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Effect of organic nutrient management practices on yield and economics of scented rice Gobindabhog

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ABSTRACT

A field experiment was conducted during wet seasons of 2008 and 2009 at Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal to find out suitable organic nutrient management practice in scented rice (cv. Gobindabhog) for higher productivity, net return, nutrient utilization and soil health. All six nutritional treatments comprising FYM, vermicompost and mustard cake either alone or in combination with others recorded higher values of growth parameters, grain and straw yield over unfertilized control. Application of sole mustard cake (50% recommended dose of nitrogen (RDN) as basal + 50% RDN at 21 DAT) recorded highest plant height at harvest (135.3 and 131.3 cm), number of tillers m^{-2} at active tillering (304 and 299) and panicle initiation (384 and 369), and leaf area index (LAI) at flowering (4.88 and 4.70). Sole mustard cake in two splits (50% basal + 50 % top dressing at 21 DAT) resulted in highest grain yield (2.68 t ha^{-1}) and N uptake (43.7 Kg ha^{-1}), which was at par with combined use of FYM (50% RDN as basal) and mustard cake (50% RDN at 21 DAT). Integrated use of FYM and mustard cake equivalent to 50 Kg N ha^{-1} could be recommended as organic nutrient management for indigenous aromatic rice of West Bengal based on overall consideration of pooled grain yield (2.63 t ha^{-1}), residual soil nutritional status, net returns (₹ 19,261 ha^{-1} and ₹ 19,071 ha^{-1}) and benefit : cost ratio (1:90 and 1.84).

Key words: *aromatic rice, organic, nutrient, growth, yield*

Gobindabhog, an indigenous short-grained aromatic rice, is manly cultivated in Burdwan, Nadia, Bankura, Hoogly, Howrah, North 24 Parganas and some adjoining districts in gangetic plains of West Bengal. It is very popular in domestic market for preparation of bhog, payash (dessert) as well as for making polao, biriyani, etc. in South Indian states like Kerala, Karnataka and Tamil Nadu. At present, the farmers cultivate such premium aromatic rice in native areas following chemical-based agricultural practices, which led to increased productivity, inferior grain quality, degraded soil health and increased pollution.

Organic farming is getting much attention in present-day agricultural system, which avoids the use of synthetic chemical fertilizers, pesticides and growth-regulating hormones, and raises the crop with the use of organic manures, green manures, bio-fertilizers, crop residues and biological pest control (Kharub and Chander, 2008). As soil organic matter has long been suggested to increase soil productivity (Haynes, 2005), the use of locally available FYM, vermicompost and mustard cake might be good options for scented rice growers in West Bengal. The cultivation of high-value rice like Basmati in Kurukshetra belt in Haryana (Mahapatra, 2004) and Joha in Assam have already been initiated. So, it is the time to promote organic cultivation of Gobindabhog rice in native areas of West Bengal for sustained productivity, superior grain quality along with premium price in niche markets within the country and abroad. The present study was undertaken to find out the suitable organic nutrient management practice for scented rice in West Bengal.

MATERIALS AND METHODS

A field experiment was conducted at Bidhan Chandra Krishi Viswavidyalaya, West Bengal during wet season of 2008 and 2009. The soil of the experimental field was sandy loam in texture (38.8% sand, 35.1% silt and

26.1% clay) with PH 6.8, organic carbon 0.61%, total N 0.053%, available P 26.8 Kg ha^{-1} and K 112.6 Kg ha^{-1}. The experiment was laid out in randomized block design with 3 replications, comprising of seven treatments; control, FYM @ 100% recommended dose of nitrogen (RDN) as basal (sole FYM), vermicompost (VC) @ 50% RDN as basal + 50% RDN at 21DAT (sole VC), mustard cake (MC) @ 50% RDN as basal + 50% RDN at 21 DAT (sole MC), FYM @ 50% RDN as basal + vermicompost @ 50% RDN at 21 DAT (FYM + VC), FYM @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT (FYM + MC) and vermicompost @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT (VC + MC). The quantity of organic manures *viz*. FYM, vermicompost and mustard cake was estimated based on recommended fertilizer dose of 50 Kg N + 25 Kg P + 25 Kg K ha^{-1} and actual nitrogen content in respective manures. The laboratory analyses of different manure samples before application in the field revealed 0.5 and 0.6% N in FYM, 1.4 and 1.5%N in vermicompost, and 4.7 and 4.9% N in mustard cake during 1st and 2nd year of investigation, respectively.

Twenty five days old rice cv. Gobindabhog were transplanted at a spacing of 15 cm × 15 cm in 5 m × 4 m plots during second fortnight of July in both the years of investigation. Neem seed extract (@ 50 g $litre^{-1}$ of water) prepared at farm was applied to each plot twice at post-flowering and soft dough stage to control gundhi bug in the experimental field. Growth parameters (plant height at harvest, tiller production at active tillering and panicle initiation, and leaf area index at flowering), yield components, grain and straw yield at maturity were recorded following standard methods. The concentration of N, P and K in soil and plant were determined using standard procedures and total uptake of nutrients by Gobindabhog rice was calculated multiplying the concentration with their respective dry matter (grain + straw) yield. The economic parameters like total cost of cultivation, net return and benefit : cost (B:C) ratio were worked out based on prevailing market prices of inputs, outputs and labour wages.

RESULTS AND DISCUSSION

All the three organic manures (*viz*. FYM, vermicompost and mustard cake) either sole or in combination with others had positive and significant influence on growth and yield attributes of Gobindabhog over unfertilized control (Table 1). It could be explained by greater release and supply of nutrients in varied proportions and times from the organic manures applied in the experiment compared to no nutrition. Application of sole mustard cake (50% RDN as basal + 50% RDN at 21 DAT) recorded highest plant height at harvest (135.3 and 131.3 cm), number of tillers m^{-2} at active tillering (304 and 299) and panicle initiation (384 and 369), and leaf area index (LAI) at flowering (4.88 and 4.70) during both 2008 and 2009. The greater tiller production in mustard cake applied plots either sole (mustard cake (MC) @ 50% RDN as basal + 50% RDN at 21 DAT) or in combinations (FYM @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT and vermicompost @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT) followed by vermicompost treated plots (vermicompost (VC) @ 50% RDN as basal + 50% RDN at 21DAT and FYM @ 50% RDN as basal + vermicompost @ 50% RDN at 21 DAT) over sole FYM plots (FYM @ 100% recommended dose of nitrogen (RDN) as basal) could be due to faster availability of nitrogen from mustard cake and vermicompost than FYM at tillering phase of the crop. On the contrary, combined application of FYM and vermicompost recorded higher number of tillers m^{-2} in dwarf scented rice (Sharma *et. al.*, 2008).

The sole use of mustard cake (50% RDN as basal + 50% RDN at 21 DAT) produced highest number of panicles m^{-2}, while combined use of FYM (50% RDN as basal) and vermicompost (50% RDN at 21 DAT) recorded maximum number of filled grains $panicle^{-1}$ during both the years of investigation, which was on par with vermicompost+mustard cake, FYM + mustard cake and sole mustard cake (Table 1). Although the test weight of grains was improved with organic nutrient treatments over control, it remained unaffected during 2009. Ghosh *et. al.* (2005) reported similar values for plant height, number of panicles m^{-2}, filled grains $panicle^{-1}$ and lower test weight for Gobindabhog rice under inorganic nutrient management system.

Nutrient management comprising FYM, vermicompost and mustard cake either sole or in combination significantly enhanced the grain and straw yield of Gobindabhog rice compared to no nutrition (Table 2). This might be due to increased growth and

Table 1. Effect of organic nutrient management practices on growth parameters and yield components of 'Gobindabhog' rice during wet season

Treatment	Plant height (cm)		Tillers m^{-2}				Leaf area index at flowering		Panicles m^{-2}		Filled grains panicle m^{-2}		1000 grain weight (g)	
			Active tillering		Panicle initiation									
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Control	124.5	119.2	241	223	298	275	4.20	4.00	223.2	190.4	94.7	102.0	10.08	10.03
FYM @100% RDN as basal (sole FYM)	130.7	125.6	273	244	335	319	4.31	4.11	280.2	254.0	107.9	115.3	10.33	10.25
VC @ 50% RDN as basal+ 50% RDN at 21 DAT (sole VC)	130.7	124.9	270	267	331	324	4.28	4.27	282.0	255.2	114.3	117.0	10.45	10.27
MC @ 50% RDN as basal + 50% RDN at 21 DAT (sole MC)	135.3	131.3	304	299	384	369	4.88	4.70	302.8	277.6	118.5	126.9	10.37	10.27
FYM @ 50% RDN as basal+VC @ 50% RDN at 21 DAT (FYM + VC)	129.8	124.0	277	266	352	349	4.42	4.40	274.6	251.2	121.2	127.1	10.39	10.35
FYM @ 50% RDN as basal + MC@50% RDN at 21 DAT (FYM + MC)	134.1	128.1	292	282	365	360	4.67	4.65	284.6	269.2	119.6	122.0	10.43	10.23
VC @ 50% RDN as basal + MC @ 50% RDN at 21 DAT (VC + MC)	132.3	126.7	277	273	365	330	4.67	4.56	238.0	262.0	119.7	123.7	10.37	10.27
CD (P<0.05)	1.20	0.98	11.36	16.64	19.87	32.10	0.14	0.13	14.24	16.70	5.81	5.83	0.11	NS

yield attributes through additional effect of organic manures in the study, while the plants in unfertilized control plots were solely dependent on soil nutrient status without receiving any kind of external inputs in the form organic manures. Sole application of mustard cake resulted in highest pooled grain yield (2.68 t ha^{-1}), which was at par with combined use of FYM and mustard cake. The pooled grain yield in mustard cake @ 50% RDN as basal + 50% RDN at 21 DAT, FYM @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT, vermicompost @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT, FYM @ 50% RDN as basal + vermicompost @ 50% RDN at 21 DAT, FYM @ 100% recommended dose of nitrogen (RDN) as basal and vermicompost (VC) @ 50% RDN as basal + 50% RDN at 21 DAT, respectively treated plots were 52.3, 40.9, 37.5, 26.1, 25.6% greater over unfertilized control, which also reflected higher grain yield obtained from sole or combined application of mustard cake than FYM and vermicompost. In the context, integrated use of FYM and vermicompost produced greater grain and straw yield than sole application of either FYM or vermicompost; which could be attributed to continuous supply of nutrients and growth hormones from vermicompost as stated by Barik *et al.* (2011). The better performance of the crop in terms of plant height, LAI, number of panicles m^{-2} and 1000 grain weight during 2008 than 2009 resulted in higher grain and straw yield during first year of investigation.

Nitrogen, phosphorus and potassium uptake was significantly influenced by the organic nutrient management practices in the study (Table 3). Application of mustard cake (@ 50% RDN as basal + 50% RDN at 21 DAT) recorded highest N and K uptake in 'Gobindabhog' rice (grain + straw); while maximum P uptake was noted with the treatment FYM @ 100% RDN as basal. In general, faster release and absorption of nutrients particularly N in mustard cake applied plots favoured the growth and development of Gobindabhog rice and led to lower residual soil nutrient status. Although N and P uptake in grain was comparatively higher than in straw, but the reverse pattern was found in K uptake.

Maximum loss in residual soil N (-20.8%), P (-25.7%) and K (-19.0%) was recoded in unfertilized control plots due to successive depletion of soil inherent nutrient status during the period of

Table 2. Effect of organic nutrient management practices on yield and economics of Gobindabhog rice during wet season

Treatment	Grain yield (t ha^{-1})			Straw yield (t ha^{-1})		Cost of cultivation(₹ ha^{-1})		Net return (ha^{-1})		B:C ratio	
	2008	2009	Pooled	2008	2009	2008	2009	2008	2009	2008	2009
Control	1.80	1.72	1.76	3.73	3.35	12,850	13,586	14,590	14,508	2.14	2.07
FYM @ 100% RDN as basal (sole FYM)	2.29	2.16	2.22	4.37	4.33	18,600	18,563	16,043	16,885	1.86	1.91
VC @ 50% RDN as basal + 50% RDN at 21 DAT (sole VC)	2.23	2.18	2.21	4.53	4.27	22,529	24,396	11,458	11,341	1.51	1.46
MC @ 50% RDN as basal + 50% RDN at 21 DAT (sole MC)	2.73	2.63	2.68	4.97	4.47	24,238	26,641	17,009	15,986	1.70	1.60
FYM @ 50% RDN as basal + VC @ 50% RDN at 21 DAT (FYM + VC)	2.44	2.40	2.42	4.60	4.50	20,564	21,480	16,286	17,611	1.79	1.82
FYM @ 50% RDN as basal + MC @ 50% RDN at 21 DAT (FYM + MC)	2.70	2.57	2.63	4.80	4.53	21,419	22,602	19,261	19,071	1.90	1.84
VC @ 50% RDN as basal + MC @ 50% RDN at 21 DAT (VC+MC)	2.60	2.37	2.48	4.70	4.50	23,383	25,519	15,837	13,132	1.68	1.51
CD (P<0.05)	0.09	0.08	0.10	0.13	0.11						

Cost of Gobindabhog seed: ₹ 30.00 Kg^{-1} (2008), 35.00 Kg^{-1} (2009); Labour wages: 75.00 man day^{-1} (2008), 81.00 man day^{-1} (2009); Rate of power-tiller: 200.00 hour^{-1} during both the years; Cost of neem seed: 10.00 Kg^{-1} during both the years; Cost of FYM: 0.50 Kg^{-1} during both the years; Cost of vermicompost: 2.5 Kg^{-1} (2008), 2.75 Kg^{-1} (2009); Cost of mustard cake: 12.00 Kg^{-1} (2008), 13.00 Kg^{-1} (2009); Rate of paddy : 1400 q^{-1} (2008), 1500 q^{-1} (2009); Rate of straw: 60.00 q^{-1} (2008), 70.00 q^{-1} (2009)

investigation. Actual gain or loss in residual soil N (-3.8 to + 5.7%), P (-1.9 to 17.9%) and K (-0.7 to +4.8%) over initial status was noted among all the six nutritional treatments in the study, which was in conformity with the findings of Kumari *et. al*. (2010) for scented rice (*cv*. Birsamati) in Jharkhand. The highest post-harvest residual total N (0.056%), available P (31.6 Kg ha^{-1}) and K status (118.0 Kg ha^{-1})

Table 3. Effect of organic nutrient management practices on nutrient uptake by Gobindabhog rice and residual soil fertility

Treatment	Nutrient uptake									Nutrient Status in soil		
	N (Kg ha^{-1})			P (Kg ha^{-1})			K (Kg ha^{-1})			Total	Available	Available
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	N (%)	P(Kg ha^{-1})	K(Kg ha^{-1})
Control	17.6	11.4	29.0	5.5	2.5	8.0	5.5	20.1	25.6	0.042 (-20.8)	19.9 (-25.7)	91.2 (-19.0)
FYM @100% RDN as basal (sole FYM)	24.0	12.3	36.3	8.5	7.0	15.5	10.5	45.7	56.2	0.056 (+5.7)	30.4 (+13.4)	113.5 (+0.8)
VC @ 50% RDN as basal + 50% RDN at 21 DAT (sole VC)	24.6	11.8	36.4	8.9	6.4	15.3	11.0	44.8	55.8	0.056 (+5.7)	31.6 (+17.9)	118.0 (+4.8)
MC @ 50% RDN as basal + 50% RDN at 21 DAT (sole MC)	31.4	12.3	43.7	8.9	5.3	14.1	12.5	46.0	58.5	0.054 (+1.9)	26.3 (-1.9)	111.8 (-0.7)
FYM @ 50% RDN as basal + VC @50% RDN at 21 DAT (FYM + VC)	26.1	12.9	39.0	8.2	4.9	13.1	11.2	44.1	55.4	0.054 (+1.9)	30.5) (+13.8)	115.0 (+2.1)
FYM @ 50% RDN as basal + MC @ 50% RDN at 21 DAT (FYM + MC)	29.9	13.3	43.2	9.0	5.2	14.2	11.5	44.7	56.1	0.052 (-1.9)	28.4 (+6.0)	113.5 (+0.8)
VC @ 50% RDN as basal + MC @ 50% RDN at 21 DAT (VC + MC)	28.7	13.4	42.1	8.6	5.2	13.7	10.8	43.4	54.3	0.051 (+1.9)	29.3 (+9.3)	113.8 (+1.1)
CD (P<0.05)	1.34	0.87	1.62	1.07	1.07	2.13	0.43	1.10	1.47	0.003	1.86	5.38
Initial value										0.053	26.8	112.6

Figures in parentheses show the percent increase (+) or decrease (-) over initial status

was obtained with vermicompost @ 50% RDN as basal + 50% RDN at 21 DAT, which was on par with the FYM @ 50% RDN as basal + vermicompost @ 50% RDN at 21 DAT.

The total cost of cultivation per hectare varied between ₹ 12,850 in control and ₹ 23,383 (vermicompost @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT) during 2008 and ₹ 13,586 in the control and ₹ 25,519 (vermicompost @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT) during 2009, mainly due to variations in N concentrations or quantities and prices of different organic manures like FYM, vermicompost and mustard cake in the study (Table 2).The combined use of FYM (50% RDN as basal) and mustard cake (50% RDN at 21 DAT) fetched highest net return (19,261 and 19,071 ha^{-1}) and higher benefit : cost ratio (1.90 and 1.84) during first and second year of investigation. Kumari *et. al.* (2010) reported that green manure + FYM fetched higher net return (₹ 35,975 ha^{-1}) and B: C ratio (2.61), when compared with rest of organic manures in scented rice. The maximum benefit : cost ratio (2.14 and 2.07) obtained from unfertilized control might not be considered due to lower net return than other four organic nutritional treatments (FYM @ 100% RDN as basal, mustard cake @ 50% RDN as basal + 50% RDN at 21 DAT, FYM @ 50% RDN as basal + vermicompost @ 50% RDN at 21 DAT and FYM @ 50% RDN as basal + mustard cake @ 50% RDN at 21 DAT). The crop Gobindabhog when grown with vermicompost either sole or in combination with mustard cake were found less remunerative given when compared to unfertilized control owing to less nitrogen content (1.4-1.5%) and more cost of vermicompost. The gross return, net return and B: C ratio of organic treatments could be improved, if the differences in market values between organic and conventional produce were made available in local and regional markets as well as taken into consideration in the study.

Among six nutritional treatments in the study, sole mustard cake in two splits (50% RDN as basal + 50% RDN at 21 DAT) equivalent to 50 Kg N ha^{-1} recorded highest grain yield (2.68 t ha^{-1}) of Gobindabhog rice; but combined use of FYM (50% RDN as basal) + mustard cake (50% RDN at 21 DAT) could be recommended as suitable organic nutrient management based on overall consideration of pooled grain yield (2.63 t ha^{-1}), residual soil nutritional status, net return and benefit : cost ratio.

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