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Residual Effect of Rock Phosphate Enriched Compost and Inorganic Fertilizers Application on Growth, Yield and Nutrient Content of Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during rainy season in 2014-15 located at an elevation of 18.93 m MSL in class IV of land capability with a moisture deficit index of –02 to –40. Treatment comprised with rock phosphate enriched compost and ordinary compost with recommended dose of nitrogen and potassium in Randomized Block Design replicated as thrice. The 75% RDF + 6 t rock phosphate enriched compost significantly increased the yield and yield attributes. The highest plant height (90.23 cm), test weight (21.47 g) and grains per panicle (131.00), number of tillers (13.83 hill^{-1}), grain yield (43.79 q ha^{-1}) and straw yield (154.41 q ha^{-1}) were recorded compared to control and other treatments. Maximum nitrogen content in grain (1.07%) was recorded with application of 100% RDF + 20 t FYM ha^{-1} while the highest phosphorus (0.63) and sulfur (0.45%) were observed with application of nutrients through 75% RDF + 6 t Enriched Compost while maximum content of potassium (0.46%) was found with 100% RDF + 20 t FYM ha^{-1}. The soil samples of the experiments were analyzed through the methods like available nitrogen, phosphorus, potassium, sulfur, organic C and Soil pH and EC.

Keywords Rice, Rock phosphate enriched compost, Yield, Growth, Content.

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INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food for more than 60% of the world's population and plays a vital role in the economic and social stability of the world. India is the second largest producer of rice only after China. In India, area under cultivation of rice is around 45.0 m ha with production of 106.29 million tonnes. Uttar Pradesh is the largest rice growing state after West Bengal, India in which it is raised over an area of about 5.29 m ha with the production of 14.41 million tonnes which is 13.80% of total Indian rice production. The conjunctive application of organics with inorganic sources of nutrient reduces the dependence on chemical inputs and it not only acts as a source of nutrient but also provides micronutrient as well as modifies the soil physical behavior and increases the efficiency of applied nutrients (Pandey et al. 2007). Utilization of indigenous organic sources, viz. farmyard manure (FYM), obnoxious weeds and green leaf manures may serve as alternatives or supplements to chemical fertilizers and help in increasing the productivity of the rice-based cropping system in all zones of the country. Organic manures play a vital role in sustaining higher productivity in intensive agriculture and irrigated rice in particular. The integrated use of enriched compost and inorganic fertilizers ensures higher productivity, minimizes expenditure on costly fertilizer inputs, improves physical properties of soil, efficiency of added nutrients and at the same time ensures good soil health and is also an environment-friendly approach (Mishra et al. 2006, Mohanty et al. 2013, Sharma and Sharma 2002). Combined application of chemical fertilizers and enriched compost improved rice productivity. Phosphorus plays a vital functional role in energy transfer and metabolic regulation and it is an important structural component of many molecules. Both phosphorus status and P-fixing capacity of soil strongly influences the phosphorus availability. Organic fertilizers not only act as the source of nutrients, but also provide micronutrients and modify soil-physical behavior as well as increase the efficiency of applied nutrients. Integration of organic sources such as vermicompost and FYM may also help in the restoration of soil health (Pillai et al. 2007).

Recycling/composting of organic wastes is one of the major solutions for reducing the huge piles of organic wastes and converting it into a value added product. Value addition in organic manures is a system of agriculture that uses environmentally sound techniques for raising crops and livestock that are used in a certain proportion with synthetic compound (Gomez and Gomez 1984). The methods used in value addition in organic manures seeks to increase long term soil fertility, balance insect and organism populations and reduce air, soil and water pollution while maintaining or increasing levels of production. Availability of FYM and other organic manures to apply to soil as per the recommendation is very difficult. Therefore, there is a need to develop viable technology to increase the efficiency of inorganic fertilizers through enriched organic manures. It has been proved that addition of P-enriched farmyard manure to the soil reduced the fixation and enhanced the availability of P to crops from the native and applied source.

MATERIALS AND METHODS

The field experiment was conducted during rainy season, 2015 at research farm, Institute of Agricultural Sciences. Banaras Hindu University, Varanasi (UP). The eleven treatment combinations comprised with rock phosphate enriched compost and ordinary compost with recommended dose of nitrogen and potassium in Randomized Block Design replicated as thrice. The treatments were T_1-Control N,P, K (00,00,00), T_2-100% RDF, T_3-100% RDF +20 t FYM ha^{-1} (Standard Package of Practice), T_4-75% RDF + 4 t Ordinary Compost, T_5 - 75% RDF +6 t Ordinary Compost, T_6-75% RDF + 4 t Enriched Compost, T_7-75% RDF + 6 t Enriched Compost, T_8-50% RDF+ 4 t Ordinary Compost, T_9- 50% RDF + 6 t Ordinary Compost, T_{10} - 50% RDF + 4 t Enriched Compost, T_{11}-50% RDF + 6 t Enriched Compost. The variety of rice IDR-763 was taken as a test crop. The initial soil of Agriculture Research Farm, I Ag. Sc, BHU, was analyzed through the methods like available nitrogen, phosphorus (Olsen et al. 1954), potassium (Hanway and Heidal 1952), sulfur (Chesnin and Yien 1950), organic C, Soil pH and EC (Jackson 1973) by electrical conductivity meter and found sandy loam in texture (Piper 1996), low in organic carbon (0.28%), available nitrogen (145.52 kg ha^{-1}), moderate in phosphorus (11.62 kg ha^{-1}), potassium content (162.65 kg ha^{-1}), sulfur (10.36 kg ha^{-1}) with a neutral in reaction (7.6 pH) and safe electrical conductivity (0.22) was observed. Nitrogen in grain and straw was determined by modified Kjeldahl method. Oven dried grain and straw samples were digested in diacid mixture and P, K and S were determined by adopting standard methods (Jackson 1973). The fertilizers were applied as half dose of N and full doses of P and K at the time of plantation of rice seedlings and remaining N fertilizer was applied in the two equal splits at 20 and 40 DOS. The recommended doses (100, 75 and 50% ha^{-1}) were applied through urea, DAP and Muriate of potash respectively.

RESULTS AND DISCUSSION

Yield and yield attributes

At harvest, the maximum plant height was observed with 75% RDF + 6 t Enriched Compost (90.23 cm) followed by treatment 100% RDF + 20 t FYM ha^{-1} (88.70 cm) and 75% RDF + 4 t Enriched Compost (81.47 cm) which was 28, 26 and 16% higher over

Table 1. Residual effect of rock phosphate enriched compost and fertilizers application on plant height, no. of tillers per hill, no. of grains per panicle, grain yield, straw yield, harvest index and test weight of rice. Compost applied in previous crop (mungbean) only T_1-Control N, P, K (00,00,00), T_2-100% RDF, T_3-100% RDF + 20 t FYM ha^{-1} (Standard Package of Practice), T_4-75% RDF + 4 t Ordinary Compost, T_5- 75% RDF + 6 t Ordinary Compost, T_6- 75% RDF + 4 t Enriched Compost, T_7-75% RDF + 6 t Enriched Compost, T_8-50% RDF + 4 t Ordinary Compost, T_9-50% RDF + 6 t Ordinary Compost, T_{10}-50% RDF + 4 t Enriched Compost, T_{11} - 50% RDF + 6 t Enriched Compost.

Treat-ments	Rice	Plant height (cm)	No. of tillers hill^{-1}	No. of grains panicle^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Test weight of 1000 grains (g)
T_1	Control	70.47	7.83	82.00	29.58	121.15	19.54	17.17
T_2	100% RDF	81.37	9.50	121.67	36.67	140.43	20.87	20.57
T_3	100% RDF + 20 t FYM ha^{-1}	88.70	11.83	127.33	40.28	148.89	21.26	21.10
T_4	75% RDF + 4 t OC	80.77	11.17	106.33	34.60	133.89	20.59	20.03
T_5	75% RDF + 6 t OC	80.60	11.67	105.67	35.54	131.94	21.26	20.37
T_6	75% RDF + 4 t EC	81.47	12.67	125.00	36.50	141.42	20.53	20.40
T_7	75% RDF + 6 t EC	90.23	13.83	131.00	43.79	154.41	22.47	21.47
T_8	50% RDF + 4 t OC	80.20	10.50	100.67	33.44	131.30	20.43	20.00
T_9	50% RDF + 6 t OC	81.13	11.67	105.00	34.82	134.44	20.78	20.20
T_{10}	50% RDF + 4 t EC	81.10	12.33	110.00	35.65	136.93	20.06	20.37
T_{11}	50 % RDF + 6 t EC	82.03	12.83	116.33	38.33	139.30	20.95	20.97
SEm ±		0.26	0.24	1.69	2.26	5.69	1.06	0.12
CD (p=0.05)		0.74	0.69	4.87	6.52	16.39	3.05	0.35

control (70.47 cm). The plant height of T_7 (75% RDF +6 t Enriched Compost) was at par with 100% RDF + 20 t FYM ha^{-1}. Maximum number of tillers per hill at (Tables 1 and 2) harvesting was observed in treatment 75% RDF + 6 t Enriched Compost (13.83) which was 77 higher over control (T_1) . The critical perusal of data contained in Table 1 showed that number of grains panicle^{-1} increased significant with application of enriched compost and inorganic sources of plant nutrients in crop. The maximum no was recorded with the application of 75% RDF + 6 t Enriched Compost (131 grains panicle^{-1}) which was 60% higher over control. The minimum grains panicle^{-1} was recorded in control (82 grains panicle^{-1}). Grain yield of rice (Table1) increased significantly by application of enriched organic compost and inorganic fertilizer. The maximum grain yield (43.79 q ha^{-1}) was obtained from treatment T_7 (75% RDF + 6 t Enriched Compost)

Table 2. Residual effect of rock phosphate enriched compost and fertilizers application on N, P, K and S (%) content in grain and straw of rice. Compost applied in previous crop (mungbean) only T_1- Control N, P, K (00,00,00), T_2-100% RDF, T_3- 100% RDF +20 t FYM ha^{-1} (Standard Package of Practice), T_4-75% RDF + 4 t Ordinary Compost, T_5 -75% RDF + 6 t Ordinary Compost, T_6-75% RDF + 4 t Enriched Compost, T_7-75% RDF + 6 t Enriched Compost, T_8-50% RDF + 4 t Ordinary Compost, T_9-50% RDF + 6 t Ordinary Compost, T_{10}-50% RDF + 4 t Enriched Compost, T_{11}-50% RDF + 6 t Enriched Compost.

Treat-ments	Rice	N (%)		P (%)		K (%)		S (%)	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	Control	0.83	0.57	0.33	0.10	0.23	0.53	0.30	0.22
T_2	100% RDF	1.04	0.81	0.53	0.22	0.43	0.12	0.37	0.51
T_3	100% RDF + 20 t FYM ha^{-1}	1.07	0.86	0.55	0.23	0.46	0.12	0.40	0.59
T_4	75% RDF + 4 t OC	1.03	0.73	0.52	0.17	0.39	0.11	0.33	0.47
T_5	75% RDF + 6 t OC	1.03	0.75	0.52	0.18	0.38	0.11	0.36	0.55
T_6	75% RDF + 4 t EC	1.03	0.81	0.59	0.21	0.42	0.12	0.42	0.61
T_7	75% RDF + 6 t EC	1.05	0.86	0.63	0.23	0.45	0.12	0.45	0.64
T_8	50% RDF + 4 t OC	1.01	0.71	0.47	0.15	0.34	0.08	0.31	0.49
T_9	50% RDF + 6 t OC	1.03	0.73	0.51	0.17	0.36	0.10	0.33	0.55
T_{10}	50% RDF + 4 t EC	1.03	0.77	0.55	0.18	0.40	0.11	0.39	0.57
T_{11}	50% RDF + 6 t EC	1.05	0.79	0.57	0.21	0.42	0.12	0.42	0.59
SEm ±		0.006	0.005	0.006	0.004	0.006	0.003	0.007	0.010
CD (p=0.05)		0.017	0.015	0.019	0.013	0.017	0.007	0.020	0.029

which has yielded 19, 9, 14 and 48% higher than 100% RDF only, 100% RDF + 20 t FYM, 75% RDF + 4 t Enriched Compost and control, respectively (Table 1). These findings are in direct conformity with Meena (2011), Singh et al. (2000). The lowest grain yield (29.58 q ha^{-1}) registered under control (T_1). The straw yield (Table 1) of ranged from 121.15 to 154.41 q ha^{-1}. The lowest straw yield (121.15 q ha^{-1}) was recorded with control (T_1) and the maximum (154.41 q ha^{-1}) was recorded with T_7 (75% RDF + 6 t Enriched Compost) which had shown about 1.2 time increase over control. Sole application of 100% RDF (T_2) has shown an increase of 16% over control which were statistically at par with each other and these findings have been closely conformed by Gandhi and Sivakumar (2010), Sangeeta et al. (2010). There was a significant increase in straw yield with application of organic and inorganic sources of plant nutrients. Harvest index showed that change was non-significant with application of organic and inorganic sources of plant nutrients. The maximum (22.47%) harvest index value was observed with treatment 75% RDF + 6 t Enriched Compost which resulted 6% increase over T_3 (100% RDF + 20 t FYM) and 8% over T_2 (100% RDF). The minimum harvest index (19.54%) was recorded in treatment T_1. Test weight of rice given in Table 1, it is evident that the test weight ranged from 17.17 to 21.47 g 1000^{-1} grain. The maximum 21.47 g 1000^{-1} grain weight was observed with the application of 75% RDF +6 t Enriched Compost followed by 21.10 g 1000^{-1} grain 100% RDF+ 20 t FYM which had 25 and 23% increased over control. Similar findings were also reported by Chaudhary et al. (2011).

Nutrient content (%)

The N content in grain ranged between 0.83 to 1.07%. The maximum N content was found with 100% RDF + 20 t FYM (1.07%) followed by 1.05% in treatment T_7 and T_{11} which was 28% and 26% higher over control. The minimum N content in grain 1.01% was observed with 50% RDF + 4 t Ordinary Compost in treatment (T_8). The nitrogen content in straw ranged from 0.57 to 0.86% with the maximum content (0.86%) equally under 100% RDF + 20 t FYM and 75% RDF + 6 t Enriched Compost. The phosphorus content in grain ranged between 0.33 to 0.63%. The maximum (0.63%) being in treatment T_7, followed by treatment T_6 (0.59%) and T_{11} (0.57%), respectively. The phosphorus content in straw ranged between 0.10 to 0.23% with maximum phosphorus content (0.23%) was observed in treatment T_7 and T_3 . The K content in grain ranged between 0.37 to 0.66%. Maximum potassium content (0.66%) was observed with 100% RDF + 20 t FYM followed by 75% RDF + 6 t Enriched Compost (0.65%) which were showed about 78 and 75 increase over control, respectively. The minimum (0.45%) was recorded in treatment 50% RDF + 4 t Ordinary Compost which was 21% higher than treatment T_1 (control). The maximum (1.30%) being in treatment T_3, followed by T_7 (1.28%) and T_5 (1.24%). The minimum (1.14%) was recorded in treatment T_8. The potassium content in control (0.67%) and (1.30%) in T_3 which was increased by 94% K concentration in straw. The sulfur content in grain ranged between 0.30 to 0.45%. The maximum S content found with 75% RDF + 6 t Enriched Compost (0.45%) followed by treatment T_6 and T_{11} (0.42%) and T_{10} (0.40%) which registered 50, 40 and 0.33% increase over control. The maximum (0.64%) being in treatment T_7 which have shown about 68% increase over treatment T_1. The minimum (0.48%) was recorded in T_2 (100% RDF only).

CONCLUSION

The residual effect of rock phosphate enriched compost was beneficial in overall growth and development of the rice crop. Soil fertility was also improved with the use of enriched compost and maximum yield was obtained with residual effect of 6 t enriched compost through saving of 25% chemical fertilizers. Therefore, further research may be included of different low cost sources for enriched compost in place of huge amount of organic manures.

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