

Research Article

Response of rice to different organic and inorganic nutrient sources at Parwanipur, Bara district of Nepal

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ABSTRACT

In order to reach an optimum and sustainable production, growers must know the fertilizing nutrient sources and their application rates. The present study aimed to determine the effect of different organic and inorganic source of fertilizers on growth and performance of rice. A field experiment was conducted at Regional Agriculture Research Station, Parwanipur, Bara, Nepal during summer season of 2013. Rice variety 'Hardinath 1' was used in these experiments. Treatments included a combination of organic and inorganic nutrients at eight rates (control, recommended dose of NPK, ½ NPK+FYM 10 t ha⁻¹, ½ NPK+20 cm crop residue, ½ NPK+Chicken manure 10 t ha⁻¹, ½ NPK+Vermicompost 10 t ha⁻¹, FYM 10 t ha⁻¹ and FYM 20 t ha⁻¹). The experiments were laid out in Randomized Complete Block Design with four replications. Treatments produced significant results for plant height, number of tillers per square meter, panicle length and grain yield but thousands grains weight was insignificant. Result showed that application of half of recommended N: P₂O₅: K₂O from the inorganic fertilizer sources along with soil incorporation of 20 cm crop residue produced significantly higher value for plant height, number of tillers per square meter, panicle length and Grain yield. Treatments did not produce significant effect on after harvest soil properties: pH, organic matter, nitrogen, phosphorus and potassium content.

Keywords: Rice, Farm yard manure (FYM), Poultry manure, Vermicompost.

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INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop, extensively cultivated in Nepal. It only accounts for more than 50% of the total calories of Nepalese people (Kharel *et al.*, 2018; Gadai *et al.*, 2019). Rice contributes 20% to the agricultural gross domestic product (AGDP) and 7% to national GDP (MOAD, 2015; Adhikari *et al.*, 2018). To feed ever increasing population, rice production in Nepal has to be increased over 6.0 million tons by 2020 to meet the growing demand of ever increasing population (Kharel *et al.*, 2018). The productivity of rice in Nepal is lower as compared with other rice producing countries like Japan, Indonesia, China, Philippines etc. (Bruinsma, 2009). Low agricultural productivity is because of gradual deterioration of soil health due to application of chemical fertilizers alone without considering the organic sources (Amgain *et al.*, 2017). According to Tilman *et al.* (2002), when inorganic fertilizers are applied without proper care and application practices, it can lead to soil degradation.

Nepalese farmers are growing rice mostly using inorganic fertilizer sources with little or no use of organic sources. According to Chen (2006), the nutrients released from chemical and organic sources have different nature and characteristics, each having its advantages and disadvantages with regard to crop growth and soil quality. The good fertilization strategy, which combines the use of chemical as well as organic sources, that increase crop productivity at the same time maintain or enhance environmental quality should be developed. Presently, indiscriminate use of chemical fertilizers alone has led to environmental pollution and deterioration of soil health. A balance application of major plant nutrients for specific region is important (Baral *et al.*, 2016). The use of organic manures/materials along with chemical fertilizers may be effective for further increasing crop yield in a sustainable basis. In view of this, the study was undertaken to find out effect of organic and inorganic fertilizers on yield of rice as well as soil characteristics under Terai condition.

MATERIALS AND METHODS

The research was carried out during summer of 2013 at Regional Agriculture Research Station, Parwanipur. The area lies in central terai region of Nepal. The site is located in the central piedmont of Nepal at 120 m above mean sea level at 27°21'N and 84°53'E. The soil is with pH 5.67, i.e., moderately acidic (Bhurer, 2013; Khadka *et al.*, 2018). The soil is an Inceptisol formed on Himalayan residuum. The area has a subtropical climate highly influenced by the southwestern monsoon. The average annual rainfall is around 1,550 mm. More than 85% of the rainfall occurs from mid-June to the end of September. November and December are the driest months and light precipitation can be expected in January and February. The mean monthly temperature ranges from a minimum of 8.5°C in January to a maximum of 34.5°C in May (Gami *et al.*, 2001). There were 8 treatments, replicated 4 times in Randomized Complete Block Design (RCBD). The details of treatments are presented in Table 1. Rice variety "Hardinath 1" was used in this experiment. Hardinath 1 was released in 2004, it 120 day of maturity with productivity of 4.0 t/ha and was recommended for terai, inner terai and river basin upto 800 m altitude (SQCC, 2019). The rice variety "Hardinath 1"

was transplanted at spacing of 20 x 20 cm. Half N and full amount of P and K were applied during transplanting. Remaining half of N was top dressed at 30 days after transplanting. All the organic manures were applied during land preparation time. Soil samples were collected from each plot before transplanting and after harvesting of rice for laboratory analysis. The crop was monitored regularly and raised with best possible management.

Table 1: Treatments combinations applied during the field experiment

Treatments	Treatments Description
T1 [Control]	No Nutrients Application
T2 [NPK]	Recommended dose of N:P ₂ O ₅ :K ₂ O @ 100:30:30 kg ha ⁻¹
T3 [½ NPK + FYM 10 t ha ⁻¹]	Half of Recommended NPK + FYM @ 10 t ha ⁻¹
T4 [½ NPK + 20cm Crop Residue]	Half of Recommended NPK + 20 cm Crop Residue
T5 [½ NPK + Chicken Manure 10 t ha ⁻¹]	Half of Recommended NPK + Chicken Manure @ 10 t ha ⁻¹
T6 [½ NPK + Vermicompost 10 t ha ⁻¹]	Half of Recommended NPK + Vermicompost @ 10 t ha ⁻¹
T7 [FYM 10 t ha ⁻¹]	FYM @ 10 kg ha ⁻¹
T8 [FYM 20 t ha ⁻¹]	FYM @ 30 kg ha ⁻¹

The experimental data were processed by using Excel 2010 and analyzed by using Genstat 13.2. The treatment means were compared by the Least Significant Difference (LSD) test at 5% level (Gomez & Gomez, 1984; Shrestha, 2019).

RESULTS AND DISCUSSIONS

Plant Growth and Yield

Treatments produced significantly different effect on all measured parameters: plant height, no of tillers per meter square, panicle length and grain yield, except thousand grains weight at 5% level of significance (Table 2). T4 produced maximum plant height (104.55 cm), followed by T8 (102.65 cm) while the T1 (86.85cm) had the shortest plants. No of tillers per meter square was also observed highest (246) in T4 while lowest in T1 (198). Longest panicle length (27.4 cm) was found in T4 followed by T8 but it was not significantly different with all other treatments except T6, which produced the shortest (24.0 cm) length of panicles. Highest grain yield (2622.80 kg ha⁻¹) of rice was produced by T4, which was followed by T8 (2425.23 kg ha⁻¹) and minimum by T1 (1661.41 kg ha⁻¹). Highest grain weight of thousand grains (213.5 g) was also produced by T4, while lowest by T5 (204.75 g).

The results showed that among the various nutrient combinations, combine application of inorganic fertilizer (half of recommended dose) along with soil incorporation of 20 cm of crop residue produced maximum grain yield as well as all the measured characteristics. Positive effect of straw incorporation was also found by Kumari *et al.* (2018) in rice-wheat cropping system. Zhao *et al.* (2019) compared straw removal with straw incorporation in rice-wheat cropping system and found that increase in wheat yield was significant and rice was not significant. Zhao *et al.* (2019) found the positive influence of straw incorporation on soil aggregation and enzyme activities. Mahapatra (1990) found that one third of the inorganic N can be substituted by applying rice or wheat straw at the time of planting to give similar rice yields. Similar results were also reported by Salahin *et al.* (2017); Sidhu and Beri (1988); Dhar *et al.* (2014).

Table 2: Effect of treatments on plant height, no of tillers m⁻², panicle length, grain yield and 1000 grains weight of rice

Treatments	Plant Height (cm)	No of Tillers/m ²	Panicle Length (cm)	Grain Yield (kg ha ⁻¹)	1000 Grain weight (g)
T1 [Control]	86.85b	198.00b	24.8ab	1661.41b	208.5
T2 [NPK]	94.65ab	203.50ab	25.6ab	1969.98ab	207.5
T3 [½ NPK + FYM 10 t ha ⁻¹]	95.85ab	207.00ab	24.7ab	1963.82ab	206.75
T4 [½ NPK + 20cm Crop Residue]	104.55a	245.75a	27.4a	2622.80a	213.5
T5 [½ NPK + Chicken Manure 10 t ha ⁻¹]	99.70a	216.75ab	25.95ab	2108.24ab	204.75
T6 [½ NPK + Vermicompost 10 t ha ⁻¹]	93.50ab	204.00ab	24.00b	1767.80ab	205.5
T7 [FYM 10 t ha ⁻¹]	99.70a	210.75ab	24.42ab	1946.74ab	208
T8 [FYM 20 t ha ⁻¹]	102.65a	236.25ab	26.52ab	2425.23ab	206
SEM	3.68	14.06	0.9576	263.27	5
p value	0.0025	0.0265	0.0269	0.024	0.7576
CV%	5.36	9.24	5.33	18.09	3.41
Grand mean	97.18	215.25	25.43	2058.25	207.56

Soil properties

After the harvest of rice, laboratory analysis of soil from the experimental plots was done and data were analyzed. Treatments didn't produce significant results for all measured parameters but variation was observed. The result showed that treatment T4 recorded highest pH (5.33), OM (1.73%), and N content (0.09%). Highest P₂O₅ (61 kg ha⁻¹) was found in T5 while highest K₂O 35.25 kg ha⁻¹) was observed in soil from T1. This study showed the positive impact of soil incorporation crop residue along with application of half of recommended NPK from fertilizers on soil pH, organic matter and nitrogen content.

Table 3: Effect of treatments on after harvest soil pH, Organic matter, Nitrogen (%), Phosphorus and Potassium

Treatments	pH	O.M.	N (%)	P ₂ O ₅ (kg ha ⁻¹)	K ₂ O (kg ha ⁻¹)
T1 [Control]	5.23	1.08	0.07	59	35.25
T2 [NPK]	5.17	1.25	0.075	51.5	31.5
T3 [½ NPK + FYM 10 t ha ⁻¹]	5.3	1.62	0.085	52	28
T4 [½ NPK + 20cm Crop Residue]	5.33	1.73	0.09	52.5	21.25
T5 [½ NPK + Chicken Manure 10 t ha ⁻¹]	5.15	0.95	0.065	61	28
T6 [½ NPK + Vermicompost 10 t ha ⁻¹]	5.13	1.13	0.07	50.25	28.25
T7 [FYM 10 t ha ⁻¹]	5.2	1.43	0.0775	47	24.5
T8 [FYM 20 t ha ⁻¹]	5.1	1.15	0.07	43	31.5
SEM	0.1226	0.6088	0.0169	7.36	9.05
p value	0.565	0.8863	0.8189	0.3152	0.85
CV%	3.33	66.71	31.7	20.01	44.84
Grand mean	5.2	1.29	0.0753	52.03	28.33

CONCLUSION

From the study, integrated application of organic manures and inorganic fertilizers was effective for enhancing growth, yield, and the yield components of rice. Soil incorporation of Crop Residues combined with half of recommended chemical fertilizer could be the best option to increase the productivity of the rice in this area. The result indicates the potential for reducing the use of chemical fertilizers without decreasing the yield of rice.

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Authors' contribution

S. Devkota Conducted of experiment, data collection, soil analysis, data analysis, and manuscript writing
 S. Panthi Data analysis, literature review and manuscript writing
 J. Shrestha Data analysis and initial draft writing of manuscript

Conflict of interest

The authors declare that there is no conflict of interest regarding publication of this manuscript.

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