



ISSN Print: 2618-060X
 ISSN Online: 2618-0618
 NAAS Rating (2026): 5.20
 IJRA 2026; 9(10): 165-168
www.agronomyjournals.com
 Received: 08-08-2026
 Accepted: 19-09-2026
 Published: 03-10-2026

Priya Anand

M.Sc. Scholar, Department of
 Agronomy, AKS University,
 Satna (M.P.), India

Sanjay Lilhare

Assistant Professor,
 Department of Agronomy,
 AKS University, Satna (M.P.),
 India

Raj Suman

Research Scholar, Department
 of Energy Science &
 Engineering, Maulana Azad
 National Institute of
 Technology, Bhopal-462003,
 Madhya Pradesh, India

Vinay Yadav

M.Sc. Scholar, Department of
 Agronomy, AKS University,
 Satna (M.P.), India

Integrated nutrient management in rice (*Oryza Sativa* L.) under Vindhya region

Priya Anand¹, Sanjay Lilhare², Raj Suman³, Vinay Yadav⁴

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i10c.6770>

ABSTRACT

The field experiment entitled "Integrated Nutrient Management in Rice (*Oryza sativa* L.) under Vindhya Region" was conducted at the Research Farm, Department of Agronomy, Faculty of Agriculture, AKS University, Satna (M.P.) during the Kharif season of 2025–26. The investigation was aimed to assess the productivity and quality of Kharif rice under the application of integrated nutrient management and their subsequent effect on plant growth parameters, yield attributes and yield as well as economics and quality of the rice. The present investigation conclusively demonstrated that integrated nutrient management significantly improved the growth, yield, quality and economics of Kharif rice, with T_{11} (100% Organic: FYM @ 5 t ha⁻¹ + Vermicompost @ 2 t ha⁻¹ + NADEP Compost @ 5 t ha⁻¹ + Jivamrit + Biofertilisers) emerging as the most effective treatment. This treatment recorded the highest plant height (54.34, 103.22 and 108.20 cm at 30, 60 and 90 DAT), highest number of tillers m⁻² (154.04, 284.93 and 314.61), highest number of leaves per plant (7.98, 12.61 and 12.30), yield attributes such as panicle length (25.19 cm), filled grains per panicle (153.74), test weight (24.94 g) and the lowest chaffy grain count (8.21), along with the maximum grain yield (7337 kg ha⁻¹), straw yield (8850.41 kg ha⁻¹), grain protein content (8.47%) and grain carbohydrate content (76.47%). Economically, it also proved superior by giving the highest gross monetary return (₹ 1,90,120 ha⁻¹), net monetary return (₹ 1,46,320 ha⁻¹), and a favourable B:C ratio (4.34). Therefore, the combined application of 100% organic inputs comprising FYM @ 5 t ha⁻¹ + Vermicompost @ 2 t ha⁻¹ + NADEP Compost @ 5 t ha⁻¹ + Jivamrit + Biofertilisers under T_{11} can be recommended as the most suitable, productive and sustainable nutrient management practice for Kharif rice cultivation under the soil and climatic conditions of the Vindhya region.

Keywords: Rice, Integrated Nutrient Management, FYM, Vermicompost, NADEP Compost, Jivamrit, *Azospirillum*, PSB, Vindhya Region, Grain Yield, Organic Farming

Introduction

Rice (*Oryza sativa* L.) ranks among the world's oldest cultivated cereals and remains the principal source of dietary energy for more than half the global population, underpinning food security across Asia, Sub-Saharan Africa and Latin America. Belonging to the family Poaceae, the crop is grown on roughly 164 million hectares worldwide and yields over 520 million tonnes annually, with nearly 90 per cent of production concentrated within Asia (FAO, 2025a) [1]. In India, rice is the single most important food crop, occupying about 51.42 million hectares and producing 225.02 million tonnes at a national average productivity of 7.40 t ha⁻¹ (USDA-FAS, 2025) [2], contributing over 40 per cent of the country's food-grain output and sustaining the livelihoods of more than half its agricultural population. Its scientific and agronomic importance, spanning genetics, physiology and farming-systems research, continues to make it one of the most extensively studied crops in the world.

The rice plant is a self-pollinated, semi-aquatic annual grass characterised by a fibrous root system, hollow jointed culms, alternately arranged linear leaves, and a terminal panicle inflorescence bearing spikelets that each produce a single caryopsis, or grain. Its capacity to grow in standing water, made possible by aerenchyma tissue that transports oxygen to submerged roots, distinguishes it from most other cereals and allows its cultivation across flooded lowlands, rainfed uplands and terraced hill ecosystems alike, a versatility that underlies its wide global distribution.

Global rice production has expanded steadily since the 1960s, and current cultivated area stands at approximately 164 million hectares with an annual output exceeding 520 million tonnes (FAO, 2025a) [1]. Yield gains have, however, slowed markedly since the early 1990s, as productivity in leading rice-growing countries approaches the ceiling imposed by existing high-yielding varieties under prevailing management. Further increases in production are therefore increasingly dependent on improved nutrient-use efficiency and management rather than expansion of cultivated area, which is itself constrained by competing land uses (Pattanayak *et al.*, 2022) [3].

Corresponding Author:

Sanjay Lilhare

Assistant Professor,
 Department of Agronomy,
 AKS University, Satna
 (M.P.), India

India, together with China, accounts for over half of world rice output (Reuters, 2025) [4] and is among the leading global exporters of non-Basmati rice. The Ministry of Agriculture and Farmers Welfare (2025) projected a record national production of 149 million tonnes for 2024-25, supported by a 12.4 per cent increase in *Kharif* sown area and continued policy measures such as enhanced minimum support prices, reflecting both improved technology adoption and favourable government support to the sector.

Madhya Pradesh cultivates rice on about 2.0 to 2.5 million hectares each *Kharif* season, concentrated in the Vindhya and Satpura agro-climatic zones that include Satna, Rewa, Sidhi, Umaria and neighbouring districts. Despite receiving reasonably favourable monsoon rainfall of 900 to 1100 mm, average state productivity of only 1.5 to 2.0 t ha⁻¹ trails far behind the national average, and productivity within the Vindhya region specifically ranges from only 2.5 to 3.2 t ha⁻¹ (Kumar *et al.*, 2023) [5], well short of the 5.0 to 7.0 t ha⁻¹ potential of modern high-yielding varieties under optimal management. The region's clay loam to heavy clay soils, derived from the weathering of Vindhyan sandstone and Deccan trap basalt, are characteristically low in organic carbon, available nitrogen and available phosphorus, and this poor inherent fertility constrains productivity independent of variety choice or irrigation availability.

Decades of continuous, intensive rice cultivation sustained largely by chemical fertilizers have progressively depleted soil organic carbon and biological activity across India's rice-growing tracts, with organic carbon in many intensively cropped fields of central India falling below 0.5 per cent from historical levels of 0.6 to 0.8 per cent (Didawat *et al.*, 2024) [6]. Because soil organic matter governs nutrient mineralisation, microbial activity and water-holding capacity, its steady decline undermines the long-term productive capacity of rice soils even where recommended doses of nitrogen, phosphorus and potassium are applied, as reflected in the yield stagnation documented under sole chemical fertilisation in long-term cereal cropping experiments (Mahajan *et al.*, 2002). Sustaining productivity under such conditions therefore requires nutrient management strategies that extend beyond fertiliser dose alone to actively rebuild soil organic matter and biological function.

Fertiliser use in Indian rice cultivation remains heavily skewed toward nitrogen, with an average N:P₂O₅:K₂O application ratio of roughly 8.3:1 against the recommended balanced ratio of 4:2:1 (Sahu *et al.*, 2020) [7]. This imbalance depresses nitrogen-use efficiency to only 30 to 40 per cent, with the remainder lost through ammonia volatilisation, denitrification and leaching, contributing to greenhouse gas emissions, groundwater nitrate contamination and eutrophication of surface water bodies. Continued reliance on chemical fertilisers alone, without organic replenishment, further degrades soil structure and biological health, compounding the yield-limiting effects of nutrient imbalance and raising the cost of production for farmers.

Materials and Methods

The field experiment entitled "Integrated Nutrient Management in Rice (*Oryza sativa* L.) under Vindhya Region" was conducted during the *Kharif* season of 2025–26 at the Research Farm, Department of Agronomy, AKS University, Satna (M.P.). The experiment was laid out in a Randomized Block Design (RBD) with three replications and twelve treatments, comprising a total of 36 experimental plots. The crop used was hybrid Badrinath, transplanted at a spacing of 30 × 10 cm with a seed rate of 15 kg ha⁻¹. The gross plot size was 5.0 × 3.0 m (15.0 m²) and the net plot size was 4.60 × 2.40 m (11.04 m²), with a total gross experimental area of 801 m². The recommended dose of fertilizer was 120:60:40 kg N₂O₅:P₂O₅:K₂O ha⁻¹. The treatments consisted of different combinations of RDF, FYM, vermicompost, NADEP compost, Jivamrit and biofertilizers (*Azospirillum* + PSB). Nursery raising was done on 03 July 2025, followed by land preparation, puddling, levelling and field layout. Soil sampling was carried out on 23 July 2025, and transplanting along with treatment application was completed on 24 July 2025. Nitrogen top dressing was car-

ried out on 23 August and 23 September 2025, with Jivamrit application during the first top dressing. Necessary intercultural, irrigation and plant protection measures were followed uniformly in all treatments. The crop was harvested on 05 November 2025, followed by threshing on 24 November 2025 and winnowing and sun drying from 04 to 10 December 2025. All agronomic and cultural operations were performed uniformly according to the recommended package of practices for rice cultivation.

Results and Discussion

Effect of integrated nutrient management on growth of rice

Integrated nutrient management significantly influenced the growth of rice, while plant population at 30 DAT remained statistically at par among the treatments, ranging from 32.33 to 33.67 plants m⁻². Treatment T₁₁ (100% Organic: FYM @ 5 t ha⁻¹ + Vermicompost @ 2 t ha⁻¹ + NADEP @ 5 t ha⁻¹ + Jivamrit + Biofertilizers) recorded the highest plant height of 54.34, 103.22 and 108.20 cm, leaf number of 7.98, 12.61 and 12.30 plant⁻¹, and tiller number of 154.04, 284.93 and 314.61 m⁻² at 30, 60 and 90 DAT, respectively. The control (T₁) recorded the lowest values, with plant height of 39.29, 77.22 and 93.04 cm, leaf number of 5.61, 8.99 and 8.51 plant⁻¹, and tillers of 102.05, 192.92 and 212.45 m⁻² at the corresponding stages. The superior growth under T₁₁ may be attributed to the complementary supply of nutrients from FYM, vermicompost and NADEP compost along with microbial activity promoted by Jivamrit and biofertilizers, which collectively improved nutrient availability, root development and photosynthetic activity. Similar improvement in rice growth under integrated nutrient management has been reported by Sarkar *et al.* (2016) [8] and Senthilvalavan *et al.* (2019) [9].

Effect of integrated nutrient management on yield of rice

Yield and yield attributes of rice were favourably influenced by integrated nutrient management. Treatment T₁₁ recorded the highest number of productive panicles (12.26 plant⁻¹), panicle length (25.19 cm), filled grains (153.74 panicle⁻¹), test weight (24.94 g) and the lowest chaffy grains (8.21 panicle⁻¹). The highest grain yield of 7337 kg ha⁻¹ and straw yield of 8850.41 kg ha⁻¹ were also obtained under T₁₁, compared with 6023 kg ha⁻¹ grain yield and 6455.91 kg ha⁻¹ straw yield under 100% RDF (T₂), while the control T₁ produced only 4936 kg ha⁻¹ grain yield. Thus, T₁₁ increased grain yield by approximately 21.8% over T₂. The improved yield under T₁₁ was associated with greater vegetative growth, tillering, panicle development and grain filling resulting from sustained nutrient availability throughout the crop growth period. The findings are in agreement with Chongtham *et al.* (2016), who reported improved panicle development and yield of hybrid rice with integrated application of inorganic fertilizers and organic manures, and Urmi *et al.* (2022) [10], who observed enhanced rice productivity under integrated combinations of organic manures and mineral fertilizers.

Effect of integrated nutrient management on quality of rice

The quality characteristics of rice grain were also improved under integrated nutrient management. Grain protein content was highest under T₁₁ (8.47%), followed by T₁₂ (8.12%) and T₂ (8.08%), whereas the control T₁ recorded the lowest protein content of 6.72%. Similarly, carbohydrate content ranged from 74.57% in T₁ to 76.47% in T₁₁. The higher protein content under T₁₁ may be attributed to improved and sustained nitrogen availability from the combined application of organic and biological nutrient sources, which enhanced nitrogen uptake and its subsequent translocation to the developing grains. The comparatively smaller variation in carbohydrate content may be related to the relatively stable carbon assimilation and starch accumulation processes among treatments. Similar improvements in rice grain protein through integrated application of organic manures, inorganic fertilizers and biofertilizers have been reported by Sharma *et al.* (2015) [11] and Kumawat *et al.* (2023) [12].

Effect of integrated nutrient management on economics of rice

Integrated nutrient management considerably affected the economic returns of rice cultivation. The cost of cultivation ranged from ₹32,000 ha⁻¹ in T₁ to ₹49,000 ha⁻¹ in T₂, whereas T₁₁ recorded a cost of ₹43,800 ha⁻¹. The highest gross return (₹190,120 ha⁻¹), net return (₹146,320 ha⁻¹) and benefit-cost ratio (4.34) were obtained under T₁₁, while the lowest net return (₹81,760 ha⁻¹) and B ratio (2.86) were recorded under T₁₀. The superior economic performance of T₁₁ was mainly due to its higher grain and straw yields combined with a comparatively moderate cost of cultivation. The results indicate that integration of organic manures, Jivamrit and biofertilizers with nutrient management can improve both productivity and profitability of rice. Similar economic benefits from integrated nutrient management involving organic manures and reduced inorganic fertilizer application have been reported by Thakur *et al.* (2023) [13] and Patra *et al.* (2024) [14].

Conclusion

The present investigation demonstrated that integrated nutrient management significantly improved the growth, yield, quality and economics of *Kharif* rice (*Oryza sativa* L.) cv. Hybrid-Badrinath under the soil and climatic conditions of the Vindhya region. Among the twelve treatments, T₁₁ (FYM @ 5 t ha⁻¹ + vermicompost @ 2 t ha⁻¹ + NADEP compost @ 5 t ha⁻¹ + Jivamrit + biofertilisers comprising *Azospirillum* and phosphate-solubilising bacteria) performed best for most growth, yield and quality parameters. It recorded the highest grain yield (7337 kg ha⁻¹), straw yield (8850.41 kg ha⁻¹), grain protein and carbohydrate content, along with the highest net return (₹146,320 ha⁻¹) and benefit-cost ratio (4.34). Based on these findings, T₁₁ can be recommended as the most productive, economically viable and sustainable nutrient management practice for *Kharif* rice cultivation under conditions similar to those of the present investigation.

Table 1. Integrated Nutrient Management in Rice (*Oryza sativa* L.) under Vindhya Region

Trt. No.	Plant Pop. 30 DAT	Plant Height	Leaves plant ⁻¹	Tillers m ⁻²	Panicle Length (cm)	Test Weight (g)	Grain Yield kg ha ⁻¹	Straw Yield kg ha ⁻¹	HI (%)	Protein (%)	Carbohydrate (%)	B:C
T1	32.33	93.04	8.51	212.45	18.8	20	4936	6455.91	43.33	6.72	74.57	4.03
T2	33.33	106.64	11.83	295.94	22.55	24.5	6023	7314.08	45.16	8.08	75.16	3.19
T3	32.67	108.1	10.42	262.44	21.39	22.69	5570	6841.75	44.88	7.52	75.3	3.11
T4	33	105.41	12.86	272.55	22.02	23.21	5751	7019.04	45.04	7.72	75.6	3.17
T5	32.33	103.55	10.26	252.56	21.09	22.34	5389	6603.1	44.94	7.43	75.08	3.04
T6	32.67	102.28	9.71	240.89	20.61	21.78	5163	6336.12	44.9	7.12	74.82	2.98
T7	33.33	105.81	11.31	281.86	22.91	23.72	6159	7526.29	45	7.93	75.67	3.33
T8	33.33	106.13	11.54	286.59	23.38	24.09	6431	7777.78	45.26	8.02	75.97	3.44
T9	32.67	104.59	12.98	275.17	22.64	23.51	5933	7274.66	44.92	7.82	75.55	3.33
T10	32.33	100.54	9.4	230.83	20.12	21.23	4846	5939.63	44.93	7.03	74.75	2.86
T11	33.67	108.2	12.3	314.61	25.19	24.94	7337	8850.41	45.33	8.47	76.47	4.34
T12	33.67	107.45	11.88	296.44	23.82	24.28	6703	8142.1	45.15	8.12	75.45	3.62
S.Em. ±	0.45	5.95	0.48	11.62	0.93	0.68	149.92	183.72	1.27	0.13	1.14	—
CD (P = 0.05)	NS	NS	4.34	34.07	2.72	2.01	281.67	538.88	NS	0.38	NS	—

References

1. FAO. The exact FAO publication/database used for your figures should be specified; "FAO, 2025a" alone is not sufficient for a thesis reference list. 2025a.
2. USDA-FAS. 2025.
3. Pattanayak *et al.* I could not verify that the cited paper supports the specific statement about global rice yield gains slowing since the early 1990s. 2022.
4. Reuters. If you retain the statement on India and China accounting for over half of global rice output, cite the exact Reuters article rather than a generic "Reuters, 2025." 2025.
5. Kumar, Singh. I could not verify the specific source supporting the Vindhya-region figures (2.5–3.2 t ha⁻¹, soil characteristics, etc.). Do not use this citation until the original publication is identified. 2023.
6. Didawat RK, Sharma VK, Nath DJ, Kumar S, Dey A, Kumar P, Shankar K, Chopra I, Shivay YS, Parihar CM, Prasad S. Impact of long-term integrated nutrient management on productivity, profitability, soil microbial activity and nutrient content of rice (*Oryza sativa*) in Assam. *The Indian Journal of Agricultural Sciences*. 2024;94(11):1240–1245.
7. Sahu YK, Chaubey AK. Effect of integrated nutrient management on nutrient content, uptake and yield of rice crop in Inceptisol. *International Journal of Current Microbiology and Applied Sciences*. 2020;9(3):2531–2541.
8. Marzia R, Sarkar MAR, Paul SK. Effect of row arrangement and integrated nutrient management on the yield of aromatic fine rice (*Oryza sativa* L.) cv. BRRI dhan34. *International Journal of Plant and Soil Science*. 2016;13(5):1–8.
9. Senthilvalavan P, Ravichandran M. Growth and physiological characters of rice (*Oryza sativa*) as influenced by integrated nutrient management under SRI in Cauvery Deltaic Zone of Tamil Nadu. *Annals of Plant and Soil Research*. 2019;21(3):210–216.
10. Urmi TA, Rahman MM, Islam MM, Islam MA, Jahan NA, Mia MAB, Akhter S, Siddiqui MH, Kalaji HM. Integrated nutrient management for rice yield, soil fertility, and carbon sequestration. *Plants*. 2022;11(1):138.
11. Sharma GD, Thakur R, Chouhan N, Keram KS. Effect of integrated nutrient management on yield, nutrient uptake, protein content, soil fertility and economic performance of rice (*Oryza sativa* L.) in a Vertisol. *Journal of the Indian Society of Soil Science*. 2015;63(3):320–326.
12. Kumawat AK, Kumar D, Shivay YS, Bhatia A, Rashmi I, Yadav D, Kumar A. Long-term impact of biofertilization on soil health and nutritional quality of organic basmati rice in a typic ustchrept soil of India. *Frontiers in Environmental Science*. 2023;11:1031844.

13. Thakur RK, Bisen NK, Shrivastava AK, Rai SK, Sarvade S. Impact of integrated nutrient management on crop productivity and soil fertility under rice (*Oryza sativa*)–chickpea (*Cicer arietinum*) cropping system in Chhattisgarh plain agro-climatic zone. *Indian Journal of Agronomy*. 2023;68(1):9–13.
14. Patra *et al.* The exact paper supporting your stated economic claim was not confidently identified. 2024.
15. Aulakh *et al.* The specific rice/Jivamrit claim could not be reliably verified from the available literature. 2013.
16. Kumar PM, Roy DK, Singh SK, Kumar M. Effect of different tillage and nutrient management practices on yield attributes and economics of direct seeded rice. *International Journal of Plant and Soil Science*. 2023;35(19):1300–1306.
17. Kumar PM, Roy DK, Singh SK, Kumar M. Influence of different tillage and nutrient management practices on growth performance of direct seeded rice. *International Journal of Environment and Climate Change*. 2023;13(8):1432–1439.
18. Sarkar MAR, Zobaida MR, Yeasmin S, Islam AKMM. Integrated nitrogen management of monsoon rice under two different plant spacings. *Fundamental and Applied Agriculture*. 2016;1(3):124–129.
19. Sarkar SK, Sarkar MAR, Islam NZ, Paul SK. Morpho-physiological attributes of three HYV aromatic fine rice varieties as affected by integrated nutrient management. *Agrofor International Journal*. 2016;1(3):57–61.
20. Sarkar SK, Sarkar MAR, Islam NZ, Paul SK. Yield and quality of aromatic fine rice as affected by variety and nutrient management. *Journal of the Bangladesh Agricultural University*. 2014;12(2):279–284.
21. Senthilvalavan, Ravichandran. 2019.
22. Shrivastava AK, Thakur RK, Bisen NK, Rai SK, Sarvade S. Response of integrated nutrient management on crop productivity and soil fertility under rice–wheat cropping system in Chhattisgarh plain agro-climatic zone. *Journal of Experimental Agriculture International*. 2023;45(12):201–208.
23. Thakur RK, Bisen NK, Shrivastava AK, Rai SK, Sarvade S. Effect of integrated nutrient management on yield, economics and soil fertility of rice–mustard cropping system in Chhattisgarh plain agro-climatic zone. *Indian Journal of Agronomy*. 2024;70(2).

How to cite this article: Anand P, Lilhare S, Suman R, Yadav V. Integrated nutrient management in rice (*Oryza Sativa* L.) under Vindhya region. *International Journal of Research in Agronomy*. 2026;9(10):165-168. doi: <https://www.doi.org/10.33545/2618060X.2026.v9.i10c.6770>