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Impact of INM Practices on Yield, Nutrient Uptake and Quality Parameters of Rice (*Oryza sativa* L.)

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Abstract—*A field experiment was conducted at Crop research farm Nawabganj, CSAUA&T, Kanpur (U.P.), during Kharif season 2013 to Study the effect of inorganic fertilizers with and without FYM on yield, Nutrient uptake and quality parameter (protein content) of rice var. Narendra 359 (NDR-359). The 13 treatments consisted of NPK (120-60-60), sulphur (40 kg ha^{-1}) and zinc (5 kg ha^{-1}) with FYM @ 10 t ha^{-1} and without FYM. The Grain and Straw yields increased with an increase integration of FYM treatment i.e. $N_{120}P_{60}K_{60}S_{40}Zn_5$ + FYM, (60.32 q ha^{-1} and 73.69 q ha^{-1}), respectively computed (approx) 123 and 129 percent higher as compared to absolute control. The application of graded doses of inorganic fertilizers without FYM i.e. $N_{120}P_{60}K_{60}S_{40}Zn_5$ (T_{12}) showed significantly higher grain and straw yields computed 107 and 112 per cent higher in comparison to the lowest at absolute control (24.55 q ha^{-1}). It was observed that the number of tillers m^{-2}, plant height and 1000 grain weight increased with increase graded levels of inorganic fertilizers with FYM than without FYM on similar dose. The total uptake of N, P, K, S and Zn found to significantly increased with the application of graded dose of fertilizers along with FYM. The effect of these nutrients also affected a significant improvement in protein content in grain. The highest protein content 8.43 per cent and 2.43 percent in grain and straw was obtained with FYM in treatment (T_7) than lowest in absolute control (6.31 and 0.56 per cent respectively). So treatment (T_7) $N_{120}P_{60}K_{60}S_{40}Zn_5$ + FYM was to be found best dose for most of the characters of the crop under study.*

Keywords*: FYM, Rice, Yield, Protien, Uptake etc.*

Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop in the world. The rice is a staple food crop which consist nearly about half of the world's population, most of whom living in developing countries. In India rice crop cover about 43.7 million hectares area and contribute about 41.7 % of the total food grain production (1). To assure food security in the rice-consuming countries of the world, those countries will have to produce 50% more rice with improved quality to meet consumers' demand by 2025 (2). This additional rice will have to be produced on less land with less water, less labour and fewer chemicals. In India during the past three decade, intensive agricultural involve high yielding varieties led to heavy withdrawal of nutrient from the soil. Further, use of imbalanced dose chemical fertilizer by farmers has also deteriorated soil health and soil organic carbon which is threat to sustainability (3). It is, therefore, necessary to develop a suitable production system its maximum productivity and minimum environmental pollution. Many research findings have shown that neither inorganic fertilizers nor organic sources alone can result in sustainable productivity (4). Furthermore, the price of inorganic fertilizers is increasing and becoming unaffordable for resource-poor smallholder farmers. So the combined application of inorganic and organic fertilizers, usually termed integrated nutrient management, is widely recognized as a way of increasing yield and or improving productivity of the soil sustainably (5). In this context integrated use of chemical fertilizer and organic manure like Farm yard manure (FYM) and crop residue assumes greater significance. Organic source of nutrient applied to the preceding crop benefit the succeeding crop to a great extent and the system productivity becomes sustainable through integrated use of organic and inorganic source of nutrient. To keeping above facts in mind conducted a experiment to study the effects of individual and different combinations of organic manures (FYM) and inorganic fertilizer to on yields, nutrient uptake and quality parameter of rice.

Materials and Methods

The experiment was conducted at crop research farm Nawabganj, C. S. Azad University of Agri. and Tech., Kanpur, during *kharif* season of 2013.The climate of Kanpur is sub-tropical with annual precipitation is about 800 mm. Surface soil sample (0-15cm) were initially drawn from randomly selected parts of the field before sowing and analyzed for some important physio-chemical properties. The soil characteristics included: bulk density and particle density 1.46, 2.42 Mg m^{-3}, respectively, porosity

44%, soil solution pH 7.9, EC 0.31(dSm^{-1}), available-N 210 kg ha^{-1}, available phosphorus 11.05 kg ha^{-1}, available potassium 170 kg ha^{-1},available Sulphur 13.42 kg ha^{-1}, available Zn 0.42 kg ha^{-1}. The Experiment was laid out in a randomized block design with 13 treatments replicated thrice. The treatment comprises one absolutely control, T_0 (no fertilizer and FYM), T_1 (FYM alone with 10t ha^{-1}), T_2 (NPK- 120:60:60+ FYM), T_3 (N-120+FYM), T_4(P-60+FYM), T_5(K-60+FYM), T_6 (NPK + S (40 kg ha^{-1} from Gypsum) +FYM), T_7 (NPK + S_{40} +Zn (5 kg ha^{-1}+FYM), T_8 (N-120), T_9(P-60), T_{10}(K-60), T_{11} (NPK + S (40 kg ha^{-1} from Gypsum), T_{12} (NPK + S_{40} +Zn (5 kg ha^{-1}). Transplanting of 25 days old seedlings was done on 16 July, 2013 in 4-5 cm standing water with plant geometry of 20×10 cm in regular rows and hills. Two seedlings were planted per hill.

1) Nitrogen, Potassium, Phosphorous, Sulphur and Zinc uptake was calculated as:

$$\frac{\text{N,P,K,S,Zn content (\%)} \times \text{yield(kg ha}-1)}{100}$$

2) Harvest index:

Harvest index is defined as the ratio of total economic yield to biological yield and is expressed in percentage. The harvest index was calculated as formula suggested by Singh and Staskopt (1971)

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Results and discussion

Yield attributing parameters

The effect of graded level of fertilizers with and without FYM on yield attributing characters have been shown in (Table 1) that integration of organic and inorganic fertilizers had significant positive effect on the 1000 grain weight, plant height, no. of tillers. On an average grain weight increase with increase the graded level of fertilizers with FYM. The highest grain weight increased with the integration of organic treatment (T_7) 24.91g in comparison to with the application of FYM alone (T_1) 21.60g. Whereas similar results were observed without application of FYM highest seed weight was observed in (T_{12}) 23.84g comparison to (T_8) 22.68g i.e. N_{120} alone. Same trend has been followed in case of plant height and tiller number, where treatment contain both organic and inorganic nutrient sources receive excellent result compare to either organic or inorganic. These finding is also supported by Khalid Usman *et al.* (8) and Fageria *et al.* (9).

Grain and straw yield

A perusal of the data shown in Table1 revealed that grain and straw yield of rice were significantly influenced by the application of graded doses of fertilizers with and without FYM. On an average the highest grain and straw yield was recorded with the treatment $N_{120}P_{60}K_{60}S_{40}Zn_5$ + FYM (T_7) 60.32 q ha^{-1} and 73.69 q ha^{-1} respectively in FYM combination and noted lowest was recorded in control (T_0) 24.55 q ha^{-1} and 28.98 q ha^{-1} respectively. Similarly on an average 52.96 q ha^{-1} and 64.32 q ha^{-1} grain and straw yield were respectively recorded in application of treatment(T_{12}) $N_{120}P_{60}K_{60}S_{40}Zn_5$ without FYM A highest harvest value was computed in absolute control (T_0) 45.86 and lowest in the treatment T_5 (K-60+FYM) 44.60. In treatment (T_7) harvest index is 45.01 which is due to higher economic yield in proportion to total biomass production. It is obvious that grain and straw yield of rice responded significantly and conspicuously with application of graded levels of fertilizers with and without FYM. The significant response of rice to these nutrients in present investigation might be attributed to its deficiency in the experimental field. These results lie in the line finding Sharma *et al.* (6) and Lavkush *et al.* (7).

Table 1: Effect of inorganic fertilizer with and without FYM on yield and yield attributing characters

S. No.	Treatments	Grain yield q ha^{-1}	Straw yield q ha^{-1}	Harvest index	Test wt. (g)	Plant ht. (cm.)	No. of tillers m^{-2}
1.	T_o	24.55	28.98	45.86	20.28	85.80	339
2.	T_1	31.36	37.84	45.32	21.60	93.68	428
3.	T_2	53.48	64.81	45.21	25.29	118.3	502
4.	T_3	48.25	58.16	45.34	22.81	106.4	487
5.	T_4	38.94	46.28	45.69	22.45	97.70	465
6.	T_5	33.21	41.24	44.60	22.11	93.25	461
7.	T_6	56.18	68.55	45.04	24.72	121.8	512
8.	T_7	60.32	73.69	45.01	24.91	128.4	521
9.	T_8	42.63	51.29	45.38	22.68	99.80	478
10.	T_9	29.81	35.39	45.72	21.11	92.50	432
11.	T_{10}	27.69	32.85	45.74	20.69	90.60	428

12.	T_{11}	50.72	61.78	45.08	23.32	113.2	483
13.	T_{12}	52.96	64.32	45.16	23.84	118.8	492
	SEm(±)	1.23	0.95	1.14	0.12	1.03	0.30
	CD(5%)	2.55	1.97	NS	0.25	2.10	0.58

Table 2: Effect of inorganic fertilizers with and without FYM on the uptake of N, P and K in rice

S. No.	Treatments	N uptake by Grain (kg ha^{-1})	N uptake by straw (kg ha^{-1})	P uptake by Grain (kg ha^{-1})	P uptake by straw (kg ha^{-1})	K uptake by Grain (kg ha^{-1})	K uptake by straw (kg ha^{-1})
1.	T_o	24.79	2.60	7.38	0.46	5.42	29.26
2.	T_1	34.80	6.05	13.20	1.05	7.55	41.24
3.	T_2	69.52	19.44	25.02	3.56	15.40	89.43
4.	T_3	58.38	12.79	21.47	2.32	12.78	72.11
5.	T_4	45.17	9.25	17.17	1.48	9.77	51.37
6.	T_5	37.85	7.14	14.01	1.19	8.23	46.18
7.	T_6	73.59	21.9	26.85	4.11	16.74	101.45
8.	T_7	81.43	28.73	29.01	4.71	18.21	114.21
9.	T_8	49.87	12.30	18.84	1.94	11.29	61.54
10.	T_9	32.19	6.01	12.25	0.88	7.12	38.57
11.	T_{10}	28.79	4.92	11.21	0.65	6.59	33.17
12.	T_{11}	59.84	16.06	22.12	2.78	13.09	77.27
13.	T_{12}	66.20	18.65	24.78	3.28	14.77	86.58
	SEm(±)	1.63	0.500	1.63	0.15	0.40	2.31
	CD(5%)	3.26	1.004	3.26	0.31	0.80	3.81

Table 3: Effect of inorganic fertilizers with and without FYM on the uptake of S, Zn and protein content in rice

S. No.	Treatments	S uptake by Grain (kg ha^{-1})	S uptake by straw (kg ha^{-1})	Zn uptake by Grain (g ha^{-1})	Zn uptake by straw (g ha^{-1})	Protein content (%)in Grain	Protein content (%)in straw
1.	T_o	3.09	3.22	5.42	29.26	6.31	0.56
2.	T_1	4.32	4.69	7.55	41.24	6.93	1.00
3.	T_2	8.69	9.33	15.40	89.43	8.12	1.87
4.	T_3	7.14	7.67	12.78	72.11	7.86	1.37
5.	T_4	5.10	5.92	9.77	51.37	7.25	1.25
6.	T_5	4.68	5.15	8.23	46.18	7.12	1.12
7.	T_6	9.43	10.21	16.74	101.45	8.18	2.00
8.	T_7	10.37	11.49	18.21	114.21	8.43	2.43
9.	T_8	6.30	6.82	11.29	61.54	7.31	1.50
10.	T_9	4.08	4.24	7.12	38.57	6.75	1.06
11.	T_{10}	3.71	3.87	6.59	33.17	6.50	0.53
12.	T_{11}	7.55	8.97	13.09	77.27	7.67	1.62
13.	T_{12}	8.36	9.32	14.77	86.58	7.81	1.81
	SEm(±)	0.50	0.23	0.40	2.31	0.30	0.19
	CD (5%)	1.0	0.46	0.80	3.81	0.59	0.51

Nutrient uptake

The affect of application of graded levels of fertilizers with and without FYM on their uptake at harvest in grain as well as straw were computed and data presented in table 2 and 3. The addition of graded levels of fertilizers with and without combination of FYM influence the uptake of nitrogen, phosphorus, potassium, sulphur and zinc. It is apparent that with increase doses of graded levels of fertilizers in combination with FYM increase the uptake of nitrogen, phosphorus, potassium, sulphur and zinc in linear order in both grain and straw is parallel to nitrogen content of fertilizers in combination with and without FYM. The highest uptake of nitrogen in grain and straw were recorded in treatment (T_7) $N_{120}P_{60}K_{60}S_{40}Zn_5$ +FYM 81.43 kg ha^{-1}, and 28.73 kg ha^{-1} respectively. Similarly if we apply only inorganic fertilizer as in treatment (T_{12}) $N_{120}P_{60}K_{60}S_{40}Zn_5$ then nitrogen uptake in grain and straw were 66.20 and 18.65 kg ha^{-1} respectively and lowest in absolute control (T_0) 24.79 and 2.60 kg ha^{-1} respectively. Similarly the highest uptake of phosphorus in grain and straw were recorded in treatment (T_7) $N_{120}P_{60}K_{60}S_{40}Zn_5$ +FYM 29.01 kg

ha^{-1}, and 4.73 kg ha^{-1} respectively, if we apply only inorganic fertilizer as in treatment (T_{12}) N120P60K60S40Zn5 then uptake in grain and straw were 24.78 and 3.28 kg ha^{-1} respectively and lowest in absolute control (T_0) 7.38 and 0.46 kg ha^{-1} respectively. similarly highest uptake of potassium in grain and straw were recorded in treatment (T_7) $N_{120}P_{60}K_{60}S_{40}Zn_5$ +FYM 18.21 kg ha^{-1}, and 114.21 kg ha^{-1} respectively, if we apply only inorganic fertilizer as in treatment (T_{12}) N120P60K60S40Zn5 then potassium uptake in grain and straw were 14.77 and 86.58 kg ha^{-1} respectively and lowest in absolute control (T_0) 5.42 and 29.26 kg ha^{-1} respectively. The highest uptake of sulphar in grain and straw were recorded in treatment (T_7) $N_{120}P_{60}K_{60}S_{40}Zn_5$ +FYM 10.37 kg ha^{-1}, and 11.49 kg ha^{-1} respectively. Similarly if we apply only inorganic fertilizer as in treatment (T_{12}) $N_{120}P_{60}K_{60}S_{40}Zn_5$ then uptake in grain and straw were 8.36 and 9.32 kg ha^{-1} respectively and lowest in absolute control (T_0) 3.09 and 3.22 kg ha^{-1} respectively. The highest uptake of zinc in grain and straw were recorded in treatment (T_7) $N_{120}P_{60}K_{60}S_{40}Zn_5$ +FYM 18.21 g ha^{-1}, and 114.21 g ha^{-1} respectively. Similarly if we apply only inorganic fertilizer as in treatment (T_{12}) $N_{120}P_{60}K_{60}S_{40}Zn_5$ then grain and straw uptake were 14.77 and 86.58 g ha^{-1} respectively and lowest in absolute control (T_0) 5.42 and 29.26 g ha^{-1} respectively. These results are lie with the finding of Shivay *et al*. (10). Das *et al*. (11).

Quality parameter (protein content)

Perusal of data presented in table 3 revealed that protein content in rice was significantly influenced by the application of graded levels of treatments with and without FYM. On an average, highest protein content was recorded with FYM combination of graded levels of nutrient i.e. $N_{120}P_{60}K_{60}S_{40}Zn_5$ + FYM (T_7) was found 34 (approx) percent higher than the lowest protein content recorded at absolute control (T0). Similarly on an average, without integration of FYM in the treatment (T12) highest protein content were recorded in grain and straw were 7.81 and 1.81 percent respectively. Treatment (T_7) N120P60K60S40Zn5 + FYM was found 8.43 and 2.43 per cent protein content in grain and straw respectively and lowest value recorded at absolute control (T0) was 6.31 and 0.56 per cent respectively. Similar finding confirmed by Patel *et al.* (12). It is very interest mention here again protein content was increased with integration of FYM on the similar graded levels of nutrients applied.

Conclusion

From the results narrated above it could inferred that to achieve higher yield of rice crop there should be application of macro and micro nutrients (N, P, K, S and Zn) as soil test basis with the integration of organic manure (FYM). Farmers are advised to test the soil of cultivated field and deficient nutrients are applied with the integration of organic (FYM) to procure better sustainable yield and to maintain the quality of rice.

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