



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2021; 10(4): 218-221

Received: 10-05-2021

Accepted: 12-06-2021

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Organic source of nutrients effect on growth, yield, quality and economy of black rice (*Oryza sativa* L.) varieties

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DOI: <https://doi.org/10.22271/phyto.2021.v10.i4c.14149>

Abstract

The experiment was carried out during *Kharif* season 2019-20 at Crop Research Farm, SHIATS Model of Organic Farm (SMOF), Department of Agronomy, NAI, SHUATS, Prayagraj (U.P.) to study the "Response of Black rice (*Oryza sativa* L.) varieties to organic production technology". Considering T₁₀Kalabhat, Vermicompost (2.25 t/ha) and Jeevamrutha (500 l/ha), performed significantly higher in No. of tillers/hill (21.93), straw yield (26.57t/ha) and Fertility ratio (91.98%). Considering T₁₅ Manipuri black, Vermicompost (2.25 t/ha) and Jeevamrutha (500 l/ha) performed significantly higher in days taken to panicle emergence [50%] (74.66 days), physiological maturity (117.33 days), grain yield (5.61 t/ha), grain protein (15.60%), also maximum Gross return (7,22,633.3₹/ha), Net return (6,29,013.3₹/ha) and B:C ratio (1:6.7). It can be concluded from the below research that application of Vermicompost (2.25 t/ha) and Jeevamrutha (500 l/ha) found to be enhancing productivity and economy of organic Manipuri black rice. Also it is a very good and sustainable cultivation practice.

Keywords: black rice varieties, economics, Jeevamrutha, organic manures, SRI, waste decomposer

Introduction

Rice (*Oryza sativa* L.) is a major cereal crop in this developing world. It is consumed as a staple food by over one-half of the world's population with approximately 95% of production in Asia. World rice production in 2018-19 was 782.00 million tonnes. India has 44.50 m ha area under rice and production of 172.58 million tonnes during 2018-19 (GOI, 2020) [1]. On accounting state wise West Bengal ranked first place followed by Uttar Pradesh. Black rice is a type of the rice species which is glutinous, packed with high level of nutrients and mainly cultivated in Asia. Supplementation of black scented rice in the diet will have a great impact on human health. Black rice is also known as purple rice, forbidden rice, king's rice and prized rice. A health benefit of black rice includes prevention of cancer, diabetes, heart diseases, Alzheimer's disease, gallstones etc. In recent years there has been adverse effect of continuous and indiscriminate use of inorganic fertilizers on deterioration of soil structure, soil health and environmental pollution. Blue baby syndrome in West Godavari district of Andhra Pradesh attributed to indiscriminate application of nitrogen in agricultural fields especially for rice crop. This incident hints us that chemical farming is not only hazardous to the health of environment, soil and other flora and fauna but also human beings. Use of organic manures have been found to be promising in arresting the decline in productivity through correction of deficiency of secondary and micronutrients and influence the physical and biological properties of soil (Pandey *et al.*, 2007) [6]. The nutrients required by the plants can be supplied through organic sources such as farmyard manure, vermicompost, and organic foliar spray. These manures can help to prevent soil erosion and also improving the infiltration capacity of the soil. Vermicompost is a better source of plant nutrients. It has potential in modifying the soil physical properties and improving crop yields. Apart from using conventional farm-based products there is an increasing demand for improvised materials like Jeevamrutha, Panchagavya, etc. which not only enrich the soil with indigenous microorganisms but also decrease the incidence of diseases in many crops. There are many beneficial micro-organisms i.e. nitrogen fixers, phosphorus solubilizers, actinomycetes and fungi in Jeevamrutha and beejamrutha.

Keeping all these things in view to improve organic black rice production the present investigation was undertaken on the basis of the objectives are to assess the effect of organic

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sources of nutrients on growth, yield and quality of black rice varieties and are to assess the effect of organic sources of nutrients on economics of black rice varieties.

Materials and Methods

The experiment was carried out during *Kharif* season of 2019 at the SMOF (SHUATS Model Organic Farm), Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. The soil of the experimental plot was sandy loam in texture, low in available nitrogen, medium in available phosphorus and high in available potash with 8.0 soil pH. The experiment was laid out in randomized block, having three varieties of black rice *viz.* Burma black, *Kalabhat*, Manipuri black and five organic sources of organic nutrients *Viz.* Control (water + Jeevamrutha 500 litres/ha), FYM (14 t/ha), FYM (7 t/ha) + Jeevamrutha (500 litres/ha), VC (4.5 t/ha), VC (2.25 t/ha) + Jeevamrutha (500 litres/ha). The net plot size was 3 × 4 m and net experimental area 768.00 m². Before puddling at the time of first irrigation Waste decomposer was applied to soil, which is rich in beneficial microorganisms. It can control all types of soil-borne, foliar diseases/ insects and pests. It also works as Biofertilizer, Bio control and as well as soil health reviver. Seed treatment was also done with Waste decomposer by soaking the seeds overnight. (NCOF, 2018) The transplanting was done on 31th July 2019 with SRI method (25x25 cm²). FYM and VC were applied as basal dose. Jeevamrutha was prepared with a mixture of four components in the ratio of 10:5:2:2, *viz.*, cow dung, cow urine, jaggery, pulse powder with 200 lit of water. Jeevamrutha is applied 3 times to field in every 20 days interval after transplanting to the field. The agronomic practices, *viz.*, Mechanical weeding with cono-weeder, hand weeding were done and irrigation was given according to the schedules for all treatments. The Meteorological data observation total rainfall was 1127.70 mm. Data on No. of tillers/hill, Days taken to panicle emergence [50%], Days taken to physiological maturity, Harvest Index (%), Fertility ratio (%), Grain yield (t/ha), Straw yield (t/ha), Grain protein content (%), Carbohydrate content (%), Gross return (₹/ha), Net return (₹/ha), B:C ratio. Data recorded on different aspects of crop, *viz.*, growth, yield, quality and economics were tabulated.

The qualitative parameter, *viz.*, protein (%) in grains was evaluated. Nitrogen in grain was estimated by Kjeldahl method by using the KjelTRON equipment in the department's laboratory and converted into protein (%) by multiplying with the power factor 5.95.

Results and Discussion

No. of tillers/hill

Significant and highest number of tillers/hill (21.93) was observed in (Table) with application of treatment T₁₀ [*Kalabhat* + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)]. However, treatment T₃ [Burma black + FYM (7 t/ha) + Jeevamrutha (500 l/ha)], T₅ [Burma black + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)] and T₈ [*Kalabhat* + FYM (7 t/ha) + Jeevamrutha (500 l/ha)] we found to be statistically at par with the highest treatment. Organic sources offer more balanced nutrition to plants, especially micro nutrients which positively affect number of tillers in plants. Organic liquid formulation containing both macro and essential micro nutrients, many vitamins, essential amino acids, growth promoting substances like Indole Acetic acid (IAA), Gibberellic acid (GA) and beneficial microorganisms, Palekar

(2006) [5]. More number of tillers per square meter might be due to the more availability of nitrogen, which plays a vital role in cell division.

Straw yield (t/ha)

The significant and highest straw yield (26.57 t/ha) was observed in (Table-1) with treatment T₁₀ [*Kalabhat* + Vermicompost (2.25 t/ha) + Jeevamrutha (500 l/ha)]. However, T₃ [Burma black + FYM (7 t/ha) + Jeevamrutha (500 l/ha)], T₅ [Burma black + Vermicompost (2.25 t/ha) + Jeevamrutha (500 l/ha)], T₈ [*Kalabhat* + FYM (7 t/ha) + Jeevamrutha (500 l/ha)], T₁₅ [Manipuri black + Vermicompost (2.25 t/ha) + Jeevamrutha (500 l/ha)] were found to be statistically at par with highest treatment. The positive and synergetic effect of foliar feeding of organic liquid manure may have caused an enhancement of straw yield. Ultimately increasing the chlorophyll production by boosting the photosynthetic process, thereby stimulating vegetative growth. The straw yield of rice was influenced by SRI management. Transplanting of seedlings from younger stage may have provided sufficient nutrients for vegetative growth and also for reproductive phase which ultimately led to increased straw yields.

Harvest Index

The Maximum harvest index (24.71%) was recorded with the application of treatment T₁₄ [Manipuri black+ VC (4.5 t/ha)] and the minimum value of 15.59% was recorded with the application of treatment T₁₀ [*Kalabhat* + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)] though non-significant.

Fertility ratio

The significant and highest fertility ratio (91.98%) was observed in treatment T₁₀ [*Kalabhat* + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)]. However, T₅ [Burma black + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)], and T₁₅ [Manipuri black + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)] were found to be statistically at par with highest treatment. Jaiswal and Singh (2001) [3] reported that, increasing the levels of available nutrient from the soil might have significantly increased accumulation of photosynthates from the source to the sink and more availability of photosynthates helps for better grain filling.

Days taken to panicle emergence [50%]

The significant and lowest days taken to panicle emergence [50%] (74.66 days) was observed in treatment T₁₅ [Manipuri black + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)]. However, treatment T₁₃ [Manipuri black + FYM (7 t/ha) + Jeevamrutha (500 l/ha)] were found to be statistically at par with lowest treatment. This finding corroborates earlier researchers i.e. it vary among genotypes and are prone to Genotype x Environment interactions.

Days taken to physiological maturity

The significant and lowest days taken to physiological maturity (117.33 days) was observed in treatment T₁₅ [Manipuri black + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)]. However, treatment T₁₃ [Manipuri black + FYM (7 t/ha) + Jeevamrutha (500 l/ha)] were found to be statistically at par with lowest treatment. Probably heritability is a measure of extent of phenotypic variation caused by the action of genes. Prevalence of low temperature coupled with less humidity at flag leaf stage which might be reduced in duration and availability of ample supply of nutrients especially nitrogen

through foliar feeding maybe the reason for the better performance with regard to number of days to maturity, Haque *et al.* (2015).

Grain protein content (%)

The significant and highest Grain protein content (15.60%) was observed in (Table-1) with treatment T₁₅ [Manipuri black + Vermicompost (2.25 t/ha) + Jeevamrutha (500 l/ha)]. However, treatment T₁₃ [Manipuri black + FYM (7 t/ha) + Jeevamrutha (500 l/ha)] found to be statistically at par with heights treatment. The protein content in grain is influenced with application of various organic manures. Also increase in protein content with the application of organic liquid manure; this might be because of promotive effects on root proliferation and higher uptake of N, P and sulphur needed for protein synthesis (Layek *et al.*, 2016)^[4].

Carbohydrate content (%)

The analyzed data of carbohydrate content (Table 2) due to effect of organic source of nutrients on black rice varieties was found non-significant. Minimum value of 72.23% was

recorded with the application of treatment T₁₅ [Manipuri black + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)].

Grain yield (t/ha)

The significant and highest grain yield (5.61 t/ha) was observed in (Table-1) with treatment T₁₅ [Manipuri black + Vermicompost (2.25 t/ha) + Jeevamrutha (500 l/ha)]. However, T₃ [Burma black + FYM (7 t/ha) + Jeevamrutha (500 l/ha)], T₅ [Burma black + Vermicompost (2.25 t/ha) + Jeevamrutha (500 l/ha)], T₈ [Kalabhat + FYM (7 t/ha) + Jeevamrutha (500 l/ha)], T₉ [Kalabhat + Vermicompost(4.5 t/ha)], T₁₀ [Kalabhat + Vermicompost (2.25 t/ha) + Jeevamrutha (500 l/ha)], T₁₃ [Manipuri black + FYM (7 t/ha) + Jeevamrutha (500 l/ha)], T₁₄ [Manipuri black+ Vermicompost (4.5 t/ha)] were found to be statistically at par with heights treatment. Higher grain yield may have contributed due to large root volume, profuse and strong tillers with big panicles, more and well filled spikelets with higher grain weight (Sreenivasa *et al.*, 2010)^[7]. Further the presence of micro-elements and plant growth regulators in organic liquid manure increased the yield of rice, Layek *et al.* (2016)^[4].

Table 1: Effect of organic sources of nutrients on growth, yield and economy of black rice varieties at harvest

Treatments	Growth parameters			Yield parameters				Quality parameters	
	No. of tillers/hill	Days taken to panicle emergence (50%)(DAT)	Days taken to physiological maturity (DAT)	Harvest index (%)	Fertility ratio (%)	Grain yield (t/ha)	Straw yield (t/ha)	Grain Protein (%)	Carbohydrate rate (%)
T ₁ : Burma black + Jeevamrutha (control)	12.60	95.66	130.00	18.20	85.65	3.25	15.23	12.33	72.67
T ₂ : Burma black + FYM (14 t/ha)	10.40	96.33	129.66	19.91	82.70	3.88	15.81	10.23	74.30
T ₃ : Burma black + FYM (7 t/ha) + Jeevamrutha	20.60	94.66	129.33	18.04	88.29	4.72	21.54	13.70	73.10
T ₄ : Burma black + VC (4.5 t/ha)	13.80	95.66	130.33	21.91	86.38	4.23	15.49	10.17	73.20
T ₅ : Burma black + VC (2.25 t/ha) + Jeevamrutha	21.13	94.33	129.33	19.02	91.39	5.28	22.38	13.93	72.70
T ₆ : Kalabhat + Jeevamrutha (control)	17.26	95.33	130.33	16.45	84.98	3.25	16.84	13.17	73.00
T ₇ : Kalabhat + FYM (14 t/ha)	13.86	96.33	130.66	23.17	83.91	4.25	13.89	11.47	73.83
T ₈ : Kalabhat + FYM (7 t/ha) + Jeevamrutha	20.46	95.33	129.33	15.67	88.26	4.53	23.69	14.50	73.13
T ₉ : Kalabhat + VC (4.5 t/ha)	13.06	95.66	130.00	17.90	86.48	4.30	19.68	11.83	73.23
T ₁₀ : Kalabhat + VC (2.25 t/ha) + Jeevamrutha	21.93	94.66	129.33	15.59	91.98	5.30	26.57	14.97	72.40
T ₁₁ : Manipuri black + Jeevamrutha (control)	10.00	76.00	119.00	21.70	84.95	3.72	14.06	13.83	72.93
T ₁₂ : Manipuri black + FYM (14 t/ha)	8.60	76.33	119.33	18.00	83.63	3.15	11.61	12.07	72.80
T ₁₃ : Manipuri black + FYM (7 t/ha) + Jeevamrutha	15.06	75.00	117.66	16.79	88.69	4.22	20.93	15.17	72.63
T ₁₄ : Manipuri black+ VC (4.5 t/ha)	10.6	75.66	118.66	24.71	86.44	4.97	15.80	12.27	72.86
T ₁₅ : Manipuri black + VC (2.25 t/ha) + Jeevamrutha	17.46	74.66	117.33	18.71	91.00	5.61	24.31	15.60	72.23
F-test	S	S	S	NS	S	S	S	S	NS
SEm±	1.05	0.88	1.08	2.37	0.35	0.46	1.75	0.21	0.45
CD (P=0.05)	3.05	0.59	0.51	-	1.04	1.34	5.08	0.61	-

N.B.-Jeevamrutha applied 500 l/ha. (FYM- Farm Yard Manure, VC- Vermicompost)

Table 2: Effect of organic sources of nutrients on economics of black rice varieties

Treatments	Economics*			
	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T ₁ : Burma black + Jeevamrutha (control)	75,720	4,21,273.3	3,45,653.3	1:4.56
T ₂ : Burma black + FYM (14 t/ha)	89,020	4,97,233.3	4,08,313.3	1:4.59
T ₃ : Burma black + FYM (7 t/ha) + Jeevamrutha	82,720	6,10,286.7	5,27,666.7	1:6.38
T ₄ : Burma black + VC (4.5 t/ha)	1,11,020	5,38,580.0	4,27,660.0	1:3.85
T ₅ : Burma black + VC (2.25 t/ha) + Jeevamrutha	93,720	6,78,773.3	5,85,153.3	1:6.24
T ₆ : Kalabhat + Jeevamrutha (control)	75,720	4,24,080.0	3,48,460.0	1:4.60
T ₇ : Kalabhat + FYM (14 t/ha)	89,020	5,37,793.3	4,48,873.3	1:5.04
T ₈ : Kalabhat + FYM (7 t/ha) + Jeevamrutha	82,720	5,91,780.0	5,09,160.0	1:6.15
T ₉ : Kalabhat + VC (4.5 t/ha)	1,11,020	5,56,160.0	4,45,240.0	1:4.01
T ₁₀ : Kalabhat + VC (2.25 t/ha) + Jeevamrutha	93,720	6,89,946.7	5,96,326.7	1:6.36
T ₁₁ : Manipuri black + Jeevamrutha (control)	75,720	4,74,926.7	3,99,306.7	1:5.27
T ₁₂ : Manipuri black + FYM (14 t/ha)	89,020	4,01,226.7	3,12,306.7	1:3.51
T ₁₃ : Manipuri black + FYM (7 t/ha) + Jeevamrutha	82,720	5,48,260.0	4,65,640.0	1:5.63
T ₁₄ : Manipuri black+ VC (4.5 t/ha)	1,11,020	6,28,006.7	5,17,086.7	1:4.66
T ₁₅ : Manipuri black + VC (2.25 t/ha) + Jeevamrutha	93,720	7,22,633.3	6,29,013.3	1:6.71

*Economics is not subjected to statistical analysis.

N.B.-Jeevamrutha applied 500 l/ha. (FYM- Farm Yard Manure, VC- Vermicompost)

Economic

Though it is not subjected to statistical analysis, the highest gross return 7,22,633.3 (₹/ha), net return 6,29,013.3 (₹/ha), B:C ratio (1:6.71) was observed in treatment T₁₅ [Manipuri black + VC (2.25 t/ha) + Jeevamrutha (500 l/ha)]. A higher economic return was due to the higher grain and straw yield in treatments with younger seedling. Application of organic liquid manure enhanced the early growth, yield attribute and yield return.

Conclusion

On the basis of one year experimentation, It can be concluded from the research that application of T₁₅ Manipuri black + VC (2.25 t/ha) + Jeevamrutha found to be enhancing productivity and economy. Also it is a very good and sustainable cultivation practice. However, these results are only indicative and require further experimentation to arrive at more consistent and final conclusion.

Acknowledgement

We are sincerely thankful to Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, for providing field, facilities and assistance in conducting this research.

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