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Effect of Integrated Use of Organic Manures and Inorganic Fertilizers in Rice (*Oryza sativa* L.)

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Abstract

A field experiment was conducted at Crop research Farm Nawabganj CSAU&T, Kanpur (U.P.), during Kharif season 2016-17 to study the integrated use of organic manures and inorganic fertilizers in rice cv. NDR-359. The 9 treatments consisted of T₁:Control, T₂: 100% RDF(120:60:60), T₃: 70% RDF+30% N as FYM, T₄: 70% RDF+30% N as VC, T₅: 70% RDF+30% N as PM, T₆: 70% RDF+15% N as FYM+15% N as VC, T₇: 70% RDF+15% N as VC+15% N as PM, T₈: 70% RDF+15% N as FYM+15% N as PM and T₉: 70% RDF+10% N as FYM+10% N as PM+10% N as 10% N as VC. The grain and straw yields increased with integration of Poultry manure + Vermicompost treatment i.e. 70% RDF + 15% VC+ 15% PM, 50.90q ha⁻¹ and 61.08q ha⁻¹, respectively computed 85.77% and 80.28% higher than control. The content of all nutrients increased with integration of FYM, VC and PM in comparison to control.

It was observed that the number of tillers hill⁻¹, plant height and 1000 grain weight increased with integration of inorganic fertilizers and FYM, VC and PM. The total uptake of N, P and K significantly increased with the application of inorganic fertilizers with FYM, VC and PM. These nutrients were also brought significant improvement in protein content in grain and straw. The highest protein content 8.44% was obtained with treatment combination of 70% RDF + 15% VC +15% PM and lowest in control (6.81%). The treatment combination 70% RDF + 15% VC +15% PM came out to be the best dose for most of the characters of the rice crop under study.

Keywords: Yield, yield attributes, nutrient uptake, quality parameter, organics

Introduction

Rice (*Oryza sativa* L.), the most cereal crop in India; occupies nearly 35% of the total area under food grains and 15-20% of the cropped area of rice comes under *kharif* acreage. In the global content India stands first in area with 43.5mha, second in production with 105mt in 2016-17 (Food Corporation of India, and GOI Budget). Cultivation of high yielding dwarf varieties responsive to fertilizer and excess use of inorganic fertilizers has depleted the inherent soil fertility. The decline or stagnation in yield has been attributed to nutrient mining and reduced use of organics (Baishya *et al.* 2015) [1]. Several long-term experiments conducted all over India indicated a decrease in rice productivity due to continuous use of chemical fertilizers (Kundu *et al.*, 2016) [6]. Integrated use of organic manures and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility (Sharma and Subehiya, 2014) [10]. The application of organic manures influences the physical and chemical properties of soil and enhances the biological activities. Combined use of organics with fertilizer entails the maintenance of soil fertility to an optimum level for crop productivity to obtain the maximum benefit from all possible sources of plant nutrients. Organics as well as inorganic in an integrated manner is essential to address the twin concerns of nutrient excess and nutrient depletion. Integrated nutrient management (INM) aims to improve soil health and sustain high level of productivity and production. Organic supply of nutrients at the peak period of absorption also provides micro-nutrients and modifies soil-physical behavior as well as increase the efficiency of applied nutrients. The combined use of organic manures and inorganic fertilizers has been reported not only to meet the nutrients need of the crop but also has been found to sustain large scale productivity goals. Limited studies have been conducted to work out the effect of combined use of inorganic fertilizers and organics (FYM, Vermicompost and Poultry manure) on rice in Kanpur (U.P.). Therefore, the present investigation was conducted to evaluate the effect of chemical fertilizer and organics on yield, yield attributes, nutrient uptake and quality of rice in alluvial soil of Kanpur (U.P.).

Materials and Methods

The experiment was conducted at crop research farm Nawabganj, C. S. Azad University of

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Agri. and Tech., Kanpur, during *khari* season of 2016. Geographically, district Kanpur, Mahanagar lies between the parallel of 25.26° and 26.58° north latitude and 79.31° and 80.34° east longitude. It is situated at an elevation of 124 meters above the sea level in the alluvial belt of Gangetic plains of central Uttar Pradesh. The mean ambient temperature and relative humidity during the experiment ranged from 20.6 °C to 34.5 °C and 55.83% to 81.66%, respectively. The soil of the experimental site was sandy clay loam in texture, slightly alkaline in reaction (pH 7.9) and had 0.35% organic carbon, nitrogen 167 kg ha⁻¹, phosphorus 9.95 kg ha⁻¹ and potassium 162 kg ha⁻¹. The experiment was carried out in a randomized block design with three replications. The treatments consisted of viz T₁: Control, T₂: 100% RDF(120:60:60), T₃: 70% RDF+30% N as FYM, T₄: 70% RDF+30% N as VC, T₅: 70% RDF+30% N as PM, T₆: 70% RDF+15% N as FYM+15% N as VC, T₇: 70% RDF+15% N as VC+15% N as PM, T₈: 70% RDF+15% N as FYM+15% N as PM and T₉: 70% RDF+10% N as FYM+10% N as PM+10% N as 10% N as VC. FYM (21.4% carbon, 0.57% N, 0.28% P₂O₅, 0.51% K₂O and C:N ratio 28.3:1), Vermicompost (32.1% carbon, 1.6% N, 2.04% P₂O₅ and 0.80% K₂O with C:N ratio 22.4:1) and Poultry manure (38.3% carbon, 3.03% N, 1.4% P₂O₅ and 1.4% K₂O with 18.4:1) were applied before 15 days of transplanting. The Urea, DAP and MOP were used as source of nitrogen, phosphorus and potassium, respectively. The rice (var. NDR-359) was transplanted in second week of July. The full dose of phosphorus and potassium and half dose of nitrogen were applied as basal at the time of sowing and remaining half of

nitrogen in two splits each at tillering and milking stage. Observations were recorded on plant height, number of tiller per hill and test weight were recorded at maturity of crop. The grain and straw yields were recorded at harvest. The nitrogen content in grain and straw samples were determined by Kjeldahl method (Jackson, 1973) [4]. The grain and straw samples were wet digested with nitric acid and perchloric acid and P in digest was determined by vanadate phosphomolybdate yellow colour method, K by Flame photometer. The nutrient uptake was calculated by multiplying the nutrient concentration values with the grain and straw. Nutrient use efficiency and agronomic efficiency was calculated as described by Fageria *et al.* (2010) [3].

Results and Discussion

Yield attributes

The yield attributes of rice significantly influenced by the integrated use of organic manures and inorganic fertilizers in rice (Table 1). At maturity stage maximum plant height (122.1cm), higher tillers (57.01m⁻¹ row) were recorded with the 70% RDF+15% N as VC+15% N as PM. The maximum test weight was recorded with the 70% RDF+15% N as VC+15% N as PM. Higher yield attributes of rice obtained with the application of integrated nutrients were mainly due to their positive effect on various yield contributing characters (Sharma *et al.*, 2014) [9, 10]. Sultana *et al.* (2015) also found significant and consistent increase in growth and yield attributes with combined application of organic and mineral fertilizers.

Table 1.

Treat.	No. of tillers / m ²	Plant ht. (cm.)	Test weight (gm)	Yield (q/ha)	
				Grain	Straw
T1	44.45	52.20	21.28	27.40	33.88
T2	52.36	120.30	25.40	46.30	56.06
T3	50.22	112.3	22.85	43.45	52.14
T4	51.23	114.4	23.23	45.80	54.96
T5	54.11	121.7	25.81	47.40	56.88
T6	53.45	117.2	24.91	46.10	55.32
T7	57.01	122.1	26.71	50.90	61.08
T8	55.82	121.4	26.10	48.75	58.50
T9	52.42	155.5	25.32	47.20	56.64

Yield

Highest grain (50.90 q ha⁻¹) and straw (61.08 q ha⁻¹) yields were recorded with the 70% RDF+15% N as VC+15% N as PM. The application of 70% RDF + 30% N by poultry manure recorded relatively higher grain (47.40q ha⁻¹) and straw (56.88q ha⁻¹) yield as compared to 70% RDF + 30% N as vermicompost (45.80q ha⁻¹ grain and 54.96q ha⁻¹ straw yield) and 70% RDF + 30% N as FYM (43.45q ha⁻¹ grain and 52.14q ha⁻¹ straw yield). It may be quickly release of nutrient from poultry manure resulting higher yield of rice. The treatment 70% RDF+15% N as VC+15% N as PM gave 9.94

and 8.95% higher grain and straw yield, respectively over 100% RDF. Application of FYM and poultry manure along with 70% NPK resulted in maximum growth and yield that establishes the fact of synchrony between availability of nitrogen at critical stages of crop as well as other benefits derived from FYM and Poultry manure. Further, application of FYM adds and exploits the fixed nutrient of soil in available form and regulates its supply to the crop through mineralization and prevents them from leaching and other losses (Rasool *et al.*, 2015).

Table 2: Effect of conjoint use of organic manures and inorganic fertilizers on nutrients uptake (kg ha⁻¹) by rice.

Treatments	Nitrogen		Phosphorus		Potassium	
	Grain	Straw	Grain	Straw	Grain	Straw
T ₁	29.87	4.74	8.77	0.71	6.33	34.22
T ₂	58.34	16.82	22.04	3.31	13.10	70.07
T ₃	53.44	13.56	20.20	2.87	12.12	63.09
T ₄	56.79	15.39	21.53	3.13	12.87	67.60
T ₅	62.61	18.20	22.75	3.53	13.79	72.81
T ₆	59.90	17.15	22.32	3.32	13.34	69.70
T ₇	68.71	23.21	24.79	3.97	15.37	80.01
T ₈	63.86	20.47	23.50	3.74	13.33	75.46
T ₉	60.89	19.26	22.61	3.45	13.64	71.93

Nutrient uptake

Application of 100% RDF recorded significantly higher nutrient uptake by rice over control. However, nutrient uptake further increased when organics (FYM, Vermicompost, Poultry manure) were applied as 30% N basis. The N uptake by grain and straw (Table 2) was significantly affected by various treatments and varied between 29.87 and 68.71 kg ha⁻¹ in grain and 4.74 and 23.2171 kg ha⁻¹ in straw. The significantly higher N uptake was noticed in 70% RDF+15% N as VC+15% N as PM followed by 70% RDF+15% N as FYM+15% N as PM (63.86 and 20.47 kg ha⁻¹ by grain and straw, respectively). Significantly highest plant accumulation of P (24.79 and 3.97 kg ha⁻¹), K (15.37 and 80.03 kg ha⁻¹) in grain and straw were observed with application of 70% RDF+15% N as VC+15% N as PM. Application of 100% RDF observed 15.09, 11.09 and 14.77% lesser N, P and K uptake by grain, respectively as compared to 70% RDF+15% N as VC+15% N as PM. The application of organics improve physical environment of soil and helped in nutrient translocation and absorption from the soil and organics itself have a good source of nutrients for the crop. Higher nutrient uptake by rice was observed with combined application of FYM or Poultry manure with the 100% recommended N P which helped the plants to synthesize maximum dry matter production and nutrients concentration in rice (Kumar *et al.*, 2012) [5].

Nutrient use efficiency

Nutrient supply through integration of both organic and chemical sources tended to increase the nutrient use efficiency as compared to those of supplying nutrients through only chemical fertilizers. Nutrient use efficiency of N, P and K were found higher with integration of organics with inorganic fertilizers (Table 3). Highest nitrogen use efficiency (47.75%) was recorded in 70% RDF+15% N as VC+15% N as PM. The maximum value of P and K use efficiencies was 32.13% and 91.38% with 70% RDF+15% N as VC+15% N as PM. The sole application of 100% RDF recorded significantly lowest N (33.79%), P (26.45%) and K (71.03%) recovery. The might be due to balanced supply of plant nutrients through both organics manures and chemical sources.

Table 3: Effect of conjoint use of organics and fertilizers on nutrient use efficiency (%) of nutrients in rice.

Treatments	NUE	PUE	KUE
T1	0	0	0
T2	33.79	26.45	71.03
T3	26.99	22.65	57.77
T4	31.30	25.30	66.53
T5	38.50	28.00	76.75
T6	35.36	26.93	70.82
T7	47.75	32.13	91.38
T8	41.43	29.60	82.07
T9	37.95	27.63	75.03

Application of organics manures stimulates nutrient uptake and ultimately influenced the nutrient use efficiency due to consistent supply of nutrients with better physical condition of soil (Salam *et al.*, 2014) [8]. It may be concluded from the present study that application of 70% RDF+15% N as VC+15% N as PM is most contributive for improving the nutrients uptake and productivity of rice. Application of 70% RDF+15% N as VC+15% N as PM also helped in improving the nutrient use efficiency of rice. The results clearly indicated the need of integrated use of 70% RDF+15% N as VC+15% N as PM to meet the nutrient requirement of rice for

sustaining the high productivity.

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