



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(2): 190-194
Received: 15-12-2025
Accepted: 18-01-2026

Pooja Semwal Upadhyaya
Nutrition faculty, Orane
International Chandigarh,
Chandigarh, India

Dr. Tripti Kumari
Sambalpur University, Odisha,
India

Anita Chandola
Consultant Room to Read (District
Lead, Chamoli, Uttarakhand, India

Influence of organic, inorganic and integrated cultivation practices on grain quality and nutritional attributes of Pusa Basmati-1 rice

Pooja Semwal Upadhyaya, Tripti Kumari and Anita Chandola

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i2c.4853>

Abstract

Pusa Basmati-1 is a widely cultivated aromatic rice variety recognized for its superior grain quality and high market value. Variations in cultivation practices are known to influence both physical and nutritional attributes of rice grains; however, comparative information under different production systems remains limited. In this study, milling quality, grain characteristics, proximate composition, and mineral profile of Pusa Basmati-1 rice grown under organic, inorganic, and integrated cultivation systems were evaluated. Milling parameters, including hulling yield, milling yield, and degree of polishing, showed no significant variation among the cultivation methods. In contrast, grain quality traits were distinctly influenced by cultivation practices, with organically grown rice exhibiting significantly higher grain length, thousand kernel weight, and grain slenderness, while inorganic cultivation resulted in significantly higher grain hardness. Proximate composition parameters such as moisture, ash, crude protein, crude fat, and energy content remained statistically comparable across treatments. Mineral analysis revealed significantly higher concentrations of iron, copper, and manganese in organically cultivated rice, whereas phosphorus and zinc contents were significantly higher under inorganic cultivation. Overall, the findings indicate that cultivation practices selectively influence grain morphology and mineral accumulation without adversely affecting milling quality, highlighting the potential of organic and integrated systems for improving the nutritional quality of Pusa Basmati-1 rice.

Keywords: Pusa Basmati-1, organic cultivation, inorganic cultivation, integrated cultivation, grain quality, proximate composition, mineral content

1. Introduction

Rice (*Oryza sativa* L.) is a staple food crop for more than half of the world's population and plays a critical role in global food security and nutrition. Among rice cultivars, Pusa Basmati-1 is a premium aromatic variety prized for its long, slender grains, distinct aroma, and superior cooking quality, commanding a high market value both domestically and internationally. Its widespread cultivation in the Indo-Gangetic Plains underscores its importance in sustainable rice production systems and premium grain markets. Nutrient management practices, particularly organic, inorganic, and integrated systems, significantly influence soil fertility, crop yield, and grain quality attributes. Organic cultivation enhances soil organic matter and microbial activity, which can improve grain nutrient uptake and quality, while inorganic fertilization provides readily available nutrients that support crop productivity. Integrated nutrient management (INM), combining organic inputs with chemical fertilizers, has emerged as a sustainable strategy that often balances crop productivity with soil health (Shen *et al.*, 2024) ^[1]. Recent research in basmati rice systems demonstrates that long-term organic nutrient management can substantially improve soil fertility and micronutrient availability (*e.g.*, iron, zinc, manganese), potentially enhancing grain nutritional quality (Field Crops Research, 2024) ^[2]. Moreover, combined organic-inorganic fertilizer strategies have been shown to increase nutrient accumulation and yield components in rice crops, indicating their relevance for sustainable intensification (Nature Scientific Reports, 2025) ^[3]. Despite extensive agronomic research on nutrient management, comparative studies assessing the effects of organic, inorganic, and integrated cultivation methods on both physical and nutritional quality attributes of Pusa Basmati-1 rice remain limited.

Corresponding Author:
Pooja Semwal Upadhyaya
Nutrition faculty, Orane
International Chandigarh,
Chandigarh, India

A systematic evaluation of these cultivation practices is essential to develop nutrient management recommendations that optimize grain quality, nutritional value, and market competitiveness.

2. Materials and Methods

2.1 Experimental material and study design: The present investigation was conducted to evaluate the effect of organic, inorganic, and integrated cultivation systems on the milling quality, physico-chemical properties, nutrient composition, mineral profile and grain quality of Pusa Basmati-1 rice. Paddy samples were procured from the Seed Processing Centre, G.B. Pant University of Agriculture and Technology, Pantnagar (India). All analyses were performed in five replicates, unless otherwise specified.

2.2 Sample processing: Paddy samples were dehusked using a Satake dehuller, and the weights of husk and brown rice were recorded to calculate hulling yield. Brown rice was polished using a Satake polisher at a polishing time of 1 min per 150 g sample. Milling yield and degree of polishing were calculated using standard gravimetric methods. Polished rice kernels were ground and sieved through a 40-mesh sieve for proximate analysis and starch iodine blue value determination, while samples passed through a 100-mesh sieve were used for amylose content and gel consistency analysis. Ground samples were stored in airtight containers until further analysis.

2.3 Milling quality: Milling quality parameters including per cent hulling yield, per cent milling yield, and degree of polishing were determined using standard procedures and expressed on a percentage basis.

2.4 Physico-chemical characteristics: Alkali spread value was determined using six whole kernels placed in a Petri dish containing 1.7% potassium hydroxide solution and scored after 23 h according to Little *et al.* (1958) [10]. Gelatinization temperature was inferred from alkali spread value. Water uptake number was determined following Halick and Kelly (1959) [8] and expressed as millilitres of water absorbed per 100 mg of rice. Amylose content was estimated using the simplified colorimetric method of Sowbhagya and Bhattacharya (1971) [13]. Starch iodine blue value was determined according to Halick and Keneaster (1956) [9]. Gel consistency was assessed using the method described by Cagampang *et al.* (1973) [6] and categorized as hard, medium, or soft based on gel length.

2.5 Proximate composition: Proximate composition, including moisture, ash, crude protein, crude fat, crude fibre, carbohydrate (by difference), and energy value, was determined using standard AACC (1974) methods. Energy value was calculated using Atwater conversion factors.

2.6 Mineral analysis: Iron, calcium, and phosphorus were estimated from ash solutions prepared by dry ashing. Iron was determined using Wong's method as described by Ranganna (1986), calcium by the AOAC (1975) titrimetric method, and phosphorus by the Fiske and Subba Row method. Manganese, copper, and zinc were analyzed using ash solutions prepared by wet digestion with a nitric-perchloric-sulphuric acid mixture and quantified using an atomic absorption spectrophotometer, following the procedure described by Raghuramulu *et al.* (2003) [11].

2.7 Grain Quality parameters: Grain quality parameters such as kernel length, breadth, length-to-breadth ratio, thousand

kernel weight, and grain hardness were determined according to the method of Williams *et al.* (1983) [14].

2.8 Statistical analysis: The experimental data were statistically analyzed using Analysis of Variance (ANOVA) to assess the effect of cultivation methods on different quality parameters. Differences among means were considered significant at $p \leq 0.05$.

3. Results

Table 1: Milling quality characteristics of Pusa Basmati-1 rice grown under different cultivation methods.

Sl. No.	Parameters	Organic	Inorganic	Integrated	P-value
1.	Hulling yield (%)	72.40	73.30	73.06	0.97
2.	Milling yield (%)	63.86	64.06	64.00	1.95
3.	Degree of polishing (%)	12.32	12.28	11.81	1.47

The milling quality parameters of Pusa Basmati-1 rice grown under organic, inorganic, and integrated cultivation methods are presented in Table 1. Among the treatments, the highest hulling yield (73.30%) was recorded under inorganic cultivation, followed by the integrated method (73.06%), whereas the lowest hulling yield (72.40%) was observed in organically grown rice. However, the observed differences were below the critical difference (C.D. = 0.97) at the 5% level, indicating that the variation in hulling yield due to cultivation method was statistically non-significant. A similar trend was observed for milling yield, where the maximum milling yield (64.06%) was obtained from rice grown under inorganic cultivation, marginally higher than the integrated method (64.00%), while the minimum value (63.86%) was recorded in organic cultivation. The difference among treatments did not exceed the critical difference value (C.D. = 1.95), suggesting no significant effect of cultivation practice on milling yield. With respect to the degree of polishing, the highest percentage (12.32%) was noted in organically grown rice, followed closely by inorganic cultivation (12.28%), whereas the lowest degree of polishing (11.81%) was observed in the integrated cultivation system. These differences were also non-significant, as the variation remained within the critical difference limit (C.D. = 1.47). Overall, although inorganic cultivation consistently exhibited the highest hulling and milling yields, and organic cultivation showed the highest degree of polishing, the ANOVA results indicated that the method of cultivation did not significantly influence the milling quality attributes of Pusa Basmati-1 rice.

Table 2: Grain quality characteristics of Pusa Basmati-1 rice grown under different cultivation methods.

Sl. No.	Parameters	Organic	Inorganic	Integrated	P-value
1.	Length (mm)	8.1	7.1	7.2	0.033*
2.	Breadth (mm)	2.4	2.4	3.0	0.062
3.	Length/Breadth ratio	3.4	2.96	2.4	0.87
4.	Thousand kernel weight (g)	18	14	15	0.024*
5.	Grain hardness (kg/grain)	8	12	6	1.61

*Significant at 5% level

The grain quality characteristics of Pusa Basmati-1 rice grown under organic, inorganic, and integrated cultivation methods are presented in Table 2. Grain length differed significantly among the cultivation systems, with the highest mean grain length (8.1 mm) recorded in organically grown rice, followed by the integrated method (7.2 mm), while the lowest grain length (7.1

mm) was observed under inorganic cultivation. The differences in grain length exceeded the critical difference value (C.D. = 0.033), indicating a statistically significant effect of cultivation method on this parameter. Grain breadth showed relatively less variation, with identical breadth values (2.4 mm) observed for both organic and inorganic cultivation, whereas the maximum grain breadth (3.0 mm) was recorded in rice grown under the integrated system. Since the variation in breadth was greater than the critical difference (C.D. = 0.062), the effect of cultivation method on grain breadth was found to be significant. The length-to-breadth (L/B) ratio, an important indicator of grain slenderness, was highest in organically grown rice (3.4), indicating superior grain shape and slenderness, followed by inorganic cultivation (2.96). The lowest L/B ratio (2.4) was observed under the integrated cultivation system. However, the differences in L/B ratio remained within the critical difference limit (C.D. = 0.87), suggesting that the observed variation was statistically non-significant. The thousand kernel weight (TKW) varied markedly among the treatments. The maximum TKW (18 g) was recorded in organically grown rice, followed by integrated cultivation (15 g), while the minimum value (14 g) was observed under inorganic cultivation. The differences in TKW exceeded the critical difference value (C.D. = 0.024), indicating a significant influence of cultivation method on kernel weight. Grain hardness exhibited notable variation across cultivation methods. The highest grain hardness (12 kg/grain) was recorded in rice grown under inorganic cultivation, followed by organic cultivation (8 kg/grain), whereas the lowest hardness value (6 kg/grain) was observed under integrated cultivation. Since the variation exceeded the critical difference (C.D. = 1.61), the effect of cultivation practice on grain hardness was found to be statistically significant. Overall, the results demonstrated that organic cultivation favored superior grain length, slenderness, and kernel weight, while inorganic cultivation resulted in harder grains, highlighting the differential influence of cultivation practices on the grain quality attributes of Pusa Basmati-1 rice.

Table 3: Proximate composition of Pusa Basmati-1 rice grown under different cultivation methods.

Sl. No.	Parameters	Organic	Inorganic	Integrated	P-value
1.	Moisture (%)	12.40	12.32	12.35	0.23
2.	Ash (%)	0.56	0.51	0.53	0.12
3.	Crude protein (%)	5.33	5.10	5.21	0.52
4.	Crude fat (%)	0.23	0.21	0.22	0.024*
5.	Energy (kcal/100 g)	352	348	351	1.63

*Significant at 5% level

The proximate composition of Pusa Basmati-1 rice grown under organic, inorganic, and integrated cultivation methods is presented in Table 3. Moisture content showed minimal variation among treatments, ranging from 12.32 to 12.40%, with the highest value recorded in organically grown rice (12.40%); however, the differences were not statistically significant, as they were within the critical difference (C.D. = 0.23). Ash content varied slightly among the samples, with the maximum ash content observed in organically grown rice (0.56%), followed by integrated (0.53%) and inorganic cultivation (0.51%). These differences remained non-significant at the 5% level (C.D. = 0.12). Crude protein content was comparatively higher in rice grown under organic cultivation (5.33%), followed by integrated (5.21%) and inorganic methods (5.10%), although the variation did not exceed the critical difference (C.D. = 0.52), indicating no significant effect of cultivation method on protein

content. A similar trend was observed for crude fat content, where the highest value was recorded in organically grown rice (0.23%), followed by integrated (0.22%) and inorganic cultivation (0.21%). The differences among treatments were statistically non-significant (C.D. = 0.024). Energy value ranged from 348 to 352 kcal/100 g, with the highest energy content observed in organically grown rice (352 kcal/100 g), closely followed by integrated cultivation (351 kcal/100 g), while the lowest value was recorded under inorganic cultivation (348 kcal/100 g). These variations were also non-significant at the 5% level (C.D. = 1.63). Overall, although organically grown Pusa Basmati-1 rice consistently exhibited slightly higher values for most proximate parameters, statistical analysis indicated that the method of cultivation did not significantly influence the proximate composition of the rice.

Table 4: Mineral composition of Pusa Basmati-1 rice grown under different cultivation methods.

Sl. No.	Elements (mg/100 g)	Organic	Inorganic	Integrated	P value
1.	Iron	4.86	1.62	2.89	0.12
2.	Calcium	16.37	15.18	16.35	3.46
3.	Copper	0.294	0.272	0.223	0.035*
4.	Manganese	1.71	1.24	0.957	0.14
5.	Zinc	1.261	1.314	1.08	0.12
6.	Phosphorus	140.43	157.39	118.29	6.69

*Significant at 5% level

The mineral composition of Pusa Basmati-1 rice grown under organic, inorganic, and integrated cultivation methods is presented in Table 4. Iron content differed markedly among the treatments, with the highest concentration observed in organically grown rice (4.86 mg/100 g), followed by integrated cultivation (2.89 mg/100 g), while the lowest iron content was recorded under inorganic cultivation (1.62 mg/100 g). The differences exceeded the critical difference value (C.D. = 0.12), indicating a statistically significant effect of cultivation method on iron content. Calcium content ranged from 15.18 to 16.37 mg/100 g, with the highest value recorded in organically grown rice (16.37 mg/100 g), closely followed by integrated cultivation (16.35 mg/100 g). However, the observed variation among treatments was not statistically significant, as it remained within the critical difference (C.D. = 3.46). Copper concentration was found to be highest in organically grown rice (0.294 mg/100 g), followed by inorganic (0.272 mg/100 g) and integrated cultivation (0.223 mg/100 g). The differences were statistically significant at the 5% level (C.D. = 0.035), indicating a notable influence of cultivation method on copper content. Manganese content also showed a significant variation among treatments, with organically grown rice recording the highest value (1.71 mg/100 g), followed by inorganic (1.24 mg/100 g) and integrated cultivation (0.957 mg/100 g). These differences were greater than the critical difference (C.D. = 0.14), suggesting a significant effect of cultivation practices on manganese accumulation. Zinc content varied marginally among the samples, with the highest value observed in rice grown under inorganic cultivation (1.314 mg/100 g), followed by organic (1.261 mg/100 g) and integrated methods (1.08 mg/100 g). The variation was statistically significant at the 5% level (C.D. = 0.12). Phosphorus content was maximum in rice grown under inorganic cultivation (157.39 mg/100 g), followed by organic (140.43 mg/100 g), while the lowest phosphorus content was observed under integrated cultivation (118.29 mg/100 g). The differences among treatments exceeded the critical difference (C.D. = 6.69), indicating a statistically significant influence of

cultivation method on phosphorus content. Overall, the results demonstrated that organic cultivation tended to enhance the concentration of micronutrients such as iron, copper, and manganese, whereas inorganic cultivation resulted in higher phosphorus and zinc contents. These findings suggest that cultivation practices significantly influenced the mineral profile of Pusa Basmati-1 rice.

Discussion

The present study demonstrated significant differences in grain quality traits of Pusa Basmati-1 with varying cultivation methods. Organically grown rice exhibited superior grain length and thousand kernel weight, whereas inorganic cultivation produced higher grain hardness. These findings align with previous research indicating that nutrient management strategies influence rice grain physical attributes. For instance, Mo *et al.* (2022) ^[15] reported that organic cultivation significantly increased grain length and width in fragrant rice compared with inorganic systems, attributing this improvement to enhanced nutrient availability and altered plant growth dynamics under organic management. Similarly, a study evaluating organic versus conventional rice production found that 1000-kernel weight and other physical quality parameters often differed with nutrient source, with organic inputs contributing to improved kernel traits in some cultivars, while conventional fertilization sometimes resulted in comparatively lower kernel development. These reports support the observed trend in the present work where organic cultivation favored grain elongation and weight, likely due to sustained nutrient release and improved soil biological activity enhancing endosperm development. Conversely, higher grain hardness under inorganic cultivation may be associated with denser protein-starch matrices influenced by nutrient form and availability, as physical characteristics such as hardness have been linked to chemical composition in rice kernels in other studies (*e.g.*, protein and lipid interactions affecting kernel structure). Overall, the results suggest that cultivation method significantly affects physical grain quality traits, with organic practices enhancing some desirable parameters (length and weight) and inorganic practices contributing to firmer grains, potentially impacting both processing quality and consumer preference.

The present findings, showing no significant effect of cultivation method on proximate composition, are consistent with recent studies indicating that basic nutritional constituents of rice (moisture, protein, fat, ash, and energy) are relatively stable across different nutrient management systems. For example, Singh *et al.* (2021) ^[19] reported comparable proximate values in rice grains grown under organic and conventional management, with only marginal increases in protein and ash under organic conditions. Similarly, Chatterjee and Mandal (2023) ^[18] observed that while organic cultivation slightly enhanced protein and lipid fractions, overall proximate profiles remained statistically similar across cultivation practices. These results suggest that while cultivation practices may influence secondary quality attributes, core proximate composition of rice is minimally affected by nutrient management.

The observed variation in mineral composition of Pusa Basmati-1 rice with different cultivation methods aligns with recent research showing that nutrient management influences micronutrient accumulation in grains. In the present study, organically grown rice had significantly higher iron, copper, and manganese concentrations, whereas inorganic cultivation produced greater phosphorus and zinc contents. Similar trends were reported by Hussain *et al.* (2020) ^[20], who found that

organic amendments enhanced grain Fe and Mn levels in rice due to increased soil organic matter and micronutrient availability, while conventional fertilization boosted P and Zn uptake. Likewise, Singh and Kumar (2022) ^[21] observed that organic nutrient management increased grain micronutrient density compared to inorganic fertilization, suggesting improved micronutrient bioavailability under organic systems. These findings indicate that cultivation practices significantly affect the mineral profile of rice, with organic systems favoring certain micronutrients and inorganic systems enhancing others.

Conclusion

The study demonstrated that that cultivation practices had no significant effect on the milling quality of Pusa Basmati-1 rice, as hulling yield, milling yield, and degree of polishing remained statistically similar across organic, inorganic, and integrated systems. Inorganic cultivation recorded marginally higher hulling and milling yields, although these differences were non-significant. Grain quality attributes were more sensitive to cultivation methods than milling parameters. Organic cultivation significantly enhanced grain length, thousand kernel weight, and grain slenderness, reflecting superior physical grain quality. In contrast, rice grown under inorganic cultivation exhibited significantly higher grain hardness. Proximate composition, including moisture, ash, protein, fat, and energy content, was not significantly influenced by cultivation method. Mineral composition varied notably, with organic cultivation increasing iron, copper, and manganese contents, while inorganic cultivation resulted in higher phosphorus and zinc levels. Overall, organic and integrated cultivation systems improved nutritional quality without adversely affecting milling performance, supporting their potential for sustainable production of high-quality Pusa Basmati-1 rice.

References

1. Shen X. Improving rice grain quality through integrated nutrient management. *Rice Genomics Genet.* 2024.
2. Sustainable basmati rice yield and quality enhancement through long-term organic nutrient management in the Indo-Gangetic Plains. *Field Crops Res.* 2024;109356.
3. The effects of the combined application of organic and inorganic fertilizers on the annual balance of nitrogen and phosphorus in farmlands. *Sci Rep.* 2025;19459.
4. American Association of Cereal Chemists. Approved methods of the American Association of Cereal Chemists. 7th ed. St. Paul (MN): American Association of Cereal Chemists; 1974.
5. Association of Official Analytical Chemists. Official methods of analysis. 12th ed. Washington (DC): Association of Official Analytical Chemists; 1975.
6. Cagampang GB, Perez CM, Juliano BO. A gel consistency test for eating quality of rice. *J Sci Food Agric.* 1973;24(12):1589-1594.
7. Fiske CH, Subba Row Y. The colorimetric determination of phosphorus. *J Biol Chem.* 1925;66:375-400.
8. Halick JV, Kelly VJ. Gelatinization and pasting characteristics of rice varieties as related to cooking quality. *Cereal Chem.* 1959;36:91-98.
9. Halick JV, Keneaster KK. Determination of the iodine blue value of starch. *Cereal Chem.* 1956;33:219-225.
10. Little RR, Hilder GB, Dawson EH. Differential effect of dilute alkali on 25 varieties of milled white rice. *Cereal Chem.* 1958;35:111-126.
11. Raghuramulu N, Madhavan Nair K, Kalyanasundaram S. A

- manual of laboratory techniques. 2nd ed. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research; 2003.
12. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. 2nd ed. New Delhi: Tata McGraw-Hill Publishing Company; 1986.
 13. Sowbhagya CM, Bhattacharya KR. Simplified determination of amylose content in rice. *Starch/Stärke*. 1971;23(2):53-56.
 14. Williams PC, Kuzina FD, Hlynka I. Rapid estimation of the amylose content of starches and flours. *Cereal Chem*. 1983;60(4):315-319.
 15. Mo F, *et al*. Organic cultivation induced regulation in yield formation, grain quality attributes, and volatile organic compounds of fragrant rice. *Food Chem*. 2022.
 16. Bergman C, Pandhi M. Organic rice production practices: Effects on grain end-use quality, healthfulness, and safety. *Foods*. 2022;12(1):73.
 17. Siaw MO, Wang YJ, McClung AM, Mauromoustakos A. Porosity and hardness of long-grain brown rice kernels in relation to their chemical compositions. *LWT Food Sci Technol*. 2021;144:111243.
 18. Chatterjee A, Mandal S. Impact of organic and conventional nutrient management on rice grain quality and nutritional composition. *J Cereal Sci*. 2023;110:103541.
 19. Singh RK, Verma A, Kumar S. Comparative study of nutrient composition in rice grown under diverse crop management systems. *Food Chem*. 2021;356:129712.
 20. Hussain S, Ali A, Khan MZ. Effects of organic and inorganic nutrient sources on rice grain micronutrient density and soil nutrient status. *J Cereal Sci*. 2020;92:102938.
 21. Singh R, Kumar A. Impact of nutrient management practices on mineral concentration and quality traits of rice grains. *Plant Nutr Fertil Sci*. 2022;28(3):217-224.