms of nitrogen in soils. The knowledge of distribution of various forms of nitrogen in soil attains greater importance in understanding the potential of a soil in supplying them to the crops and also to understand the nitrogen use efficiency by crops. Hence, it becomes an essential part of nitrogen management during the process of crop production.

***Author for correspondence :** E-mail: prabu1977krishna@gmail.com

Materials and Methods

The experiment was conducted at Experimental Farm, Annamalai University during 2016 to study effect of INM on distribution of nitrogen fractions in The experiment was laid out in randomized complete block design with three replications and nine treatments (Table 2).

Nitrogen use efficiency (NUE)

The agronomic nitrogen use efficiency (ANUE), physiological nitrogen use efficiency (PNUE), apparent recovery of applied nitrogen (ARN) and partial factor productivity for applied nitrogen (PFP_N) were calculated using the following equations (Cassman *et al.,* 1998).

Results and Discussion

Inorganic N fractions

The results presented indicate that exchangeable NH/-N

Table 1: Physical and chemical properties of the representative soil of the experimental site

Properties	Values
Soil taxonomy	Typic Haplustalf
Sand (%)	71.78
Silt (%)	11.89
Clay (%)	16.33
Textural class of soil	Sandy Loam
Soil pH	5.10
Organic carbon (%)	0.33
Available macronutrient status	
Nitrogen (kg ha^{-1})	197.20
Phosphorus (kg P_20_5 ha^{-1})	52.80
Potassium (kg K_zO ha^1)	182.40

fraction in soil was significantly higher (14.00 mg kg^{-1}) in treatment T_5 (150% N + 7.5 t ha^{-1} FYM), followed by the treatment T_4 (100% N + 7.5 t ha^{-1} FYM) which recorded the NH_4^+-Nof 13.80 mg kg^{-1}. This could be attributed due to the increased rate of mineralization of organic matter in the soil which was enhanced by the addition of organic manures (FYM or vermicompost) and hence caused a build up of NH_4^+-Nin soil. Similarly, Yadav and Singh, (1991) reported that increasing rates of NPK application had a favorable influence on exchangeable NH_4^+-Nin soil. In the treatments where nitrogen applied only through fertilizers, exchangeable NH_4^+-Ncontents was low probably because of leaching loss (Duraisami *et al.,* 2001). A positive effect of 50 percent and 75 percent N substitution through FYM or vermicompost was observed in terms of improved NH_4^+-Ncontents of

Table 2: Effect of integrated nutrient management practices on available nitrogen status in soil at different growth stages of maize.

T_1- Absolute Control	196.14	180.20	176.00
T_2 - 100% N through fertilizer	249.24	210.00	196.00
T_3 - 150% N through fertilizer	266.30	216.00	200.50
T_4 - 100% N + 7.5t ha^{-1} FYM	306.00	282.00	240.80
T_5 - 150% N + 7.5t ha^{-1} FYM	305.20	280.00	238.00
T_6 - 100% N (50%N through fertilizer + 50%N through FYM)	288.20	276.00	241.20
T_7 - 150% N (75%N through fertilizer + 75%N through FYM)	290.33	278.00	243.60
T_8 - 100% N (50%N through fertilizer + 50%N through vermicompost)	286.20	275.80	239.20
T_g - 150 % N (75%N through fertilizer + 75%N through vermicompost)	290.00	278.96	242.90
S.Em±	2.96	4.45	3.46
CD at 5%	8.87	13.35	10.38

DAS - Days after sowing

Note : 100% P & K applied to all treatments except absolute control.

the soil due slow release In this study NO^-_3-N recorded significantly higher in the treatment T_5 (150% N + 7.5 t ha^{-1} FYM) which recorded NO_3 N of 8.80 mg kg^{-1}, followed by T_4 (100% N + 7.5 t ha^{-1} FYM). This could be attributed to increased microbial activity increase in soil pH might have enhanced nitrification process with a reduction in leaching losses (Udaysoorian *et al.,* 1989; Benbe *et al.,* 1991). In case of only fertilizer treated plots without organics, the conversion of NH_4^+-N to NO^-_3-N was rapid as reported by Udaysoorian *et al.,* (1989) and Benbe *et al.,* (1991) and this might have resulted in more leaching loss of NO^-_3-N.

Organic N fractions

Among the organic N- fraction, amino acid -N was the most dominant fraction (30.74 -36.03% of total N) followed by Treatments Available nitrogen (kg ha^{-1}) 30 DAS 60 DAS Harvest hydrolysable NH_4^+-N(24.75-27.03% of total N) and hexosamine -N (5.71-8.62 % of total N). This indicates that total hydrolysable -N contributed more to the total -N compared to other fractions, thus indicating the existence of major portion of N in the organic form (Tisdale *et al.,* 1985). The application of NPK along with either FYM or vermicompost favoured immobilization of N in different hydrolysable fractions and also improved the level of organic nitrogen. The accumulation of slightly higher amounts of N as hydrolysable and non-hydrolysable in INM treatments was observed. This could be due to higher biomass production and predominance of cereal crops which will return lot of roots and stubbles to the soil (Subba Rao and Ghosh, 1981).

-* ■ 30 DAS -B- 60 DAS A Harvest

Similarly, Duraiswamy, (1992) reported that increased amounts of organic N fractions under FYM and vermicompost plus fertilizers treatments would indicate that the added forms of inorganic and organic N undergo series of transformation processes and thereby contributing to each pool of organic N formed in soil. A study conducted by SubbaRao and Ghosh, (1981) revealed that there existed a metastable equilibrium between immobilization and mineralization processes going on individual fractions with a clear and perceptible shift towards greater immobilization and consequent accu-mulation of nitrogen in organic forms.

Effect of integrated nutrient management practices on nitrogen use efficiency by maize crop

Data presented (Table 4) reveals that agronomic nitrogen use efficiency (ANUE), physiological nitrogen use efficiency (PNUE), Apparent recovery of applied nitrogen (AR) and partial factor productivity for applied

Table 3: Effect of integrated nutrient management practices on distribution of different nitrogen fractions in soil at harvest stage of maize (mg kg $^{-1}$).

Treatments	NO_3-N	Exch. NH_4^+-N	Hydrolysable Nitrogen					NHN	Total Nitrogen
			HAN	HSN	AAN	UHN	THN		
T_1 - Absolute Control	4.80 (1.44)	8.20 (2.47)	90.00 (27.03)	19.00 (5.71)	120.00 (36.03)	63.60 (19.09)	292.60	27.40 (8.23)	333.00
T_2 - 100% N through fertilizer	6.20 (1.83)	10.60 (3.11)	90.00 (26.44)	19.60 (5.76)	120.60 (35.42)	62.80 (18.45)	293.00	30.60 (8.99)	340.40
T_3 - 150% N through fertilizer	8.00 (2.33)	10.80 (3.14)	91.60 (26.71)	19.80 (5.78)	120.80 (35.21)	61.60 (17.96)	293.80	30.40 (8.87)	343.00
T_4 - 100% N+ 7.5t ha^{-1} FYM	8.40 (2.12)	13.80 (3.48)	98.00 (24.75)	26.00 (6.57)	131.60 (33.23)	64.80 (16.36)	320.40	53.40 (13.49)	396.00
T_5 - 150% N + 7.5t ha^{-1}FYM	8.80 (2.22)	14.00 (3.53)	98.80 (24.90)	28.00 (7.05)	132.00 (33.27)	62.80 (15.83)	321.60	52.40 (13.20)	396.80
T_6 - 100% N (50%N through fertilizer + 50% N through FYM)	6.80 (1.67)	11.40 (2.69)	111.60 (26.44)	35.80 (8.48)	129.80 (30.74)	70.80 (16.76)	348.00	55.80 (13.22)	422.00
T_7 - 150% N (75%N through fertilizer + 75% N through FYM)	7.20 (1.62)	12.80 (3.00)	112.00 (26.18)	36.00 (8.43)	132.60 (30.99)	71.40 (16.69)	352.00	56.00 (13.09)	428.00
T_8 - 100% N (50% N through fertilizer + 50%N through vermicompost)	7.00 (1.69)	11.00 (2.60)	110.80 (26.26)	35.20 (8.34)	130.00 (30.82)	71.80 (17.02)	347.80	56.00 (13.27)	421.80
T_9 - 150 % N (75% N through fertilizer + 75% N through vermicompost)	7.60 (1.67)	12.60 (2.95)	110.90 (25.82)	37.00 (8.62)	132.80 (30.91)	72.30 (16.85)	353.00	56.60 (13.18)	429.80
S.Em±	0.45	0.51	1.36	1.06	1.77	0.86	12.26	2.24	1.18
CD at 5%	1.37	1.53	4.09	3.20	5.33	2.59	36.76	6.73	3.54

Note: 100% P & K applied to all treatments except absolute control. Total N = ($N0_3$-N + Exch. NH_4^+-N + THN + NHN), Figures in parenthesis indicate percentage distribution of nitrogen fractions, HAN - Hydrolysable Ammonical Nitrogen, AAN - Amino acid Nitrogen THN -Total Hydrolysable Nitrogen, HSN - Hexosamine Nitrogen, UHN - Unidentified Hydrolysable Nitrogen, NHN - Non Hydrolyable Nitrogen.

N of maize were significantly higher in the treatment T_4 (100% N + 7.5 t ha^{-1} FYM) compared to other treatments. Further integrated treatments (T_6, T_7, T,, and T_9) recorded better nitrogen use efficiency over control and treatments which received only fertilizers without any organic manure. This may be due to favorable influence of soil moisture coupled with adequate nutrient supply during crop growth. The maximum nitrogen 65 Green Farming use efficiency seemed to have been registered in the treatment T,, (100% N + 7.51 ha^{-1} FYM) in all the parameters studied. On the whole it can be concluded that blending of 50 and 75 percent N fertilizer integrating with 50 and 75 percent N through organic manures had the potential to substitute recommend fertilizer N and is likely that N losses due to leaching, de-nitrification might have reduced due to blending of N fertilizer with manures resulting in improved N use efficiency and long term release of nutrients from manures (Table 4). This premise is supported by the fact of N contents in stover and grain and total N uptake by maize. These results are in line with the findings of (Wolkowski, 2003; Rizwan Ahmad *et al.,* 2006 and Moll *et al*., 1982).

Table 4: Effect of integrated nutrient management practices on nitrogen use efficiency of maize.

Treatments	ANUE	PNUE	AR	PFPN
T_1	0.00	141.52	0.00	0.00
T_2	36.00	111.14	36.53	58.00
T_3	26.73	108.72	27.56	41.33
T_4	73.00	83.34	98.24	95.00
T_5	46.50	81.52	64.57	61.11
T_6	67.00	83.33	91.24	89.00
T_7	45.90	83.33	62.16	60.44
T_8	65.56	83.34	89.47	84.56
T_9	44.86	81.96	62.22	59.51
S.Em±	3.11	0.74	3.50	3.23
CD at 5%	9.33	2.23	10.51	9.71

Note : 100% P & K applied to all treatments except absolute control. ANUE - Agronomic Nitrogen Use Efficiency, PNUE - Physiological Nitrogen Use Efficiency, AR - Apparent recovery of applied N, PFPN - Partial Factor Productivity for applied N.

References

Benbe, D.K., C.R. Biswas and J.S. Kalkai (1991). Nitrate distribution and acccumualtion in an ustochrept soil profile in a long term fertilizer experiment. *Fertl. Res.*, **28:** 173-177.

Bharadwaj, V., R.K. Omanwar and Vishwanath (1994). Long term effects of continuous rotational cropping and fertilization on crop yields and soil properties II. Effects on EC, pH, organic matter and available nutrients of soil. *J. Indian Soc. Soil. Sci.,* **42:** 387-392.

Bhardwaj, V. and V.V. Tyagi (1994). Impact of continuous manuring on crop yields and uptake of nitrogen, phosphorus and potassium. *Journal of Potassium Research.*, **10:** 290-293.

Cassman, K.G., S. Peng, D.C. Oik, J.K. Ladha, W. Reichardt, A. Dobermann and U. Singh (1998). Opportunities for increased nitrogen-use efficiency from improved resource management in irrigated rice systems. *Field Crops Research.,* **56:** 7±39.

Duraisami, V.P., R. Perumal and A.K. Mani (2001). Changes in organic carbon, available nitrogen and inorganic nitrogen fractions under integrated nitrogen management of sorghum in a mixed black soil. *J. Indian Soc. Soil Sci.,* **49:** 435-439.

Duraiswamy, P. (1992). Efficacy of fertilizer nitrogen with and without coir pith and biofertilizers on role and inter cropped sorghum - maize - soybean cropping sequences. *Ph.D Thesis,* TNAU, Coimbatore.

Giesenking, J.E. (1975). *Soil Components : Inorganic components.*Springer Verlay, Berlin-Heidelberg, New York.

Moll, R.H., E.J. Kamprath and W.A. Jackson (1982). Effect of modified area formulation on N use efficiency in maize. *Agron. J.,* **78:** 526.

Rizwan Ahmad, Naseer Abid, Zahira and Sultan Tariq (2006). Integrated use of recycled organic waste and chemical fertilizers for improving maize yield. *International J. Agric. Biol.,* **6:** 840-843.

Santhy, P., S. Jayasreesankar, P. Muthuvel and D. Selvi (1998). Long term fertilizer experiments - Status of N, P and K fractions in soil. *J. Indian Soc. Soil Sci.*, **46(3):** 395-398.

Santhy, R., P. Muthuvel and D. Selvi (2001). Nitrogen fractions: status and impact of yield, uptake and available nitrogen in a long term fertilizers experiment. *Madras Agric. J.,* **88:** 26-31.

SubbaRao, A. and A.B. Ghosh (1981). Effect of continuous cropping and fertilizer use on the organic nitrogen fractions in a typicustochrept soils. *PI.Soil.,* **62:** 377-383.

Tisdale, S.L., W.l. Nelson and J.D. Beaton (1985). *Soil Fertility and Fertilizers 4th ed.* Macmillan Publishing Company, New York, 251.

Udaysoorian, C., U.S. Sreeramulu and P. Paramasivam (1989). Effect of continuous manuring and fertilization on the fractions of soil nitrogen. *Madras Agric. J.,* **76:** 257-261.

Uma Reddy, R. (1999), Integrated nutrient management in tomato-onion cropping system. *Ph.D. Thesis, Acharya N.G. Ranga Agricultural University,* Hyderabad.

Wolkowski, R.P. (2003). Nitrogen management considerations for land spreading municipal solid waste compost. *J. Environ. Quality.* **32:** 1844-50.

Yadav, M.D and K.D. Singh (1991). Transformation of applied nitrogen in relation to its availability to sugarcane in a calcareous soil. *J. Indian Soc. Soil Sci.*, **39:** 292-297.