

EFFECT OF DIFFERENT COMBINATIONS OF ORGANIC MANURES AND BIOFERTILIZERS ON GROWTH, YIELD, GRAIN QUALITY AND ECONOMICS IN ORGANIC FARMING OF SCENTED RICE

Hargilas* and S.N. Sharma

India Agricultural Research Institute, New Delhi

Email Id: hargilasm73@gmail.com

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Abstract: The field experiments carried out at the Indian Agricultural Research Institute, New Delhi during *Kharif* season of 2002 and 2003 to study the effects of different combinations of organic manures and biofertilizers on growth, yield, quality and economics of scented rice. The results indicated that application of farmyard manure (FYM) and Sesbania green manuring (SGM) significantly increased all the growth parameters and yield attributes of rice over absolute control which led to 17-27% and 26-33% increase in grain yield of rice, respectively. Combination of SGM + FYM was significantly superior to SGM and FYM alone and increase grain yield of rice by 44-53% over control. Inoculation of BGA with SGM and SGM + FYM resulted in a 4-11 and 3-8% increase in the grain yield over SGM and SGM + FYM, respectively. The highest grain yield of rice was obtained with the combinations of FYM + SGM + BGA this combination is, thus recommended for organic farming of rice.

Keywords: Organic farming, Farmyard manure, Sesbania green manuring, Blue green algae

INTRODUCTION

Rice is the staple food for millions of people in the Asia-pacific region; 90% of the 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 tones) next only to China. With the release of short/mid duration high yielding varieties of rice in the early seventies, the production of rice has increased from 20.6 mt 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 doses of fertilizers, but the use of higher doses of high analysis fertilizers (containing only N, P and K) and insufficient use of organics has created deficiencies of secondary and micronutrients particularly of Zn and Fe and 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). Farmers have to use more and more fertilizers year after year to obtain the same yield as of previous years. Excessive use of chemical fertilizers and pesticides also pollutes our air and water (Singh *et al.*, 1995). Other aspects of food quality have also been changed for the worse. Organic farming presents a valid alternative approach (Stockdale *et al.*, 2001). It entails the use of compost, FYM, vermicompost, crop residues, green manures, green leaf manuring, crop rotation, and biofertilizer to enrich soil organic carbon, supply plant nutrients and improve soil properties. It is also preferred because of improvement in grain quality and other natural resources as well as elimination of ground water and atmospheric pollution. Keeping all

these things in view, the investigation was undertaken to study the effect of organic farming on growth, yield and quality of scented rice.

MATERIAL AND METHOD

The field experiments were conducted during *Kharif* season of 2002 and 2003 at the Research Farm of Indian Agricultural Research Institute, New Delhi (28°35'N latitude, 77°12'E longitude and at an altitude of 228.61 m above mean sea level). The average of 56 years, receives an annual rainfall of 769.3 mm, of which nearly 85 per cent is received during July to September and the rest during October to June. The soil of experimental field was sandy clay loam (Ustochrept) with alkaline in reaction (pH 8.12), low in organic carbon (0.54%), low in available nitrogen (162.2 kg N/ha), medium in available phosphorus (19.22kg P/ha) and high in available potassium (245.32kg K/ha) in root zone at initial year of experiments. The experiment was laid out in a factorial Randomized plot design with three replications. Six treatment combinations consisted of Absolute control, Farm Yard Manure (FYM), Sesbania Green Manuring (SGM), Sesbania Green Manuring + Blue Green Algae (SGM+BGA), Sesbania Green Manuring + Farm Yard Manure (SGM+FYM), Sesbania Green Manuring + Farm Yard Manure + Blue Green Algae (SGM+FYM+BGA). The quantity of nutrients applied through organic manuring and biofertilizers is presented in Table 1.

Well decomposed FYM @ 10t/ha on dry weight basis used before sowing of sesbania in FYM treated plots. *Sesbania aculeata* was seeded for green

*Present address: Agricultural Research Station, Borwat Farm, Dahod Road, Banswara-327001, Rajasthan

*Corresponding Author

manuring in SGM treated plots at a uniform row spacing of 30 cm in last week of April and it incorporated in-situ about 60 DAS with the help of tractor mould board plough followed by heavy disc and then paddling of field for rice transplanting. Multani mitti based, Blue Green Algae (BGA) containing four micro-organisms species *Aulosira fertilissima*, *Nostoc muscorum*, *Tolypothrix tenuis* and *Anabaena variabilis* was inoculated twice in the plots having BGA treatment. The first inoculation was done at 10 days after transplanting (DAT) and then second at 20 DAT @ 4 kg ha⁻¹ and field was kept flooded for a month after each inoculation. The Pusa Sugandh 3 variety of lowland rice (*Oryza sativa* L.) was used for transplanting in the field. It matures in 120 days, responds to nutrients, shows a moderate resistance to lodging, and has synchronous tillering. Its kernels are long (7-7.5 mm) with good aroma and excellent cooking quality. It has a yield potential of 5-8.5 Mg ha⁻¹ and fetches 2-2.5 times more price than non-basmati rice. Data of each character were subjected to analysis of variance using F-test. Mean separation was done by the least significant difference (LSD) at 5% error probability.

RESULT AND DISCUSSION

Effect of weather conditions

Weather conditions during second year of study were more favorable than first year. Mean monthly maximum and minimum temperature were relatively low during second year as compared to first year. Mean monthly relatively, on the other hand, was relatively higher during second year than during first year. Total rainfall during crop growth period of rice was about eight times more in second year than in first year. All these favorable weather conditions resulted in higher yield during second year as compared to first year.

Growth parameters and yield attributes

The plant height, tillers, panicle, panicle length and grains, grain's fertility and test weight were influenced by different organic manures and biofertilizers. The data (Table 2&3) revealed that the application of FYM significantly increased all the growth parameters and yield attributes of rice over control. Plant height, tillers/m², panicles/m², grains/panicle, grain filling % and test weight (g) were recorded significantly superior from 5.06-10.12%, 7.97-18.21%, 11.63-28.57%, 9.50-13.4, 2.34-26.13, 18.8 and 3.34% over control, respectively. The fertility and test weight were found at par in first year and significantly higher in second year. These led to significantly higher grain and straw yields with FYM as compared to control. The effect of SGM on plant height, tillers/m² and grains/panicle was found significantly superior over FYM and at par on rest characters. The combined effect of SGM+BGA on

plant growth and yield attributes was found not significant higher over SGM. The number of tillers and panicle/m², grains/panicle in both year and plant height and test weight in second year were increased significantly through combined application of SGM+FYM over SGM+BGA. The combined effect of SGM+FYM+BGA on growth and yield attributes were found at par with combination of SGM+FYM and significantly higher over their individual effect in both the year. Awan *et al.* (2000), Shanmugan and Veeraputhran (2001) and Bhattachary *et al.* (2003) reported beneficial effects of organic manures on growth and yield parameters and yield of rice.

Grain yield, straw and harvest index

The data on grain and straw yield and harvest index of rice as influenced by different sources of nutrients are presented in table 4. Application of FYM to rice had significant effect on grain yield, straw yield and harvest index. The grain, straw yield and harvest index were recorded 17-28, 10-12 and 4.0% higher than control. The effect of SGM and FYM were found at par during first year but in second year, SGM alone proved significantly superior over FYM due to cumulative effect of SGM is higher than FYM. Combined effect of SGM+BGA on grain yield was found significantly higher than SGM alone. The combined effect of SGM+FYM on grain yield was found more than SGM+BGA. The cumulative effect of SGM+FYM+BGA on grain, straw yield and harvest index was found significant over SGM and FYM alone. Awan *et al.* (2000), Shanmugan and Veeraputhran (2001) and Bhattachary *et al.* (2003) reported beneficial effects of FYM on of rice and Mann *et al.* (1999) and Aulakh *et al.* (2000) reported beneficial effects of SGM on yield parameters and yield of rice. These results are in accordance with nitrogen supply through FYM and SGM. FYM @ 10 t ha⁻¹ supplied 48-50 kg N ha⁻¹, whereas SGM resulted in recycling of 119-121 kg N ha⁻¹, about two-third of this quantity might have fixed by *Sesbania* from atmosphere. Mann *et al.* (1999) and Aulakh *et al.* (2000) reported that *Sesbania* fixed about 109 and 120 kg N ha⁻¹ during 60-70 days. Palaniappan (2000) also reported an increase in grain and straw yields through green manuring.

Physio-chemical quality of rice

Physical quality of kernel

The data of physical quality of kernel are presented in Table 5. The hulling percentage in first year and milling percentage in second year and elongation and expansion ratio of kernel in both the years were found unaffected to FYM application, whereas, SGM significantly increased the hulling, milling percentage in both the years and elongation ratio of kernel in second year over control. The effect of SGM+BGA

was found non-significant over SGM. The combined effect of SGM+FYM was also found non-significant over SGM and FYM. The effect of SGM+FYM+Biofertilizers on hulling and milling was found significantly higher than individual effect SGM and FYM but it recorded non-significant in elongation and expansion ratio of kernel. Prakash *et al.* (2002) reported a significant increase in physical quality of rice kernel with organic manures. These effects might be due to supply of nutrient through mineralization of organic sources.

Amylose and protein content

The data on amylose and protein content of rice grain as influenced by different combinations of organic sources presented in Table 6. Amylose content was increased similarly by FYM and SGM in both the years. The maximum amylose content was recorded by SGM+FYM+BGA, however, there was no significant difference between SGM and FYM in both the years. Effects of FYM, SGM and SGM+BGA on protein content were statistically similar and significantly higher than control during first year, whereas, SGM was superior to FYM. Zhang and Shao (1999) and Prakash *et al.* (2002) also reported significant effect of organic sources on qualities of rice kernel.

Nutrient content

The data on N, P and K concentration in rice grain as influenced by different combination of organic manures and biofertilizer presented in table 7. Application of FYM had no significant effect in nutrient concentration in rice, whereas, SGM, SGM+BGA significantly increased nutrient content over control. However, there was no significant difference FYM, SGM and SGM+BGA. Similarly, combinations of SGM+FYM and SGM+FYM+BGA were at par but significantly increased nutrient concentration in rice grain over other combinations of organic manures and biofertilizer in both years. These results are in accordance with Singh *et al.* (2000), Hemalatha *et al.* (2000) and Quyen and Sharma (2003) regarding the physico-chemical properties of rice kernel.

Nutrient uptake

The data on N, P and K uptake by rice as influenced by different combinations of organic manures and biofertilizer presented in Table 8. In both the years, significantly higher N, P and K uptake was recorded by FYM and SGM over control, whereas, SGM was also recorded higher over FYM. These results were found positively correlated with the yield of crop. The combined effect of SGM+FYM on nutrient uptake was found significantly superior over SGM+BGA, SGM and FYM alone. The maximum N, P and K uptake was

recorded with SGM+FYM+BGA which also recorded significantly 15-21, 15-23 and 11-12% N, P and K uptake higher than SGM+ BGA and 21-34, 23-39 and 18-19% N, P and K uptake higher than SGM alone. Which clearly indicate that the amount of NPK removal by the grain and straw was mainly depends on the grain and straw yields. Similar, findings were also reported by Rathore *et al.* (1995) and Dixit and Gupta (2000). Quyen and Sharma (2003) also reported higher increase in NPK uptake of rice by SGM as compared to FYM. Hemalatha *et al.* (2000) and Sriramachandrasekharan (2001) reported that combination of green manuring + farmyard manure supplied 167-171 N + 42 kg P + 152-156 kg K ha⁻¹ besides significant quantities of micronutrients.

Economics of cultivation

The data on gross return, net return and B:C ratio of rice cultivation as influenced by different combinations of organic manures and biofertilizer are presented in Table 7. Significant effect of FYM over control, SGM over FYM, SGM+FYM over SGM and SGM+FYM+BGA over SGM+FYM was recorded in respect to increase in gross return during first year, whereas effects of FYM and SGM+FYM+BGA were found similar over control and SGM+FYM during second year. The cost of cultivation of a particular treatment did not vary with replications. Therefore, the data of cost of cultivation were not analyzed and the cost of treatments cost not repeated with year wise. The addition of FYM, SGM, SGM+BGA, SGM+FYM and SGM+FYM+BGA increased cost of cultivation over control by 14, 17, 18, 31 and 32% respectively. Net return was significantly increased with FYM and SGM over control and SGM found at par with FYM. The effect of SGM+BGA on net return was found significantly superior over FYM due to its low cost and comparable higher yield. The combined effect of SGM+FYM on net return was significantly superior over SGM but could not prove better over SGM+BGA. The highest net return was recorded with SGM+FYM+BGA which found significantly higher than SGM+FYM. Combination of SGM+FYM was found lesser beneficial to rice due to higher cost of cultivation incurred in this combination. Whereas, inoculation of BGA with SGM and SGM+FYM showed higher net return compared to FYM, SGM and SGM+FYM. The inoculation of BGA being a non-monetary input costing about Rs 200 ha⁻¹ hence, inoculation of BGA with SGM + FYM increased gross and net profit of rice. Rana *et al* (1988) reported the similar results on economy of fertilizer nitrogen through green manuring in rice.

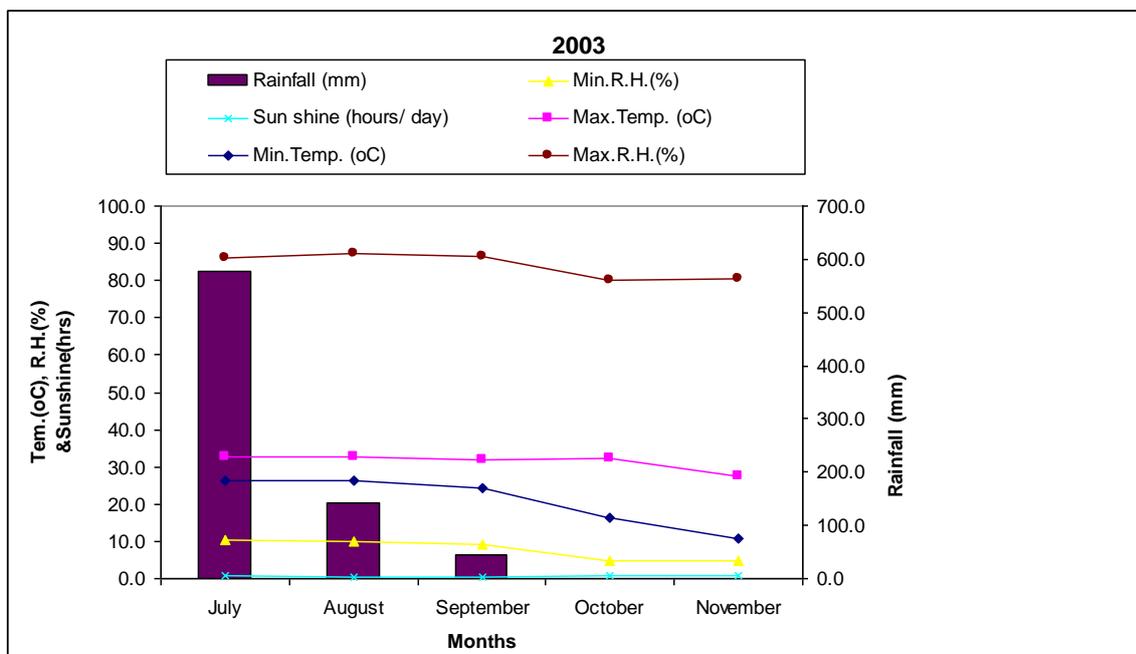
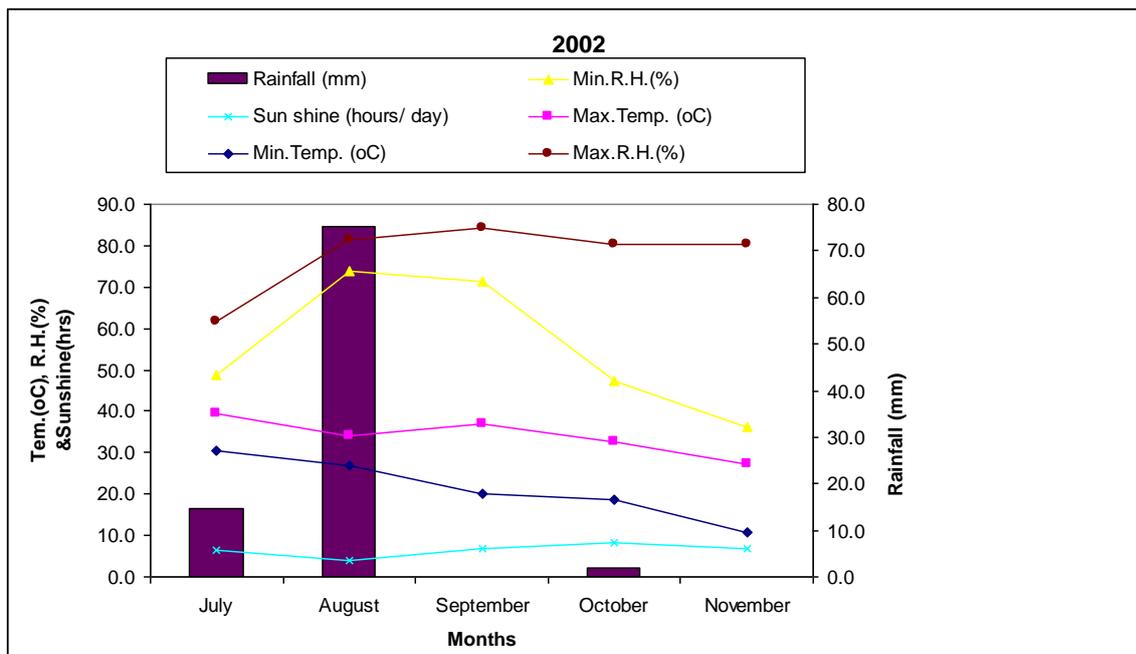


Fig.1. Monthly meteorological data during crop season of 2002 and 2003

Table 1. Quantity of nutrients (kg/ha) applied in treatments through organic manures and its C: N ratio

Treatments	Organic C (kg/ha)	Total N (kg/ha)	Total P (kg/ha)	Total K (kg/ha)	C:N ratio
Control	0.00	0.00	0.00	0.00	0.00
FYM	1390	49	26	52	27.00
SGM	1763	120	18	103	14.70
SGM+BGA	1814	140	18	103	13.96
SGM+FYM	3165	169	43	154	18.73
SGM+FYM+BGA	3164	189	43	154	16.74

Table 2. Effect of different combinations of organic manures and biofertilizers on growth parameters of rice

Treatments	Plant height (cm)		Tillers/m ²		Panicles/m ²		Panicle length (cm)	
	2002	2003	2002	2003	2002	2003	2002	2003
Control	96.9	95.8	331.1	341.0	215	210	22.1	22.3
FYM	101.8	105.5	357.5	403.1	240	270	24.2	25.3
SGM	105.3	109.7	383.0	418.4	260	315	25.7	26.7
SGM+BGA	106.6	112.4	396.0	420.1	270	320	25.8	26.8
SGM+FYM	110.0	119.5	419.6	432.5	300	320	27.1	28.3
SGM+FYM+BGA	112.5	121.3	436.5	440.4	305	345	28.4	29.2
LSD (p=0.05)	0.03	3.66	17.20	11.71	25	75	1.51	1.98

Table 3. Effect of different combinations of organic manures and biofertilizers on yield attributes of rice

Treatments	Filled grains/panicle		Unfilled grains/panicle		Fertility (%)		Test weight (g)	
	2002	2003	2002	2003	2002	2003	2002	2003
Control	80.1	80.0	22.3	36.7	78.2	68.6	21.5	21.6
FYM	83.0	120.0	21.8	27.2	79.2	81.5	22.2	22.3
SGM	86.5	125.8	21.2	27.0	80.3	82.3	22.7	22.8
SGM+BGA	87.0	128.7	21.2	26.2	80.4	83.1	22.8	22.9
SGM+FYM	91.1	138.7	20.1	21.3	81.9	86.7	23.2	23.5
SGM+FYM+BGA	93.9	145.0	19.9	18.5	82.5	88.7	23.4	23.7
LSD (p=0.05)	2.12	5.08	0.65	3.15	2.16	4.06	0.88	0.52

Table 4. Effect of different combinations of organic manures and biofertilizers on grain and straw yield (t/ha) and harvest index (%)

Treatments	Grain yield (t/ha)		Straw yield (t/ha)		Harvest index (%)	
	2002	2003	2002	2003	2002	2003
Control	3.09	3.52	5.58	5.97	35.6	36.3
FYM	3.63	4.49	6.14	6.68	37.1	37.7
SGM	3.89	4.68	6.60	7.16	37.3	38.2
SGM+BGA	4.33	4.89	7.06	7.51	38.0	38.5
SGM+FYM	4.74	5.06	7.39	8.16	39.0	39.2
SGM+FYM+BGA	5.14	5.21	7.56	8.25	40.4	40.6
LSD (p=0.05)	0.301	0.18	0.404	0.486	0.49	1.77

Table 5. Effect of different combinations of organic manures and bi-fertilizers on kernel quality of rice

Treatments	Hulling		Milling		Elongation ratio of kernel		Expansion ratio	
	2002	2003	2002	2003	2002	2003	2002	2003

Control	66.3	65.2	57.9	53.1	1.67	1.24	1.51	1.48
FYM	69.3	71.2	61.0	57.6	1.68	1.36	1.45	1.54
SGM	73.4	74.5	64.1	64.9	1.69	1.48	1.41	1.61
SGM+BGA	73.4	75.4	64.5	65.9	1.70	1.48	1.48	1.67
SGM+FYM	74.6	77.6	67.6	69.6	1.71	1.54	1.42	1.71
SGM+FYM+BGA	78.8	78.8	68.7	71.3	1.73	1.62	1.47	1.73
LSD (p=0.05)	3.39	5.22	3.06	5.35	0.03	0.21	0.11	0.23

Table 6. Effect of different combinations of organic manures and bio-fertilizers on amylose and protein content of rice grain

Treatments	Amylose content (%)		Protein content (%)	
	2002	2003	2002	2003
Control	22.3	21.5	6.64	7.20
FYM	24.1	25.1	7.15	7.68
SGM	25.3	25.8	7.38	7.85
SGM+BGA	25.3	26.5	7.42	7.91
SGM+FYM	26.5	26.8	7.53	8.09
SGM+FYM+BGA	28.1	27.9	7.70	8.21
LSD (p=0.05)	1.43	2.05	0.24	0.55

Table 7. Effect of different combinations of organic manures and bi-fertilizers on NPK content in grain of rice

Treatments	N concentration (%)		P concentration (%)		K concentration (%)	
	2002	2003	2002	2003	2002	2003
Control	1.20	1.09	0.210	0.210	0.224	0.220
FYM	1.25	1.29	0.220	0.230	0.238	0.230
SGM	1.29	1.32	0.234	0.240	0.251	0.253
SGM+BGA	1.30	1.33	0.240	0.250	0.255	0.256
SGM+FYM	1.33	1.36	0.249	0.250	0.268	0.270
SGM+FYM+BGA	1.35	1.38	0.257	0.250	0.271	0.274
LSD (p=0.05)	0.06	0.093	0.019	0.023	0.02	0.018

Table 8. Effect of different combinations of organic manures and bi-fertilizers on NPK uptake by rice

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	2002	2003	2002	2003	2002	2003
Control	61.0	63.6	10.2	11.1	85.6	89.9
FYM	73.5	88.6	12.2	15.0	95.9	105.1
SGM	81.8	96.9	13.9	16.7	105.1	116.3
SGM+BGA	90.7	101.9	15.7	17.8	113.2	123.2

SGM+FYM	100.1	111.3	17.6	19.3	121.4	135.1
SGM+FYM+BGA	109.3	117.0	19.3	20.5	125.2	137.5
LSD (p=0.05)	5.52	8.40	1.45	1.24	6.57	9.99

Table 9. Effect of different combinations of organic manures and biofertilizers on economy of organic rice cultivation

Treatments	Gross return (Rs/ha)		Cost of cultivation (Rs/ha)	Net return (Rs./ha)	
	2002	2003		2002	2003
Control	27311	31007	17892	9419	13115
FYM	31949	39271	20392	11578	18879
SGM	34175	41020	20972	13203	20048
SGM+BGA	38064	42868	21147	16918	21721
SGM+FYM	41579	44463	23472	18107	20991
SGM+FYM+BGA	44928	47295	23646	21281	23649
LSD (p=0.05)	2039	2136		2066	2161

CONCLUSION

On the basis of results it is concluded that combined effect of SGM+FYM+BGA for higher productivity and profitability in organic cultivation of rice under sub-tropical condition.

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