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Economic viability of different rice varieties grown under organic farming

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Abstract
A field experiment was conducted at Instructional Research Farm, Krishi Nagar, Adhartal, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP) during the *Kharif* season of 2019-20 and 2020-21 to evaluate the different rice varieties under organic farming in Kymore Plateau and Satpura Hills Zone. The experiment was carried out using randomized block design with three replications involving twelve rice varieties *viz*., Pusa Sugandha 5, Sahyadri, Pusa Sugandha 4, Pusa Sugandha 3, Pusa Basmati 1, Danteshwari, Madhumati, BVD 109, JR 201, IR 36, MTU 1010 and IR 64. The recommended dose of NPK @ 120:60:40 kg per ha respectively was applied through FYM, Neem cake and Vermicompost, each 1/3rd on the basis of nitrogen content. Grain and Straw yields varied significantly among the above-mentioned rice varieties. Rice variety IR 64 recorded the maximum grain yield and straw yield closely followed by Pusa Sugandha 3, whereas significantly superior over other varieties. However, the minimum grain yield and straw yield was noted in Danteshwari. While considering economic aspects of different rice varieties with the common cost of cultivation, the GMR and NMR were recorded maximum in PS 3 (Rs. 157330 and 93414 ha^{-1} respectively) and minimum in Danteshwari (Rs. 75050 and 11134 ha^{-1} respectively). With regard to the B:C ratio, markedly highest profitability was noted in the rice variety PS 3 (2.46) as compared to other varieties.

Keywords: Organic farming, rice varieties, gross monetary returns, net monetary returns and benefit-cost ratio

Introduction
Rice (*Oryza sativa* L.) is the most important cereal crop of the world, grown in more than hundred countries, with a total area of 158 million hectares, producing more than 700 million tonnes (MT) annually. India is the 2nd largest producer and consumer of rice in the world. In India, rice was grown on an area of 43.78 mha with the production of 118.43 MT and productivity of 2705 kg/ha during the year 2019-20. Whereas in M.P, area under rice was estimated to be 2.02 mha with the production of 4.80 MT and productivity of 2382 kg/ha (Agriculture Statistics at a Glance, 2020). In 2017, area under organic cereal in the world was 4.5 million hectares, equivalent to 0.6% of total cereal area (FAOSTAT, 2019) [5]. India produces around 1.35 million tons of certified organic products which include 0.05 million tones Basmati rice (4%). In India, Madhya Pradesh has covered largest area under organic certification followed by Himachal Pradesh and Rajasthan (Anonymous, 2016) [1]. Intensive agriculture, escalating prices of chemical fertilizers and deterioration in soil health, demands the use of organic manures for maintaining soil health and attaining sustainable crop production. Organic farming encourages the use of locally available resources which are cheap, easy to manipulate and best in maintaining soil fertility on sustainable basis towards an eco-friendly environment. Thus, organic farming is gaining momentum during recent times due to awareness of people towards environment and healthy food. Organic and inorganic produce differ in quality parameters. Organic food markets in India are expanding quite fast owing to growing demand for organic food and the high premium it fetches. Therefore, this approach enhances the economical way of crop production by reducing the cost of cultivation and increasing the market value of produce. Kumar *et al*., (2007) [8] recorded higher yield of rice and wheat with the use of organic manures. Selection of a variety plays a crucial role under organic farming as it has a direct effect on yield and economics of a crop than conventional farming (Revilla *et al*. 2008). Varieties under organic farming must have ability to maintain high yield level, yield stability and product quality such as taste, color, nutritional value and keeping quality to attain optimum monetary returns.

Aromatic rice has immense potential to attract rice consumer for its taste and deliciousness, and high price to boost up the economic condition of the rice grower in the country. Scented rice has a special place in the world rice market and is generally the highest priced rice (Efferson, 1985) [4]. Keeping above in view, the present experiment was conducted to evaluate the suitable rice varieties for organic farming and to assess their economic viability.

Materials and Methods

The field experiment was conducted during *kharif* 2019-20 and 2020-21 at Instructional Research Farm, Krishi Nagar, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP). The treatments comprised of twelve rice varieties *viz*., Pusa Sugandha 5, Sahyadri, Pusa Sugandha 4, Pusa Sugandha 3, Pusa Basmati 1, Dhanteshwari, Madhumati, JR 201, MTU 1010, BVD 109, IR 64 and IR 36 in randomized block design with three replications. The soil of the experimental site was sandy loam, neutral in reaction (pH 7.25) with normal EC (0.34 dS m^{-1}), medium in OC contents (0.71%), low in available N (272 kg ha^{-1}), medium in available P (20.72 kg ha^{-1}), and high in available K (345 kg ha^{-1}) contents. The rainfall received during crop season in 2019-20 and 2020-21 amounted to be 1064.8 mm and 1159.0 mm respectively. However, weather conditions were normal for better growth and development of the rice crop during both years. The recommended dose of NPK i.e., 120:60:40 kg per ha respectively was applied through FYM, Neem cake and Vermicompost, each 1/3rd on the basis of nitrogen content. Twenty days old seedlings of all rice varieties were transplanted manually on 12th July in 2019, and 17th July in 2020 with the planting geometry of 20 cm x 20 cm. Weeds were controlled by using Cono Weeder at 25 days after transplanting followed by hand weeding. The economics of different varieties has been worked out in terms of cost of cultivation, gross monetary returns (GMR), net monetary returns (NMR) and benefit-cost ratio (B:C ratio) on per hectare area basis to ascertain the economic viability of the rice varieties.

The monetary returns with different varieties have been computed by including price of grain as well as straw. For favour of comparing rice varieties the GMR were worked out in terms of non-scented organic rice. The net monetary returns per hectare for different varieties were determined by subtracting the cost of cultivation of a particular variety from the GMR of the same variety. To estimate the benefits obtained from different varieties over each rupee of expenditure incurred, B:C ratio of each variety was calculated as per formula given below:

B: C ratio = Gross monetary returns per hectare / cost of cultivation per ha

Results and Discussion

Grain yield

The data presented in Table 1 revealed that the mean grain yield of rice varieties grown with organic nutrient management varied significantly. The maximum grain yield (4174 kg ha^{-1}) was recorded with the rice variety IR 64 which showed parity to Pusa Sugandha 3 (3933 kg ha^{-1}) but significant superiority over other varieties. The next best varieties *viz*., Pusa Sugandha 4, Sahyadri, and MTU 1010 were in descending order with the grain yields of 3680, 3570 and 3420 kg ha^{-1} respectively. These varieties had superior growth parameters and yield attributing characters therefore, they produced significantly higher grain yields than others. Whereas the minimum grain yield (2502 kg ha^{-1}) was noted in the rice variety Danteshwari which could be attributable to the lowest values of growth parameters and yield attributes. These findings were in closed conformity with those of Kumar *et al*. (2018) [9] who concluded that the higher yield was associated with increase in yield attributes *viz*., effective tillers m^{-2}, panicles m^{-2}, panicle length, grains per panicle and filled grains per panicle. Similar results were reported by Chand *et al*. (2016) [3] and Krishna Kumar *et al.* (2005) [7].

Straw yield

The data given in Table 1 showed that different rice varieties sought significant variations in straw yield. The highest straw yield (4943 kg ha^{-1}) was recorded in IR 64 which was statistically at par with Pusa Sugandha 3 (4905 kg ha^{-1}), Pusa Sugandha 4 (4792 kg ha^{-1}), Sahyadri (4721 kg ha^{-1}) and MTU 1010 (4670 kg ha^{-1}) but was significantly superior to others, since these varieties had significant superiority in their growth parameters, thus the maximum straw yields were obtained in these varieties. While the lowest straw yield (4159 kg ha^{-1}) was found in Danteshwari which could be as a result of the minimum growth attributes. Comparable results on straw yield were reported by Kumar *et al.* (2018) [9] who reported that improved growth attributes resulted in higher straw yields.

Economics

The cost of cultivation for different rice varieties amounted Rs. 63916 ha^{-1} (common for both the years). The higher cost of organic manures as well as charges of their application accounted for high cost of cultivation in organic farming as compared to integrated nutrient management or chemical farming.

Gross monetary returns

It is clear from the data presented in Table 2 that among different rice varieties the GMR was maximum (Rs. 157330 ha^{-1}) in Pusa Sugandha 3 closely followed by Pusa Sugandha 4 (Rs. 147199 ha^{-1}) and Sahyadri (Rs. 142810 ha^{-1}). The GMR obtained in Pusa Sugandha 3, Pusa Sugandha 4 and Sahyadri was highest because these are scented rice varieties which fetched more price and comparable grain and straw yields. Danteshwari having lesser grain and straw yields, also being non-scented gave minimum GMR (Rs. 75050 ha^{-1}) than other varieties.

Net monetary returns

It is obvious from the data given in Table 2 that the NMR of different rice varieties varied remarkably. The NMR of different rice varieties followed the same trend as of their GMR, because higher GMR gives higher NMR with the same cost of cultivation. Thus, among different rice varieties Pusa Sugandha 3 fetched the maximum NMR (Rs. 93414 ha^{-1}) followed by Pusa Sugandha 4 (Rs. 83283 ha^{-1}) and Sahyadri (Rs. 78894 ha^{-1}), whereas the minimum NMR (Rs. 11134 ha^{-1}) was recorded with Danteshwari.

Benefit-cost ratio

Perusal of the data given in Table 2 revealed that among different rice varieties, the maximum B:C ratio (2.46) was noted with Pusa Sugandha 3 closely followed by Pusa Sugandha 4 (2.30) and Sahyadri (2.23), while the minimum

B:C ratio (1.17) was recorded with Danteshwari. Remaining varieties were at intermediary position. Singh and Rai (2007) [10] also reported that shifting from inorganic agriculture to organic agriculture may be more remunerative by growing high value crops. Similar findings on economics of organic rice were reported by Dubey *et al*. (2020) [6] who founded that scented varieties are more profitable in organic farming than non-scented variety.

Table 1: Mean Grain yield and straw yield of different rice varieties under organic farming

Varieties	Grain yield (Kg/ha)	Straw yield (Kg/ha)
Pusa Sugandha 5 (V_1)	2697	4326
Sahyadri (V_2)	3570	4721
Pusa Sugandha4 (V_3)	3680	4792
Pusa Sugandha 3 (V_4)	3933	4905
Pusa Basmati 1 (V_5)	3263	4532
Danteshwari (V_6)	2502	4159
Madhumati (V_7)	2600	4228
JR 201 (V_8)	2941	4415
MTU 1010 (V_9)	3420	4670
BVD 109 (V_{10})	3045	4478
IR 64 (V_{11})	4174	4943
IR 36 (V_{12})	3172	4512
S.Em ±	99.40	132.11
CD at 5%	292.95	389.35

Table 2: Economic analysis of different rice varieties under organic farming

Varieties	GMR Rs ha-1	NMR Rs ha-1	B:C ratio
Pusa Sugandha 5 (V_1)	107890	43974	1.69
Sahyadri (V_2)	142810	78894	2.23
Pusa Sugandha4 (V_3)	147199	83283	2.30
Pusa Sugandha 3 (V_4)	157330	93414	2.46
Pusa Basmati 1 (V_5)	130532	66616	2.04
Danteshwari (V_6)	75050	11134	1.17
Madhumati (V_7)	104015	40099	1.63
JR 201 (V_8)	88235	24319	1.38
MTU 1010 (V_9)	102591	38675	1.61
BVD 109 (V_{10})	91362	27446	1.43
IR 64 (V_{11})	125210	61294	1.96
IR 36 (V_{12})	95168	31252	1.49

Cost of cultivation - Rs. 63916 ha^{-1}

Market price of scented rice - Rs. 40 kg^{-1} and non-scented rice - Rs. 30 kg^{-1}

Conclusion

From the present study, it could be concluded that the rice variety Pusa Sugandha 3 was more productive (grain yield 3933 kg ha^{-1}) and remunerative (NMR Rs. 93414 ha^{-1}) with highest B:C ratio (2.46) followed by Pusa Sugandha 4 (grain yield 3680 kg ha^{-1}, NMR Rs. 83283 ha^{-1}, B:C ratio 2.30) and Sahyadri (grain yield 3570 kg ha^{-1}, NMR Rs. 78894 ha^{-1}, B:C ratio 2.23). Thus, these varieties can be recommended for growing under organic farming in Jabalpur region of Kymore Plateau and Satpura Hills Zone.

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