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EFFECT OF NPK LEVELS AND BIO-ORGANICS ON YIELD AND NUTRIENT REMOVAL BY BASMATI RICE CV. HUBR 10-9

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ABSTRACT
A field experiment conducted during rainy season of 2014 at Varanasi to study the effect of NPK levels and bio-organics on basmati rice cv. HUBR 10-9. Results revealed that increasing NPK levels up to 100% RDF (120-60-60 kg ha^{-1}) significantly improved yield attributes, grain yield (52.28 q ha^{-1}) and straw yield(78.19 q ha^{-1}) as well as NPK removal by grain (75.52, 19.12 & 17.33 kg ha^{-1}) and straw (53.31, 7.58 & 118.67kg ha^{-1}). Combined application of FYM + BGA + PSB proved significantly superior resulted increase in grain yield (4.70 & 10.62%) and straw yield (5.02 & 10.96%) over FYM + BGA and FYM alone. Variety HUBR 10-9 shown higher grain and straw yield potential due to NPK application @100% RDF (120-60-60 kg ha^{-1}) combined with FYM + BGA + PSB. Hence, study suggests no saving of fertilizer NPK possible even after integration of bio-organics to the earlier recommended NPK dose.

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for more than 65 per cent of the people and provides livelihood security to 70 per cent of Indian population (Kulkarni *et al.*, 2015). Presently, rice is grown in an area of 43.9 million hectare with a total production of 106.5 million tonnes and average productivity of 24.24 q ha^{-1} (Anonymous, 2014). By the year 2020, India has to produce 170-180 million tonnes of rice with an average productivity of 40.30 q ha^{-1} to continue with the present level of self- sufficiency (Mishra *et al.*, 2006).

Applying inorganic fertilizers even in balanced amount cannot sustain soil fertility and crop productivity under diversified continuous cropping / mono cropping as a result agriculture is now facing lot of stresses (Kundu *et al.*, 2010). Improvement in nutrient use efficiency and their by stabilizing yield and farmer's income are the issues of prime concern.Such issues may be addressed efficiently by adopting integrated nutrient management which emphasizes judicious use of inorganic and bio-organic sources of nutrients to increase the productivity in a sustainable manner.

Farmyard manure is easily available, cheap, proven source of nutrition and has been traditionally used by farmers. Application of cyano bacterial inoculants could be the cheapest and easiest way to increase rice yield because of their capacity to fix atmospheric nitrogen in wetland rice. Among various organic sources, FYM and use of blue green algae (BGA) in wetland rice are the common practices (Begum *et al.*, 2009). Phosphorus solubilising bacteria (PSB) solubilise the fixed soil phosphorus and increase the efficiency of applied phosphate resulting in higher rice yield (Gull *et al.,* 2004).

Basmati rice cultivation is popular mainly in the 13 districts of North Western Uttar Pradesh and a comprehensive study indicated that non-traditional basmati varieties have higher productivity and profitability thus area under non-traditional basmati rice is increasing. The productivity of non-traditional basmati varieties ranged between 3.5-4.0 tonne ha^{-1} compared to the traditional basmati cultivars which ranged between 2-3 tonne ha^{-1} (Singh *et al.*, 2006). Attempts have been made to develop medium maturity scented (HUR-105, 2009) as well as basmati rice varieties (HUBR 2-1, 2005; HUBR 10-9, 2013) under irrigated conditions with considerably high productivity and wider adaptability to diverse agro-eco regions. The average productivity of the recently released basmati cultivar (HUBR 10-9) is highest among the basmati group (6-6.5 tonne ha^{-1}). Thus, it is hypothesized that to exploit the production potential of new basmati variety there is an urgent need to find out and readjust the integrated nutrient management practice for Varanasi region. The objective of the present study was to compare the effect of NPK levels in conjunction with bio-organics on yield attributes, yield and removal of primary nutrients by basmati rice cv. HUBR 10-9 under eastern Uttar Pradesh conditions.

MATERIALS AND METHODS

The field experiment was carried out during rainy season of

2014 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to compare the effect of NPK levels in conjunction with bio-organics on yield attributes, yield and removal of primary nutrients by basmati rice cv. HUBR 10-9 under eastern Uttar Pradesh conditions. Soil samples (0-15 cm depth) were collected from experimental site and analysed for mechanical and physico-chemical properties. The soil was sandy clay loam in texture, neutral in reaction pH 7.52, low in organic carbon 0.41% (Jackson, 1973), low in available nitrogen 213.07 kg ha^{-1} (Subbiah and Asija, 1956), medium in available phosphorus 25.60 kg ha^{-1} (Olsen *et al*., 1954) and potassium 156.80 kg ha^{-1}(Jackson, 1973). Factorial experiment was laid out in randomized complete block design involving four NPK levels *i.e.* control , 50% RDF , 75% RDF and 100% RDF and three bio-organic sources *viz*. FYM, FYM + BGA and FYM + BGA + PSB with a total of twelve treatment combinations replicated thrice. Recommended dose of fertilizer (RDF) for Varanasi region N-P_2O_5-K_2O (120-60-60 kg ha^{-1}) used to calculate various NPK levels. Half of the nitrogen and full dose of phosphorus and potassium applied basally and the remaining half nitrogen was applied in two equal splits at active tillering and panicle initiation stages as per treatments to their respective plots. Fertilizer sources used for NPK were urea (46% N), di-ammonium phosphate (18% N and 46% P_2O_5) and muriate of potash (60% K_2O). Four week old seedlings of recently recommended Basmati cultivar HUBR 10-9 were transplanted on the puddled field during third week of July keeping two seedlings hill^{-1} at a spacing of 20 cm × 15 cm. Well decomposed FYM was applied uniformly @ 5 tonne ha^{-1} two days prior to transplanting in all the experimental plots. Blue green algae was applied @ 10 kg ha^{-1} 10 days after transplanting in the respective treatments. The liquid PSB culture (*Bacillus polymyxa*) obtained from the Department of Soil Science and Agricultural Chemistry, BHU was used for seedling treatment. Before transplanting, inoculants suspension prepared with water in ratio of 1:10 and seedling roots were dipped in solution for about 30 minutes under shade and transplanted immediately to their respective plots. Throughout the crop period, experimental crop received 757.9 mm rainfall and about ± 5 cm water level was continuously maintained till flowering then after field was kept under saturated condition. Recommended agronomic practices were followed to raise the experimental crop. The N content in grain and straw was analysed by micro Kjeldahl method. Phosphorus was determined by Vanado molybdo phosphoric acid yellow colour method and potassium by Flame photometer (Jackson, 1973). Nutrient removal by grain and straw for individual treatment was calculated by multiplying grain and straw yield with respective nutrient content. The data recorded were analyzed following standard statistical analysis of variance procedure as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Yield attributes and yield

Increasing NPK levels significantly increased panicle length, panicle weight, number of filled spikelets panicle^{-1} and straw yield up to 75% RDF. Further increment in NPK level (100% RDF) though increased the values but remained at par with 75% RDF. Increase in the levels of NPK up to 75% RDF significantly reduced the number of unfilled spikeletspanicle^{-1}. Further increase in NPK level (100 % RDF) though reduced the number of unfilled spikelets panicle^{-1} but could not reach to the level of significance. Highest number of unfilled spikelets panicle^{-1} was noted with the control treatment. Rice grain yield increased significantly with each increment in the NPK level up to the highest level of 100% RDF which registered maximum grain yield (52.28 q ha^{-1}). Continuous supply of nutrients in balanced amount throughout the growth period augmented production of sufficient photosynthates and their effective translocation from source to sink resulted in better yield attributes, grain and straw yield. Similar findings were also reported by Singh *et al*. (2014) and Srivastava *et al*. (2014).

Various bio-organics significantly affected length and weight of panicle, number of filled spikelets panicle^{-1}, number of unfilled spikelets panicle^{-1}, grain and straw yield. The maximum value for these parameters except number of unfilled spikelets

Table 1: Effect of NPK levels and bio-organics on yield attributes and yields of rice

Treatments	Panicle length (cm)	Panicle weight (g)	Number of filled spikelets panicle^{-1}	Number of unfilled spike lets panicle^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
NPK levels (% RDF)						
0	21.94	2.57	101.71	32.81	39.67	59.50
50	22.98	2.99	128.64	25.72	47.44	71.17
75	23.72	3.23	138.98	22.64	50.03	76.02
100	24.29	3.36	144.29	21.73	52.28	79.19
SEm±	0.23	0.06	1.98	0.51	0.75	1.13
CD (*P*=0.05)	0.69	0.20	5.83	1.52	2.22	3.32
Bio-organics						
FYM	22.57	2.81	121.02	26.47	44.92	67.72
FYM + BGA	23.21	3.04	129.55	25.70	47.46	71.55
FYM + BGA + PSB	23.91	3.26	134.64	25.00	49.69	75.14
SEm±	0.20	0.05	1.72	0.45	0.65	0.98
CD (*P*=0.05)	0.60	0.17	5.05	1.32	1.92	2.88
Interaction	NS	NS	NS	NS	NS	NS

RDF: N-P_2O_5-K_2O (120-60-60 kg ha^{-1}), FYM (Farmyard manure) @ 5 tonne ha^{-1}, BGA (Blue Green Algae), PSB (Phosphate Solubilising Bacteria)

Table 2: Effect of NPK levels and bio-organics on nutrient removal by rice grain and straw

Treatments	Nitrogen removal (kg ha^{-1})		Phosphorus removal (kg ha^{-1})		Potassium removal (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
NPK levels (% RDF)						
0	44.79	28.35	12.47	3.14	10.55	71.92
50	62.73	42.49	16.75	5.62	14.23	99.10
75	70.33	49.01	18.09	6.86	16.03	111.60
100	75.52	53.31	19.12	7.58	17.33	118.67
SEm±	1.12	1.03	0.28	0.11	0.32	2.00
CD (P=0.05)	3.29	3.03	0.82	0.32	0.95	5.87
Bio-organics						
FYM	58.04	37.92	15.52	5.12	13.33	92.44
FYM + BGA	63.51	43.50	16.65	5.81	14.55	100.50
FYM + BGA + PSB	68.48	48.45	17.65	6.46	15.72	108.03
SEm±	0.97	0.89	0.24	0.09	0.28	1.73
CD (P=0.05)	2.85	2.62	0.71	0.28	0.82	5.09
Interaction	NS	NS	NS	NS	NS	NS

RDF: N-P_2O_5-K_2O (120-60-60 kg ha^{-1}), FYM (Farmyard manure) @ 5 tonne ha^{-1}, BGA (Blue Green Algae), PSB (Phosphate Solubilising Bacteria)

panicle^{-1} was found associated with combined use of FYM + BGA + PSB which was significantly higher than the application of FYM + BGA and sole application of FYM. Combined use of FYM + BGA + PSB also resulted in lowest number of unfilled spikelets panicle^{-1} observed significantly lower than application of FYM alone only but statistically at par with application of FYM + BGA. Application of FYM alone and FYM + BGA observed comparable in respect of unfilled spikelets panicle^{-1}. Yield enhancement due to combined application of FYM + BGA + PSB may not be solely due to balanced nutrient supply, N fixation or phosphate solubilisation, but also because of several other factors such as release of growth promoting substances, control of plant pathogens and proliferation of beneficial organisms in the rhizosphere. Increased values of yield attributes, grain and straw yield may be ascribed to combined application of bio-organics which might enhance soil microbial population resulting better root proliferation, nutrients availability and their uptake, ultimately led to the better dry matter production and its distribution in the crop. The result substantiates the findings of Quyen and Sharma (2003), Singh *et al*. (2013) and Meena *et al*. (2015).

NPK removal

Increasing NPK levels resulted significant increase in NPK removal by grain and straw. Maximum NPK removal by grain and straw was recorded with 100% RDF while the minimum removal was noticed with the control treatment. The increase in the uptake of nutrients with increasing dose of NPK seems because of greater availability of these nutrients and prolific root system developed due to balanced application of nutrients, resulting better absorption of nutrients (Brar *et al*., 1995). Result supports the findings of Murali and Setty (2001) and Srivastava *et al*. (2014). Among bio-organics, combined use of FYM + BGA + PSB removed higher N, P and K by grain and straw. Removal of NPK observed minimum by grain and straw with FYM alone and increased significantly with addition of each bio-organic source (BGA and PSB) and reached to its maximum with use of FYM + BGA + PSB. Farmyard manure helped in the proliferation of BGA and PSB and supplied considerable N and P from its own and also through the process of N fixation and P solubilisation. Hence, increased nutrients availability in soil led to better uptake by crop. Bhat *et al*. (2005) and Kumar *et al*. (2010) also reported similar results.

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