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Effect of integrated nutrient management on yield and uptake of nutrients in wheat (*Triticum aestivum*) under reclaimed sodic soil

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ABSTRACT

A field experiment was conducted on a reclaimed sodic soil at farmer field of Etah district of Uttar Pradesh to study the effect of INM practices on yield (Triticum aestivum) and uptake of nutrients in by wheat rice-wheat cropping system. The ten treatments were evaluated in randomized block design with three replications. Application of 10t FYM ha^{-1} along with 100% chemical fertilizers recorded significantly higher values of growth attributes over other treatments except 100% NPK + green manure. This treatment (100% NPK + 10t FYM ha^{-1}) also recorded significantly highest grain (4.35t ha^{-1}) and straw (5.71t ha^{-1}) yield closely followed by 100% NPK + green manure. Application of 100% NPK with organic manures (FYM and green manure) recorded higher protein content (12.9%) and protein yield (561.1 kg ha^{-1}). The uptake of major nutrients (N, P and K) and micronutrients (Zn, Fe and Mn) by the wheat crop followed the same trend as in case of grain and straw yield. All fertilizer treatments reduced the soil pH and improved the status of organic carbon, available N, P and K as compared to initial values. However, the improvements in these parameters were much higher with 100% NPK + 10t FYM ha^{-1} and 100% NPK + green manure over other treatments.

Key words: INM, yield, nutrient uptake, soil fertility, rice-wheat system

INTRODUCTION

Improving and maintaining soil quality for enhancing and sustaining agricultural production is of utmost importance for food and nutritional security. In India about 6.7 M ha^{-1} are lying barren or produce very low and uneconomical yields of various crops due to excessive accumulation of salts. So increasing yields from these salt affected soils is of utmost importance. Integrated plant nutrient supply system is more valid for increasing and managing these sodic soils. After the initial reclamation, nutrient imbalance created by continuous use of nitrogen alone or combined with sub-optional rates of other nutrients like P and Zn has been the primary cause of non-sustainable yields in a rice-wheat system (Kumar *et al.* 2012). Under these circumstances, integrated use of organic manures and inorganic fertilizers has assumed great importance for sustainable production and maintaining soil health (Pandey 2018). Application of organic manure helps in mitigating multiple nutrient deficiencies at the same time provides better environment for growth and development by improving physical, chemical and biological properties of sodic soils. Not much work has been done on the integrated nutrient management on wheat on re claimed sodic soil in Agra. Hence, the present investigation was carried out to study the effect of integrated nutrient management on wheat yield, and soil fertility in the reclaimed sodic soil.

MATERIALS AND METHOD

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, 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. FYM (0.55% N, 0.30% P and 0.80% K) was applied to the soil one week before sowing of wheat. Wheat (PBW 343) was sown in second week of November using 100 kg seed ha$^{-1.}$ Fertilizers used were urea, single super phosphate and muriate of potash. All amounts of P and K and one third of N were applied as basal dressing and remaining amount of N was top dressed in

two splits. Wheat crop was harvested at physiological maturity and yields (Grain and Straw) were recorded. Grain and straw samples were analysed for nitrogen content 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 spectro photometer. Uptake of nutrients was calculated by multiplying nutrient contents in grain and straw with their respective yield. Soil were collected after harvest of the crop and analysed for pH, organic carbon, available N, P, K, Fe, Zn and Mn by adopting standard procedures (Jackson 1973).

RESULTS AND DISCUSSION

Growth and yield

Plant height and number of tillers were significantly 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 as inorganic fertilizers helped to produce more number of tillers and tallest plants. Application of NPK fertilizers (50 to 150%) produced significantly higher yield of grain and straw over control. Similar results were reported by Singh and Singh (2017) and 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 wheat 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 wheat 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).

Table 1: Effect of INM treatments on growth yield and quality of wheat 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)	80.5	3.2	1.96	2.79	10.8	211.6
T_2 $N_{120}P_0K_0$ kg ha^{-1}	83.0	4.2	2.40	3.70	11.1	266.4
T_3 $N_{120}P_{26}K_0$ kg ha^{-1}	84.2	4.5	2.85	3.80	11.2	319.2
T_4 $N_{120}P_{26}K_{42}$ kg ha^{-1} (100% NPK)	88.0	6.1	3.05	4.06	11.7	356.8
T_5 $N_{180}P_{39}K_{63}$ kg ha^{-1} (150% NPK)	87.5	5.9	3.10	4.55	11.6	359.6
T_6 $N_{60}P_{13}K_{21}$ kg ha^{-1} (50% NPK)	86.0	5.0	2.45	3.40	11.4	279.3
T_7 50% NPK + green manure	85.0	4.7	2.80	4.00	11.3	316.4
T_8 50% NPK + 10 t FYM ha^{-1}	87.0	5.3	3.00	4.25	12.5	375.0
T_9 100% NPK + green manure	89.5	6.9	4.10	5.58	12.8	524.8
T_{10} 100% NPK + 10t FYM ha^{-1}	90.0	7.2	4.35	5.71	12.9	561.1
SEm +	2.08	0.10	0.29	0.28	0.11	18.4
CD (P=0.05)	4.26	0.22	0.61	0.58	0.23	52.7

Quality

A study of the data (Table 1) revealed that the protein content in grain of wheat improved with various treatments over control. The range of protein in wheat grain was from 6.75% at control to 11.75% 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 143.7 kg ha^{-1} at control to 552.2 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 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).

Table 2: Effect of INM treatment on total uptake of nutrients (grain + straw) by wheat

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)	51.3	11.2	51.8	59.5	713.7	292.8
T_2 $N_{120}P_0K_0$ kg ha^{-1}	69.0	15.7	84.0	90.7	975.1	409.8
T_3 $N_{120}P_{26}K_0$ kg ha^{-1}	81.1	18.6	92.1	107.3	1114.3	443.0
T_4 $N_{120}P_{26}K_{42}$ kg ha^{-1} (100% NPK)	101.3	21.8	123.6	151.0	1525.5	531.7
T_5 $N_{180}P_{39}K_{63}$ kg ha^{-1} (150% NPK)	100.0	21.8	132.0	154.7	1579.7	551.6
T_6 $N_{60}P_{13}K_{21}$ kg ha^{-1} (50% NPK)	74.5	16.5	93.4	102.4	1091.0	398.5
T_7 50% NPK + green manure	83.8	18.0	106.1	114.5	1223.6	457.8
T_8 50% NPK + 10 t FYM ha^{-1}	93.6	20.6	120.0	136.1	1414.6	506.8
T_9 100% NPK + green manure	43.8	30.0	172.8	208.5	2112.9	721.8
T_{10} 100% NPK + 10t FYM ha^{-1}	164.9	33.5	190.8	224.4	2292.0	768.2
SEm+	0.69	1.83	2.88	5.00	29.00	6.95
CD (P=0.05)	1.98	5.26	8.27	14.01	81.20	19.46

Nutrient uptake

Application of NPK levels (50 and 150%) significantly improved the uptake of N, P and K by wheat grain and straw over control and relatively higher values were recorded with 150% NPK alone (Singh and Singh 2018). 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 wheat 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 wheat (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, these was no significant difference in total N uptake by wheat crop. The total uptake of P and K by wheat 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 wheat 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 wheat 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 wheat 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). The increase in total uptake of these micronutrients by wheat 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 micronutrients. 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 wheat were recorded in control and NPK fertilizers alone treatments (Swarup and Yaduvenshi 2004).

Soil fertility

Application of organic sources with fertilizers significantly decreased the soil pH over that control and inorganic fertilizer alone but the difference between FYM and GM with fertilizers was not significant (Table 3). EC value slightly increased with fertilizers alone over control. Addition of organic manures (FYM and GM) with 50 and 100% NPK increased organic carbon content over other treatments. The increase in organic carbon content with manures has also been reported by Kumar *et al.* (2012). Application of organic manures and inorganic

Table 3: Effect of INM treatments on soil fertility of post harvest soil

Treatments	pH	EC dSm^{-1}	ESP	Available Nutrients (kg ha^{-1})			Available micronutrients (mg kg^{-1})		
				N	P	K	Zn	Fe	Mn
T_1	9.05	0.30	28	130	24.5	197	0.84	16.0	5.3
T_2	9.03	0.29	27	143	26.0	198	0.88	16.2	5.4
T_3	9.04	0.29	27	145	27.3	200	0.87	16.4	5.4
T_4	9.02	0.29	24	145	27.4	208	0.90	16.5	5.6
T_5	9.03	0.29	27	148	27.9	213	0.93	16.5	5.7
T_6	9.02	0.29	25	136	26.2	206	0.95	16.6	5.8
T_7	9.02	0.29	23	140	26.3	208	0.97	16.6	5.8
T_8	9.01	0.29	21	142	28.0	211	0.96	16.8	5.9
T_9	8.61	0.28	20	150	28.4	214	0.98	17.0	6.0
T_{10}	8.60	0.28	20	154	29.3	216	0.99	17.5	6.0
CD (P=0.05)	0.09	NS	2.1	3.7	0.45	65	0.22	0.65	0.17

fertilizers significantly increased the status of available N in post harvest soil over control. The increase in available N may be attributed to nitrogen mineralization from organic sources, The available P content of the soil increased with fertilizers and organic manures as compared to control. Higher amount of available P was recorded under 100% NPK + FYM, 100% NPK + GM and 150% NPK. The increase in available P status of the soil fertilizers and organic manures with may be due to greater mobilization of native soil P. Incorporation of organic manures with 100% NPK increased the available K over control (Table 3). The status of DTPA-Zn, Fe and Mn in soil increased with the application of organics as compared to inorganic fertilizers. The amounts of these micronutrients increased with 100% NPK + 10t FYM ha^{-1} as compared to 100% NPK. Application of 100% NPK + GM also increased the amounts of these micronutrients in soil over control.

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) undr 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.

Pandey, M. (2018) Effect of integrated nutrient management on yield, quality and uptake of nutrients in oat (*Avena sativa*) in alluvial soil. *Annals of Plant and Soil Research* **20** (1): 1-6

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.

Singh, S. and Singh, V. (2018) Maximizing wheat (*Triticum aestivum*) productivity and profitability using site specific nutrient management strategy. *Annals of Plant and Soil Research* **20** (1): 103-106

Swarup, A. and Yaduvanshi, NPS (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.