ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 15, Issue, 12, pp.69620-69622, December, 2025
https://doi.org/10.37118/ijdr.30407.12.2025

REVIEW ARTICLE OPEN ACCESS

RESPONSE OF PADDY TO OPTIMIZING YIELD AND REDUCING CHEMICAL COST THROUGH ORGANIC PRACTICES

[1]Dekhane, S. S., [2]Pisal, R. R. and [3]Patel, D. J.

[1]Research Officer, ASPEE, Agricultural Research and Development Foundation, At - Nare, Taluka - Wada, District - Palghar, (MH)- 421 312; [2]Asst Professor, Navsari Agriculture University, Navsari - 396 450; [3]Ex. Principal and Dean, B. A. Collegeof Agriculture, AAU, Anand (GJ) - 388 110

ARTICLE INFO

Article History:

Received 29th September, 2025
Received in revised form
10th October, 2025
Accepted 24th November, 2025
Published online 30th December, 2025

KeyWords:

Organic Farming, Rice, Vermicompost, Azotobacter, PSB, INM, Sustainable Agriculture.

****Corresponding author:***
Dekhane, S. S.,

ABSTRACT

A field experiment was conducted during Kharif 2024–25 at ASPEE Agricultural Research & Development Foundation Farm, Palghar, Maharashtra, to study the effect of different organic and integrated nutrient management practices on the growth and yield of rice variety Ratnagiri-8. Seven nutrient management treatments involving organic manures, biofertilizers, integrated inputs, and chemical fertilizers were tested in a Randomized Block Design with three replications. Among all treatments, T_2 (100% RDN through vermicompost + Azotobacter + PSB) recorded significantly higher plant height (101 cm), number of tillers (12.93), panicles (10), panicle length (25.12 cm), seeds per panicle (251.87), test weight (21.05 g), grain yield (5.10 t ha^{-1}), and straw yield (6.03 t ha^{-1}). The results demonstrate that complete replacement of chemical fertilizers with vermicompost along with biofertilizers is the most efficient practice to enhance yield while reducing dependency on inorganic fertilizers.

Citation: Dekhane, S. S., Pisal, R. R. and Patel, D. J. 2025. "Response of Paddy to Optimizing Yield and Reducing Chemical Cost through Organic Practices" *International Journal of Development Research*, 15, (12), 69620-69622.

INTRODUCTION

Rice (*Oryza sativa* L.) remains the primary staple food crop in India and contributes significantly to national food security. Modern agriculture has become increasingly dependent on chemical fertilizers to sustain production; however, prolonged chemical usage has resulted in declining soil fertility, micronutrient imbalances, reduced microbial activity, and escalating production costs. Organic farming practices offer a sustainable alternative that maintains soil health through the use of biological and organic inputs such as farmyard manure, vermicompost, oilcakes, and biofertilizers. Biofertilizers like Azotobacter and Phosphate Solubilizing Bacteria (PSB) play a critical role in biological nitrogen fixation and phosphorus solubilization, thereby improving nutrient uptake efficiency. Integrated Nutrient Management (INM) integrates organic, biological, and inorganic sources to achieve balanced nutrition while reducing chemical load. This experiment was conducted to identify an effective organic or integrated nutrient combination for achieving optimal yield and minimizing fertilizer costs in rice cultivation.

MATERIALS AND METHODS

The field experiment was conducted during the Kharif season of 2024–25 at the ASPEE Agricultural Research & Development Foundation Farm, located at Village Nare, Taluka Wada, District Palghar, Maharashtra. The experimental site represents a typical coastal agro-climatic zone characterized by high rainfall during the monsoon season and moderately fertile soil, which is suitable for lowland rice cultivation. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications to minimize the experimental error arising from field variability. Each treatment was randomly allocated within each replication. Each plot measured 3.60 m × 4.40 m, and bunds and irrigation channels were maintained to prevent lateral movement of water and nutrients. The rice variety 'Ratnagiri-8' was used as the test crop. Healthy seedlings were raised in a nursery bed following standard agronomic practices and transplanted on 14 July 2024 at a spacing of 20 cm × 15 cm using two seedlings per hill. Uniform plant geometry was maintained in all treatments to ensure comparable plant population across plots. Seven nutrient management treatments were evaluated. These included organic and integrated nutrient strategies and a chemical fertilizer control. The treatments comprised use of farmyard manure (FYM), vermicompost, castor cake, biofertilizers (Azotobacter and Phosphate Solubilizing Bacteria), integrated nutrient management (INM), and recommended chemical fertilizer dose. Biofertilizers were applied at the rate of 2 liters per hectare for each inoculant. Organic manures were incorporated into the soil during final land preparation to allow adequate decomposition and nutrient mineralization before transplanting. Integrated nutrient management treatment involved application of 40:20 kg NP ha^{-1} through chemical fertilizers combined with Azotobacter and PSB.

The chemical fertilizer treatment received the recommended dose of fertilizers as per local agricultural recommendations. All organic inputs were applied on nitrogen equivalence basis to substitute recommended dose of nitrogen (RDN). Manual weeding was carried out uniformly across treatments to ensure weed-free conditions. Plant protection measures were adopted only when pest or disease incidence exceeded the economic threshold level to minimize external chemical influence on treatment effects. Biometric observations were recorded at different growth stages and at harvest. Plant height, number of tillers per plant, and number of panicles per plant were recorded at physiological maturity from five randomly selected plants in each plot. Yield attributes such as panicle length, number of seeds per panicle, and test weight were measured at harvest following standard procedures. Grain and straw yield were recorded from each net plot and expressed on per hectare basis after adjusting grain moisture content to standard level. The data collected were subjected to statistical analysis using analysis of variance (ANOVA) as applicable to the Randomized Block Design. Significance of treatment effects was determined using critical difference (CD) at 5 percent probability level.

RESULTS AND DISCUSSION

The present investigation revealed that organic and integrated nutrient management practices exerted a significant influence on growth parameters, yield attributes, and productivity of rice variety Ratnagiri-8. A comparative evaluation of seven treatments indicated a clear advantage of vermicompost combined with biofertilizers over other organic sources and chemical fertilizer-based nutrition.

Number of panicles per plant: The number of productive tillers (panicles per plant) was significantly influenced by nutrient management treatments. Treatment T_2 exhibited the maximum number of panicles (10), which corresponded with the highest tiller numbers and effective nutrients partitioning toward reproductive growth phases. Similar outcomes were reported by Pramanick et al. (2013), indicating that organic nutrient systems improve efficiency of nutrient conversion from vegetative to reproductive structures.

Effect on Yield Attributes

Length of panicle: Panicle length is an important indicator of grain-bearing capacity. The longest panicle (25.12 cm) was observed under T_2, significantly higher than chemical fertilizer control (23.33 cm). Organic nutrient sources enriched with microbial consortia enhance overall metabolic activity and improve carbohydrate transport to reproductive structures, resulting in increased panicle length. This is in agreement with results from Maheshwari et al. (2017), who reported augmented panicle length in rice under organic manure amendments.

Number of seeds per panicle: The maximum number of seeds per panicle (251.87) was achieved with T_2. Vermicompost provides balanced nutrition and improves enzymatic function and plant energy transfer efficiency, resulting in better spikelet fertility and grain setting. Azotobacter enhances nitrogen fixation whereas PSB releases phosphorus in plant-available form, ensuring a continuous nutrient supply during flowering and grain filling stages. Similar findings were reported by Khan et al. (2009), who stated that organic biostimulants and microbial inoculants significantly improve grain formation.

Table 1. Effect of organic practices on growth and yield of rice (Ratnagiri-8)

Treatment	Plant Height (cm)	No. of tillers per Plant	No. of Panicles per Plant	Length of panicle (cm)	No. of seeds Per panicle	Test Weight (g)	Grain Yield (t/ha)	Straw Yield (t/ha)
T1	93.97	11.53	8.2	24.07	212.6	19.35	4232	5162
T2	101	12.93	10	25.12	251.87	21.05	5103	6033
T3	94.45	12	8.47	24.42	216.67	19.48	4350	5280
T4	98.69	12.67	9.53	24.86	247.6	19.99	4762	5692
T5	96.72	12.47	8.87	24.57	230.8	19.58	4527	5457
T6	91.61	11.07	7.87	23.93	197.2	19.3	4009	4912
T7	90.81	10.53	7.13	23.33	186	18.89	3506	4221
S.Em.±	0.90	0.2	0.23	0.16	2.57	0.11	0.48	0.44
C.D.	2.78	0.61	0.71	0.51	7.91	0.34	1.49	1.37

Effect on Growth Parameters

Plant height: Among all nutrient management strategies, treatment T_2 (100% RDN through vermicompost + Azotobacter + PSB) recorded the tallest plants (101.0 cm), which was significantly superior to all other treatments including the recommended dose of chemical fertilizers (T_7). The increased plant height under vermicompost application may be attributed to improved soil physical properties, such as porosity and moisture retention, and enhanced availability of macro- and micronutrients. Vermicompost is known to improve soil structure and stimulate auxin and cytokinin production through microbial activity, resulting in enhanced shoot elongation and vegetative growth (Arancon et al., 2004). The presence of Azotobacter further contributed to nitrogen fixation, while PSB improved phosphorus solubilization leading to improved nutrient uptake efficiency (Subba Rao, 1999).

Number of tillers per plant: Tillering capacity directly determines yield potential in rice. T_2 recorded the highest number of tillers per plant (12.93), followed by T_4 (12.67) and T_5 (12.47). Organic matter derived from vermicompost promotes microbial proliferation and provides a steady nutrient supply, resulting in improved early crop establishment and enhanced tiller production. These findings support those of Ghosh et al. (2004), who reported higher tillering in rice under integrated use of organic manures and biofertilizers compared to chemical fertilizers alone. Additionally, improved nutrient proneness and root development under organic treatments enhanced nutrient absorption and vegetation growth.

Test weight: Test weight reflects grain filling efficiency and endosperm development. T_2 recorded the highest test weight (21.05 g), while chemical fertilizer treatment recorded the lowest (18.89 g). Vermicompost-enriched soils release nutrients slowly, thereby maintaining carbohydrate availability during grain development. According to Zodape et al. (2010), organic nutrient systems enhance photosynthetic activity and enzymatic efficiency, resulting in heavier grains.

Effect on Yield

Grain yield: Grain yield differed significantly across treatments, with T_2 producing the highest yield (5.10 t ha^{-1}), followed by T_4 (4.76 t ha^{-1}) and T_5 (4.53 t ha^{-1}). Chemical fertilizer treatment (T_7) produced the lowest grain yield (3.51 t ha^{-1}), revealing the inefficiency of sole chemical dependence. The improvement in grain yield can be attributed to better tillering, improved panicle development, and enhanced nutrient uptake under organic systems. Integrated nutrient supply ensures nutrient availability throughout crop growth. Arancon et al. (2004) reported similar yield increases in crops treated with vermicompost due to improved nutrient assimilation and soil biology. Maheshwari et al. (2017) also concluded that organic manures contribute to yield sustainability and reduced input dependency.

Straw yield: Straw yield followed a similar trend to grain yield, with T_2 recording highest biomass production (6.03 t ha^{-1}). Enhanced straw yield indicates better photosynthetic activity and plant vigor under organic treatments. Ghosh et al. (2004) reported that organic fertilization increases biomass output in rice through improved soil nutrition and microbial activity.

Comparative Performance of Organic Systems vs Chemical Fertilizer: Among all treatments, chemical fertilizer application (T_7) consistently recorded lower plant growth and yield parameters. This may be due to nutrient leaching, reduced microbial activity, and imbalanced nutrient supply often associated with chemical fertilizers.
Long-term reliance on chemical fertilizers reduces soil organic carbon and adversely affects soil physical properties (Jackson, 1973). Conversely, addition of organic matter improves nutrient retention, water-holding capacity, and biological activity, thus enhancing crop performance.

Sustainability and Economic Implications: Besides achieving higher productivity, the organic treatments reduced dependency on chemical fertilizers, thereby lowering production costs. Enhanced soil health under organic management ensures long-term sustainability.
Organic nutrient systems improve nutrient use efficiency and reduce environmental pollution risks (Prakash et al., 2016). Vermicompost, in particular, offers both economic and ecological advantages to small and marginal farmers.

SUMMARY

The results clearly demonstrate that complete replacement of chemical fertilizers with vermicompost combined with Azotobacter and PSB not only enhances crop growth and yield attributes but also sustains soil health and reduces fertilizer costs. Therefore, T_2 (vermicompost + biofertilizers) is recommended for sustainable rice production.

CONCLUSION

The study concludes that treatment T_2 (100% RDN through vermicompost + Azotobacter + PSB) is the most efficient nutrient strategy for rice cultivation under organic management. It significantly enhanced growth, yield attributes, and final yield compared to chemical fertilizer application. Replacing chemical fertilizers with vermicompost and biofertilizers can reduce input cost and improve sustainability without compromising yield.

REFERENCES

Arancon, N. Q., Edwards, C. A., Atiyeh, R., & Metzger, J. D. (2004). Effects of vermicomposts on growth and fruit yield of field tomatoes. *Pedobiologia*, 47(5-6): 731–735.

Subba Rao, N. S. (1999). *Soil Microbiology*. Oxford & IBH Publishing, New Delhi.

Ghosh, N., Singh, R. D., & Verma, M. R. (2004). Effect of FYM and biofertilizers on rice yield. *Indian Journal of Agronomy*, 49(3), 167–170.

Prakash, Y. S., Bhadoria, P. B. S., &Rakshit, A. (2016). Comparative efficacy of organic and inorganic nutrient management in rice. *International Journal of Agriculture Sciences*, 8(22), 1481–1484.

Maheshwari, V. K., Bairwa, F. C., &Darvell, A. (2017). Organic inputs and sustainable rice production. *International Journal of Current Microbiology and Applied Sciences*, 6(12), 2685–2695.

Jackson, M. L. (1973). *Soil Chemical Analysis*. Prentice Hall, New Delhi.

Pramanick, B., Brahmachari, K., & Ghosh, A. (2013). Organic nutrient management in rice. *The Bioscan*, 8(4): 1305–1309.

Khan, W., Rayirath, U.P., Subramanian, S., et al. (2009). Seaweed and microbial biostimulants. *Journal of Plant Growth Regulation*, 28: 386–399.

Zodape, S.T., et al. (2010). Organic biostimulants and crop yield. *JSIR*, 69: 468–471.

****