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Effect of different nutrient sources on growth, yield and economics of aromatic rice under organic production system

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Abstract

The present investigation was conducted to evaluate the “Effect of different nutrient sources on growth, yield and economics of aromatic rice under organic production system. In experiment eight treatments of different organic nutrient management combinations with three replications in Randomized block design (RBD). Among the treatments growth parameters of rice viz. plant height, number of tillers, leaf area index, dry matter accumulation were significantly increased with the application of 100% RDN through 45% GM + 55% FYM + Foliar spray of at 20% cow urine at 20 days interval as compared to other organic nutrient combinations. As regards to yield attributes and yield, application of 100% RDN through 45% GM + 55% FYM + Foliar spray of at 20% cow urine at 20 days interval produces highest yield attributes like effective tillers, panicle weight, and filled grains. Thus increase in yield attributes results in increased yield of rice crop. The increase in grain and straw yield of rice observed more significantly with the application of 100% RDN through 45% GM + 55% FYM + Foliar spray of at 20% cow urine at 20 days interval. Economics of scented rice maximum gross return (125970 Rs ha⁻¹) was recorded in application of 100% RDN through 45% GM + 55% FYM + Foliar spray of at 20% cow urine at 20 days interval. But application of 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval give maximum net return (81466 Rs ha⁻¹) as well as gave the more B:C ratio (3.02).

Keywords: Organic nutrient management, aromatic rice, ghanjivamrit, cow urine

Introduction

Rice (*Oryza sativa* L.) one of the most important cereal crop of the world and the staple food for more than 50 percent of population. Rice occupies an important place among cultivated food crops and is the cause of both nutritional and food safety revolution on earth (Barker and Jena, 2015). The state of Chhattisgarh is referred to as the “Rice Bowl of India” since it contributes significantly to national rice production and has the most area planted in rice during the *kharif* season. Rice production 37.91 lakh hectares with production of 71.61 lakh tons and productivity of 1889 kg ha⁻¹ (Anonymous 2021) ^[1]. Aromatic rice has huge potential for increasing rice consumers for their taste and delicacy and high prices to boost the economic condition of the country’s rice grower. Due to its natural chemical compounds, aromatic rice offers a price higher than non-aromatic rice which gives it a distinctive fragrance or taste when fried. Increasing demand for premium rice calls for increased yield of available aromatic varieties without compromising the quality of the crop. (Kumar and Prasad, 2001) ^[7]. At the global level, the “green revolution” brings a huge change especially in terms of both area and production of cereals that started in 1940 and found its peak in the 1960s. With the advent of the green revolution in India during the 1960s, the production and productivity of crop increased at a high level, which was achieved due to over-reliance on high yielding cultivars, synthetic fertilizers, insecticides, herbicides and farm mechanization that resulted in heavy pressure on our natural resource base. Excessive use of chemically synthesized straight fertilizers, agro-chemicals, and other unsustainable cropping practices have an adverse effect on nature, this results in a net

negative nutrient balance and ultimately leads to a decline in soil fertility and productivity by impairing the soil health. Organic farming improves soil organic carbon, accessible nutrient content, microbial population and enzymatic activity, making it more sustainable for organic crop production (Dahiphale *et al.*, 2003) [5]. Adding different organic origin nutrients in the soil such as organic manure, bio-fertilizer and FYM will be effective in further improving productivity sustainably. Green manuring improves soil physical, chemical, and biological properties, thereby reduces leaching losses of nitrate (NO_3^-) and lower fertilizer N requirements for succeeding crops. Ghanjeevamrit indigenous components/supplements have a greater load of microorganisms, which helps in the mineralization of essential macro and micronutrients elements that aid in plant availability and uptake. These formulations are incredibly rich in microorganisms that proliferate in the soil easily and help in boosting the microbial processes and their activity (S. Palekar 2006) [10]. Cow urine as a liquid organic manure is a major component in eco-friendly agricultural system. Cow urine contains 95% water, 2.5% urea, and 2.5% minerals, salts, hormones and enzymes. It also contains essential minerals like iron, calcium, phosphorus, carbonic acid, potash, nitrogen, ammonia, manganese, sulphur, phosphates and potassium, urea, uric acid, amino acids, enzymes, cytokinin, plant hormones etc. (Bhadauria, 2002) [4]. It improves soil texture and has also been used as a plant hormone to alleviate vitamin deficiencies.

Materials and Methods

A field experiment was conducted during kharif season 2023 at Instructional cum Research Farm, Raipur (C.G.) Indira Gandhi Krishi Vishwavidyalaya, The soil was neutral in nature with low available nitrogen content, medium phosphorus content and higher level of potassium. In experiment eight treatments of different organic nutrient management combinations that's are T₁: 100% RDN through 45% GM + 55% FYM, T₂: 75% RDN through 60% GM + 40% FYM + 250 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB, T₃: 75% RDN through 60% GM + 40% FYM + 500 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB, T₄: 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB, T₅: 100% RDN through 45% GM + 55% FYM + Foliar spray of at 20% cow urine at 20 days interval after transplanting, T₆: 75% RDN through 60% GM + 40% FYM + 250 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval after transplanting, T₇: 75% RDN through 60% GM + 40% FYM + 500 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval after transplanting, T₈: 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval after transplanting. Rice variety LoktiMachhi selection-1 traditional variety of Chhattisgarh is taken as a test crop. It is a short grain and long duration (140-145 days) scented rice have yield potential of 40-45 q ha⁻¹. The test crop nursery was sown on 18th June and transplanted on 14th July 25 days old seedling transplanted at 20x10 cm. Recommended dose of nitrogen (80 kg ha⁻¹) was applied with green manure, FYM and ghanjeevamrit as basal application before transplanting. Foliar spray of 20 percent cow urine solution at 20, 40, 60, 80 and 100 DAT. The crop was harvested at maturity and threshed as per schedule. The data for growth attributes ; Plant height (cm), Tillers (m⁻²), LAI, Dry matter accumulation (g hill⁻¹) were recorded at different stage of growth at 30, 60, 90, 120 DAT and at harvest. The grain yield is

calculated from different yield attributes data viz. effective tillers hill⁻¹, panicle weight (g) and filled grains panicle⁻¹ at harvest. These parameters were statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized block design.

Results and Discussion

Growth attributes

The plant height was increased with the progress in the crop age. The plant height significantly varied due to different levels of various organic nutrient sources from beginning to till harvest. Among the different levels of organic nutrient sources application of 100% RDN (45% GM + 55% FYM) + Foliar spray of 20% cow urine at 20 days interval (T₅) treatment was recorded significantly highest plant, however it was comparable with 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB (T₄), 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval (T₇), 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval (T₈) On the other hand lowest plant height observed under 75% RDN through 60% GM + 40% FYM + 250 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB (T₂). Application of organic nutrients increase photosynthesis, cell division and root growth which leads to increase in plant height. have also been reported by Singh *et al.* (2002) [11]. Number of tillers hill⁻¹ increased rapidly with increasing the crop age up to 90 DAT and gradually slowed down thereafter this decline may be ascribed to the mortality of rate formed tillers due to shading of upper tillers. Application of 100% RDN (45% GM + 55% FYM) + Foliar spray of 20% Cow urine at 20 days interval (T₅) significantly recorded highest number of tillers. Which was at par with 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval (T₇), 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval (T₈). The results revealed that there was a significant difference in tiller production at different organic nutrient application due continuous availability of nitrogen during entire growth period due to combination of two or more organic manures which decomposes in two different time intervals. This finding was supported by Patel *et al.* (2012) [12] Application of 100% RDN (45% GM + 55% FYM) + Foliar spray of 20% Cow urine at 20 days interval (T₅) an appreciably more LAI as compared to nutrient sources combinations which was mainly due to higher production of tillers at all growth stages. The application combination of organic manures results in cumulative effect of nutrients at different intervals which produced the highest number of tillers and finally leaves. The significant increase in leaf area and leaf area index due to application of nutrients have been also reported Shanmugam and Veeraputhran (2000) [9].

Yield attributes

The number of effective tillers hill⁻¹ significantly the highest were recorded under 100% RDN (45% GM + 55% FYM) + Foliar spray of 20% CU (T₅) Which was comparable with 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval (T₇), 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with

Azospirillum + PSB + Foliar spray of at 20% cow urine at 20 days interval (T_8). As the cumulative effect of organic sources enhanced availability and uptake of nutrients and utilization of food material at both early and later stages produced more number of effective tillers. The increased effective tillers has been also reported by Dwivedi and Thakur (2000) [6]. The similar results found by Patel (2012) [12]. Panicle weight is also an important yield contributing character that influence rice yield. Different organic nutrient management also exhibited marked differences in weight of panicle. Among the organic nutrient management treatments 100% RDN (45% GM + 55% FYM) + Foliar spray of 20% cow urine at 20 days interval (T_5). Different organic nutrient management significantly influenced the number of filled grains panicle⁻¹ of rice. The maximum number of filled grains panicle⁻¹ were recorded with a combined use of 100% RDN (45% GM + 55% FYM) + Foliar spray of 20% cow urine at 20 days interval. Organic nutrient management exhibited significant variations in the grain and straw yield. The performance of 100% RDN (45% GM + 55% FYM) + Foliar spray of 20% cow urine at 20 days interval (T_5) was

significantly superior over other treatments and was found at par with 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha⁻¹ + Azo + PSB + Foliar spray of 20% cow urine at 20 days interval (T_7) (38.44 q ha⁻¹) and 75% RDN(60% GM + 40% FYM) + 1000 kg GJ ha⁻¹ + Azo + PSB + Foliar spray of cow urine at 20 days interval (T_8). The rice that produces more number of effective tillers hill⁻¹, filled grains panicle⁻¹, panicle weight and reduces sterility percentages produces the higher grain yield as also reported by Pandey *et al.* (1991) [8].

Economics

Highest cost of cultivation (44544 Rs ha⁻¹) and gross return (125970 Rs ha⁻¹) was recorded in application of 100% RDN through 45% GM + 55% FYM + Foliar spray of at 20% cow urine at 20 days interval after transplanting (T_5). Application of 75% RDN through 60% GM + 40% FYM + 1000 kg GJ ha⁻¹ + seedling treatment with *Azospirillum* + PSB + Foliar spray of at 20% cow urine at 20 days interval after transplanting (T_8) give maximum net return(81466 Rs ha⁻¹) as well as gave the more B:C ratio (3.02).

Table 1: Plant height, Number of tillers and LAI of aromatic rice as influenced by various nutrient sources under organic production system

Treatment	Plant height (cm) at 120 DAT	No. of tillers hill ⁻¹ at 90 DAT	LAI at 90 DAT
T ₁ : 100% RDN (45% GM + 55% FYM)	155.18	10.98	6.97
T ₂ : 75% RDN (60% GM + 40% FYM) + 250 kg GJ ha ⁻¹ + Azo + PSB	149.63	9.66	6.61
T ₃ : 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha ⁻¹ + Azo + PSB	152.51	10.41	6.67
T ₄ : 75% RDN(60% GM + 40% FYM) + 1000 kg GJ ha ⁻¹ + Azo + PSB	163.83	11.22	7.18
T ₅ : T ₁ + Foliar spray of 20% CU	178.73	14.42	8.48
T ₆ : T ₂ + Foliar spray of 20% CU	159.41	11.55	7.00
T ₇ : T ₃ + Foliar spray of 20% CU	165.50	13.11	7.59
T ₈ : T ₄ + Foliar spray of 20% CU	175.50	13.55	8.20
SEm±	6.10	0.68	0.38
CD(P=0.05)	18.50	2.06	1.15

RDN = Recommended dose of nitrogen, GM = Green manuring FYM = Farm Yard Manure, GJ = Ghanjeevamrit, Azo + PSB = Seedling treatment with *Azospirillum* + phosphorus solubilizing bacteria, CU= Cow urine (20, 40, 60, 80, and 100 DAT).

Table 2: Number of effective tillers, filled grains and panicle weight of aromatic rice as influenced by various nutrient sources under organic production system

Treatment	No. of effective tillers hill ⁻¹	Filled grains panicle ⁻¹	Panicle weight (g)
T ₁ : 100% RDN (45% GM + 55% FYM)	8.09	222.33	2.28
T ₂ : 75% RDN (60% GM + 40% FYM) + 250 kg GJ ha ⁻¹ + Azo + PSB	6.99	198.67	2.23
T ₃ : 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha ⁻¹ + Azo + PSB	7.29	211.33	2.26
T ₄ : 75% RDN(60% GM + 40% FYM) + 1000 kg GJ ha ⁻¹ + Azo + PSB	8.85	230.67	2.46
T ₅ : T ₁ + Foliar spray of 20% CU	10.12	261.00	2.82
T ₆ : T ₂ + Foliar spray of 20% CU	8.35	227.67	2.32
T ₇ : T ₃ + Foliar spray of 20% CU	9.64	239.67	2.59
T ₈ : T ₄ + Foliar spray of 20% CU	9.97	244.33	2.78
SEm±	0.44	9.82	0.12
CD(P=0.05)	1.92	29.79	0.34

RDN = Recommended dose of nitrogen, GM = Green manuring FYM = Farm Yard Manure, GJ = Ghanjeevamrit, Azo + PSB = Seedling treatment with *Azospirillum* + phosphorus solubilizing bacteria, CU= Cow urine (20, 40, 60, 80, and 100 DAT).

Table 3: Grain yield, straw yield and harvest index of aromatic rice as influenced by various nutrient sources under organic production system

Treatment	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest Index (%)
T ₁ : 100% RDN (45% GM + 55% FYM)	37.14	107.27	25.74
T ₂ : 75% RDN (60% GM + 40% FYM) + 250 kg GJ ha ⁻¹ + Azo + PSB	33.55	98.56	25.43
T ₃ : 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha ⁻¹ + Azo + PSB	35.92	103.20	25.84
T ₄ : 75% RDN(60% GM + 40% FYM) + 1000 kg GJ ha ⁻¹ + Azo + PSB	37.39	108.24	25.68
T ₅ : T ₁ + Foliar spray of 20% CU	41.99	114.99	26.73
T ₆ : T ₂ + Foliar spray of 20% CU	37.32	106.95	25.87
T ₇ : T ₃ + Foliar spray of 20% CU	38.44	108.99	26.11
T ₈ : T ₄ + Foliar spray of 20% CU	40.58	111.80	26.62
SE(m)±	1.36	2.54	0.91
CD(P=0.05)	4.14	7.69	NS

RDN = Recommended dose of nitrogen, GM = Green manuring (moong bean), FYM = Farm Yard Manure, GJ = Ghanjeevamrit, Azo + PSB = Seedling treatment with *Azospirillum* + phosphorus solubilizing bacteria, CU= Cow urine (20, 40, 60, 80, and 100 DAT)

Table 4: Economics of aromatic rice influenced by various nutrient sources under organic production system

Treatment	Cost of cultivation (Rs ha ⁻¹)	Gross Return (Rs ha ⁻¹)	Net return (Rs ha ⁻¹)	B:C Ratio
T ₁ : 100% RDN (45% GM + 55% FYM)	42374	112920	70546.00	2.66
T ₂ : 75% RDN (60% GM + 40% FYM) + 250 kg GJ ha ⁻¹ + Azo + PSB	37107	103770	66663.00	2.80
T ₃ : 75% RDN (60% GM + 40% FYM) + 500 kg GJ ha ⁻¹ + Azo + PSB	37439	110760	73321.00	2.96
T ₄ : 75% RDN(60% GM + 40% FYM) + 1000 kg GJ ha ⁻¹ + Azo + PSB	38104	115170	77066.00	3.02
T ₅ : T ₁ + Foliar spray of 20% CU	44544	125970	81426.00	2.83
T ₆ : T ₂ + Foliar spray of 20% CU	39277	108960	69683.00	2.77
T ₇ : T ₃ + Foliar spray of 20% CU	39609	115320	75711.00	2.91
T ₈ : T ₄ + Foliar spray of 20% CU	40274	121740	81466.00	3.02

RDN = Recommended dose of nitrogen, GM = Green manuring (moong bean), FYM = Farm Yard Manure, GJ = Ghanjeevamrit, Azo + PSB = Seedling treatment with Azospirillum + phosphorus solubilizing bacteria, CU= Cow urine (20, 40, 60, 80, and 100 DAT)

Conclusion

Based on my research trail, the treatment combination 100% RDN through 45% GM + 55% FYM + Foliar spray of at 20% cow urine at 20 days interval after transplanting (T₅) was found to be more productive. Although the findings are based on one season further research is needed to confirm the findings and their recommendation.

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