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Performance of rice varieties for higher yield under organic farming in Jharkhand, India

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Abstract
Performance of modern cultivars in terms of yield under organic farming differs from that of conventional system. As the demand for organic rice is increasing, so to maintain high productivity, there is a need to evaluate modern high yielding rice varieties under organic farming systems. A field experiment was conducted at research farm of Birsa Agricultural University, Jharkhand with an objective to evaluate yield attributes, yield and economics of different rice varieties under organic farming in the region of Jharkhand. The soil of experimental plot was sandy clay loam in texture having average carbon (6.16 Kg/ha), nitrogen (254.78 kg/ha), phosphorous (39.59 Kg/ha) and potassium (208.26 Kg/ha) with soil pH 6.04. Field experiments were carried out using randomized block design replicated thrice involving twelve treatments with twelve rice varieties viz. BVD 203, Birsa Dhan 201, Birsa Vikas Sugandha 1, BVD 110, Sahbhagidhan, Birsamati, Anjali, Lalat, M.T.U. 1010, Akshay, Pusa Sugandha and Naveen. Result of the study revealed that maximum no. of effective tillers per m^2 (256.67) was observed in Birsamati, no. of grains per panicle (113.00) was observed in Lalat, no. of unfilled grains per panicle (37.67) was observed in Sahbhagidhan, panicle length (26.80 cm) was observed in Lalat. M.T.U. 1010 recorded the highest 1000 grain wt. (24.09 g), panicle wt. (3.95 g), grain yield (40.22 kg/ha), straw yield (62.96 kg/ha), harvest index (39.01%), gross return (93669 ₹/ha), net return (56057 ₹/ha) and B:C ratio (1.49) can be recommended under organic rice production in the region of Jharkhand (India).

Keywords: Organic farming, Rice varieties, yield and economics

Introduction
Rice is the lifeline for millions of people in the world, particularly in developing countries. Among the rice growing countries, India has the largest area (43.4 m ha) and ranks second in production (104.32 mt) next to china with productivity of 2404 kg/ha. In Jharkhand, rice is grown in about 1.59 m ha with production of 2.88 mt and productivity of 1814 kg/ha (Directorate of Economics and Statistics, Ministry of Agriculture and Farmer Welfare Government of India, 2016-17) [4].

The unbalanced and injudicious use of chemical fertilizers and pesticides has clearly visible adverse effect on soil structure, microflora, quality of water, food and fodder. The quality of produce is also deteriorated due to entry of chemical residues in the plant body and then to food chain. The emerging scenario necessitates the need of adoption of the practices which maintains the soil health, keeps the production system sustainable and provides qualitative food for meeting the nutritional requirements of human beings. There is a great demand for high quality products and organically grown foods in the international market and can capitalize on its potential to go for organic farming on a large scale. India, with its varied agro-climatic conditions and agricultural biodiversity, is most suited for organic farming. It is necessary to educate the farmers about the scientific methods of organic farming so that their income will increase gradually. So in the context of improved quality of food and maintenance of ecological balance the major source of food that is rice under organic farming is emphasized. Adoption of organic farming will able to make rice more sustainable without adverse effects on the natural resources and the environment (Stockdale *et al.*, 2001) [12].

In this context there is always a continuous search for agronomic improvement to optimize farming system under organic farming and needs suitable varieties to realize its potential (Kokare *et al.*, 2014). Despite the potential benefits of organic farming in terms of better soil health and quality of produce, maintenance of high yields is one of major challenge under organic farming systems (Tilman *et al.*, 2002) [13]. Modern cultivars have been selected by plant breeders under conventional systems and they may not perform well under organic farming systems where they are grown in stressed environment without addition of external inputs that is entirely different to those in which they were selected (Ceccarelli, 1996; Murphy *et al.*, 2007) [1, 7]. So, there is a need to select varieties for organic farming which can be better suited to stressed environment as crops are not supplied with chemicals for either supplying nutrients or to protect the crop from pests and diseases.

Organic farmers depend greatly on conventionally produced varieties, but require varieties better adapted to organic farming systems for further optimization of organic agriculture. This includes a greater need for 'reliable' varieties contributing to higher yield stability. For further optimization of organic product yield stability, new varieties are required that are adapted to organic farming systems as the choice of a variety in organic farming is of much higher importance than in traditional farming as modern varieties in conventional farming are not also good under organic agriculture. Some traits associated with conventional varieties are unsuitable for organic production systems and certain traits required in organic farming systems are not present in recently developed "conventional" varieties. The organic systems approach requires varieties that match a different crop ideotype in which it is more important that varieties grown under organic farming should be well adapted to organic farm conditions as organic agriculture needs regionally adapted varieties which are well adapted to regional soil, climate and production systems. They possess greater genetic diversity within and between varieties which enhances the plant's ability to adapt to local farming conditions. The priorities for variety selection in organic farming may be different as phenotype and genotype of varieties are considered equally under organic farming.

Therefore, keeping these points in view, these varieties were chosen to evaluate their performance under organic farming in this study. Our results will make farmers informed about the choices of high yielding varieties for organic rice production in the region of Jharkhand.

Material and Method

The experiment to study the performance of rice varieties for higher productivity in rice under organic farming was conducted at research farm (plot no. 43) of Birsa Agricultural University, Kanke, Ranchi (23^0 26' N latitude, 85^0 19' E longitude and 625 m above the mean sea level) during *kharif* season of 2017-18. The experimental plots had assured irrigation facility coupled with uniform topography, good drainage and soil characteristics typical to suit rice cultivation. The soil of experimental plot was sandy clay loam in texture having average carbon (6.16 Kg/ha), nitrogen (254.78 kh/ha), phosphorous (39.59 Kg/ha) and potassium (208.26 Kg/ha) with soil pH 6.04. Field experiments were carried out using randomized block design replicated thrice involving treatments with twelve rice varieties viz. Birsa Vikas Dhan 203, Birsa Dhan 201, Birsa Vikas Sugandha 1, BVD 110, Sahbhagidhan, Birsamati, Anjali, Lalat, M.T.U. 1010, Akshay, Pusa Sugandha and Naveen. The crops received a total rainfall of 1259.4 mm from July 2017 to November 2017, temperature ranges from 5.4 ^{0}C to 31.5 ^{0}C, total experimental area was 62.5m X 11m, gross plot size was 5m X 3m. The nursery seeding was done on 05th July 2017 and plot was ploughed twice in the dry condition and then puddled giving two ploughings in standing water to convert the upper layer of the soil into fine soft mud. The field was prepared on 6th July 2017 and leveled properly for twelve beds of 6.0 X 1.0 m^2 area were prepared 25 days before uprooting the seedlings for transplanting. Drainage channel 50 cm wide was constructed in between the two seed bed. At final puddling 15 kg of well decomposed FYM were applied to each nursery bed. The healthy, genuine certified and sprouted seeds of 12 rice variety were evenly broadcasted in each nursery bed keeping a thin layer of water. The beds were covered with a thin layer of well rotten FYM. Special care was taken for water management in these beds. Harvesting of early varieties, medium varieties and late varieties were done on 4th Nov. 2017, 8th Nov. 2017 and 9th Nov. 2017 respectively. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. Observations were recorded on yield attributes of ten randomly selected plants in each replication. Grain and straw yield were recorded at harvesting. In calculation of economics, the purchase rates of input and the selling rates of outputs were assumed as per the prevailing local market rates.

Statistical analysis

The data were analyzed statistically by applying "Analysis of Variance" (ANOVA) technique of RBD (Cochran and Cox 1957) [2]. The significance of different sources of variations was tested by Error mean square of Fisher Snedecor's 'F' test at probability level 0.05. Least significant difference (LSD) at 5% level of significance was worked out for each character of the experiment.

Result and Discussion

Yield attributes and Yield: No. of effective tillers per m^2, no. of filled grain per panicle, no of unfilled grains per panicle, 1000 grain weight (g), panicle length (cm) and panicle weight (g) were significantly influenced by rice varieties. Among the rice varieties, Birsamati proved its distinct superiority over Sahbhagidhan, Akshay, Anjali and BVD -110 in respect of effective tiller per meter^2 but failed to cause significant variation with other rice varieties. The tillering ability of the plant is genetically controlled so, the favorable condition for the formation of higher number of tillers also resulted in production of higher number of effective tillers in Birsamati. Lalat recorded maximum and significantly higher number of filled grain per panicle than Birsa Dhan 201, Shahbhagidhan, Akshay, Anjali and BVD 110 but remained comparable to Birsamati, Pusa Sugandha, Naveen, Birsa Vikas Sugandha-1, M.TU 1010 and Birsa Vikas Dhan 203. Lalat also recorded maximum and significantly longer panicle length than MTU-1010, Sahbhagidhan, Birsa Dhan 201, Akshay, Birsa Vikas Dhan 203 and BVD 110 but remained at par with rest of them. The highest no. of filled grain per panicle and panicle length in Lalat was might be due to the result of better assimilation of carbohydrate in the panicle. The maximum number of unfilled grains per panicle was recorded with Sahbhagidhan which remained at par to Birsamati, Birsa Vikas Sughandha, MTU 1010 and Birsa Vikas Dhan 203 but the former expressed its significant superiority over rest of the varieties which might

be due to reduced nutrient and moisture availability during growing period. The maximum 1000 grain wt. and panicle wt. were recorded with MTU 1010 which was significantly superior to BVD 110, Birsa Vikas Dhan 203, Anjali, Naveen, Birsa Vikas Sugandha1, Pusa Sugandha and Birsamati but remained comparable to rest varieties in case of 1000 grain wt. and in case of panicle wt. it was at par with Lalat but superior over rest of the varieties. The 1000 weight is genetically controlled which can be regulated to some extent through environmental factors influencing the translocation of photosynthate to the sink hence variety MTU 1010 has higher 1000 grain weight and panicle weight among different rice varieties.

Findings of the present study indicated clear effect of varieties on grain yield (Table 2). The maximum grain yield was recorded from variety MTU 1010 closely followed by Lalat and Birsamati respectively. However, the former showed its significant superiority over rest of the varieties. The increase in yield was associated with the increase in panicles per m^2, panicle length, grains per panicle and 1000 grain weight. Longer duration of MTU 1010 (126 days), Lalat (121 days) and Birsamati (126 days) had favorably influenced the dry matter accumulation and its portioning towards reproductive organs which consequently produced higher yield and yield attributes. Singh *et al.,* (2015) also reported that long duration varieties have higher yield attributes cycle in comparison to medium duration varieties as they gets more time to complete the life cycle. Straw yield is closely related to the vegetative growth comprising of plant height, number of tiller/m^2, leaves/hill, dry matter production/hill and final plant population. Under the present study straw yield was significantly higher in MTU 1010 followed by Lalat, Birsamati, Naveen and Birsa Vikas Dhan 203. Among rice varieties, MTU 1010 proved instrumental in improving growth attributes and ultimately led to higher straw yield. Latif *et al.,* (2005) also reported that long duration varieties yielded higher than short duration varieties by more photosynthate production and accumulation. The maximum harvest index was recorded from variety Birsa Dhan 201 which remained at par with MTU 1010, Lalat, Pusa sugandha, Birsamati, Naveen, Shahbhagidhan and Birsa Vikas Dhan 203. Singh *et al.,* (2007) [9], Singh *et al.,* (2008) [10] and Davari *et al.,* (2010) [3] were also recorded the similar yield results including grain yield, straw yield as well as harvest index.

Table 1: Yield attributes of rice varieties under organic farming

Treatments	Yield attributes of rice					
	No. of effective tillers m^{-2}	Number of filled grains per panicle	Number of unfilled grains per panicle	1000 grain weight (g)	Panicle length (cm)	Panicle weight (g)
T_1: Birsa vikas Dhan 203	250.00	101.00	34.67	21.35	22.40	2.65
T_2: Birsa Dhan 201	238.33	97.67	28.00	22.88	23.10	2.54
T_3: Birsa vikas Sugandha 1	241.33	103.67	36.00	20.50	24.87	2.51
T_4: B.V.D 110	211.67	91.00	26.67	21.92	22.23	1.92
T_5: Sahbhagidhan	225.00	96.33	37.67	22.29	23.23	2.47
T_6: Birsamati	265.00	111.00	36.33	19.35	25.90	3.11
T_7: Anjali	221.00	93.33	22.00	21.23	22.57	2.19
T_8: Lalat	244.67	113.00	26.67	22.34	26.80	3.78
T_9: M.T.U 1010	256.67	102.33	35.33	24.09	24.57	3.95
T_{10}: Akshay	223.33	94.00	25.67	22.68	22.93	2.28
T_{11}: Pusa Sugandha	248.33	107.67	31.67	20.37	25.73	2.74
T_{12}: Naveen	251.67	105.33	32.33	21.13	25.50	2.84
SEm±	10.04	3.72	1.40	0.64	0.71	0.13
C.D(P=0.05)	29.45	10.92	4.12	1.89	2.08	0.38
C. V (%)	7.25	6.36	7.82	5.15	5.08	8.24

Table 2: Yield of rice varieties under organic farming

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1: Birsa vikas Dhan 203	34.33	56.56	37.77
T_2: Birsa Dhan 201	33.33	52.00	39.09
T_3: Birsa Vikas Sugandha 1	32.44	54.00	37.51
T_4: B.V.D 110	26.67	47.78	35.81
T_5: Sahbhagidhan	30.22	48.89	38.18
T_6: Birsamati (126)	36.44	58.42	38.42
T_7: Anjali (104)	27.33	46.44	37.12
T_8: Lalat (121)	38.44	60.20	38.97
T_9: M.T.U 1010 (126)	40.22	62.96	39.01
T_{10}: Akshay (117)	29.56	51.22	36.56
T_{11}: Pusa Sugandha (131)	34.89	54.98	38.84
T_{12}: Naveen (122)	35.56	57.11	38.37
SEm±	1.58	2.68	0.51
C.D(P=0.05)	4.63	7.85	1.50
C.V.(%)	8.21	8.56	2.33

Economics: Economics of rice production depends on several factors such as input cost, labour requirement and above all the weather condition prevailing during the crop period. Among rice varieties, MTU 1010 led to higher gross return, net return, and benefit cost ratio followed by Lalat, Birsamati, Naveen, Pusa Sugandha, Birsa Vikas Dhan 203, Birsa vikas sugandha, Birsa dhan 201,Shahbhagidhan, Akshay, Anjali and BVD 110 in decreasing order (Table no.3). The increased yield attributes and yield of rice variety MTU 1010 resulted in higher gross return, net return and B:C ratio. This experimental finding has similar conformity with Shrivastava *et al.,* (2003) [8].

Table 3: Economics of production of rice varieties under organic farming

Treatments	Economics of rice production		
	Gross return (≠/ha)	Net return (≠/ha)	B:C ratio
T_1: Birsa Vikas Dhan 203	80660	43048	1.14
T_2: Birsa Dhan 201	77583	39971	1.06
T_3: Birsa Vikas Sugandha 1	77983	40371	1.07
T_4: B.V.D 110	63611	25999	0.69
T_5: Sahbhagidhan	70778	33166	0.88
T_6: Birsamati	87039	49427	1.31
T_7: Anjali	64569	26957	0.72
T_8: Lalat	89537	51925	1.38
T_9: M.T.U 1010	93669	56057	1.49
T_{10}: Akshay	70069	32457	0.86
T_{11}: Pusa Sugandha	83087	45475	1.21
T_{12}: Naveen	83167	45555	1.21
SEm±	3736	3736	0.10
C.D(P=0.05)	10958	10958	0.29
C. V (%)	8.25	15.83	15.83

Conclusion

From one year experimentation it can be concluded that MTU 1010 recorded the highest 1000 grain wt. (24.09 g), panicle wt. (3.95 g), grain yield (40.22 kh/ha), straw yield (62.96 kg/ha), harvest index (39.01%), gross return (93669 ≠/ha), net return (56057 ≠/ha) and B:C ratio (1.49) and can be recommended under organic rice production for higher yield in the region of Jharkhand (India).

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