mergence. Rice yield increase of 10–25% could be achieved through neem-coated urea and better nitrogen management, involving split application of 50% N 1 week after transplanting, 25% N at tillering and the remaining N applied as foliar spray during reproductive stage resulted in the highest yield. Neem-coated urea application resulted in higher net returns and benefit: cost ratio compared to prilled urea.

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Research Paper

Influence of nutrient-management practices on yield, quality and nutrient uptake of scented rice varieties under temperate conditions of Kashmir

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ABSTRACT

A field experiment was conducted under the temperate conditions of Khudwani, Anantnag, Jammu and Kashmir in the rainy (*kharif*) season of 2015 and 2016, to study the influence of nutrient-management practices on performance of scented rice (*Oryza sativa* L.) under. The experiment comprised 2 scented rice varieties, i.e. 'Pusa Sugandh 3' and 'Mushkbudji' evaluated under 8 nutrient-management practices. In general, 'Pusa Sugandh 3' showed significantly higher values of yield and yield attributes, quality parameters, nutrient concentration and their uptake compared to 'Mushkbudji'. However, 'Mushkbudji' recorded higher 1,000-grain weight and head-rice recovery than 'Pusa Sugandh 3'. Application of recommended fertilizer dose (RFD) 60, 40, 20 kg N, P, K/ha + farm yard manure (FYM) @ 5 t/ha + vermicompost (VC) 2.5 t/ha resulted in significantly higher number of panicles, with an overall increase of 12.45% and 23.35% over the RFD and control respectively. Same treatment also resulted in significantly higher grain yield than the other treatments. Among the nutrient-management practices, combined application of VC and FYM along with 75% RFD recorded significantly higher values of amylose content, protein, L: B ratio after cooking over the treatments, RFD and the control. However, head-rice recovery was significantly higher with 75% RFD + 2.5 t/ha VC over the control and RFD + FYM 5 t/ha + VC 2.5 t/ha. Of the nutrient-management practices, the application of RFD + FYM 5t/ha + VC 2.5 t/ha resulted in significantly higher nutrient content compared to sole application of RFD and the control. Significantly higher uptake of these nutrients in both grain and straw were recorded in the treatment receiving RFD along with FYM 5 t/ha and VC 2.5 t/ha followed by 75% RFD along with FYM 5 t/ha and VC5 t/ha. The highest benefit: cost (B: C) ratio of 4.10 and 3.87 was recorded in 'Pusa Sugandh 3' under recommended fertility levels.

Key words: Scented rice, Growth, Yield, Quality, Inorganic and Organic manure

Rice is the staple food for more than half population of the world and two-thirds of Indians depend on rice for their survival. The crop serves as a main staple food followed by maize for major portion of the population of Jammu and Kashmir and is associated with economic, social and cultural heritage of the region (Rashid *et al.,* 2019). Development of high-yielding and early-maturing rice varieties has been the major objectives for plant breeders to ensure food security under temperate conditions of the Kashmir valley. Nowadays, quality considerations also assume enhanced importance and most of the rice producers are looking for ways to improve the quality of their produce, either for local consumption or as a revenue-generating export. As living conditions are improving steadily, human demand for high-quality rice is continuously on increase. In the future, grain quality will be even more important as once the very poor, many of whom depend largely on rice for their staple food become better off and begin to demand higher quality rice (Welch and Graham, 2002; Waza and Jaiswal, 2015).

Among various quality parameters, protein content, milled rice recovery, grain colour, grain dimensions and aroma are of primary importance across the rice-growing areas (Raikar *et al.,* 2009; Singh *et al.,* 2010). The Kashmir valley is well known for indigenous scented *japonica* rices (like 'Mushkbudji','Gulzag', 'Kamad') which have the potential to fetch premium prices in local and international markets.

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Cooking-quality features of scented rice varieties are greatly influenced by environmental factors such as soil fertility, irrigation, plant-to-plant spacing, time of transplanting, harvesting and storage. Moreover, the scented rice varieties extract a substantial amount of major nutrients from the soil and deficiency of these nutrients reduce their grain yield (Singh *et al.,* 2012). Organic manures not only act as the source to replenish these nutrients but also modify the soil physical behaviour as well as increase the efficiency of applied nutrients, thereby enhancing the yield and quality of produce (Sudhakar *et al.,* 2002). It is imperative to use technologies in an integrated manner so that the potential yield of the quality rice can be realized on sustained basis. Integration of organic and inorganic sources of nutrients not only reduces the per unit cost and disease incidence but also maintains the quality of produce. The integrated approach for nutrient management in scented rice not only enhances the yield but also improves soil health and grain quality, besides sustaining the productivity. Therefore, present study was carried out to evaluate the influence of nutrient-management practices on yield and quality parameters of 2 scented varieties of rice under temperate conditions of Kashmir.

MATERIALS AND METHODS

The experiment was conducted at the Mountain Research Centre for Field Crops Khudwani, during the rainy (*kharif*) seasons of 2015 and 2016. The experimental site is situated at (34°N and 74°E, with an altitude of 1,564 m above mean sea-level). The soil (0–15 cm) of the experimental site is silty, clay loam in texture, with *p*H of around 6.9, organic carbon 0.83%, available nitrogen 238 kg/ha, available phosphorus 22.5 kg/ha and available potassium 160 kg/ha. The experiment was carried out in a randomized block design with 3 replications. The treatments comprised 2 scented rice varieties, viz. 'Pusa Sugandh 3' and 'Mushkbudji' grown over the 8 nutrient-management treatment, viz. control (T_1), recommended dose of fertilizer [RFD 60 : 40 : 20 N, P_2O_5, K_2O kg/ha (T_2)], RFD + 5 t FYM/ha (T_3), RFD + 2.5 t VC/ha (T_4), 75% RFD + 5 t FYM/ha (T_5), 75% RFD + 2.5 t VC/ha (T_6), RFD + 5 t FYM + 2.5 t VC/ha (T_7) and 75% RFD + 5 t FYM + 2.5 t VC/ha (T_8). Thirty one-days old seedlings @ 2 seedlings/hill were transplanted for maintaining a spacing of 15 cm × 15 cm. Full recommended doses of phosphorus (diammonium phosphate) and potassium (muriate of potash) and half of N (as urea) @ 60 kg N : 40 kg P_2O_5 : 20 kg K_2O/ha were uniformly applied basal to each plot. The entire quantity of FYM and vermicompost was applied before the transplanting of rice seedlings. The remaining N was top-dressed in 2 equal splits–at active tillering and at panicle-initiation stages–during both the years. All the recommended agronomic practices were followed throughout the growing season of the crop.

Yield and quality features of the produce were recorded using appropriate protocols. Chemical analysis of the plant samples was carried out after recording the dry weight (kg/ha) from each plot. The samples were grounded in Wiley's mill and passed through 32-mesh sieve. Nitrogen concentration was estimated by digesting 0.5 g sample with 10 ml concentrated sulphuric acid and digestion mixture. Total nitrogen was determined by micro-Kjeldahl's method. Nitrogen uptake was worked out by multiplying nitrogen concentration with dry-matter production at harvesting time and converted into kg/ha. Phosphorus concentration was determined by Vandomolybdate yellow-colour method and the intensity of yellow-colour was read on spectrophotometer at 460 nm. Potassium concentration was determined flame photometer (Jackson, 1973). Uptake of P and K was determined by multiplying the concentration with dry matter at harvesting and then converted into kg/ha.

$$\text{Uptake of N, P and K (kg/ha)} = \frac{\text{Nutrient (\%) in the material} \times \text{Dry weight (kg/ha)}}{100}$$

Micronutrient cations (Zn, Fe, Cu and Mn) concentration in the plant digest was determined by atomic adsorption spectrometer (Lindsay and Norvell, 1978). Uptake of micro-nutrients were calculated by multiplying nutrient concentration with dry matter and expressed in g/ha.

$$\text{Micro-nutrient uptake (g/ha)} = \frac{\text{Nutrient conc. (ppm) in dry matter} \times \text{Dry matter production (kg/ha)}}{1{,}000}$$

Protein content in grain was determined by multiplying nitrogen content in grain by a factor 5.95 (AOAC, 2000). For the determination of amylose content, milled rice grains were ground on Restch mill equipped with 100-mesh sieve, according to the method reported by Juliano (1971). The intensity of blue colour was read in spectrophotometer at 620 wavelengths.

Before cooking, length (L) and breadth (B) of dehulled rice was measured. The average length and breadth of 10 grains were measured with a digital calipers and expressed in mm. The L: B ratio was obtained by dividing the length of a single kernel by corresponding breadth (Lorenz and Kulp, 1991). And the L: B ratio after cooking was measured by taking 2 grams of milled rice in a labeled test-tube and 10 ml tap-water was added and soaked for 10 minutes. The tubes were placed in water-bath maintained at boiling temperature for 20 minutes. After cooking the test-tubes were cooled and cooked rice from test-tubes was emptied into petri-plates. Ten cooked kernels (intact in both the ends) were taken and length/breadth measure using a graph paper mounted in a glass frame. The ratio of average length and breadth after cooking was calculated as discussed above.

For the calculation of head-rice recovery, 300 g rough rice from different treatments after harvesting was dehulled in power huller. The brown rice obtained was collected and weighed. The quantity of hulled sample was subjected to milling process. The milled fraction was passed through an opening of 14-mesh sieve. The head and broken rice were separated and determined the yield.

$$\text{Head-rice recovery (\%)} = \frac{\text{Head rice weight (g)}}{\text{Paddy weight (g)}} \times 100$$

The rice samples cooked for their optimum cooking quality and aroma treatment-wise were evaluated by a panel of 10 members for aroma on 3-point headonic scale (Saikia and Bains, 1993).

RESULT AND DISCUSSION

Attributes yield and yield

'Pusa Sugandh 3' recorded significantly higher number of panicles/m^2, panicle length, panicle weight, filled grains/panicle, spikelets/panicle and spikelet sterility than 'Mushkbudji' rice. However, 1,000-grain weight was significantly higher in 'Mushkbudji' (Table 1). Application of nutrients resulted in relatively higher values for number of panicles/m^2, test weight, grain and straw yields. Application of RFD + 5 t/ha FYM + 2.5 t/ha VC resulted in significantly higher number of panicles, with an increase of 12.45 and 23.35% over RFD and the control respectively. The results may be attributed to more uptake and utilization of nutrients. Moreover, 'Pusa Sugandh 3' had significantly dwarfed plants, more panicles/m^2, longer and heavier panicles and higher number of filled grains/panicle than 'Muskbudji' rice. Higher values of the yield-contributing attributes gave an advantage to 'Pusa Sugandh 3' rice, thereby recording significantly higher grain and straw yields over 'Mushkbudji' (Table 2).

Marked effect of integrated nutrient management was noticed on grain and straw yields during both the years. Data over 2 years showed that an application of RFD + 5 t/ha FYM + 2.5 t/ha VC provided significantly higher grain yield than the other treatments. All the integrated nutrient management practices resulted in higher grain yield over the RFD. Higher grain yield on application of integrated treatments (application of FYM or VC along with RFD) can be attributed to the constant availability of nutrients that resulted in significant increase in yield-contributing components (Singh *et al.,* 2010). This indicated that an application of organics with recommended dose of fertilizers helps in slow release of major and micro-nutrients which have catalytic role in photosynthate assimilation and translocation of metabolites from source (leaf) to sink (seed). Singh *et al.* (2012) and Lungmauna and Patra (2013) also reported the enhancement in grain yield owing to the combined use of inorganic and organic manures (FYM and VC).

Quality parameters

'Pusa Sugandh 3' scented rice registered significantly higher values for amylose content, protein, L : B ratio be-

Table 1. Effect of varieties and nutrient-management practices on various yield attributes of scented rice

Treatment	Panicles /m^2	Panicle length (cm)	Panicle weight (g)	Spikelets/ panicle	Filled grains/ panicle	Spikelet Sterility (%)	1,000-grain weight (g)
Varities							
'Pusa Sugandh 3'	345.5	21.8	3.1	108.8	72.8	34.4	24.6
'Mushkbudji'	311.0	19.6	2.4	77.5	61.2	20.0	27.2
SEm±	2.1	0.1	0.2	0.7	0.6	0.7	0.2
CD (P=0.05)	6.5	0.4	0.1	2.2	1.9	1.76	0.8
Nutrient-management							
Control	280.5	18.4	2.2	73.7	47.9	32.5	24.9
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	308.5	20.4	2.6	86.4	60.7	28.2	25.7
RFD + 5 t FYM/ha	335.5	20.8	2.9	90.7	72.0	26.0	26.0
RFD + 2.5 t VC/ha	341.0	20.9	2.9	94.3	72.5	25.2	26.0
75% RFD + 5 t FYM/ha	328.5	20.9	2.9	97.1	65.7	25.0	26.1
75% RFD + 2.5 t VC/ha	340.5	21.3	2.9	97.6	69.0	23.0	26.4
RFD + 5 t FYM + 2.5 t VC/ha	346.5	21.7	2.9	103.5	74.2	29.3	25.7
75% RFD + 5 t FYM + 2.5 t VC/ha	345.0	21.1	2.8	102.1	73.7	28.1	26.6
SEm±	4.3	0.3	0.0	1.5	1.33	1.2	0.5
CD (P=0.05)	12.4	0.8	0.2	4.2	3.8	3.5	NS

RFD, Recommended dose of fertilizer; VC, vermicompost

fore cooking, L : B ratio after cooking and aroma compared to 'Mushkbudji'. However, head-rice recovery was relatively higher for 'Mushkbudji' (Table 3). Among the nutrient-management practices, combined application of VC and FYM along with 75% RFD recorded significantly higher values of amylose content, protein, L : B ratio after cooking over the treatments, i.e. RFD and the control.

Table 2. Grain and straw yield (t/ha) and harvest index (%) of scented rice as affected by varieties and nutrient-management practices

Treatment	Grain yield	Straw yield	Harvest index
Varieties			
'Pusa Sugandh 3'	4.49	8.53	34.30
'Mushkbudji'	3.77	7.68	32.96
SEm±	0.25	0.69	0.248
CD (P=0.05)	0.74	2.03	0.722
Nutrient-management			
Control	2.70	6.10	30.72
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	4.03	7.64	34.60
RFD + 5 t FYM/ha	4.20	8.22	33.89
RFD + 2.5 t VC/ha	4.34	8.33	34.29
75% RFD + 5 t FYM/ha	4.30	8.01	35.00
75% RFD + 2.5 t VC/ha	4.36	8.06	35.19
RFD + 5 t FYM + 2.5 t VC/ha	4.50	9.55	32.01
75% RFD + 5 t FYM + 2.5 t VC/ha	4.46	8.93	33.35
SEm±	0.55	1.40	0.57
CD (P=0.05)	1.57	4.05	1.63

RFD, Recommended dose of fertilizer; VC, vermicompost

However, head-rice recovery was significantly higher with 75% RFD + 2.5 t/ha VC over the control and RFD + 5 t/ha FYM + 2.5 t/ha VC. Conjunctive use of organic manures and NPK fertilizers resulted in better quality parameters, viz. amylose content, protein content and head-rice recovery, which can be attributed to uninterrupted availability of N with increased absorption and assimilation by plants (Rao *et al.*, 2006). Application of organic manures resulted in higher L : B ratio after cooking than the inorganic fertilizers. The application of inorganic fertilizers increased both length and breadth of kernel compared to the control, while application of organic manures resulted in higher length than width. The adequate and continued supply of nutrients from organics (FYM and VC) with RFD resulted in vigorous growth of plants which is reflected in quality parameters (Raikar *et al.*, 2009). Gandhi and Sivakumar (2010), Choudhary *et al*. (2011) and Surakha *et al.* (2013) reported improvement in amylose content, protein and L : B ratio by the use of FYM and vermicompost with inorganic fertilizers. Application of 75% RFD along with VC or FYM showed increased aroma compared to sole application of RFD.

Nutrient concentration and uptake by grain and straw

The treatment varieties showed significant differences in nutrient concentration and uptake. 'Pusa Sugandh 3' exhibited significantly higher values of N, P, K, Zn, Fe, Mn and Cu content and uptake compared to 'Mushkbudji' rice during both the years (Tables 4 to 9). Significant variation in nutrient uptake among the genotypes might be owing to

Table 3. Effect of varieties and nutrient-management practices on grain quality parameters of scented rice

Treatment	Amylose content (%)	Protein content (%)	Head rice recovery (%)	L:B ratio before cooking	L:B ratio after cooking	Aroma score
Varrieties						
'Pusa Sugandh 3'	22.42	7.93	40.44	4.37	4.79	2.94
'Mushkbudji'	15.30	7.42	49.21	1.76	2.71	1.83
SEm±	0.29	0.11	0.56	0.03	0.04	-
CD (P=0.05)	0.83	0.34	1.61	0.83	0.13	-
Nutrient-management						
Control	15.46	5.35	43.79	2.96	3.04	2.19
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	17.09	6.93	43.53	3.01	3.22	2.25
RFD + 5 t FYM/ha	18.72	8.22	47.38	3.07	3.86	2.41
RFD + 2.5 t VC/ha	19.28	8.31	47.23	3.04	3.88	2.38
75% RFD + 5 t FYM/ha	20.42	8.31	48.10	3.02	4.09	2.44
75% RFD + 2.5 t VC/ha	20.86	8.32	48.32	3.04	4.07	2.47
RFD + 5 t FYM + 2.5 t VC/ha	19.27	8.68	43.55	3.07	3.75	2.42
75% RFD + 5 t FYM + 2.5 t VC/ha	19.56	8.52	44.44	3.07	4.04	2.42
SEm±	0.59	0.23	1.11	0.05	0.08	-
CD (P=0.05)	1.66	0.67	3.23	4.37	0.25	-

RFD, Recommended dose of fertilizer; VC, vermicompost

their differential genetic make-up. Sharma *et al.,* (2012) and Rao *et al.*, (2013) also observed differential uptake and concentration of N, P and K in scented rice varieties.

Among the nutrient-management practices, an application of RFD + 5 t FYM + 2.5 t VC/ha ensued significantly higher nutrient content compared to sole application of RFD and the control. The treatments RFD along with FYM and VC registered significantly higher N, P, K, Zn, Fe, Mn and Cu content over RFD alone during both the years. The contribution of organic manure (FYM and VC) and inorganic (RFD) improves soil structure, which imparts better environment for root growth, thereby creates more absorptive surface for uptake of nutrients (Singh *et al.,* 2010; Garai *et al.*, 2013).

The uptake of micronutrients Zn, Fe, Mn and Cu were influenced by an amount of inorganic fertilizer and VC as well as FYM. The quantity of these nutrients in grain and straw were in order of Fe >Mn >Zn > Cu. Significantly higher uptake of these nutrients in both grain and straw were exhibited by the treatments receiving 100% RFD along with 5 t FYM/ha and 2.5 t/ha VC followed by 75% RFD along with 5 t FYM/ha and 2.5 t VC/ha. It may be due

Table 4. Effect of varieties and nutrient-management practices on nutrient concentration (%) of grain and straw of scented rice

Treatment	Nitrogen		Phosphorus		Potassium	
	Grain	Straw	Grain	Straw	Grain	Straw
Varieties						
'Pusa Sugandh 3'	1.38	0.76	0.29	0.21	0.33	1.92
'Mushkbudji'	1.25	0.67	0.26	0.19	0.29	1.77
SEm±	0.02	0.02	0.00	0.00	0.00	0.02
CD (P=0.05)	0.05	0.04	0.01	0.01	0.01	0.25
Nutrient-management						
Control	0.90	0.385	0.18	0.16	0.21	1.15
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	1.16	0.52	0.26	0.18	0.29	1.73
RFD + 5 t FYM/ha	1.35	0.705	0.28	0.20	0.31	1.89
RFD + 2.5 t VC/ha	1.35	0.745	0.28	0.21	0.32	1.95
75% RFD + 5 t FYM/ha	1.39	0.72	0.28	0.21	0.32	1.96
75% RFD + 2.5 t VC/ha	1.40	0.735	0.29	0.21	0.32	1.96
RFD + 5 t FYM + 2.5 t VC/ha	1.46	0.82	0.31	0.22	0.37	2.10
75% RFD + 5 t FYM + 2.5 t VC/ha	1.43	0.79	0.30	0.22	0.36	2.03
SEm±	0.03	0.0325	0.00	0.00	0.00	0.04
CD (P=0.05)	0.11	0.09	0.01	0.01	0.01	0.05

RFD, Recommended dose of fertilizer; VC, vermicompost

Table 5. Effect of varieties and nutrient-management practices on Zn and Fe concentration (ppm) in scented rice

Treatment	Zn		Fe	
	Grain	Straw	Grain	Straw
Varieties				
'Pusa Sugandh 3'	23.75	33.79	41.78	58.30
'Mushkbudji'	18.19	28.17	33.81	46.05
SEm±	0.43	0.44	0.52	0.65
CD (P=0.05)	1.24	1.27	1.50	1.89
Nutrient-management				
Control	15.76	23.59	27.37	41.25
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	19.47	28.71	32.97	48.80
RFD + 5 t FYM/ha	20.87	31.61	39.71	53.65
RFD + 2.5 t VC/ha	21.55	32.26	39.95	54.25
75% RFD + 5 t FYM/ha	21.34	31.30	40.00	53.65
75% RFD + 2.5 t VC/ha	22.11	31.71	40.12	54.25
RFD + 5 t FYM + 2.5 t VC/ha	23.42	34.41	41.37	56.15
75% RFD + 5 t FYM + 2.5 t VC/ha	23.00	34.27	40.61	55.15
SEm±	0.86	0.88	1.04	1.31
CD (P=0.05)	2.49	2.55	3.01	3.79

RFD, Recommended dose of fertilizer; VC, vermicompost

to more micronutrient content and higher yield in these treatments. The treatments receiving RFD along with FYM and VC improved micronutrient uptake over the sole application of RFD. The reason may be the synergetic effect of FYM and VC on nutrient availability and soil health for root development and absorption of nutrients. The improved nutrient uptake by the application of FYM and VC was reported by Singh *et al*. (2007), Dash *et al*. (2010), Garai *et al*., (2013), Lakshmi *et al*. (2013) and Meena et *al*. (2013).

Economics

Among the varieties, 'Pusa Sugandh 3' provided higher gross returns, net returns and benefit: cost (B: C) ratio. The highest average gross returns (₹289,600/ha) and net returns (₹203,300/ha) were obtained by growing 'Pusa Sugandh 3' with the application of RFD + 5 t FYM + 2.5 t VC/ha (Table 10). 'Mushkbudji' scented rice fertilized with 75% RFD + 5 t FYM/ha also provided higher net returns of ₹200,800/ha. The lowest gross returns, net returns and cost of cultivation in case of both the varieties were recorded in the control plots receiving no fertilizers. The highest ben-

Table 6. Effect of varieties and nutrient-management practices on Mn and Cu concentration (ppm) in scented rice

Treatment	Mn		Cu	
	Grain	Straw	Grain	Straw
Varieties				
'Pusa Sugandh 3'	33.51	52.18	11.90	10.63
'Mushkbudji'	30.33	47.36	10.38	8.27
SEm±	0.48	0.58	0.25	0.24
CD (P=0.05)	1.38	1.67	0.73	0.70
Nutrient-management				
Control	26.00	42.14	8.16	6.75
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	29.97	48.18	10.16	8.61
RFD + 5 t FYM/ha	32.35	50.27	11.79	9.79
RFD + 2.5 t VC/ha	32.98	50.82	12.00	9.65
75% RFD + 5 t FYM/ha	32.58	50.18	11.27	9.62
75% RFD + 2.5 t VC/ha	32.76	50.87	11.41	9.79
RFD + 5 t FYM + 2.5 t VC/ha	34.21	53.25	12.43	11.05
75% RFD + 5 t FYM + 2.5 t VC/ha	33.84	52.95	12.23	10.34
SEm±	0.96	1.15	0.50	0.48
CD (P=0.05)	2.77	3.33	1.45	1.40

RFD, Recommended dose of fertilizer; VC, vermicompost

Table 7. Effect of varieties and nutrient-management practices on N, P and K uptake (kg/ha) of scented rice

Treatment	Nitrogen		Phosphorus		Potassium	
	Grain	Straw	Grain	Straw	Grain	Straw
Varieties						
'Pusa Sugandh 3'	63.91	64.59	13.43	18.39	15.62	167.13
'Mushkbudji'	48.83	52.06	10.05	14.94	11.49	138.30
SEm±	0.78	1.60	0.15	0.29	0.18	2.21
CD (P=0.05)	2.27	4.63	0.44	0.85	0.51	6.39
Nutrient-management						
Control	24.35	22.26	4.99	10.25	5.85	70.51
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	47.32	39.47	10.52	13.67	11.75	129.62
RFD + 5 t FYM/ha	60.42	58.31	12.29	17.29	13.77	163.39
RFD + 2.5 t VC/ha	64.15	62.47	13.05	17.40	14.68	158.70
75% RFD + 5 t FYM/ha	59.97	57.76	12.21	16.56	14.01	156.19
75% RFD + 2.5 t VC/ha	63.27	59.07	13.085	16.815	14.765	159.56
RFD + 5 t FYM + 2.5 t VC/ha	66.715	78.455	14.285	21.315	17.03	198.2
75% RFD + 5 t FYM + 2.5 t VC/ha	64.765	70.815	13.525	19.465	16.525	179.275
SEm±	1.57	3.205	0.305	0.585	0.355	4.43
CD (P=0.05)	4.54	9.265	0.875	1.685	1.03	12.795

RFD, Recommended dose of fertilizer; VC, vermicompost

Table 8. Micro-nutrient uptake (g/ha) of scented rice as affected by varieties and nutrient-management practices

Treatment	Zn		Fe	
	Grain	Straw	Grain	Straw
Varieties				
'Pusa Sugandh 3'	105.9	288.6	189.6	498.0
'Mushkbudji'	68.7	216.6	128.6	354.5
SEm±	1.8	3.9	2.3	7.1
CD (P=0.05)	5.2	12.3	6.7	21.0
Nutrient-management				
Control	42.6	144.0	74.1	252.0
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	78.6	219.6	133.9	373.0
RFD + 5 t FYM/ha	85.1	260.2	168.0	441.5
RFD + 2.5 t VC/ha	93.7	269.2	174.8	453.0
75% RFD + 5 t FYM/ha	91.9	251.1	173.4	430.5
75% RFD + 2.5 t VC/ha	96.5	255.8	175.6	437.5
RFD + 5 t FYM + 2.5 t VC/ha	105.5	329.2	188.2	537.0
75% RFD + 5 t FYM + 2.5 t VC/ha	102.7	306.4	183.7	493.0
SEm±	3.6	7.8	4.6	11.5
CD (P=0.05)	10.6	23.5	13.4	35.4

RFD, Recommended dose of fertilizer; VC, vermicompost

Table 9. Effect of varieties and nutrient-management practices on Mn and Cu uptake (g/ha) in scented rice

Treatment	Mn		Cu	
	Grain	Straw	Grain	Straw
Varieties				
'Pusa Sugandh 3'	148.4	449.0	53.8	91.9
'Mushkbudji'	116.5	368.0	39.6	64.6
SEm±	2.3	6.8	1.2	2.1
CD (P=0.05)	6.8	19.7	3.2	6.2
Nutrient-management				
Control	82.9	256.5	22.2	41.3
RFD (60, 40 and 20 N, P_2O_5, K_2O kg/ha)	131.2	369.5	41.2	66.5
RFD + 5 t FYM/ha	139.3	415.0	49.9	81.2
RFD + 2.5 t VC/ha	141.6	425.5	50.1	80.9
75% RFD + 5 t FYM/ha	140.9	399.5	49.4	78.0
75% RFD + 2.5 t VC/ha	148.4	412.5	49.4	79.6
RFD + 5 t FYM + 2.5 t VC/ha	153.5	526.5	56.4	105.9
75% RFD + 5 t FYM + 2.5 t VC/ha	131.8	492.0	54.9	93.1
SEm±	4.7	10.9	2.2	4.3
CD (P=0.05)	13.6	39.6	6.5	12.4

efit: cost B: C ratio of 4.10 and 3.87 was also recorded by 'Pusa Sugandh 3' and 'Mushkbudji' under recommended fertility levels (60, 40 and 20 N, P_2O_5, K_2O kg/ha).

In the present integrated nutrient management study, an application of RFD + FYM @ 5 t/ha +2.5 t VC/ha significantly improved the N, P, K, Zn, Fe, Mn and Cu contents in grain as well as uptake of these nutrients in scented rice varieties 'Pusa Sugandh 3' and 'Mushkbudji'. Among the nutrient-management practices, 'Pusa Sugandh 3' combined with RFD + 5 t FYM + 2.5 t VC/ha, closely followed by 75% RFD + 5 t FYM + 2.5 t VC recorded higher values of yield-contributing characters, yield and quality parameters, while 'Mushkbudji' registered higher values of growth, yield, quality and nutrient uptake at 75% RFD + 2.5 t VC/ha which indicates that 'Pusa Sugandh 3' required higher nutrient levels compared to 'Mushkbudji'.

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