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Effect of integrated nutrient management on yield, quality and nutrient uptake in rice (*Oryza sativa*) in recently reclaimed sodic soil

RAJPAL SINGH, R.B. SINGH, MANOJ PANDEY AND U.N. SINGH

Department of Agricultural Chemistry and Soil Science, Raja Balwant Singh College, Bichpuri, Agra (U.P.) 283105

ABSTRACT

Field experiment was conducted on a reclaimed sodic at farmer field of Etah distract of Uttar Pradesh to evaluate the effect of integrated nutrient management practices on yield, quality and uptake of nutrients in rice (Oryza sativa L). Ten treatments were evaluated under randomized block design with three replications. Results revealed that the application of 50 and 100% NPK and organic manure significantly increased the plant height, number of tillers/plant and yield of rice over control. The maximum yields of rice grain (4.70t ha^{-1}) and straw (6.55 t ha^{-1}) were obtained with 100% NPK + 10t FYM ha^{-1} than 50% NPK + 10t FYM ha^{-1} and 100% NPK alone treatment. The 100% NPK with organic manures (FYM and GM) recorded higher protein content (10.75 and 10.37%) and protein yield (505.7 q ha^{-1}). The highest total uptake of N (grain + straw) (126.7 kg ha^{-1}), P (25.7 kg ha^{-1}), K (210.0 kg ha^{-1}), Zn (251.3 g ha^{-1}), Fe (2020 g ha^{-1}) and Mn (4111.0 g ha^{-1}) were recorded with 100% NPK + 10t FYM ha^{-1} followed by 100% NPK + GM. The lowest values of total uptake (grain + straw) of these nutrients were recorded under control.

Keywords: INM, yield, nutrient uptake, rice, reclaimed sodic soil

INTRODUCTION

In India, rice (Oryza sativa) is the most important and extensively grown food crop. India has the largest area under rice in the world. Rice is also grown on a sizable area of sodic soils in northern part of India. In India, about 6.73 M ha are lying barren or produce very low and uneconomical yields of various crops due to excessive accumulation of salts. This area is expected to increase with spread of water logging and salinity due to increase in canal irrigation and intensive exploitation of poor quality ground waters for agriculture in the non-canal commands. The concept of integrated nutrient management is more valid for rehabilitation of a sodic soil. After the initial reclamation, nutrient imbalance created by continuous use of N alone or combined with sub-optimal rates of other nutrients (especially P and Zn) has been the primary cause of non-sustainable yields of rice (Kumar *et al.* 2012). Integrated use of organic manures and inorganic fertilizers has assumed great importance for sustainable production and maintaining soil fertility. The organic manures not only supply macro and micro nutrients, but also improve the soil physical, chemical and biological properties of the reclaimed sodic soil. In view of this, the present study was undertaken to assess the effect of integrated nutrient management on yield, quality and uptake of nutrients by rice in the reclaimed sodic soils.

MATERIALS AND METHODS

A field experiment was conducted on reclaimed sodic soil at farmer field in Etah district of Uttar Pradesh. Initial soil characteristics (0-15 cm depth) of the experimental soil were: pH 8.6, EC 3.1 dSm^{-1}, BSP 24 organic Carbon 4.5 g kg^{-1}, available N 142 kg ha^{-1}, P 26.0 kg ha^{-1}, K 206 kg ha^{-1}. The DTPA-Fe, Mn and Zn were 16, 5.5 and 0.90 mg kg^{-1}, respectively. The treatments were: T_1 control ($N_0P_0K_0$), T_2 $N_{120}P_0K_0$, T_3 $N_{120}P_{26}K_0$, T_4 $N_{120}P_{26}K_{42}$ (100% NPK), T_5 $N_{180}P_{39}K_{63}$ (150% NPK), T_6 $N_{60}P_{13}K_{21}$ (50% NPK), T_7 50% NPK + GM, T_8 50% NPK + 10t FYM ha^{-1}, T_9 100% NPK + GM and T_{10} 100% NPK + 10t FYM ha^{-1}. The experiment was laid out in randomized block design with three replication. Dhaincha was sown as a green manure on 20 May and the crop was harvested after fifty days of sowing and incorporated in to the soil by power tiller and after 1-2 days, the rice was transplanted. FYM (0.55% N, 0.30% P and 0.80% K) was applied to soil one week of transplanting of rice. The 1R-64 (30 day old) seedlings were transplanted in standing water (6 cm deep) in first week of July at a spacing of 20 cm between rows and 15 cm between plants. Fertilizer used were urea, single superphosphate and muriate of potash. All

amounts of P and K and one third of N were applied as basal dressing and remaining amount was top dressed in two splits. Rice crop was harvest at physiological maturity. The grain and straw yields were recorded at harvest. Grain and straw samples were analysed for nitrogen by modified Kjeldahl method (Jackson 1973). Phosphorus and potassium in di-acid (HNO_3:$HClO_4$) digest were determined by vanadomolybdate yellow colour method and flame photometer, respectively. Zinc, Iron and Mn in di-acid digest were determined on atomic absorption spectrophotometer. Uptake of nutrients was calculated by multiplying nutrient contents in grain and straw with their respective yield.

RESULTS AND DISCUSSION

Growth and yield

Plant height and mumber of tillers were significant influenced due to application of organic manures and inorganic fertilizers in comparison to control (Table 1). Application of 100% NPK + 10 t FYM ha^{-1} recorded tallest plant (96.5 cm) and higher number of tillers per plant (11.3) than 100% NPK alone. Application of 100% NPK + green manuring was statistically on par with 100% NPK + 10t FYM ha^{-1} with respect to plant height and number of tillers per plant. This may be due to the fact that slowly released nutrients through FYM and green manure and applied inorganic fertilizers helped to produce more number of tillers and tallest plants. Application of NPK fertilizer (50 to 150%) levels produced significantly higher yield of grain and straw over control. Similar results were reported by Kashyap *et al.* (2018). The significantly higher grain (3.75 t ha^{-1}) and straw (5.25 t ha^{-1}) yields were recorded with 150% NPK which may be attributed to increased availability of nutrients to plants. Application of organic sources with 100% NPK further increased the grain and straw yield of rice over 100% NPK alone. Green manuring along with 100% NPK produced significantly higher grain (4.41 t ha^{-1}) and straw (6.18 t ha^{-1}than 100% N, 100% NP treatments. The yield of rice was lowest under control, whereas it was highest in the plots fertilized with 100% NPK + 10t FYM ha^{-1}. The yield of rice from FYM and green manuring with 100% NPK was higher as reported by Kumar *et al.* (2012) and Kumar *et al.* (2017).

Quality

A study of the data (Table 1) revealed that the protein content in grain of rice improved with various treatments over control. The range of protein in rice grain was from 7.75% at control to 10.75% with 100% NPK + 10t FYM ha^{-1}. The protein content also improved with 150% NPK over control. Treatment T_9 (100% NPK + green manuring) and T_{10} (100% NPK + 10t FYM ha^{-1}) were statistically at par in respect of protein content (Kashyap *et al.* 2018 and Sharma *et al.* 2015). Protein yield ranged from 165.0 kg ha^{-1} at control to 505.7 kg ha^{-1} with 100% NPK + 10t FYM ha^{-1}. This increase in protein yield may be attributed to increased grain yield and improvement in protein content due to application of NPK fertilizer and FYM (100% NPK + 10t FYM ha^{-1}). Green manuring along

Table 1: Effect of 1 NM treatments on growth, yield and quality of rice crop

Treatments	Plant height (cm)	Tillers/ plant	Yield (t ha^{-1})		Protein content (%)	Protein yield (kg ha^{-1})
			Grain	Straw		
T_1 $N_0P_0K_0$ (Control)	82.5	7.2	2.13	3.02	7.75	165.0
T_2 $N_{120}P_0K_0$ kg ha^{-1}	83.0	7.8	2.95	4.12	8.25	243.4
T_3 $N_{120}P_{26}K_0$ kg ha^{-1}	85.0	8.0	3.25	4.70	8.87	288.2
T_4 $N_{120}P_{26}K_{42}$ kg ha^{-1} (100% NPK)	93.5	10.0	3.37	4.77	11.12	374.7
T_5 $N_{180}P_{39}K_{63}$ kg ha^{-1} (150% NPK)	92.0	9.7	3.75	5.25	10.62	398.2
T_6 $N_{60}P_{13}K_{21}$ kg ha^{-1} (50% NPK)	87.5	8.8	3.00	4.39	9.37	281.1
T_7 50% NPK + green manure	86.0	8.3	3.50	4.00	8.75	306.2
T_8 50% NPK + 10t FYM ha^{-1}	90.0	9.1	3.80	5.41	9.12	205.0
T_9 100% NPK + green manure	95.0	10.8	4.41	6.18	10.37	457.3
T_{10} 100% NPK + 10t FYM ha-1	96.5	11.3	4.70	6.55	10.75	505.7
SEm ±	1.43	0.27	0.14	0.15	0.44	8.67
CD (P=0.05)	2.92	0.55	0.28	0.31	0.90	17.68

with 100% NPK (T_9) also increased the protein yield over most of the integrated nutrient management options. This treatment (100% NPK + GM) was statistically at par with that of 100% NPK + 10t FYM ha^{-1}. Similar results were reported by Kumar *et al.* (2017).

Nutrient uptake

Application of NPK levels (50 and 150%) significantly improved the uptake of N, P and K by rice grain and straw over control and relatively higher values were recorded with 150% NPK alone. The 100% NPK with organic sources (FYM and GM) recorded higher N uptake by 35.5 and 24.3%, respectively as compared to 100% NPK alone. Similar results were reported by Kashyap *et al.* (2018). Higher total N uptake by rice was observed on combined application of FYM or green manure with the 100% NPK, which helped the plants to synthesize maximum grain and straw yield of rice (Table 2). Yaduvanshi (2003) and Kumar *et al.* (2017) also reported similar results. Among the treatments with organic sources along with 50% or 100% recommended NPK, there was no significant difference in total N uptake by rice crop. The total uptake of P and K by rice crop ranged from 6.7 to 25.7 kg ha^{-1} and 63.9 to 210 kg ha^{-1}, respectively. The maximum values of total uptake of P and K were recorded with 100% NPK + 10t FYM ha^{-1} closely followed by 100% NPK + GM. The increase may be attributed to higher grain and straw production of rice with these treatments. The minimum values of total uptake of P and K were recorded under control which may be due to poor yield of rice grain and straw. Similar results were reported by Kumar *et al.* (2012) and Sharma *et al.* (2015). The total uptake of Zn, Fe and Mn by rice crop with different combinations of fertilizer and organic manures ranged between 68.8 and 251.3 g ha^{-1}, 784 and 2220 g ha^{-1} and 1658 and 4111 g ha^{-1}, respectively (Table 2).

Table 2: Effect of 1NM practice on total uptake (grain + straw) of nutrient by rice

Treatments	Nutrient uptake (kg ha^{-1})			Micro nutrient uptake (g ha^{-1})		
	N	P	K	Zn	Fe	Mn
T_1 $N_0P_0K_0$ (Control)	34.8	6.7	63.9	68.8	784	1658
T_2 $N_{120}P_0K_0$ kg ha^{-1}	58.4	11.6	94.3	98.1	1174	2423
T_3 $N_{120}P_{26}K_0$ kg ha^{-1}	69.1	13.3	114.6	111.0	1360	2755
T_4 $N_{120}P_{26}K_{42}$ kg ha^{-1} (100% NPK)	86.4	17.0	142.6	157.4	1443	2926
T_5 $N_{180}P_{39}K_{63}$ kg ha^{-1} (150% NPK)	93.9	18.1	154.1	165.3	1580	3208
T_6 $N_{60}P_{13}K_{21}$ kg ha^{-1} (50% NPK)	68.7	13.6	124.3	117.6	1291	2595
T_7 50% NPK + green manure	74.9	15.2	134.2	124.9	1444	2933
T_8 50% NPK + 10t FYM ha^{-1}	91.8	17.6	155.2	155.2	1618	3258
T_9 100% NPK + green manure	116.3	23.2	195.1	225.0	1885	3258
T_{10} 100% NPK + 10t FYM ha^{-1}	126.7	25.7	210.0	251.3	2020	4111
SEm $\pm$	2.40	1.34	1.96	1.20	10.6	17.8
CD (P=0.05)	7.15	3.86	5.65	3.45	31.5	51.6

The increase in total uptake of these micronutrients by rice crop may be attributed to higher grain and straw production. Green manuring along with 100% NPK also proved significantly superior to most of the treatments in respect of total uptake of these micro nutrients. Thus, the total uptake of these micronutrients increased significantly with the conjoint application of organic manures and recommend NPK in comparison with control. The lowest values of total uptake of these micronutrients by rice were recorded in control and NPK fertilizers alone treatments (Swarup and Yaduvenshi 2004).

From the results, it may be concluded that incorporation of organic manuring (FYM and green manure) in combination with fertilizers could maintain sustainable rice yield in reclaimed sodic soil. Application of FYM and green manure also improved the quality of produce and uptake of major and micro nutrients compared with chemical fertilizers.

REFERENCES

Jackson, M. L. (1973) *Soil Chemical Analysis*. Prentice Hall of India Private Limited, New Delhi.

Kashyap, N., Das, K.N., Deka, B., Dutta, M. and Basumatary, A. (2018) Individual and combined effect of phosphorus and potassium on yield and nutrient uptake by hybrid rice (Oryza sativa) under 1PNS in an alluvial soil of Assam. *Annals of Plant and Soil Research* **20**(2) : 109-115.

Kumar, M., Yaduvanshi, N. P.S. and Singh, Y.V. (2012) Effects of integrated nutrient management on rice yield, nutrient uptake and soil fertility status in reclaimed sodic soils. *Journal of the Indian Society of Soil Science* **60**(2) : 132-137

Kumar, V., Kumar, T., Singh, G. and Singh, R. N. (2017) Effect of integrated nutrient management on yield of rice in rice-wheat system under low land. *Annals of Plant and Soil Research* **19**(4) : 360-365.

Sharma, G.D., Thakur, R., Chouhan, N. and Kumar, K.S. (2015) Effect of integrated nutrient management on yield. Nutrient uptake, protein content, soil fertility and economic performance of rice (Oryza sativa L.) in a vertisol. *Journal of the Indian Society of Soil Science* **63**(3): 320-326.

Swarup, A. and Yaduvanshi, N.P.S. (2004) Nutrient stress Management for sustaining crop production in salt affected soils. CSSRI Bulletin No.1/2004, Central Soil Salinity Research Institute, Karnal.

Yaduvanshi, N. P. S. (2003) Substitution of inorganic fertilizers by organic manures and the effect on soil fertility in a rice-wheat rotation on reclaimed sodic soil in India. *Journal of Agricultural Science* **140**: 161-168.