

Productivity and profitability of basmati rice (*Oryza sativa*) in response to integrated use of organic and inorganic sources of nutrients

KOMAL YADAV¹ AND R.B. YADAV²

Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh 250 110

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ABSTRACT

An experiment was carried out during the rainy (*kharif*) season 2013, to study the effect of inorganic and organic sources of nutrients on plant growth, productivity and economics of basmati rice in rice (*Oryza sativa* L.)–wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] cropping system at Meerut, Uttar Pradesh. Ten treatments consisting of control (N₀ P₀ K₀), 100% recommended dose of fertilizers (RDF) (120 : 60 : 60 NPK kg/ha) and 125% RDF were studied against combination of organic manures with chemical fertilizers, i.e. 50% RDF + vermin-compost (VC) @ 3.82 t/ha, 50% RDF + farm yard manure (FYM) @ 11.71 t/ha, 50% RDF + poultry manure (PM) @ 1.85 t/ha, 50% RDF + VC (@ 1.91 t/ha) + FYM (@ 5.85 t/ha), 50% RDF + VC (@ 1.91 t/ha) + PM (@ 0.97 t/ha), 50% RDF + FYM (@ 5.85 t/ha) + PM (@ 0.97 t/ha) and 50% RDF + FYM (@ 3.90 t/ha) + PM (0.65 t/ha) + VC (@ 1.32 t/ha), in randomized block design with 3 replications. Highest plant height, tillers, dry matter, yield attributes and grain yield (4.56 t/ha) of Basmati rice were recorded with the application of 125% RDF through inorganic source of nutrients which was statistically at par with the treatment of 50% RDF + poultry manure (4.28 t/ha) and significantly higher than 100% RDF (3.84 t/ha) and the control. Among different combination of organic manures with inorganic sources of nutrients, the replacement of 50% RDF with poultry manure recorded in significantly higher yield attributes and yield along with higher net returns and benefit: cost ratio.

Key words : Basmati rice, Net returns, Organic and inorganic sources of nutrients, Productivity

The high-yielding cultivars of basmati rice, which have higher nutrient requirements, the use of inorganic fertilizers alone has increased considerably imbalance of nutrients in soil (Hossain and Singh, 2000). Perverse to detrimental effects of inorganic fertilizers, organic manures are available indigenously which improve soil health resulting in enhanced crop yield. However, the use of organic manures alone might not meet the plant requirement due to limited availability and presence of relatively low levels of nutrients (Kumar *et al.*, 2014). It is widely recognized that neither use of organics alone nor chemical fertilizers can achieve the sustainability of the yield under the modern intensive farming. Therefore, adoption of modern inte-

grated nutrient management (INM) farming practices consisting chemical fertilizers in conjunction with application of organics such as farmyard manure (FYM), crop residues, industrial and urban wastes, poultry manures are essential to produce rice crop of standards quality and in enough quantity (Ramalakshmi *et al.*, 2012). Since, much attention has not been paid on the integrated use of poultry manure along with FYM or vermi-compost in basmati rice production in conjunction with chemical fertilizers, the present research work was conducted.

A field experiment was conducted during rainy (*Kharif*) season (June–November) of 2013 at Crop Research Centre of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh. The soils had 155.4 kg/ha alkaline permanganate-oxidizable N, 14.76 kg/ha available P, 139.82 kg/ha 1 N ammonium acetate-exchangeable K and 7.6 pH. The rice variety ‘Pusa Basmati 1121’ was transplanted at 20 cm × 15 cm spacing on 16 July 2013. The net plot size was 4.0 m × 3.2 m. Recommended dose of fertilizers was applied through urea, diammonium phosphate (DAP) and muriate of potash (MOP) to supply the nitrogen, phosphorus and potash respectively. Half dose of nitrogen and full dose of phos-

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Corresponding author Email: ykomal87@gmail.com

¹Research Scholar, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 263 145; ²Associate Professor, Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh 250 110

phorus and potash were applied basal and remaining half nitrogen was top dressed in 2 split doses through urea. As per treatments the 50% of recommended dose of fertilizers were applied through organic manures, i.e. farmyard manure (FYM), vermin-compost (VC) and poultry manure (PM), it was calculated on the basis of nitrogen present in that particular organic manure. All the organic manures were applied and mixed in soil 15 days before the transplanting. Observations on plant growth, yield attributes, yield and economics of basmati rice were recorded as per standard procedures. All the data under randomized block design were statistically analysed using the *F*-test as per the standard procedure. LSD values at *P* = 0.05 were used to determine the significance of difference between treatment means.

Results showed that plant growth parameters, viz. plant height, number of tillers and dry-matter, were the lowest with control treatment and increased significantly with increasing rates of fertilizers application up to 125% RDF (Table 1). The highest plant height, tillers/m² and dry-matter accumulation were recorded with application of 125% RDF at harvesting stage and all these parameters were the lowest with the control. The crop growth expressed in terms of plant height, number of tillers and dry-matter of crop, increased significantly owing to different combination of organic and inorganic fertilizers. Kumar (2001) also reported similar findings. In present study, integrated use of organic and inorganic sources of nutrients had significant bearing on the number of tillers/m² in respect of rate of fertilizer application in different mode. In present context, the various organic, inorganic and integrated fertilizer treatments exhibited significant influence on the dry-matter accumulation at the maximum tillering stage.

All the treatments including 125% RDF and use of organic sources of nutrient with inorganic produced significantly higher dry matter than the common practice of applying inorganic nitrogen, i.e. 100% RDF. The increase in plant height and dry-matter of rice owing to application of 125% RDF might be associated with stimulating effect of nitrogen levels on various physiological processes including hypertrophy and hyperlasia. Our results confirm the findings of Kumar *et al.* (1995). Adequacy of nitrogen probably favoured the cellular activities during panicle formation and development that led to increased number of tillers/hill. Application of nitrogen fertilizer alone or in combination with FYM, PM or VC significantly enhanced yield attributes like number of panicle, length of panicle, grains/panicle and 1,000-grain weight over the control. Application of 125% RDF resulted in the highest number of panicles/m² which was significantly higher than all other treatments, but statistically at par with 50% RDF + PM. The combination of organic manures with inorganic fertilizer significantly increased number of panicles/m² over 100% RDF as well as the control. Application of 125% RDF recorded the maximum length of panicles, which was statistically at par with 50% RDF + PM, 50% RDF + VC + FYM and 50% RDF + VC + PM and significantly higher than rest of the treatments. Application of nitrogen fertilizer alone or in combination of FYM, PM or VC enhanced the number of grain/panicle. The maximum number of grain/panicle was recorded with 125% RDF which is significantly superior over all other treatments except treatment 50% RDF + PM. The 1,000-grain weight of the crop showed similar trend. The application of 125% RDF resulted in highest value of yield attributes, which might be owing to increased in plant growth parameters that provide

Table 1. Plant growth (at maturity) and yield-attributing characters of rice as influenced by different nutrient management practices

Treatment	Plant height (cm)	Tillers/m ²	Dry-matter (g/m ²)	No. of panicles/m ²	Panicle length (cm)	Total grains/panicle	Test weight (g)
Control (N ₀ P ₀ K ₀)	94.0	270	645	63	18.8	186	20.2
100% RDF (N ₁₂₀ P ₆₀ K ₆₀)	112.0	354	973	97	19.2	190	20.8
125% RDF	120.0	370	1086	107	22.1	196	21.5
50% RDF + VC (@ 3.82 t/ha)	113.3	354	1035	100	21.3	194	21.3
50% RDF + FYM (@ 11.71 t/ha)	112.0	332	1027	102	20.3	191	21.0
50% RDF + PM (@ 1.85t/ha)	116.0	340	1036	104	22.0	195	21.5
50% RDF + VC (@ 1.91 t/ha) + FYM (@ 5.85 t/ha)	117.3	346	1015	101	21.8	192	21.2
50% RDF + VC (@ 1.91 t/ha) + PM (@ 0.97 t/ha)	115.6	332	1015	101	21.8	194	21.4
50% RDF + FYM (@ 5.85 t/ha) + PM (@ 0.97 t/ha)	116.0	342	1023	102	21.0	193	20.7
50% RDF + FYM (@ 3.90 t/ha) + PM (0.65 t/ha) + VC (@1.32 t/ha)	110.0	340	1015	102	19.9	191	20.9
SEm±	2.0	8.9	8.1	1.41	0.26	0.71	0.10
CD(P=0.05)	6.0	26.8	24.3	4.23	0.79	2.12	0.31

RDF, Recommended dose of fertilizers; FYM, farmyard manure; PM, poultry manure; VC, vermin-compost, N-1.5%, P₂O₅-1.02% and K₂O-0.73%, FYM, N-0.5%, P₂O₅-0.2% and K₂O-0.5% PM, N-3.0%, P₂O₅-2.63%, and K₂O- 1.4%

Table 2. Yield and economics of basmati rice as influenced by different nutrient-management practices

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Gross returns ($\times 10^3$ /ha)	Cost of cultivation ($\times 10^3$ ₹/ha)	Net returns ($\times 10^3$ ₹/ha)	Benefit: cost ratio
Control (N ₀ P ₀ K ₀)	2.44	4.05	37.62	94.7	26.0	68.6	1:2.6
100% RDF (N ₁₂₀ P ₆₀ K ₆₀)	3.88	5.94	39.50	150.5	32.1	118.4	1:3.6
125% RDF	4.56	6.49	41.27	176.7	33.6	143.1	1:4.2
50% RDF + VC (@ 3.82 t/ha)	4.17	6.34	39.69	161.8	37.5	124.2	1:3.3
50% RDF + FYM (@ 11.71 t/ha)	4.10	6.31	39.38	159.1	35.4	123.7	1:3.4
50% RDF + PM (@ 1.85 t/ha)	4.28	6.23	40.73	165.8	31.2	134.6	1:4.3
50% RDF + VC (@ 1.91 t/ha) + FYM (@ 5.85 t/ha)	4.14	6.14	40.28	160.5	36.5	124.0	1:3.3
50% RDF + VC (@ 1.91 t/ha) + PM (@ 0.97 t/ha)	4.23	6.18	40.61	163.9	34.3	129.5	1:3.7
50% RDF + FYM (@ 5.85 t/ha) + PM (@ 0.97 t/ha)	4.15	6.35	39.52	161.0	33.3	127.7	1:3.8
50% RDF + FYM (@ 3.90 t/ha) + PM (0.65 t/ha) + VC (@ 1.32 t/ha)	4.12	6.23	39.81	159.7	34.7	125.0	1:3.5
SEm \pm	0.13	0.19	0.04				
CD(P=0.05)	0.39	0.56	0.12				

RDF, Recommended dose of fertilizers; FYM, farmyard manure; PM, poultry manure; VC, vermin-compost, N- 1.5%, P₂O₅-1.02% and K₂O-0.73%, FYM, N-0.5%, P₂O₅-0.2% and K₂O-0.5% PM, N-3.0%, P₂O₅-2.63%, and K₂O- 1.4%

more photosynthetic surface, resulted in the synthesis of more food materials, consequently better development of yield attributes. Various organic, inorganic and integrated fertilizer treatments had significant bearing on the number of panicles/m². The treatment 125% RDF and 50% RDF + PM produced significantly higher number of panicles/m² than all other treatments. Greater survival of tillers under these treatments could be owing to continuous but controlled supply of nutrients particularly N, commensurate with the requirement at different growth stages. Difference in 1,000-grain weight due to different organic and inorganic fertilizer treatments were found significant; may be due to variation in source of nutrient. Grain weight increased significantly with the application of nutrient, through FYM, VC and PM. The results of present investigation in respect of yield attributes are in agreement with the finding of Singh *et al.* (2005).

Application of chemical fertilizer alone or in combination of PM or VC or FYM significantly enhanced the grain yield (Table 2). The highest grain yield (4.56 t/ha) was recorded with the 125% RDF which was statistically at par with the treatment 50% RDF + PM, whereas of lowest yield was recorded in the control plot (2.44 t/ha). The highest straw yield (6.49 t/ha) was obtained with 125% RDF which was statistically at par with all other treatments but significantly higher than the control. Effect of different sources of nutrients on harvest index was also significant. The maximum harvest index was noticed under 125% RDF treatment. Grain yield is function of yield attributes, viz number of tillers, number of grains/panicle, 1,000-grain weight. The increase in yield of rice was prob-

ably owing to the fact that applications of organic manures improve the physio-chemical conditions of soil and better supply of nutrients to crop and ultimately resulted in to higher yields. These findings are in conformity with the finding of Kumar *et al.* (2005). Application of chemical fertilizer alone or in combination of FYM, VC and PM enhanced the net return (Table 2). Application of 125% RDF gave the highest gross returns and net returns, whereas the minimum net returns with the control. Among various treatments with organic combinations, the minimum cost of cultivation was incurred with 50% RDF + PM treatment, whereas the maximum with 50% RDF + VC treatment due to higher cost of vermi-compost. The maximum and minimum benefit: cost ratio was found with treatment 50% RDF + PM and control respectively. Kewat *et al.* (2002) also reported similar results.

Our study indicated that 50% dose of recommended fertilizer can be replaced by organic manures, i.e. vermi-compost or farmyard manure or poultry manure in basmati rice crop which was found economic in terms of cost of production, soil fertility and environmental safety.

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