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Impact of Organic and Inorganic Source of Nutrients on Growth and Yield of Basmati Rice under SRI

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A B S T R A C T

A field investigation was carried out at Agronomy Research Farm-N.D. University of Agriculture & Technology, Kumarganj-Ayodhya during rainy (*kharif*) season of 2017 and 2018 to study the effect of different sources of nutrients on growth and yield of basmati rice. The experiment was laid-out in randomized block design with ten treatments and three replicates. The results revealed that plant height, number of tillers hill^{-1}, dry matter accumulation gm^{-2}, length of panicles, grains/panicle, test weight, and grain and straw yields increased significantly over control due to fertilizer application. The maximum values of growth, yield attributes and grain (56.50 and 59.00 q/ha) and straw yield (75.93 and 78.43 q/ha) were recorded with 125% RDF+25% VC closely followed by 125% RDF+25%FYM, indicating the superiority of vermicompost over FYM. Application of VC and FYM was found to be more beneficial in terms of growth and yield of basmati rice. The uptake of N, P and K was highest with 125% RDF+25% VC and lowest in control. Net returns (Rs. 79976.78 /ha) and B:C ratio (2.22) were also highest with 125% RDF+25% VC.

Introduction

Rice (*Oryza sativa* L.) is one of the most important stable food crops in the world. It belongs to family Poaceae (Gramineae). It is a high calorie food which contains 75% starch, 6-7% protein, 2-2.5 % fat, 0.8% cellulose and 5–9 % ash. In Asia, more than two billion people are getting 60-70 % of their energy requirement from rice and its derived products. Rice is cultivated world-wide over an area of about 160.68 million ha^{-1} with an annual production of about 650.19 million tonnes. In India rice is cultivated over an area of about 39.16 million hectares with an annual production of about 85.59 million tones and the productivity of 2.20 tonnes ha^{-1}. Utter Pradesh is an important rice growing state in

the country. The area and production of rice in this state is about 13.84 million hectare and 14.00 million tonnes respectively with an average production of 2.35 tonnes (Tomar *et al.*, 2018). Further, to sustain present food self- sufficiency and to meet future food requirements, India has to increase its rice productivity by 3 percent per annum. Rice cultivation requires large quantity of water and for producing one kg rice, about 3000-5000 litres of water is required depending on the different rice cultivation methods such as transplanted rice, direct sown rice (wet seeded), alternate wetting and drying method (AWD), system of rice intensification (SRI) and aerobic rice, respectively. Application of inorganic fertilizers alone could not sustain the soil fertility and productivity under cropping sequences. There are valuable benefits of integrated nutrient management over sole application of the individual fertilizer sources in improving yield and nutrient uptake and properties of the soil in rice based cropping system (Wolie and Admassu, 2016). Valuable benefits of The price of inputs, mainly inorganic fertilizers, is increasing day by day, therefore emphasis is needed to maximize the nutrient-use efficiency and grain yield, and minimize the cost of production. The efficiency of applied nutrient may be raised by the combined use of organic and inorganic fertilizers or supplying the nutrients at the peak period of absorption.

Materials and Methods

The present experiment was conducted during *Kharif s*eason 2017 and 2018 at Agronomy Research Farm in Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya. The experimental soil was silty loam with pH (8.30 and 8.29) having low organic carbon (0.31 and 0.32 %), available nitrogen (180.20 and 182.82 kg ha^{-1}) and medium in available phosphorus (13.70 and 13.80 kg/ha) and high in potassium (208.22 and 212.32 kg/ha). The experiment was laid out in randomized block design with three replications. The experiment included ten treatments, viz. T_1- Control, T_2- 100% RDF, T_3-125% RDF, T_4-150% RDF, T_5-75% RDF+25% FYM, T_6-75% RDF+ 25% VC, T_7-100%RDF +25% FYM, T_8-100% RDF +25% VC, T_9- 125% RDF+25%FYM and T_{10}-125% RDF+25% VC. Potassium in the form of muriate of potash was applied at planting; the crop received nitrogen in the form of half as basal and the rest half dose of nitrogen was top dressed in two splits i.e. after first at 45 and second 60 days after transplanting. Phosphorus was applied as DAP at transplanting. Well decomposed farmyard manure (0.51% N, 0.25% P and 0.55% K) and vermicompost (2.5% N, 1.5% P and 1.5% K) were applied as per the treatments two week before transplanting. The seedlings of rice, cv. Pusa Basmati-1 were transplanted in first week of July by keeping planting geometry of 25×25 cm with the seed rate 4 kg/ha. The crop was harvested second week of November during 2017 and 2018, respectively. The observations on growth attributes, yield attributes and yields of the crops were recorded through standard procedures. Plant samples (grain and straw) were collected at harvest and analyzed for NPK uptake. The data were statistically analyzed by using statistical procedures and comparisons were made at 5% level of significance.

Results and Discussion

Growth and yield attributes

Addition of various sources of organic manures along with inorganic fertilizers influenced growth characters of basmati rice positively (Table 1 and 2). Application of 125% RDF+25% VC improved the growth and yield attributes significantly over control, and relatively higher values of these parameters were recorded with 125%

RDF+25% VC. This could be due to availability of nutrients in balanced and adequate amounts. The crop receiving higher amounts of nutrients through organic or inorganic nutrient sources recorded higher plant height and number of tillers/hill.

Among the nutrient management practices, application of 125% RDF+25% VC produced taller plants (103.0 and 104.57 cm), higher number of tillers/hill (20.68 and 21.96), dry matter accumulation (820.44 and 821.35 gm^{-2}), length of panicles (25.0 and 26.18 cm), grains/panicle (197.0 and 198.04), test weight (23.02 and 23.97 g) during both the years, respectively. The lowest values of these growth and yield attributes were recorded under control. Adequate and continuous availability of nutrients with NPK or combined use of organic manures with NPK might have improved the growth and yield attributes of basmati rice crop (Tomar *et al.,* 2018). The addition of organic manure significantly influenced the beneficial microorganisms to colonize in rhizosphere and stimulate plant growth by providing necessary nutrients besides synthesizing some plant hormones Venkatasalam *et al.,* (2012); which may be the reason for increase in growth and yield attributes in treatments supplied with organic manures.

Productivity

The grain and straw yields of basmati rice exhibited significant variation due to different nutrient management practices (Table 2). Application of 125% RDF+25% VC (T_{10}) recorded the highest grain (56.50 and 59.00 q/ha) and straw yield (75.93 and 78.43 q/ha) and found statistically at par with T_8 and T_9. The lowest grain yield (28.24 and 28.74 q/ha) and straw yield (55.02 and 55.52 q/ha) of basmati rice were recorded in T_1 (control) during both the cropping season, respectively. These trends are in consonance with earlier reports of Tomar *et al.,* (2018).

Total nutrient uptake

The total uptake N, P and K by basmati rice varied significantly under different nutrient management practices (Table 3). Integrated nutrient management practices (T_{10}) recorded significantly higher uptake of N (120.57 and 125.90 kg ha^{-1}), P (34.67 and 36.40 kg ha^{-1}) and K (119.13 and 146.43 kg ha^{-1}) which was significantly superior to all the rest of the treatments and the lowest uptake of N (60.16 and 61.54 kg ha^{-1}), P (14.85 and 15.63 kg ha^{-1}) and K (68.61 and 78.51 kg ha^{-1}) was recorded under control plots during both the years, respectively. The higher uptake of nutrients under integrated nutrient management (T_9 and T_{10}) was ascribed to continuous supply of nutrients throughout the crop growth period as the nutrients from inorganic sources were readily available to the crop in the early stages besides the slow and continuous release of nutrients from the organic source made available at later stages of the crop growth. Higher uptake of N, P and K under organic-inorganic nutrient combination was also reported by Pandey *et al.,* (2007) in rice.

Economics

Economic analysis reveals that the net returns and B:C ratio of basmati rice differed noticeably in different nutrient management options (Table 2) and that was directly related to the price of the crop produce and cost incurred on nutrient inputs under different treatments. The highest net returns of basmati rice (Rs 79976.78 Rs/ha) were recorded in T_{10}-125% RDF+25% VC followed by T_9.

Table.1 Effect of different nutrient management practices on plant height (cm), number of tillers hill^{-1}, dry matter accumulation gm^{-2}, length of panicles (cm) and grains/panicle of basmati rice

Treatments	Plant height at harvest		number of tillers at harvest		dry matter accumulation at harvest		length of panicles		grains/panicle	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
T_1-Control	91.05	91.41	15.68	15.80	544.26	548.92	20.70	20.96	120.47	120.92
T_2-100% RDF	94.31	95.56	16.29	17.29	805.59	806.50	21.85	22.33	188.44	189.41
T_3-125% RDF	96.89	101.34	17.41	18.34	811.32	812.44	23.16	23.59	194.54	195.07
T_4-150% RDF	100.33	102.94	19.44	20.85	817.81	818.83	23.86	25.22	196.02	197.13
T_5-75% RDF+25% FYM	95.97	98.02	16.47	18.01	807.12	808.29	22.54	22.96	188.49	189.27
T_6-75% RDF+25%VC	96.48	100.69	17.01	18.04	808.71	809.46	22.91	23.01	192.90	193.75
T_7 -100% RDF+25% FYM	98.89	101.42	18.45	19.30	813.90	814.18	23.61	23.96	195.61	196.06
T_8-100% RDF+25% VC	99.50	102.75	19.97	20.25	816.00	817.06	23.77	24.92	195.67	196.83
T_9 -125% RDF+25% FYM	102.18	103.93	20.56	21.13	819.38	820.42	24.53	25.50	196.72	197.60
T_{10}-125 RDF+25% VC	103.00	104.57	20.68	21.96	820.44	821.35	25.00	26.18	197.00	198.04
SEM±	**1.14**	**1.18**	**0.36**	**0.38**	**17.57**	**18.13**	**0.36**	**0.39**	**0.83**	**0.84**
CD (P=0.05)	**3.39**	**3.52**	**1.07**	**1.41**	**52.19**	**53.85**	**1.08**	**1.15**	**2.46**	**2.48**

Table.2 Effect of different nutrient management practices on test weight (g), grain yield (q/ha), straw yield (q/ha), net return (Rs./ha) and B:Cratio (pooled of two season data) of basmati rice

Treatments	test weight		grain yield		straw yield		net returns	B:C ratio
	2017	2018	2017	2018	2017	2018		
T_1-Control	19.08	19.73	28.24	28.74	55.02	55.52	33841.46	1.27
T_2-100% RDF	19.66	20.61	43.95	44.70	62.32	63.07	56957.83	1.74
T_3-125% RDF	20.95	21.97	46.78	47.68	65.66	66.56	61281.48	1.80
T_4-150% RDF	22.51	22.65	52.07	53.47	70.61	72.01	70877.13	2.01
T_5-75% RDF+25% FYM	20.06	21.31	44.02	44.82	64.06	64.86	53215.71	1.44
T_6-75% RDF+25%VC	20.58	21.34	45.65	46.50	64.70	65.55	60004.16	1.81
T_7 -100% RDF+25% FYM	21.05	22.13	48.28	49.28	66.91	67.91	60033.78	1.57
T_8-100% RDF+25% VC	21.52	22.5 1	51.48	52.68	69.00	70.20	69991.78	2.02
T_9 -125% RDF+25% FYM	22.90	23.89	54.52	56.42	73.43	75.33	71665.58	1.80
T_{10}-125 RDF+25% VC	23.02	23.97	56.50	59.00	75.93	78.43	79976.78	2.22
SEM±	**0.12**	**0.13**	**0.40**	**0.42**	**0.30**	**0.33**	-	-
CD (P=0.05)	**0.37**	**0.40**	**1.18**	**1.25**	**0.88**	**0.97**	-	-

Table.3 Effect of different nutrient management practices on total uptake of N, P and K (kg/ha) of basmati rice

Treatments	total uptake of N		total uptake of P		total uptake of K	
	2017	2018	2017	2018	2017	2018
T_1-Control	60.16	61.54	14.85	15.63	68.61	78.51
T_2-100% RDF	90.71	92.35	23.35	23.86	85.51	101.91
T_3-125% RDF	97.42	99.36	26.26	26.98	94.04	113.04
T_4-150% RDF	110.59	113.53	31.32	32.35	110.32	133.05
T_5-75% RDF+25% FYM	92.09	93.82	24.35	24.90	88.91	105.65
T_6-75% RDF+25%VC	95.00	96.86	25.12	25.75	92.15	110.06
T_7 -100% RDF+25% FYM	100.89	103.00	27.58	28.93	100.45	120.24
T_8-100% RDF+25% VC	106.80	109.49	29.76	31.06	107.11	128.83
T_9 -125% RDF+25% FYM	116.00	119.87	33.00	34.36	114.90	139.80
T_{10}-125 RDF+25% VC	120.57	125.90	34.67	36.40	119.13	146.43
SEM±	**0.86**	**0.87**	**0.36**	**0.37**	**0.81**	**1.10**
CD (P=0.05)	**2.55**	**2.85**	**1.07**	**1.09**	**2.42**	**3.20**

Higher net returns may be attributed to a higher grain yield. Among the various nutrient treatments, maximum B:C ratio of 2.22 was recorded under 125% RDF+25% VC. Similar results were reported by Barik *et al.*, (2008). The minimum values of net returns (Rs. 33841.46 Rs/ha) and B:C ratio (1.27) were recorded under control due to poor yield of rice.

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