Indian Journal of Agronomy **55** (3): 220–223 (September 2010)

Effect of organic nutrient management on yield, nutrient uptake and nutrient balance sheet in scented rice (*Oryza sativa*)

NIRU KUMARI*, ASHOK KUMAR SINGH , S.K. PAL AND R.THAKUR

Birsa Agricultural University, Ranchi, Jharkhand 834 006

Received : June, 2009

ABSTRACT

A field experiment was conducted at Ranchi during *kharif* seasons of 2004 and 2005, to identify suitable organic nutrient management in scented rice for higher productivity, nutrient utilization and soil health. Scented rice (*Birsamati*) grown with recommended inorganic fertilizer produced 20.09% higher grain yield when compared with the best organic source combination of green manuring (GM) @ 5 t/ha + FYM @ 10 t/ha (3.3 t/ha). The yield attributing characters also followed the trend of grain yield. Similarly, the uptake of N, P and K by rice grown with fertilizers was 31.69%, 25.98%, and 23.74% higher than GM + FYM. The maximum available N (277 kg/ha) and minimum N loss (3 kg/ha) was recorded from the plots that received GM 5 t/ha + BGA 10 kg/ha + *Azotobacter* @ 500 g/ha. Similarly maximum available P (24.7 kg/ha) and maximum gain in soil P (0.7 kg/ha), was recorded with the application of Karanj cake (KC) 2.5 t/ha. However, maximum available K (202 kg/ha) and maximum gain in soil K (2.0 kg/ha) was recorded from the plot receiving GM 5 t/ha + PS 10 t/ha. Among organic sources, GM + FYM fetched significantly higher net return (35, 975 Rs/ha) and B: C (2.61) when compared with rest of the organic sources under test.

Key words: Economics, Nutrient uptake, Organic fertilizers, Rice, Yield, Nutrient balance sheet

India is self sufficient in food grain production due to intensive cropping, with high doses of chemical fertilizers to tap the potential of high-yielding crop varieties in irrigated condition under a constant plant protection umbrella. However, modern chemical-based agriculture practices have led to several new challenges, *viz.* decline in productivity, degradation of soil and water resources, diminishing biodiversity and increase in environmental pollution. Under such situation organic nutrient management has significant role in improving productivity of crop and soil fertility. Organic nutrient management involves substantial use of green manure, organic manure, crop residues and biofertilizer either alone or in combination. Green manuring which is of organic origin offers the twin benefits of soil quality and fertility enhancement while meeting a part of nutrient need of crops. Organic manures provide regulated supply of N by releasing it slowly resulting in increased yields of rice and nutrient use efficiency (Sharma, 2002).

Crop residues have potential for improving soil and water conservation, sustaining soil productivity and enhancing crop yields (Das *et al*., 2003). Alternate sources of soil fertility build up through renewable sources like biofertilizer may also play an important role in improving the nutrient supply capacity for achieving higher yield of scented rice (*Oryza sativa* L.) under organic nutrient management, and maintained soil health besides providing non-polluting environment. The present study was undertaken to find out the suitable organic nutrient management for higher productivity, nutrient uptake, and nutrient balance sheet of scented rice.

MATERIALS AND METHODS

The experiment was carried out at Birsa Agricultural University Farm, Ranchi during *kharif* seasons of 2004 and 2005. The soil of the experimental plot was sandy loam in texture (59.4% sand, 21% silt and 19.6% clay) with bulk density 1.5 Mg/m^3, acidic in reaction (pH 6.1), low in organic carbon (0.47%), medium in available N (280 kg/ha), P (24 kg/ha) and K (200 kg/ha). Ten treatments consisting of organic as well as inorganic nutrients alone or in combination, *viz.* control, recommended dose of fertilizer i.e. RDF (100:50:25 kg N:P:K/ha), green manuring (GM) @ 10 t/ha, GM @ 5 t/ha + paddy straw (PS) @ 10 t/ha, GM @ 5 t/ha + FYM @ 10 t/ha, Karanj (*Pongamia pinnata* (L.) Pierre) cake (KC) @ 2.5 t/ha,

***Corresponding author** (E mail:nirubau@yahoo.co.in)

Vermicompost (VC) @ 2.5 t/ha, GM @ 5 t/ha + FYM @ 5 t/ha + blue green algae (BGA) @ 10 kg/ha, GM @ 5 t/ha + FYM @ 5 t/ha + Azotobacter (*Azotobacter chroococcum*) @ 500 g/ha, and GM @ 5 t/ha + phosphorus solublising bacteria (PSB) @ 5 kg/ha were laid out in randomized block design replicated 4 times. *Dhaincha* (*Sesbania aculeata*), FYM, PS, KC and VC contained 2.46-0.03-0.32, 0.53-0.12-0.42, 0.41-0.04-0.99, 3.9-0.44-0.42, and 2.9-0.39-1.2% N-P-K, respectively.

Dhaincha as green manure crop was grown using 50 kg seed/ha during May in separate plots till 60 days and then harvested, weighed, chopped and incorporated as per treatments one day before transplanting in the puddled field. Likewise, paddy straw was chopped into small pieces and applied one day before transplanting of rice. FYM, KC and VC were also applied one day before transplanting of rice. BGA was inoculated @ 10 kg/ha. Roots of rice seedlings were dipped in *Azotobacter* suspension @ 500 g/ha overnight before transplanting. The PSB culture of *Pseudomonas striata* obtained from the Division of Soil Science, Birsa Agricultural University, Ranchi (500 g) was mixed with 1,000 ml Jaggary solution, which was diluted to 10 litre with water and inoculation was done by dipping the roots of rice seedlings in the solution. Fertilizers (100-21.8-20.8 kg N-P-K/ha) were applied through urea, single superphosphate and muriate of potash. Half of the N and full dose of P and K were applied at the time of puddling while remaining N was applied in three equal splits i.e. at early tillering, late tillering and panicle initiation stage. Twenty five day old seedlings of "Birsamati" scented rice were transplanted on 4 and 5 August during 2004 and 2005, respectively, at a spacing of 20 cm x 10 cm. Nutrient balance of the soil was worked out by subtracting the initial value from the soil available nutrient status after crop harvest adopting the method suggested by Palaniappan (1985). The economic parameters like net returns and benefit: cost ratio were worked out by using prevailing market price of inputs and outputs.

RESULTS AND DISCUSSION

Yield

Yield is the manifestation of various yield components. Application of RDF produced maximum grain (3.95 t/ha) and biological (9.49 t/ha) yield which was higher by 20.9% and 24.3% than the best organically grown crop producing treatment of GM @ 5 t/ha + FYM @ 10 t/ha. Again, application of GM @ 5 t/ha + FYM @ 10 t/ha produced 26.59%, 32.19% and 35.74% higher grain yield than GM @ 5 t/ha + PS @ 10 t/ha, GM @ 5 t/ha + FYM @ 5 t/ha + BGA @ 10 kg/ha and GM @ 10 t/ha, respectively. Unfertilized control treatment recorded the lowest grain and biological yields. Constant N supply due to slow release from the incorporated GM matched with the absorption pattern of rice resulting in improved crop yield (Westcott and Mikkelson, 1987). The influence of treatments on harvest index was not significant. Similar results were also obtained by Dixit and Gupta (2000).

Higher mean yield attributes i.e. panicles/m^2, grains/panicle and 1,000 grain weight (g) i.e. 322, 97 and 22.35 in RDF than best organic nutrition treatment GM + FYM (289, 70.5 and 22.07) led to differential yield of the treatments. The lower yield of other organic nutrition treatments including control was due to their lower yield attributes.

Maximum and higher total nutrient uptake (84.3 : 14.8: 90.4 N:P:K kg/ha) was recorded by RDF that was signifi-

Table 1. Yield attributes, grain, biological yield and harvest index of scented rice as influenced by nutrient management

Treatment	Panicles/m^2		Grains/panicle		1,000 grain weight (g)		Grain yield (t/ha)		Biological yield (t/ha)		Harvest index	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Control	135	104	45	39	18.34	17.83	0.90	0.72	2.40	1.92	37.5	37.5
RDF	330	314	100	94	22.36	22.33	4.00	3.89	9.70	9.28	41.2	41.9
GM 10 t	222	215	68	66	21.85	21.54	2.46	2.38	5.62	5.38	43.8	44.2
GM 5 t + PS 10 t	235	227	71	70	22.14	21.99	2.60	2.59	5.90	5.79	44.1	44.7
GM 5 t + FYM 10 t	295	284	90	86	22.18	22.06	3.30	3.27	7.70	7.57	42.9	43.2
KC 2.5 t	168	168	60	60	21.46	21.42	1.70	1.73	4.12	4.13	41.3	41.9
VC 2.5 t	165	158	61	59	21.42	21.36	1.69	1.65	4.09	3.95	41.3	41.8
GM 5 t + FYM 5 t + BGA	227	225	70	68	22.06	21.86	2.50	2.47	5.75	5.57	43.5	44.3
GM 5 t + BGA + *Azo*	162	156	59	56	21.15	21.03	1.67	1.63	4.06	3.83	41.1	42.6
GM 5 t + PSB 5 kg	158	145	59	54	20.83	20.52	1.60	1.56	3.98	3.71	40.2	42.0
SEm ±	7	6	7	6	0.14	0.10	0.11	0.12	0.59	0.48	1.3	2.7
CD (P=0.05)	20	17	19	16	0.39	0.31	0.33	0.35	1.21	0.99	NS	NS

BGA, Bluegreen algae, FYM, Farmyard manure; GM, Green manuring; KC, Karanj Cake; PS, Paddy straw; PSB, Phosphorus solubilizing bacteria; VC, Vermicompost; Azo, Azotobacter

Table 2. Organic carbon, nutrient uptake and economics of scented rice as influenced by nutrient management

Treatment	Nutrient uptake (kg/ha)						Cost of cultivation (Rs/ha)	Net return (Rs/ha)		B:C ratio	
	N		P		K						
	2004	2005	2004	2005	2004	2005		2004	2005	2004	2005
Control	15.12	11.72	2.51	1.97	18.85	14.68	8,240	6,015	3,160	0.73	0.38
RDF	85.02	83.57	15.15	14.53	93.16	87.58	10,939	40,453	38,661	3.70	3.53
GM 10 t	41.59	40.67	8.06	7.75	50.34	47.22	11,039	26,151	24,711	2.37	2.24
GM 5 t + PS 10 t	46.29	45.61	8.94	8.28	53.53	52.35	29,789	9,320	8,986	0.31	0.30
GM 5 t + FYM 10 t	63.82	64.20	11.81	11.75	73.62	72.43	13,789	36,264	35,686	2.63	2.59
KC 2.5 t	33.16	33.99	5.81	5.88	37.01	36.81	23,439	2,657	2,986	0.11	0.13
VC 2.5 t	30.70	29.97	5.73	5.61	36.11	34.85	20,039	4,809	4,286	0.24	0.20
GM5 t + FYM5 t + BGA	44.88	43.72	8.56	8.41	51.71	49.84	11,939	25,814	25,136	2.16	2.10
GM 5 t + BGA + *Azo*	30.62	28.79	4.95	4.78	32.63	30.08	9,989	15,675	14,786	1.57	1.48
GM 5 t + PSB 5 kg	28.55	27.33	4.89	4.68	31.82	29.19	10,289	14,468	13,511	1.41	1.30
SEm ±	2.16	2.04	0.12	0.25	1.36	1.15		1,506	1,445	0.11	0.11
CD (P=0.05)	6.24	5.90	0.35	0.73	3.93	3.32		4,356	4,181	0.32	0.32

Grain, Rs. 10,000/t (inorganic), Rs 12,500/t (Organic), Straw, Rs 2,000/t
GM, Rs 250/t; FYM: Rs 400/t; Azo: Azotobacter, KC, Rs 6,000/tonne; VC, Rs 5,000/t; BGA, Blue green algae

Table 3. Nutrient balance (kg/ha) after harvest of scented rice as influenced by nutrient management (after 2 years)

Treatment	Organic carbon (%)	Nutrient added (B)			Nutrients removed (C)			Soil available nutrient (D)			Actual gain/loss (D-A*)		
		N	P	K	N	P	K	N	P	K	N	P	K
Control	0.35	-	-	-	26.9	4.5	33.5	241	18.3	175	-39	-5.7	-25
RDF	0.47	200	43.6	41.6	168.6	29.7	180.7	250	20.8	185	-30	-3.2	-15
GM 10 t	0.58	84	6.5	61.4	82.3	15.8	97.7	275	21.8	197	-5	-2.2	-3
GM 5 t + PS10 t	0.52	124	12.0	34.9	91.9	17.7	105.9	265	24.0	202	-15	0.0	2
GM 5 t + FYM 10 t	0.56	142	20.7	97.1	128.0	23.6	146.1	271	23.0	201	-9	-1.0	1
KC 2.5 t	0.54	192	20.1	49.8	67.2	11.7	73.8	269	24.7	196	-11	0.7	-4
VC 2.5 t	0.52	150	21.8	62.3	60.7	11.3	71.0	266	24.2	199	-14	0.2	-1
GM 5 t + FYM 5 t + BGA	0.56	92	12.0	63.9	88.6	17.0	101.6	272	22.1	200	-8	-1.9	0
GM 5 t + BGA + *Azo*	0.58	42	3.3	14.1	59.4	9.7	63.4	277	22.0	195	-3	-2.0	-5
GM 5 t + PSB	0.53	42	3.3	14.1	55.9	9.6	61.0	265	24.3	192	-15	0.3	-8

*Initial status, 280 : 24 : 200 kg N : P : K/ha (A); Azo: Azotobacter

cantly higher than rest of the treatments (Table 2). Similar higher uptake of nutrients with RDF were also reported by Dixit and Gupta (2000). Among various organic sources, application of GM @ 5 t/ha + FYM @ 10 t/ha had significantly higher nutrient uptake (64.01 : 11.78 : 73.0 N:P:K kg/ha) than other organic treatments. The higher yields has enhanced nutrient uptake. Further integrated use of FYM with GM enhanced nutrient uptake by preventing the leaching and other losses. This confirms the finding of Kumar and Yadav (1995).

Soil fertility

Scented rice showed a loss in the soil nitrogen irrespective of treatments after 2 years of study (Table 3). Interestingly crop supplied with inorganic fertilizers had more loss than crop with organic nutrient management. Maximum available N (277 kg/ha) and minimum N loss (3 kg/ha) was recorded from plot receiving GM @ 5 t/ha + BGA @ 10 kg/ha + *Azotobacter* @ 500 g/ha. Similarly maximum available P (24.7 kg/ha) was recorded from plot receiving KC @ 2.5 t/ha. However, maximum available K (202 kg/ha) and gain in soil K (2.0 kg/ha) was recorded from the plot that received GM @ 5 t/ha + PS @ 10 t/ha. Soil available N after harvest of crop was successively lower than its initial status. Dixit and Gupta (2000) also observed that application of FYM and BGA either alone or in combination significantly increased the N, P and K status of soil.

Economics

Scented rice under inorganic nutrition (RDF) recorded maximum net return and benefit :cost ratio. The net returns of RDF treatment were on average was higher by Rs

3,582/ha over the best organic nutrition treatment i.e. GM @ 5 t/ha + FYM @ 10 t/ha. Crop with KC @ 2.5 t/ha and VC @ 2.5 t/ha were observed less remunerative even when compared with unfertilized control owing to more cost of manures. Singh *et al.* (2006b) have also observed that GM and FYM to rice were economically viable.

Scented rice (*Birsamati*) receiving *Dhaincha* green manure @ 5 t/ha + FYM @ 10 t/ha was found to be most appropriate organic nutrient management system for higher productivity as well as profitability. Inorganic crop receiving recommended dose of fertilizers gave the highest productivity and profits. However, use of different organic amendments and biofertilizer requirement of organic scented rice has enhanced the soil fertility after 2 years of study. Over years, it is expected to match or excel the fertilizer based production system.

REFERENCES

Das, K., Medhi, D.N. and Guha, B. 2003. Application of crop residues in combination with chemical fertilizers for sustainable productivity in rice (*Oryza sativa*) – wheat (*Triticum aestivum*) system. *Indian Journal of Agronomy* **48**: 8–11.

Dixit, K.G. and Gupta, B.R. 2000. Effect of farmyard manure, chemical and biofertilizers on yield and quality of rice (*Oryza sativa* L.) and soil properties. *Journal of Indian Society of Soil Science* **48**(4): 773–780.

Kumar, A. and Yadav, D.S. 1995. Use of organic manure and fertilizer in rice *(Oryza sativa)* - wheat *(Triticum aestivum)* cropping system for sustainability. *Indian Journal of Agricultural Sciences* **65**(10): 703–707.

Palaniappan, Sp. 1985. *Cropping Systems in the Tropics*: *Principles and Management*. Wiley Eastern Ltd, New Delhi.

Sharma, S.N. 2002. Nitrogen management in relation to wheat (*Triticum aestivum*) residue management in rice (*Oryza sativa*). *Indian Journal of Agricultural Sciences* **72**: 449–452.

Singh, N.B., Verma, K.K. and Yadav, R.S. 2006b. Nitrogen substitution in rice (*Oryza sativa*) – wheat (*Triticum aestivum*) cropping system through green manuring for sustainable production in eastern part of Uttar Pradesh. In: *Extended Summaries, National Symposium on "Conservation Agriculture and Environment*" 26-28 October, BHU, Varanasi, pp. 257–258.

Singh, Y.V., Singh, B.V., Pabbi, S., Dhar, D.W. and Singh, P.K. 2006a. Influence of integrated plant nutrient supply system on grain yield, quality and fertility in rice *(Oryza sativa)* – wheat *(Triticum aestivum)* cropping system. In: *Extended Summaries, National Symposium on 'Conservation Agriculture and Environment*'. 26-28 October, BHU, Varanasi, pp. 157–158.

Westcott, M.P. and Mikkelsen, D.S. 1987. Comparison of organic and inorganic nitrogen sources for rice. *Agronomy Journal* **79**: 937–943.