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Effect of Nitrogen forms under INM approach on a *Vertisols* of Chhattisgarh plains

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Abstract

Effect of Nitrogen forms under INM approach on a *Vertisols* of Chhattisgarh plain was studied under long-term fertilizer experiment during kharif 2019 at research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment comprised of different levels or doses of NPK fertilizers alone and in combination with zinc sulphate, farmyard manure (FYM), blue green algae (BGA) and green manuring (GM) was laid out in randomized block design with four replications and ten treatments viz. Control (T1), 50, 100, 150% NPK (T2, T3, T4, respectively), 100% NPK + ZnSO₄ (T5), 100% NP-K (T6), 100% N-PK (T7), 100% NPK + FYM (T8), 50% NPK + BGA (T9) and 50% NPK + Green manure (T10). Different nitrogen form was estimated after urea applies. Application of 100% NPK + FYM significantly highest available nitrogen (252 kg ha⁻¹), a decreases of available N was observed at increase in the depth of soil from 0-15 to 15-30 cm. Ammonical N (142 and 134 mg kg⁻¹) was recorded highest at 0-15cm respectively, after urea applied 24 and 48 hrs. Application of 150% NPK had higher content of ammonical nitrogen. Nitrate - N (212 and 217 mg kg⁻¹) was recorded highest in 150% NPK at 0-15cm after 24 and 48 hrs respectively. Highest grain and straw yields of rice was recorded when 150% NPK (6970 and 8364 kg ha⁻¹, respectively). The yield of rice had highest correlation with Ammonical N (r=0.802**) followed by available N (r=0.731**) and Nitrate N (r=0.570**).

Keywords: Ammonical N, Nitrate N, available nitrogen

Introduction

Nitrogen (N) is the most important mineral nutrient affecting the growth and yield of crops and its adequate supply in the soil in forms which roots can take up is essential for high yields. Inorganic N forms (mainly NH₄⁺-N and NO₃⁻-N) in soils are the available forms that plants and microorganisms can use, but excess of NO₃⁻-N can move below the root zone as water moves through it in rice fields. As crops can remove about 40 to 60% of applied N from inorganic N fertilizer, manure and other N amendment, the residual soil N (NO₃⁻-N + NH₄⁺-N) after crop harvest can be lost to the environment.

Prolonged application of fertilizers and organic manures differentially influenced mineral N (NO₃⁻-N and NH₄⁺-N), organic N fractions, and total N in soils. Mineralization of organic nitrogen fraction may play a major role in the N supply of plants. Nitrogen mineralization is of great importance because it converts organic N into NH₄⁺ which is available for plant uptake and microbial processes, Mineralization of soil organic N must be taken in to account if N fertilizers are to be used efficiently, Unfortunately, little progress has been made in identifying and measuring an easily mineralizable fraction, or dealing with year to year variability in net mineralization under field conditions, which arises from the effects of temperature and moisture supply on N-cycle process Hence N-fertilizer recommendations have often been made on the basis of cropping or economics factor rather than soil testing. Understanding the effect of N forms is prerequisite for precise N management under intensively grown rice in *Vertisols* of Chattisgarh. Therefore, the present investigation was carried out to study the Effect of Nitrogen forms under INM approach in a *vertisols*.

Materials and Methods**Experiment site**

A long-term field experiment on at Instructional Farm, Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh.

The treatments comprised 10 different combinations of manures and fertilizers (Table 1).

Table 1: Effect of various treatment on available nitrogen, ammonical N and Nitrate N

Treatment no.	Treatment name
T1	Control
T2	50% N:P ₂ O ₅ :K ₂ O (Sub optimal dose) 60:30:20
T3	100% N:P ₂ O ₅ :K ₂ O (Optimum dose) 120:60:40
T4	150% N:P ₂ O ₅ :K ₂ O (Super optimal dose) 180:90:60
T5	100% N:P ₂ O ₅ :K ₂ O + Zn @ 10 kg/ha (through ZnSO ₄)
T6	100% N:P ₂ O ₅ (120:60:0)
T7	100% N (120:0:0)
T8	100% N:P ₂ O ₅ :K ₂ O + FYM @ 5 t/ha
T9	50% N:P ₂ O ₅ :K ₂ O + BGA @ 10kg/ha
T10	50% N:P ₂ O ₅ :K ₂ O + Green Manure (Sunhamp)

Experiment was laid out in randomized completely block design (RBD) with four replications. Two soil samples were collected from surface (0-15 cm) and sub-surface (15-30 cm) layer of soil for available nitrogen and two samples were collected after urea applied within 24 and 48 hrs for form of inorganic nitrogen. Soil samples were air-dried in shade, carefully and gently ground with the wooden pestle and mortar to break soil lumps (clods) and passed through 2-mm sieve. The sieved samples were mixed thoroughly and stored in polythene bags, properly labeled and preserved for subsequent analysis.

To estimate the available nitrogen, alkaline potassium permanganate method was adopted as described by Subbiah and Asija (1956) and expressed in kg ha⁻¹. For Ammonium-nitrogen- Take fresh wet soil and then oven dry at 105°C to 24hrs and then take 3 gm of soil and add 15ml of 2M KCl extractant and shake for 1 hr, then pipette out 10ml in kjeldahl tube and add 0.2gm MgO powder and transfer 5ml boric acid(2%) and distillation and finally titrate with 0.02N sulphamic acid and for Nitrate-nitrogen- 3gm of fresh wet soil, add 2gm of Devarda alloy in digestion tube and NO₃⁻ - N determined b Kjeldahl distillation in presence of Devarda alloy. A.O.A.C. (1950).

Results

Available nitrogen

The increase in continuous nitrogen availability in the soil promotes the biological nitrogen fixation and through the atmospheric nitrogen. Due to this“the greater multiplication of soil microbes which converts organically bound N to inorganic”form.

On perusal of data presented in Table 2 indicated that available nitrogen in soil was significantly increased with balanced application of fertilizer on rice. Incorporation of fertilizers and manure influence the available nitrogen which gradually decreases with soil depth irrespective of the nutrients application ranged between 177 to 252 and 147 to 182 (kg ha⁻¹) in 0-15 and 15-30 cm soil depth, respectively.

Significantly higher available nitrogen in 252 and 182 (kg ha⁻¹) was recorded at 0-15 cm and 15-30 cm, respectively in 100% NPK + FYM @ 5 t ha⁻¹ followed by 150% NPK, whereas, significantly lower available nitrogen were noted 177 and 147 (kg ha⁻¹) in control plot.

“Katkar *et al.* (2011) [3] noted that the significantly highest nitrogen status was recorded in the application of FYM manure at 10 t ha⁻¹ + 100% NPK. The soil N was enhanced due to long-term application of FYM at 10 t ha⁻¹ + 100% NPK. The nitrogen was observed under NPK + FYM over NPK alone through mineral fertilizer.”

Ammonical nitrogen

Data pertaining to the effect of continues application of inorganic fertilizers and manures on ammonical nitrogen were presented in Table 2. Application of fertilizers alone or in combination with FYM resulted in a significant build up of ammonical nitrogen over control. Data shows that ammonical nitrogen of the soil after applying Urea on rice crop varied from 51 to 142 and 49 to 134 mg kg⁻¹ amongst various treatments at 0-15cm depth, after 24 and 48 hrs, respectively. Application of 150% NPK had highest ammonical nitrogen. The data also revealed that the highest ammonical N (142 mg kg⁻¹) in 150% NPK followed by 135 mg kg⁻¹ in 100% NPK+FYM as compared to 51 mg kg⁻¹ under control was obtained after 24 hrs of applied urea.

Application of 150% NPK had higher ammonical nitrogen. The data also revealed that the highest NH₄⁺- N, 134 mg kg⁻¹ in 150% NPK followed by 129 mg kg⁻¹ NH₄⁺- N with 100% NPK+FYM as compared to 49 mg kg⁻¹ under control was obtained after 48 hrs of applied urea.

The increase in ammonical content in soil with higher rates of fertilizer N (Rajput *et al.*, 1984) [5], similar finding were reported by Kaur *et al.* (2010) [4]. Santhy *et al.* (1998) [6] measured the highest NH₄⁺-N in“the plots with combined application of NPK and FYM, which was ascribed due to increased microbial activity and resultant in enhanced nitrification process and reduction in leaching losses.”

Nitrate nitrogen

Nitrate nitrogen content (Table 2) of the soil at 0-15cm depth after applying urea on rice crop varied from 128 to 212 mg kg⁻¹ and 130 to 217 mg kg⁻¹, respectively, after of applied urea 24 and 48 hrs amongst various treatments. The higher NO₃⁻ - N was recorded in 150% NPK, 212 and 217 mg kg⁻¹ at 0-15cm depth, respectively, after 24 and 48 hrs of applied urea followed by 150% NPK+FYM, 208 and 215 mg kg⁻¹ at 0-15cm depth respectively, after 24 and 48 hrs of applied urea. Whereas, the lowest value was recorded in control 128 and 130 mg kg⁻¹ at 0-15cm depth, respectively, after 24 and 48 hrs of applied urea.

Santhy *et al.* (1998) [6] measured the“highest NO₃⁻-N in the plots with application of 150% NPK, which was ascribed due to increased microbial activity and resultant in enhanced nitrification process and reduction in leaching losses.

Table 2: Effect of various treatment on available nitrogen, ammonical N and Nitrate N

S. No.	Treatment	Available N (kg ha ⁻¹)		Urea application			
		0-15 cm	15-30 cm	Ammonical N (mg kg ⁻¹)		Nitrate -N (mg kg ⁻¹)	
				After 24 hrs	After 48 hrs	After 24 hrs	After 48 hrs
T ₁	Control	177	147	51	49	128	130
T ₂	50% NPK	193	155	91	88	156	159
T ₃	100% NPK	220	164	114	110	177	179
T ₄	150% NPK	250	180	142	134	212	217
T ₅	100% NPK + Zn	217	168	119	114	185	190
T ₆	100% NP	213	164	107	101	168	170
T ₇	100% N	206	157	94	91	156	159
T ₈	100% NPK + FYM	252	182	135	129	208	215
T ₉	50% NPK + BGA	193	153	96	96	157	160
T ₁₀	50% NPK + Green Manure	202	162	114	106	187	189
	SEm (±)	1.8	1.1	4.3	3.5	8.9	7
	CD (p = 0.05)	5.2	3.2	12	10	26	22

Rice yield

This experiment was very important from the point of view to understanding the complex interaction between soil plants climate and management practice ultimately reflecting in crop productivity. The data on grain and straw of rice are presented in Table 4.16 and graphical in Fig. 4.18. The various treatments significantly influenced grain and straw of rice.

The grain yield of rice range from 2430 to 6970 kg ha⁻¹ and straw yield of rice range from 3110 to 8364 kg ha⁻¹ among different treatments. The grain yield of rice was significantly influenced due to balanced application of nutrients alone as well as along with organic manures (using INM approach) over imbalanced application of nutrients and control. Highest grain yield (6970 kg ha⁻¹) of rice was obtained with application of 150% NPK which was significantly superior over all the treatments except 6890 kg ha⁻¹ yield obtained in 100% NPK + FYM, whereas, lowest yield was obtained in control (2430 kg ha⁻¹). Similarly, zinc sulphate also increased the grain and straw yields in 100% NPK + ZnSO₄ over sole application of nitrogen fertilizer and control. The 100% NPK + FYM showed significantly higher yields as compared to control on par with 150% NPK. Only control recorded lowest yields because of low fertility status and/or availability of nutrients.

Table 3: Effect of different treatments on grain and straw yields of rice

S. no.	Treatment	Yields (kg ha ⁻¹)	
		Grain	Straw
T ₁	Control	2430	3110
T ₂	50% NPK	4580	5496
T ₃	100% NPK	6625	7950
T ₄	150% NPK	6970	8364
T ₅	100% NPK + Zn	6565	7878
T ₆	100% NP	6500	7800
T ₇	100% N	3535	4595
T ₈	100% NPK + FYM	6890	8268
T ₉	50% NPK + BGA	4600	5520
T ₁₀	50% NPK + Green Manure	4920	5904
	SEm (±)	173	208
	CD (p = 0.05)	503	603

Sharma *et al.*, (2015) [8] resulted that “the application of fertilizers alone or in combination with organic manure increased the grain and straw yields of rice significantly over control. Application of 100% NPK increased with grain and straw yield of rice over-control. Conjoint use of fertilizers and

organic manure significantly increased the grain and straw yield of rice over control.”

“The higher response of FYM over 100% NPK in rice was explainable on the basis that it was applied in rice crop however if FYM was added and the increase in yield was due to the residue effect, it means that might have improved the chemical properties of soil over the years. The integrated use of chemical fertilizers with organic manure *viz.*, FYM with straw, green manure might have added huge quantity of organic matter in soil that increased grain and straw yield. This might be due to the improvement in physico-chemical properties of soil that resulted in increased productivity by increasing availability of nutrients.”

Relation among forms of nitrogen and yield

Table 4: Correlation among Nitrogen forms and rice yield

	Available N	Ammonical N	Nitrate N	Yield
Available N				
Ammonical N	0.849**			
Nitrate N	0.720**	0.708**		
Yield	0.731**	0.802**	0.570**	

** = 1% level of significance

It is evident from the data (Table 4) all forms of nitrogen correlated to each other with respect highly significantly positive. Available N was positive correlated with ammonical N and nitrate N (r= 0.849** and 0.720**, respectively). All the N fractions have highly significant positive correlation with yield of rice. The yield of rice had highest correlation with Ammonical N (r=0.802**) followed by available N (r=0.731**) and Nitrate N (r=0.570**).

Conclusion

On the basis of foregoing results, it can be concluded that integrated use of fertilizers and FYM significantly increased the inorganic and organic N fractions. Different forms of nitrogen significantly and positively correlated with rice yield. The result also revealed that available N was decreased with depth of soil and ammonical nitrogen was also decreased with time but nitrate nitrogen was increased with a particular time period after urea applies.

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