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Long-term effect of fertilizers and organics on yield of rice (*Oryza sativa*) under rice-wheat sequence in calcareous soil of Bihar

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Abstract
The present investigation on the integrated effect of fertilizers and organics on yield of 30th crop rice (cv.Rajshree) under rice-wheat crop rotation was under taken from a long-term experiment running at RAU, Pusa farm since Rabi, 1988-89. Initial soil of the experimental plot have pH 8.40, E.C 0.36 dSm^{-1}, organic carbon 5 g kg^{-1}, available N, P_2O_5 and K_2O 236, 19.7 and 100.0 Kg ha^{-1}, respectively. Four levels of recommended NPK fertilizers were used as main treatments in main plot (F_0 - 0, F_1 - 50, F_2 - 100 and F_3 -150 percent of RDF) and each main plot was divided into four sub-plots in which organics (M_0 – control i.e. no organics, M_1 –Compost @10 t ha^{-1}, M_2 –crop residue of previous crop and M_3 – Compost @10 t ha^{-1} + crop residue) were superimposed over the chemical fertilizers as sub-plot treatments comprising a total of forty eight treatment combinations. The experiment was laid out in a split plot design with three replications. The recommended N: P_2O_5: K_2O were 120: 60: 40 for rice crop. Result reveals that the grain and straw yield of rice increased significantly with increasing levels of NPK fertilizers. Among the NPK treatments maximum grain yield of rice (45.3q ha^{-1}) and maximum straw yield of rice (76.6 q ha^{-1}) were obtained with 150 per cent NPK. However, the maximum yield at 150 percent NPK was at par with 100 per cent NPK. The yield was further increased with the conjoint application of organics in the order: compost + crop residues> compost > crop residues >no manure. The grain and straw production with the application of compost or crop residue alone were at par. The result indicated that compost @ 10 t ha^{-1} could be substituted with crop residues. The grain yield of rice (38.3 q ha^{-1}) with 50 per cent NPK+ compost+ crop residues was found at par with the grain yield of rice (38.6 q ha^{-1}) obtained at 100 per cent NPK alone which suggest that compost + crop residues could save 50 per cent of the recommended dose of NPK i.e. 60 kg N, 30 kg $P_2O_5$and 20 kg K_2O ha^{-1}.

Keywords: Compost, Crop residues, superimposition, Long- term experiment.

Introduction
To feed the increasing population of already intensively cropped area, we need to grow more food from less area and possibly from marginal quality land. The agricultural scenario of India has completely changed due to modern intensive agriculture with high doses of fertilizers, biocide and high yielding fertilizer responsive varieties of crops. Eighteen long-term experiments reported up to date reveal that while the situation for wheat is reasonably good but there is sign of stagnation or even decline in case of rice productivity. There are numerous possible causes of temporal variability of crop yield including differences in planting date, weather and pressure from pest and diseases. Our soil is subjected to high risk of soil and environmental degradation because of multiple nutrient deficiencies etc. so restoration of degraded soil and ecosystem in tropics is high priority both for food security and for environmental quality.

The integrated use of organic and inorganic fertilizers and their management resulted in higher crop production and better maintenance of soil health. After the introduction of high yielding varieties, rice-wheat rotation is one of the important rotations adopted by farmers in the state of Bihar to which inorganic fertilizers and organic manures are applied with a view to get desirable yield. Fertilizers, no doubt increase the crop yield as well as the respective nutrients' status but at the same time it adversely affects the physico-chemical properties of the soil specially when used in imbalance proportion resulting in the reduction in productivity of the soil which adversely affects the sustainability of crop production. Different organic materials are known to improve the productivity of soil. Though, nutrient recycling through crop residues and organic matter is not new, the economic significance of organic waste has gained momentum in recent years due to its various utilization as a renewable source of energy in the field of agriculture, agro-based and bio-tech industry. Considering the importance of organic waste recycling the present investigations (A part of long-term experiment being carried out by STCR, RAU, Pusa, Bihar. Since Rabi 1988-89) have been undertaken to study the long-term

effect of fertilizers and organic matter on yield of 30th crop rice under rice-wheat cropping system in calcareous soil.

Materials and Methods: A long-term experiment is being carried out by STCR, R.A.U., PUSA since Rabi, 1988-89. At the start of the experiment, the initial soil of was having pH 8.40, E.C 0.36 dSm^{-1}, organic carbon 5 g kg^{-1}, available N, P_2O_5 and K_2O 236, 19.7 and 100.0 Kg ha^{-1}, respectively. Four levels of recommended NPK fertilizers were used as main treatments in main plot (F_0 - 0, F_1 - 50, F_2 - 100 and F_3 -150 percent of RDF) and each main plot was divided into four sub-plots in which organics (M_0 – control i.e. no organics, M_1 –Compost @10 t ha^{-1}, M_2 –crop residue of previous crop and M_3 – Compost @10 t ha^{-1} + crop residue) were superimposed over the chemical fertilizers as sub-plot treatments comprising a total of forty eight treatment combinations. The recommended N: P_2O_5: K_2O were 120: 60: 40 for rice crop. The experiment was laid out in a split plot design with three replications for rice-wheat cropping sequence (rice c.v. Rajshree and wheat cv. UP 262) and 30th crop rice of 16th rotation and their post harvest soil were taken for present study.

Results and Discussion

Influence of Organic manure, crop residue and inorganic fertilizers on grain and straw yield of Rice (cv. Rajshree)

The grain and straw yield of rice (Table-1) as influenced by graded levels of chemical fertilizers and crop residue alone or in combination with organic manure increased significantly with increasing level of fertilizers up to 100 per cent NPK level.

Table 1: Influence of organic manure, crop residues and inorganic fertilizers on yield (q ha^{-1}) of rice under rice-wheat cropping system in calcareous Soil

Treatments	Grain Yield (q ha^{-1})					Straw Yield (q ha^{-1})				
	No organics	Compost @10t ha^{-1}	Crop Residues	Compost + Crop residues	Mean	No Organics	Compost @10 t ha^{-1}	Crop Residues	Compost +Crop residues	Mean
Fertilizers										
No NPK	6.6	17.3	14.6	24.6	15.8	16.6	27.0	25.3	35.3	26.1
50 % NPK	22.6	34.3	33.3	38.3	32.1	34.0	55.0	56.6	61.6	51.8
100% NPK	38.6	42.3	43.3	47.6	43.0	62.6	72.6	70.0	79.3	71.1
150% NPK	40.6	45.6	46.6	48.3	45.3	64.3	78.6	77.3	86.3	76.6
	2 7.1	34.9	34.5	39.7	-	44.4	58.3	57.3	65.6	-
S.Em.$^{+}$- CD 5 % S.Em.$^{+}$- CD 5 %										
Fertilizer (F)		0.85	2.97				0.60	2.07		
Manure (M)		0.45	1.32				0.65	1.91		
FXM		0.90	2.99				1.31	3.83		

The results indicated that levels of fertilizers, organics and their interaction were significant. Grain yield of rice varied from 6.6-48.3 q ha^{-1} with the application of different fertilizer levels and organics. An increase in grain yield of rice over control was 103.2, 172.2 and 186.7 per cent with the application of 50, 100 and 150 per cent NPK fertilizers, respectively whereas, increase

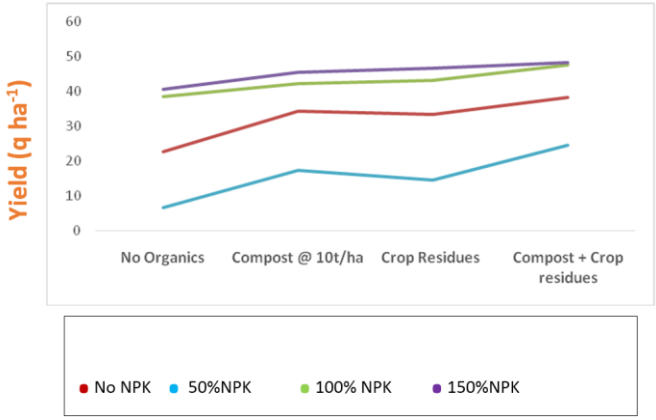

Fig 1: Influence of organic manure, crop residues and inorganic fertilizers on yield (q ha^{-1}) of rice under rice-wheat cropping system in calcareous Soil

In straw yield were found 98.46, 172.4 and 193.4 percent over control with increasing levels on NPK in above sequence. Among the NPK treatment maximum grain yield (45.3 q ha^{-1}) and straw yield (76.6 ha^{-1}) were obtained with 150 per cent NPK which were at par with grain yield obtained at optimum dose of fertilizer (100% NPK). This may be due to increased vegetative growth causing lodging and ultimately decrease in the rate of increase in grain yield at 150 per cent levels of fertilizer.

On incorporation of organic sources, the grain yield of control (27.1 q ha^{-1}) significantly increased to the tune of 28.78, 27.31 and 46.49 per cent with the application of compost, crop residues and compost + crop residue, respectively. Similarly, straw yield in control (44.4 q ha^{-1}) was increased significantly to 31.3, 29.1 and 47.5 per cent due to application of compost, crop residue and compost + crop residue, respectively. The grain and straw production with the application of compost or crop residue alone were at par. This indicates that compost @ 10 t ha^{-1} may be substituted with the application of crop residues. These results are in conformity with results of Prasad (1994) [4], Kulkarni *et al*. (1978) [2] and Rokima (1985). It was also observed that integrated effect of fertilizer and organics were more beneficial than the chemical fertilizer alone. Similar results were also reported by Yadav and Kumar (2002) and Stalin and Stalin *et al*. (2006) [8]. The grain yield in control increased to the tune of 272.2, 69.5, 23.3 and 19.0 per cent with the application of compost + crop residue at 50, 100 and 150 per cent NPK fertilizers, respectively.

This increase in crop yield may be attributed to application of organic manure, which improves the availability of nutrients besides favorable condition for crop growth. Grain yield with 50 % NPK + compost + crop residue (38.3 q ha^{-1}) was at par with yield obtained at 100 % NPK alone (38.6 q ha).Data on straw yield indicates that straw yield of rice follow the similar trend as grain and highest straw yield (86.3 q ha^{-1}) was obtained with 150 % NPK + compost + crop residue.

Similarly, the straw yield obtained at 50 % NPK + compost + crop residue (61.6 q ha^{-1}) was at par with yield obtained at 100 % NPK alone (62.6 q ha^{-1}). The results thus suggested that compost + crop residue could save 50 per cent recommended dose of NPK i.e. 60 Kg N, 30 Kg P_2O_5 and 20 Kg K_2O ha^{-1}. Similar types of results were also reported by Rokima (1985) [5], Pandey (1999) [3], Singh *et al.* (2001 and 2002) [6]. Fertilizers when combined with compost proved slightly better than when combined with crop residue, but overall integrated effect of compost + crop residue with fertilizer on yield parameter was further improved as compared to their individual application. The relative performance of organic manure + crop residue on yield of rice varied in order compost + crop residue (39.67q ha^{-1}.)> compost (34.9 q ha^{-1}.)> crop residue (34.5q ha^{-1}.)> No compost or crop residue (27.1 q ha^{-1}.). Similar types of results were also reported by Gawde *et al.* (2017) [1] where yield of rice significantly increased with increasing the levels of mineral nutrients from 50 to 100% RDF in rice which was at par with 50% RDF+50%FYM-100%RDF.

Conclusion

The grain and straw yield of rice increased significantly with increasing levels of NPK fertilizers up to 100 % level beyond which increase was non-significant. The yield was further increased with the conjoint application of organics in the order: compost + crop residues > compost > crop residues >no manure. More or less similar yield due to the incorporation of compost as well as crop residue indicated that compost @ 10 t ha^{-1} could be substituted with crop residues. The grain yield of rice (38.3 qha^{-1}) with 50 per cent NPK+ compost+ crop residues was found at par with the grain yield of rice (38.6 q ha^{-1}) obtained at 100 per cent NPK alone which suggest that compost + crop residues could save 50 per cent of the recommended dose of NPK i.e. 60 kg N, 30 kg P_2O_5 and 20 kg K_2O ha^{-1}.

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