Effect of integrated nutrient management on productivity and quality of basmati rice (*Oryza sativa* L.)

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ABSTRACT

The effect of integrated nutrient management on aromatic rice var. basmati-370 was studied. Treatments included 100% recommended dose of fertilizer (RDF:80:40:40 NPK), 75% RDF, and 75% RDF in combination with pelleted form of organic manure (0.4 t ha^{-1}), organic manure rich with humus (0.1 t ha^{-1}), Karanja (Pongamia pinna) cake (0.6 t ha^{-1}), neem seed powder (0.8 t ha^{-1}), FYM (4.0 t ha^{-1}) and crop residue (3.8 t ha^{-1}). All the organic manures applied at the time of land preparation. Supply of inorganic sources of nutrient in conjunction with organic sources significantly increased grain yield (21.2-76.8%) over sole inorganic application. The highest grain yield of rice (2.83 t ha^{-1}) registered under integrated use of 75% RDF + pelleted form of organic manure. It was closely followed by the grain yield (2.56 t ha^{-1}) obtained with the application of 75% RDF + neem seed powder. However, sole chemical fertilizer addition produced lower grain yield (1.6 t ha^{-1}) compared to combined use of organic and inorganic sources. Further considerable improvement in grain quality was recorded under the treatments of integrated nutrient supply. Uptake of N, P and K was improved up to 54.6, 72.3 and 28.3% respectively with the integrated use of organic and inorganic fertilizer compared to RDF. Under integrated nutrient management considerable build up of soil fertility status (N, P and K content) was observed. This furnished the possibility of replacing 25% RDF through pelleted form of organic manure or neem seed powder or FYM for sustainable production, improving quality and fertility build up of soil.

Key words: *Integrated nutrient management, productivity, quality, uptake, soil fertility*

Basmati is a globally reputed aromatic group of rice, having pleasant aroma, superfine grain (› 6.5 mm long) along with extensive kernel elongation, and soft texture of cooked rice. Export of basmati rice from India has grown steadily during the last decade. Basmati rice from India and Pakistan contributes about 10 per cent of the world trade. Production of high quality aromatic rice by the farmers for domestic as well as export purpose is a major concern of future agricultural strategy. The cultivation of aromatic rice is mainly confined to the foot hills of the Himalayas along with some distant pockets in few states of our country (Siddiq, 2002). Therefore the cultivation of basmati rice in non-traditional areas with intensive management is a strategy to increase the production of aromatic rice. Aromatic rice cv. Pusa Basmati–1 responded significantly to the organic manure (vermi compost). Combined application of vermi compost with chemical fertilizer (125:62.5:62.5 N:P_2O_5:K_2O kg ha^{-1}) produced equivalent yield with good quality grain compared to highest level of fertilizer (150:75:75 N:P_2O_5:K_2O kg ha^{-1}) alone showing the reduction of 25% cost on chemical fertilizer (Murali and Setty, 2004). To restore desirable grain quality and maintain sustainable production, integrated nutrient management provides immense opportunity. Keeping this in view, the productivity and quality of basmati rice was studied under alluvial soils of west Bengal. The change in fertility status of the soil was also observed.

MATERIALS AND METHODS

A field experiment was carried out at Kalyani, West Bengal, during wet season of 2004 and 2005. The experimental site was medium land having well drained alluvial soil, and moderate climate during the growing season. The soil was clay loam with pH 6.9, organic carbon 0.58% and available N, available P and K 180.2,

15.52 and 130.63 kg ha^{-1}, respectively. Eight treatments comprising of different nutrient management practices viz. T_1- 100% recommended dose of fertilizer (RDF) (control); T_2- 75% RDF; T_3- 75% RDF + 25% N by addition of pelleted form of organic manure (through 0.4 t ha^{-1} Biomax); T_4- 75% RDF+25% N by addition of organic manure rich with humus (through 1.0 t ha^{-1} Biomas); T_5- 75% RDF + 25% N by addition of Karanja (*Pongamia pinna*) cake (through 0.6 t ha^{-1} Enmite); T_6- 75% RDF + 25% N by addition of Neem seed powder (through 0.8 t ha^{-1} Neematex); T_7- 75% RDF + 25% N by addition of FYM (4.0 t ha^{-1}); T_8- 75% RDF+ incorporation of crop (summer rice) residues @ 3.8 t ha^{-1} at the time of land preparation. The treatments were laid out in randomized block design with 3 replications. The chemical composition of different commercial formulation of organic sources was presented in Table 1.

Seed was sown on 6th June and 8th June in 2004 and 2005, respectively in seed bed. Twenty-five days old seedlings of Basmati-370 were transplanted in a puddled field at 20 cm x 15 cm spacing with 2-3 seedlings $hill^{-1}$ in experimental plot of 5m x 4m size. The crop was harvested at the end of October. The recommended dose of fertilizer (RDF) for basmati rice in the experiment was 80:40:40 kg N, P_2O_5 and K_2O ha^{-1}, respectively. Half of the fertilizer N and K, full dose of P were applied as basal. Remaining half of N and K was applied in two equal splits once at tillering and rest at panicle initiation stage. Organic manure was applied at the final land preparation as per the treatment secedule. Continuous submergence of 2-3 cm water was maintained at transplanting, at later stage 3-5 cm submergence was maintained up to maximum tillering stage. With drawal of submergence was done 15 days before harvesting. The other agronomic practices were followed as per standard recommendations. Yield parameters were recorded along with grain and straw yield. Quality tests of grain viz. hulling, milling and head rice recovery were done by using a composite sample of three replicates.

The length of 10 kernels for each treatment was recorded by a dial micrometer. Standard methods were followed to determine protein content (Sadasivam and Manickam, 1996) and amylose content (Juliano, 1971). Total N, available P and K contents in semi dry soil samples (0-15 cm depth) collected before transplanting and after harvesting of crop were estimated following Jackson (1973). Finely-ground grain (after milling) and straw samples were used for determination of N, P and K concentration (Jackson 1973). Total N, P and K uptake was calculated from grain and straw weight and their respective nutrient concentration.

RESULS AND DISCUSSION

All the yield components except 1000 seed weight were found to differ significantly under different nutrient management practices (Table 2). The highest values of yield attributes were with the application of 75% RDF + pelleted form of organic manure. This was followed by the treatments receiving 75% RDF + neem seed powder (T_6) and 75% RDF + FYM (T_7). On the other hand, poor performance of basmati-370 was found in treatments T_2 i.e. reduced rate of nutrient application (75 % RDF).

Grain yield increased with integrated nutrient management over 100% RDF was to the extent of 21.2 to 76.8 per cent. This might be due to the favourable soil condition and synchronized release of nutrients throughout the crop growth period. (Murali and Setty 2004). The highest grain yield was recorded under the treatment receiving 75% RDF + pelleted form of organic

Table 1. Nutrient composition of different commercial formulation of organic sources

Organic sources	Chemical composition			C:N ratio
	N	P	K	
Pelleted form of organic manure (Biomax)	5	2	1	4.14:1
Manure rich with humus (Biomas)	2	4	1	3.743:1
Karanja cake (Enmite)	3	2	1.25	8.919:1
Neem seed powder (Neematex)	2.5	1	1	10.509:1
Farm yard manure	0.5	0.2	0.5	24.83:1
Crop residues (Rice)	0.525	0.198	0.190	92.45:1

Table 2. Effect of integrated nutrient management on yield components, yield and grain quality of rice cv. Basmati-370 (pooled data of 2004 and 2005)

Treatment	Panicle hill^{-1}	Filled grains panicle^{-1}	1000 seed weight (g)	Grain yield (t ha^{-1})	Hulling (%)	Milling (%)	Head rice recovery (%)	Kernel length (mm)	Amylose content (%)	Protein content (mg g^{-1})
100% RDF	7.6	67.0	20.82	1.60	66.3	60.3	46.5	6.80	19.0	67.0
75% RDF	7.2	62.3	20.73	1.20	62.0	54.1	42.5	6.56	18.4	58.9
75% RDF + pelleted form of organic manure	9.1	90.4	21.31	2.83	77.6	69.2	58.4	6.9	20.7	69.5
75% RDF + organic manure rich with humas	8.1	78.0	21.10	2.25	72.0	65.8	49.8	6.83	19.9	68.4
75% RDF + Karanja (*Pongamia pinna*) cake	8.0	77.3	21.08	2.22	72.2	65.2	49.0	6.84	19.8	68.8
75% RDF + Neem seed powder	8.3	85.4	21.29	2.56	75.2	68.4	54.3	6.86	20.1	69.3
75% RDF + FYM	8.2	83.2	21.20	2.48	74.8	67.5	53.0	6.86	20.1	69.2
75% RDF + crop residues	8.0	72.8	21.00	1.94	71.7	64.0	47.2	6.80	19.3	67.6
CD (P=0.05)	1.03	4.08	NS	0.21	2.21	1.92	3.62	NS	0.72	2.06

manure (Biomax) (T_3). Higher grain yield were also recorded in the treatment receiving 75% RDF + neem seed powder (T_6) and 75% RDF + FYM (T_7), which was also at par with each other. 25% reduction of chemical fertilizer from recommended dose of fertilizer (T_2) resulted lowest grain yield. Mondal *et al* (2004) also reported similar findings. Thus substitution of 25% chemical fertilizer with organic sources viz. pelleted form of organic manure or neem seed powder or FYM provided an opportunity to harness the benefits of integrated nutrient management.

Quality parameters like hulling, milling, head rice recovery, amylose and protein content were influenced by nutrient management practices (Table 2). Application of pelleted form of organic manure, neem seed powder and FYM along with 75% RDF recorded more than 50% head rice recovery compared to sole inorganic treatments. Hulling and milling percentage of rice improved significantly when the crop was fertilized with 75% RDF + pelleted form of organic manure as compared with the application of 100% RDF. Judicious use of inorganic sources along with organic manure gave high head rice recovery compared with sole fertilizer application. Treatments did not exert any significant influence on kernel length. The highest amylose (20.7%) and protein content (69.5 mg g^{-1}) were recorded when the crop was fertilized with 75% RDF + pelleted form of organic manure. The lowest content of protein and amylose were recorded with 75% RDF. The quality of rice grain improved might be due to more availability of nutrients (macro and micro) and balanced fertilization to the plants with addition of organic manure over the chemical fertilizers only. Improvement in quality parameters of rice due to combined application of organic sources of nutrient along with inorganic fertilizer was also reported by Dixit and Gupta (2000).

Significant variation was observed in the uptake due to different nutrient management practices (Table 3). The highest assimilation of N was recorded under the treatment receiving 75% RDF + pelleted form of organic manure, closely followed 75% RDF + neem seed powder, and 75% RDF + FYM, respectively. In case of P the maximum uptake was observed under 75% RDF + organic manure rich with humus. Application of neem seed powder, FYM and pelleted form of organic manure along with 75% RDF also resulted in better uptake of P compared to 100%RDF, which were statistically at par. Uptake of K was the highest when the crop was fertilized with 75% RDF + neem seed powder. Better assimilation of K was recorded in all the treatments supplied with integrated nutrient management. Uptake of K by the crop was statistically at par among the treatments comprising of integrated sources of nutrient except crop residue incorporation. Uptake of nitrogen was always higher

Table 3. Effect of integrated nutrient management on uptake of nutrients (pooled of 2004 and 2005) and soil fertility status (after the second year)

Treatment	Composition of organic manures (%)			Nutrient uptake (kg ha^{-1})			Soil fertility status (kg ha^{-1})		
	N	P	K	N	P	K	Total N	Available P	Available K
100% RDF				42.8	11.2	70.6	1239 (-43)	13.81 (-1.71)	126.31 (-4.32)
75% RDF				34.6	9.2	60.4	1210 (-72)	11.76 (-3.76)	121.67 (-8.96)
75% RDF + pelleted formof organic manure	5	2	1	66.2	17.9	85.3	1313 (+31)	17.35 (+1.83)	132.80 (+2.17)
75% RDF + organic manure rich with humas	2	4	1	52.6	19.3	82.9	1291 (+9)	20.56 (+5.04)	133.60 (+2.97)
75% RDF + Karanja (*Pongamia pinna*) cake	3	2	1.25	50.8	16.3	84.5	1295 (+13)	16.92 (+1.40)	133.46 (+2.83)
75% RDF + Neem seed powder	2.5	1	1	60.2	18.7	90.6	1301 (+19)	16.62 (+1.10)	133.20 (+2.63)
75% RDF + FYM	0.5	0.2	0.5	58.8	18.1	87.2	1298 (+16)	16.71 (+1.19)	138.19 (+7.56)
75% RDF + crop residues	0.525	0.198	0.190	48.3	16.0	79.3	1286 (+4)	16.19 (+0.67)	133.00 (+2.37)
CD (P=0.05)				4.3	1.6	8.1	17.42	1.14	4.61

Initial soil fertility status: total N, available P and K 1282, 15.52 and 130.63 kg ha^{-1}; values in the parenthesis show the increase or decrease over initial value

with combined use of organic and inorganic sources of nutrient which was in conformity with the findings of Balasubramaniyan (2004).

Nutrient status of soil after the harvest of rice in second year was improved with combined sources of inorganic and organic nutrients. The highest total N was observed under 75% RDF + pelleted form of organic manure, closely followed 75% RDF + neem seed powder and 75% RDF + FYM. On the other hand the highest improvement in P and K status of soil was recorded under 75% RDF + organic manure rich with humus. Treatments received different organic sources of nutrient along with inorganic fertilizer found higher K status. Considerable improvement in soil fertility status owing to combination of organic nutrient sources and inorganic fertilizer was also reported by Sanyal et al (1993).

Application of 75% RDF in conjunction with 25% N through pelleted form of organic manure or neem seed powder or FYM improve the productivity, quality of aromatic rice and fertility build up of soil. So, the farmers can safely reduce 25% chemical fertilizers with the addition of 0.4, 0.8 and 4.0 t ha^{-1} of pelleted form of organic manure, neem seed powder and FYM, respectively.

REFERENCES

Balasubramaniyan P 2004. Yield potential of fine grain rice (*Oryza sativa*) under integrated nutrient management. Indian J of Agronomy 49(3): 157-159

Dixit KG and Gupta BR 2000. Effect of FYM, chemical and biofretlizer on yield and quality of rice and soil properties. Jounal of Indian Society of Soil Science 48(4): 773-780

Jackson ML 1973. Soil Chemical analysis. New Delhi: Prentice hall of India Pvt. Ltd.

Juliano BO 1971. A simplified assay for milled rice amylose. Cereal Science Today 16**:** 334-340

Mondal SS, Acharya D, Ghosh A and Thapa U 2004. Integrated management of organic and inorganic sources of nutrient to improve productivity and qualitative character of rice and onion in rice – onion cropping sequence. Environment & Ecology 22(1): 125-128

Murali MK and Setty RA 2004. Effect of fertilizer, vermicompost and triacontanol on growth and yield

of scented rice. Oryza 41(1 & 2): 57-59

Sdasivam S and Manikdamp A 1996. Biochemical methods. New Delhi: New Age International Publishing (P) Ltd.

Sanyal B, Mondal SSand Chatterjee BN 1993. Fertilizer management with bulky organic matter/manure in rice – potato–groundnut sequence for sustaining productivity. Journal Potassium Research 9(3): 218-227

Siddiq EA 2002. Exploring means to adopt GM rice. In Survey of India Agriculture. The Hindu, Chennai pp.47-52