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Comparative study on Productivity, Profitability and Energetics of Aromatic rice (*Oryza sativa* L.) Genotypes under different organic nutrient management conditions of Chhattisgarh plains

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ABSTRACT
The present investigation was carried out at Research cum Instructional Farm, I.G.K.V., Raipur, during kharif season of 2013. The experiment was laid out in split plot design with 3 replications. The main plot consisting of three scented rice varieties with five organic nutrient management treatments in sub plots. among all the scented rice varieties, maximum energy output (130.94 MJ x10^3) of grain + straw and maximum energy output: input ratio (15.30) was registered in Dubraj. However, the total maximum energy output was generated (136.28 MJ x10^3) under T_1 (1/3 N through each of enriched compost + cow dung manure + neem cake). Gross return (65,971 Rs ha^{-1}), net return (41,472 Rs ha^{-1}) and B:C ratio (1.67) was superior in variety CR Sugandha Dhan 907. Highest grain yield and net return (40,020 Rs ha^{-1}) were recorded highest with the application of 1/3 N applied through enriched compost + cow dung manure + neem cake (T_1).
Keywords: *Kharif seasons, neem cake*

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INTRODUCTION

Rice is the most important and staple food crop for feeding more than two third populations in the world. The slogan 'Rice is life' is most appropriate for India as this crop plays a vital role in our national food security and is a mean of livelihood for millions of rural households. More than 90 percent of world's rice is grown and consumed in Asia, where 60 percent of the earth's population lives. India is the second largest producer of rice after China and has an area of over 43.77 m ha and produced 89.05 million tonnes during 2010. (Anonymous, 2011). Chhattisgarh is popularly known as "Rice Bowl of India" having an area around 3.57 million hectares under rice cultivation with the production of 6.25 million tonnes and productivity of 1751 kg ha^{-1}. Based on the outstanding performance in the rice production, Chhattisgarh had been selected for the 'Best Performing State' award in rice production during 2010-11 in the category of individual crop. But productivity of rice in the state is very low even below the national average (4.81 t ha^{-1}).

Energy is one of the most valuable inputs in production agriculture. Agriculture itself is energy user and energy supplier in the form of bio-energy (Alam et al., 2005). Energy is one of the most important indicators of crop performance. Energy analysis, therefore, is necessary for efficient management of scarce resources for improved agricultural production. It would identify production practices that are economical and effective. Other benefits of energy analysis are to determine the energy invested at every step of the production process, to provide a basis for conservation and to aid in making sound management and policy decisions. The possible way to increase the productivity of rice under organic management condition is through formulating better production technologies with location specific improved genotypes. The productivity of aromatic rice in the state can be increased by following the appropriate cultural practices along with high yielding rice genotypes

METHOD AND MATERIALS

The present investigation entitled "Effect of organic nutrient management on soil properties, productivity and quality of scented rice (*Oryza sativa* L.) varieties" was carried out at Research cum Instructional

Farm, IGKV, Raipur, during kharif season of 2013. The soil of experimental field was 'Vertisols' which is locally known as 'Kanhar'. The soil was neutral in reaction and medium in fertility having 5.20 g kg^{-1} soil organic carbon, low in nitrogen (208.5 kg ha^{-1}) medium phosphorus (17.23 kg ha^{-1}) and high potassium (348 kg ha^{-1}). The experiment was laid out in split plot design with 3 replications.

The main plot consisting of three aromatic rice varieties viz. Dubraj, Badshahbhog and CR Sugandha Dhan 907 with five organic nutrient management treatments as subplot viz. T_1 (1/3N through enriched compost + cow dung manure + neem cake), T_2 (3/4 N through poultrymanure + 1/4 N vermiwash foliar application), T_3 (paddy crop residue treated with Trichoderma + rock phosphate + PSB @ 10 kg ha-1), T_4 (3/4 N vermicompost +1/4 N vermiwash foliar application) and T_5 (in-situ green manuring + Azolla + BGA).

Cost of production for all treatments was worked out on the basis of the prevailing input and market price of the produce. The net return ha^{-1} was calculated by deducting the cost of production ha^{-1} from the gross return ha^{-1}. Ultimately, net return per rupees invested (cost: benefit ratio) was calculated treatment wise to assess the economic impact of the treatments by dividing the net return ha^{-1} by the cost of production.

The benefit: cost ratio was calculated with the help of following formula:

$$\text{Benefit: cost ratio} = \frac{\text{Net return (Rs ha}^{-1}\text{)}}{\text{Total cost of cultivation (Rs ha}^{-1}\text{)}}$$

Energy inputs were calculated and estimated in Mega Joule (MJ) ha^{-1} with reference to the standard values prescribed by Mittal *et al*. (1985). These inputs were taken to each treatment of rice and wheat crops. Energy values, which were taken for energy estimation. The standard energy coefficient for seed and straw of rice and wheat was multiplied with their respective yields and summed up to obtained the total energy output. The energy input and output for different scented rice and the organic nutrient management options was calculated by adding the respective values. Energy values of different organic sources were calculated on the basis of their respective N, P and K content. Energy use efficiency, energy output–input ratio were calculated as per the following formulas –

$$\text{Energy use efficiency (q MJ}^{-1} \text{ X } 10^{-3}\text{)} = \frac{\text{Total produce}}{\text{Energy input (MJ X } 10^{-3}\text{)}}$$

$$\text{Energy output input ratio} = \frac{\text{Energy output}}{\text{Energy input}}$$

RESULTS AND DISCUSSION

Yield

Among the scented rice varieties, CR Sugandha Dhan 907 produced significantly the higher grain yield (35.41 q ha^{-1}) over variety Badshahbhog (29.70 q ha^{-1}). Dubraj (33.01 q ha^{-1}) also produced comparable grain yield to that of CR Sugandha Dhan 907. Significantly highest straw yield was produced by Badshahbhog which was at par with Dubraj. Among the different organic nutrient management practices, significantly higher grain yield (34.76 q ha^{-1}) was recorded in T_1 (1/3 N through each of enriched compost + cow dung manure + neem cake) over T_2, T_4 and T_5). Application of paddy crop residue treated with Trichoderma + rock phosphate + PSB @ 10 kg ha^{-1} also produced comparable grain yield (33.92 q ha^{-1}) to that of T_1 same has been reported by Surekha, (2007).Almost similar results was obtained in case of straw yield and harvest index. Organic nutrition has increased the plant vigour with higher absorption of nuttients resulted in higher productive tiller production and ultimately higher grain yield (Nagarju and Krishnappa, 1995).

Energetics:

The data showed that however, energy input was similar among the rice varieties but the maximum total energy output (130.94 MJ $x10^3$) of grain + straw and maximum energy output: input ratio (15.30) was registered in Dubraj (Table 2). Maximum energy use efficiency (grain and straw) was recorded under CR Sugandha Dhan 907 followed by Dubraj and Badshahbhog. Among the different nutrient management treatments, application of paddy crop residue treated with *Trichoderma* + rock phosphate + PSB @ 10 kg ha^{-1} required maximum energy input (9.49 MJ $x10^3$) while minimum energy input (7.81 MJ $x10^3$) was calculated under *in-situ* green manuring + Azolla + BGA (T_5). The total maximum energy output generated (136.28 MJ $x10^3$) under T_1 (1/3 N through each of enriched compost + cow dung manure+ neem cake) which was at par with T_3 (paddy crop residue treated with *Trichoderma* + rock phosphate + PSB @ 10 kg ha^{-1}). Whereas, significantly maximum value of energy output: input ratio (16.38) was calculated under T_5 (*in -situ* green manuring + Azolla + BGA (T_5) which was closely followed by T_1. Energy use efficiency of seed (0.42 kg MJ $x10^{-3}$ ha^{-1}) was higher under treatment T_1 (1/3 N through each of enriched compost +

cow dung manure + neem cake) which was at par with T_4 and T_5. But in case of energy use efficiency of straw, it was recorded higher (0.82 kg MJ x10^{-3} ha^{-1}) under treatment T_5 *(In -situ* green manuring + Azolla + BGA), which was significantly superior over treatment T_2 and T_3 but statistically at par with rest of treatment .Similar observations were recorded by Jha *et al.* (2004).

ECONOMICS

Economics is the ultimate deciding factor to adopt a particular practice by farmers. It is governed by the cost involved in production and price given to the final product. Variable organic nutrient sources used in the study cost differently hence they affect the total cost of individual treatment. The variety 'CR Sugandha Dhan 907' recorded significantly higher gross return (65,971 Rs. ha^{-1}), net return (Rs 41,472 Rs. ha^{-1}) and B:C ratio (1.67) followed by Dubraj having gross return, net return and B:C ratio of Rs 62,373 ha^{-1}, Rs 37,874 ha^{-1} and 1.52, respectively (Table 3). Variation in economic values was mainly due to grain yield of rice which was different for different varieties. Highest gross income and net return of Rs 66,604 ha^{-1} and of Rs 40,020 ha^{-1} generated from the treatment where, 1/3 N applied through each of enriched compost + cow dung manure + neem cake (T_1). Interestingly noted that despite of lesser grain yield obtained under T_5, appreciably good net return Rs. 39,257 ha^{-1} and B:C ratio (1.72) was obtained with the application of *in –situ* green manuring + Azolla + BGA mainly due to lesser cost of cultivation. While, in spite of producing higher gross return (Rs 63,923 ha^{-1}), T_3 (paddy crop residue treated with *Trichoderma* + rock phosphate + PSB @ 10 kg ha^{-1}) failed to fetch higher net return (Rs 35,963 ha^{-1}) owing to the higher cost incurred. Davari *et al*., (2010) and Deshpande and Devsenapathy (2010) also reported appreciable increase in net return with the application of combined use of FYM + biofertilizer and vermicompost + biofertilizer or green manure + poultrymanure.

CONCLUSION

Application of 1/3 N through each of enriched compost + cow dung manure + neem cake had prominent effect on grain and straw yield which ultimately increased the net return. While, among varieties, CR Sugandha Dhan 907 gave significantly highest grain yield but it was at par to Dubraj. Scented rice varieties, CR Sugandha Dhan 907 recorded significantly highest net return (Rs 41,472 ha^{-1}) and B:C ratio (Rs.1.67). Similarly among the organic nutrient management, the highest net return (Rs 40,020 ha^{-1}) was obtained with application of 1/3 N through each of enriched compost + cow dung manure + neem cake (T1), respectively.

Scented rice varieties, maximum energy output (130.94 MJ x10^3) of grain + straw and maximum energy output: input ratio (15.30) was registered in Dubraj. Among the organic nutrient management, the total maximum energy output generated (136.28 MJ x10^3) under T_1 (1/3 N through each of enriched compost + cow dung manure + neem cake).

Table 1: Grain yield, straw yield, harvest index as influenced by scented rice varieties and organic nutrient management

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
Scented rice varieties			
V1= Dubraj	33.01	65.94	33.36
V2= Badshahbhog	29.70	66.71	30.80
V3= CR SugandhaDhan 907	35.41	60.08	37.09
SEm±	**0.79**	**1.30**	**0.52**
CD (P=0.05)	**2.73**	**4.51**	**1.81**
Organic nutrient management			
T_1=1/3 N through each of enriched compost + cow dung manure + neem cake	34.76	67.36	34.06
T_2=3/4 N through poultrymanure +1/4 N vermiwash (foliar application)	30.24	59.69	33.65
T_3= Paddy crop residue treated with *Trichoderma* + rock phosphate + PSB@10 kg ha^{-1}	33.92	65.99	33.97
T_4=3/4 N vermicompost + 1/4 vermiwash (foliar application)	32.25	63.95	33.54
T_5= *In-situ* green manuring + Azolla + BGA	32.36	64.22	33.52
SEm±	**0.77**	**1.48**	**0.58**
CD(P=0.05)	**2.23**	**4.27**	**NS**

Table 2: Energetics of scented rice and organic nutrient management

Treatment	Energy input (MJ x 10^3 ha^{-1})	Energy output (MJ x 10^3 ha^{-1})			Energy output-input ratio	Energy use efficiency (kg MJ x 10^3 ha^{-1})	
		Seed	Straw	Total		Seed	Straw
Scented rice varieties							
V1= Dubraj	8.58	48.52	82.43	130.94	15.30	0.39	0.77
V2= Badshahbhog	8.58	43.95	83.38	127.33	14.90	0.35	0.78
V3= CR SugandhaDhan 907	8.58	52.16	75.09	127.25	14.90	0.42	0.70
SEm±	-	**1.05**	**1.63**	**2.40**	0.28	**0.01**	**0.02**
CD (P=0.05)	-	**3.63**	**5.64**	**8.29**	0.97	**0.03**	**0.05**
Organic nutrient management							
T_1=1/3 N through each of enriched compost + cow dung manure+ neem cake	8.46	52.07	84.20	136.28	16.11	0.42	0.80
T_2=3/4 N through poultrymanure +1/4 N vermiwash (foliar application)	8.85	44.13	74.61	118.74	13.41	0.34	0.67
T_3=Paddy crop residue treated with *Trichoderma* + rock phosphate + PSB@10 kg ha^{-1}	9.49	49.86	82.48	132.35	13.95	0.36	0.70
T_4=3/4 N vermicompost + 1/4 vermiwash (foliar application)	8.31	47.41	79.94	127.34	15.32	0.39	0.77
T_5= *In-situ* green manuring + Azolla + BGA	7.81	47.57	80.27	127.84	16.38	0.41	0.82
SEm±	-	**1.11**	**1.85**	**2.40**	**0.29**	**0.01**	**0.02**
CD(P=0.05)	-	**3.21**	**5.34**	**6.95**	**0.83**	**0.03**	**0.05**

Table.3: Economics as affected by scented rice varieties and organic nutrient management

Treatment	Cost of cultivation (Rs ha^{-1})	Grass income (Rs ha^{-1})	Net return (Rs ha^{1})	B:C Ratio
Scented rice varieties				
V1= Dubraj	24828	62373	37874	1.52
V2= Badshahbhog	24828	57195	32696	1.31
V3= CR SugandhaDhan 907	24828	65971	41472	1.67
SEm±	_	**1287**	**1287**	_
CD (P=0.05)	_	**4454**	**4454**	_
Organic nutrient management				
T_1= 1/3 N through each of enriched compost + cow dung manure + neem cake	26478	66604	40020	1.52
T_2=3/4 N through poultrymanure +1/4 N vermiwash (foliar application)	23350	56702	33652	1.43
T_3= Paddy crop residual treated with *Trichoderma* + rock phosphate + PSB@10 kg ha^{-1}	28560	63923	35963	1.24
T_4=3/4 N vermicompost + 1/4 vermiwash (foliar application)	23300	60896	37846	1.61
T_5= *In-situ* green manuring + Azolla + BGA	22450	61107	39257	1.72
SEm±	_	**1323**	**1323**	_
CD(P=0.05)	_	**3828**	**3828**	_

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