Omonrice 10: 74-78 (2002)

Comparative study of organic and traditional farming for sustainable rice production

Nguyen Van Quyen[1], SN Sharma[2] and RC Gautam[2]

ABSTRACT

The comparative effect of organic and traditional farming on productivity and quality of a scented rice c.v. Pusa Basmati-1 as well as soil fertility was investigated through a field experiment conducted during the Kharif season of the crop year 2001 at the Indian Agricultural Research Institute, New Delhi. Grain yield of rice increased significantly with increasing rate of fertilizer application from 0 to 60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1} (50% recommended fertilizer dose). Effect of 10 t ha^{-1} FYM and Sesbania green manuring (SGM) before crop transplanting was found to be similar to 50% RFD, whereas combined effect of FYM + SGM was similar to 120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} (100% RFD). Inoculation of Blue Green Algae (BGA) and Phosphate solubilizing bacteria (PSB) or application of 50% RFD with SGM + FYM had no additional significant advantage on yield of rice. Rice quality parameters i.e. milling %, kernel length (KL), kernel breadth (KB) and L:B ratio before cooking of rice were not affected by different sources of nutrients, but the Head rice recovery, KL, KB and L:B ratio after cooking showed an increasing trend with the application of organic sources. Application of the highest dose of fertilizers 180 kg N + 90 kg P_2O_5 + 60 kg K_2O ha^{-1} gave 4.5 t ha^{-1} grain and 0.68% organic C in soil, whereas FYM + SGM + BGA + PSB gave 5.2 t ha^{-1} grain and 0.75% organic C.

Keywords*:* Organic farming; Traditional farming; Milling %; Head rice recovery; Kernel length; Kernel breadth; L:B ratio; Soil fertility; Organic C.

INTRODUCTION

Rice is staple food for millions of people in Asia-pacific region: 90% of world's rice is grown and consumed in Asia. Among the rice growing countries, India stands first in area (44.8 m ha) and second in production (91.0 m tonnes) next only to China. With the release of short/mid duration high yielding varieties of rice in early seventies, the production of rice has increased from 20.6 m tonnes in 1996 to 89.5 in 2000 (FAI, 2000). Most of the growth in rice production during this period is attributed to release of high yielding varieties and use of higher dose of fertilizer, but use of higher dose of high analysis fertilizers (containing high amounts of N, P and K only) and insufficient use of organics has created deficiencies of secondary and micronutrients particularly Zn and Fe (Takkar, 1996). The soils are showing signs of fatigue, as judged by decline in the yields of rice as well as a lower response to applied chemical fertilizers (Yadav *et.al*, 1998). Other aspects of food quality have also been changed to the worse. Instead of recycling our wastes back into the soil as the source of nutrients we burn them to pollute our environment. We use non-renewable energy resources to produce chemical fertilizers. In future we may force to make radical adjustment in such agricultural practices. Organic farming is referred to the

[1] Division of Agronomy, Cuu Long Delta Rice Research Institute, O Mon, Can Tho, Vietnam
[2] Division of Agronomy, Indian Agricultural Research Institute, New Delhi-12, India

cultivation of plant without addition of synthetic materials. It entails the use of compost, FYM, vermicompost, crop residues, green manures, green leaf manuring, crop rotation, and biofertilizers, to enrich soil organic carbon, supply plant nutrients and improve soil properties. It is general preferred because of improvement in quality of food grain and other natural resources as well as elimination of ground water and atmosphere pollution. Keeping all these things in view the present investigation was undertaken to study the effect of organic and traditional farming on productivity and quality of scented rice as well as soil fertility.

MATERIALS & METHODS

A field experiment was carried out on research farm of Indian Agricultural Research Institute, New Delhi during *Kharif* season of the crop year 2001. The soil experimental field was sandy clay loam having 52.8% sand, 21.5% silt and 25.7% clay. It contained 0.56, 163.2 kg ha^{-1} NaOH-K MnO_4 hydrolysable N, 21.1 kg ha^{-1} 0.5 $NaHCO_3$ extractable P and 232.4 kg ha^{-1} M NH_4AC extractable K and had a pH value of 8.2. The experiment was laid out in a randomized block design with 3 replications. Treatments consisted of four rates of inorganic fertilizers i.e. control, 60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1}, 120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} and 180 kg N + 90 kg P_2O_5 + 60 kg K_2O ha^{-1} and seven combinations of organic sources i.e. FYM, *Sesbania* green manuring (SGM), FYM + blue green algae (BGA), SGM + BGA, FYM + SGM, FYM + SGM + BGA and FYM + SGM + BGA + phosphate solubilizing bacteria (PSB) with and without 50% RFD. FYM was applied at 10 t ha^{-1} at the time of final puddling. *Sesbania* was grown for 60 days and was incorporated 5 days before transplanted. BGA was inoculated 10 days after transplanted, whereas PSB was inoculated by dipping the roots of rice seedling in the slurry of PSB culture. Rice (variety Pusa Basmati 1) was transplanted on 19 July 2001, 2-3 seedlings of 30 days age $hill^{-1}$ at a spacing of 20 x 15 cm. Rice was harvest on November 5, 2001.

RESULTS & DISCUSSION

Rice yield

Application of inorganic fertilizers resulted in an increase in grain yield of rice, but the increase was only significant with increment of fertilizers from 0 to 60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1}. Further increase in rate of inorganic nutrients did not give significant increase grain yield of rice (Table 1). Application of farm yard manure (F.Y.M) @ 10 t ha^{-1} alone produced grain yield of rice (4.20 t ha^{-1}) significantly higher than the control (3.68 t ha^{-1}) and equal to that obtained with 60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1} (4.14 t ha^{-1}). Combined use of 10 t ha^{-1} FYM and 60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1} was equal to 120 kg N + 60 kg P_2O_5 + 20 kg K_2O ha^{-1}. Thus 10 tonnes FYM ha^{-1} was found to be equal to 60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1}. This result was in accord with the findings of Singh *et al.*, (1996). Sesbania green manuring (SGM) was better than FYM which gave significantly more grain yield than 120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}. Inoculation of blue green algae (BGA) with FYM and SGM had no significant additional advantage over FYM and SGM alone whereas combined application of FYM and SGM resulted in higher yield than that obtained with either FYM or SGM. The highest yield of rice was obtained when FYM, GM, BGA and phosphate solubilizing bacteria (PSB) were applied together and there was no additional advantage of applying fertilizers with this combination.

Rice quality parameters

There was no definite trend in the milling %, kernel length, breadth and L/B ratio of rice before cooking as influenced by different sources of nutrients. Application of inorganic fertilizers at various rates (0-150% recommended fertilizer dose) did not affect on HRR of rice (Table 1). As compared to inorganic, organic manures had clearer effective on HRR of rice and they showed an increasing trend in organic treatments as compared to control (unmanured). In general, application of organic manures gave a higher L/B ratio of rice after cooking than with inorganic fertilizer. This is because application of inorganic fertilizers increased both length and breadth of kernel compared to control, while application of organic manures resulted

in higher length of kernel only. This character is considered as desirable trait in high quality rice.

Soil fertility status

Soil samples taken before and after rice crop showed that without fertilization organic C content in soil slightly increased, while available N, P, and K content decreased as compared to initial value (Table 2). However, application of 50% RFD (60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1}) significantly increased available P, K content of the soil over the control. Further increase the rate of fertilizers up to 150% RFD (180 kg N + 90 kg P_2O_5 + 60 kg K_2O ha^{-1}) significantly increased available K content of the soil only, whereas available N and organic C content of the soil significantly increased over the control only at higher level of fertilizer application (120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} and 180 kg N + 90 kg P_2O_5 + 60 kg K_2O ha^{-1}, respectively). The increase in organic C content of the soil may be due to an increase in root biomass with higher rate of fertilizer application. Data from the International Rice Research Institute long-term experiment also showed a significant increase in organic C content due to N fertilizer (Blair and Lefroy 1998).

The plot treated with FYM or SGM alone or in combination with BGA, PSB or 50% RFD resulted similar organic C content and invariable improved the organic carbon content as compared to the control or 50% RFD alone (Table 2). This was probably due to improper decomposition of organic C manures (FYM and SGM) as they were applied just before rice transplanting. *Sesbania* green manuring was better than FYM application and it significantly increased available N, P, and K content of the soil over the control and this increase was equal to that observed with 50% RFD, whereas FYM significantly improved available P and K status in soil only. BGA inoculation with FYM and SGM did not give any additional in available N, P, and K of the soil over FYM or SGM alone. Similarly, application of FYM and SGM together with or without BGA and PSB inoculation had no additional advantage in the availability of N and P content in soil over FYM and SGM alone, but significantly increased available K content in soil over FYM alone and was at par with 100% RFD. A combination of FYM + SGM + BGA was better than 100% RFD and FYM + SGM + BGA + PSB was better than 150% RFD in term of improving soil organic C. Addition of 50% RFD with different sources of organic manure or biofertilizers did not increase available N, P, and K content of the soil further.

It can be inferred from the present study that rice can be grown organically and soil can be sustain production better with a combination of FYM + SGM + BGA + BGA + PSB than 180 kg N + 90 kg P_2O_5 + 60 kg K_2O/ha.

Table 1. Effect of inorganic fertilizers, organic manures and bio-fertilizers on yield and quality parameters of rice variety Pusa Basmati-1.

Treatments	Yield (t ha^{-1})	Milling %	HRR (%)	KLBC (mm)	KBBC (mm)	LBBC	KLAC (mm)	KBAC (mm)	LBAC
Control	3.68	62.2	39.6	6.30	1.67	3.77	12.33	2.07	5.96
50%NPK	4.14	61.6	39.7	6.33	1.68	3.77	12.66	2.10	6.02
100%NPK	4.47	60.8	39.6	6.34	1.69	3.77	12.68	2.11	6.01
150%NPK	4.52	62.5	40.8	6.34	1.69	3.76	12.73	2.14	5.95
FYM	4.20	60.0	41.3	6.32	1.69	3.75	12.33	2.02	6.12
GM	4.72	64.1	41.0	6.33	1.69	3.75	12.41	2.05	6.07
FYM+BGA	4.24	62.8	41.4	6.33	1.69	3.74	12.46	2.03	6.16
GM+BGA	4.83	61.2	41.2	6.33	1.69	3.75	12.61	2.04	6.19
FYM+GM	4.79	64.7	41.5	6.34	1.69	3.74	12.45	2.04	6.10

Table 1: continue

Treatments	Yield (t ha^{-1})	Milling %	HRR (%)	KLBC (mm)	KBBC (mm)	LBBC	KLAC (mm)	KBAC (mm)	LBAC
FYM+GM+BGA	4.91	61.7	41.6	6.34	1.70	3.73	12.56	2.04	6.16
FYM+GM+BGA+PSB	5.15	63.0	41.9	6.34	1.70	3.73	12.48	2.03	6.15
50% NPK+FYM	4.39	63.0	41.7	6.33	1.69	3.74	12.44	2.03	6.13
50% NPK+GM	4.79	63.2	40.6	6.34	1.69	3.75	12.53	2.05	6.11
50% NPK+FYM+BGA	4.49	62.4	41.7	6.33	1.70	3.72	12.38	2.03	6.14
50% NPK+GM+BGA	4.88	60.9	41.7	6.34	1.70	3.74	12.61	2.05	6.14
50% NPK+FYM+GM	4.99	62.4	41.9	6.34	1.70	3.72	12.63	2.04	6.18
50% NPK+FYM+GM+BGA	5.16	62.7	41.9	6.34	1.71	3.71	12.48	2.05	6.13
50% NPK+FYM+GM+BGA+PSB	5.23	60.9	41.8	6.35	1.71	3.71	12.47	2.04	6.12
S Em±	0.16	1.2	0.9	0.09	0.03	0.07	0.22	0.04	0.17
CD 5%	0.45	NS	NS	NS	NS	NS	NS	NS	NS

HRR: Head rice recovery, KLBC: Kernel length before cooking, KBBC: Kernel breadth before cooking, KLAC: Kernel length after cooking, KBAC: Kernel breadth after cooking, LBAC: L/B ratio after cooking
Recommended fertilizer dose: 120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}

Table 2: Effect of inorganic fertilizers, organic manures and bio-fertilizers on organic C, available nutrient content of the soil.

Treatments	Organic C (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Control	0.61	160.9	18.1	231.5
50%NPK	0.63	166.0	24.1	247.3
100%NPK	0.67	179.6	26.1	257.6
150%NPK	0.68	181.4	26.7	280.4
FYM	0.70	169.6	23.2	242.7
GM	0.70	177.4	24.9	250.1
FYM+BGA	0.71	170.6	23.2	247.3
GM+BGA	0.71	182.4	24.7	253.9
FYM+GM	0.73	183.7	24.9	255.1
FYM+GM+BGA	0.74	184.4	24.7	255.1
FYM+GM+BGA+PSB	0.75	182.0	24.4	254.1
50% NPK+FYM	0.72	182.0	25.4	252.6
50% NPK+GM	0.71	183.7	25.9	254.7
50% NPK+FYM+BGA	0.73	182.3	25.5	251.1
50% NPK+GM+BGA	0.72	185.4	25.8	259.3
50% NPK+FYM+GM	0.75	185.4	26.7	256.3
50% NPK+FYM+GM+BGA	0.76	186.5	26.9	258.9
50% NPK+FYM+GM+BGA+PSB	0.77	184.7	26.5	259.7
S Em±	0.02	5.3	1.3	3.8
CD 5%	0.07	15.2	3.7	10.9
Initial	0.56	163.2	20.1	232.4

Recommended fertilizer dose: 120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}

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SUMMARY IN VIETNAMESE

Nghiên cứu so sánh biện pháp kỹ thuật canh tác vô cơ và hữu cơ cho việc ổn định năng suất lúa cao sản

Ảnh hưởng tương đối giữa biện pháp kỹ thuật canh tác vô cơ và hữu cơ tới năng và phẩm chất lúa cao sản *Pusa Basmati-1* và độ phì nhiêu của đất được nghiên cứu thông qua thí nghiệm đồng ruộng vụ *Kharif* (Hè-Thu) 2001 tại Học Viện Nghiên Cứu Nông nghiệp Ấn Độ, New Delhi. Bón phân vô cơ ở mức 60 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1} (50% NPK so với mức khuyến cáo) làm gia tăng năng suất lúa có ý nghĩa so với đối chứng. Năng suất lúa vẫn tiếp tục gia tăng với tốc độ giảm dần khi tăng mức phân bón tới mức 180 kg N + 90 kg P_2O_5 + 60 kg K_2O ha^{-1} (150% NPK so với mức khuyến cáo). Vùi cây phân xanh *Sesbania aculeate* hoặc bón 10 tấn phân chuồng cho 1 hectare trước khi cấy làm tăng năng suất lúa tương đương với bón 50% NPK mức khuyến cáo. Trong khi đó bón kết hợp giữa phân chuồng (10 t ha^{-1}) và cây phân xanh gia tăng năng suất lúa tương đương với bón 120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} (100% NPK so với mức khuyến cáo). Bón phân vi sinh Blue green algae (BGA) và Phosphate solubilizing bacteria (PSB) hoặc 50% NPK với phân chuồng và phân xanh không làm gia tăng suất lúa có ý nghĩa so với bón phân chuồng và cây phân xanh. Các chỉ tiêu phẩm chất gạo như phần trăm gạo trắng, chều dài và chiều rộng hạt gao và tỷ lệ L/B (dài chia rộng) trước khi nấu không có khác biệt ý nghĩa giữa các nghiệm thức. Nhưng phần trăm gạo nguyên, chiều dài và chiều rộng hạt gao và tỷ lệ L/B (dài chia rộng) sau khi nấu có khuynh hướng gia tăng ở các nghiệm thức bón phân hữu cơ. Bón phân vô cơ ở liều lượng cao nhất 150% NPK cho năng suất lúa 4.5 t ha^{-1} và 0.68 % hàm lượng hữu cơ trong đất. Trong khi đó, bón kết hợp giữa phân chuồng, phân xanh và phân vi sinh cho năng suất lúa 5.2 t ha^{-1} và cung cấp 0.75 % hàm lượng hữu cơ trong đất