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IMPACT OF INTEGRATED NUTRIENT MANAGEMENT ON QUALITY PARAMETERS OF NON-SCENTED RICE (*ORYZA SATIVA* L.) UNDER DSR

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ABSTRACT

This study, conducted during the *kharif* season of 2022 at the Agriculture Research Farm of Maharishi Markandeshwar (Deemed to be University), Mullana, Haryana, sought to investigate the comprehensive impact of Integrated Nutrient Management (INM) on non-scented rice production under the Direct Seeded Method (DSR). Employing a factorial randomized block design with three replications, in this research we have evaluated three non-scented rice varieties V_1 : HKR-47, V_2 : HKR-48 and V_3 : PR-126 subjected to five distinct treatments: T_1 : Control, T_2 : 100% recommended dose of nitrogen through urea, T_3 : 75% recommended dose of nitrogen through urea + 25% remaining nitrogen through vermicompost, T_4 : 50% recommended dose of nitrogen through urea + 50% remaining nitrogen through vermicompost and T_5 : 25% recommended dose of nitrogen through urea and 75% remaining nitrogen through vermicompost. The study had three primary objectives. Firstly, it aimed to compare quality parameters across different INM Treatments. Secondly, the research aimed to identify the most suitable doses of vermicompost and inorganic fertilizers in DSR. Lastly, the Compare Varietal Responses to INM. The findings revealed a positive response of PR-126 to the INM technique, significantly improving crucial quality parameters. Additionally, Treatment T_3 (75% recommended dose of nitrogen through urea + 25% remaining nitrogen through vermicompost) registered superior results in hulling, milling and head rice recovery. Overall, this research contributes essential insights into the nuanced dynamics of nutrient management practices, emphasizing their implications on both agronomic and economic aspects of non-scented rice cultivation.

Key words : Rice, Vermicompost, DSR, PR-126, HKR-47, HKR-48.

Introduction

Oryza sativa L., an Asian native domesticated plant that was first cultivated around 9000 years ago in India and China before spreading to the rest of the world (Purugganan, 2010). Rice is the primary source of grain calories for 40% of the world's population. In India, rice is grown on 44 million hectares, yielding about 2.37 tonnes per hectare with 104.32 million tonnes of grain produced. (Satyanarayana *et al*, 2002) revealed that using inorganic fertilizer to support crops increased productivity for a brief time. Maximum usage of inorganic fertilizers for crop production led to a reduction in natural soil fertility. The loss or stagnation in yield has been attributed to nutrient mining and a decline in the utilization of organics (John *et al*, 2001). In years to come, it will be unproductive

to use inorganic sources of nutrients which also damage the land. Applying organic and inorganic nutrients in a balanced, coordinated manner using either one or both can provide solutions to issues like increased costs for inorganic fertilizers and a decline in the fertility and production of the soil. These combinations can be used carefully to maintain soil fertility and crop productivity (Sindhi *et al*, 2018). If production does not expand more quickly than it is, stocks of rice will eventually run out due to the increased demand for it. This shows that increasing rice output is necessary to achieve food security. Improved soil health and fertility, which could support long-term agricultural expansion. Long-term fertility experiments have had a major positive impact on soil fertility management and crop production sustainability in various agroecosystems (Rawal *et al*, 2017).

Through the application of organic manures along with inorganic fertilizers, rice grain production was significantly increased (Singh and Niranjana, 2005). By controlling the quantities of nitrogen, phosphorus, potassium and other crucial elements, integrated nutrition management helps to reduce disease infestation. Disease occurrence may be affected by a plant's overall health (Nas *et al.*, 2012). Integrated nutrient management reduces the quantity of chemicals needed in agriculture by combining the use of organic and inorganic fertilizers. It fills the gap between the nutritional requirements and fertilizer inputs. Improved soil fertility is yet another crucial role of INM. By adding organic matter through the application of organic manures, the physicochemical and biological qualities of the soil are improved. Farmer income and yield are increased by using INM strategies. In addition to this, it also reduces environmental contamination (Zhang *et al.*, 2014).

The "Vermiculture Movement" is gaining momentum in India, driven by various objectives such as community waste management, providing a cost-effective approach to crop production by replacing expensive chemical fertilizers, and contributing to poverty eradication programs in rural areas (Adhikary, 2012). Soil treated with vermicompost exhibits enhanced aeration, porosity, bulk density and water retention. Furthermore, improvements are observed in chemical properties like pH, electrical conductivity, and organic matter content, contributing to a more favourable environment for increased crop yield (Lim *et al.*, 2015). The inclusion of vermicompost in the seedling matrix for nursery cultivation significantly elevated the levels of photosynthetic pigments, improved net photosynthesis and greatly enhanced the growth of fragrant rice cultivars in the nursery-raising process (Ruan *et al.*, 2021).

The profitability of cultivating medium-short duration cultivars stems from the advantages of lower production costs, reduced reliance on chemical inputs, and diminished need for irrigation water. This makes them a financially favourable option in agricultural practices (Kasniya *et al.*, 2022). Cultivating short-duration rice varieties offers additional benefits, such as accommodating the growth of other crops in between. It has been noted that embracing short-duration rice varieties is a strategy to alleviate the emission of methane and nitrous oxide, both of which are greenhouse gases (Chhogyell *et al.*, 2016). The introduction of early-maturing cultivars with a short duration and effective nutrient management practices, coupled with the widespread adoption of integrated weed management techniques has motivated numerous farmers to transition from traditional transplanted cultivation to

Direct Seeded Rice (DSR) methods (Joshi *et al.*, 2013).

Dry direct drill seeding shows considerable promise in South Asia as a viable alternative to the traditional method of puddled transplanting. This serves as a solution to evolving resource limitations, particularly shortages in labour, water, and energy, as well as addressing the escalating costs associated with cultivation (Kumar and Ladha, 2011). Farmers exhibited a positive inclination towards embracing the practices of Direct Seeded Rice (DSR) and the cultivation of short-duration, high-yielding varieties of paddy. They also embraced other recommended technologies such as Integrated Pest Management (IPM), judicious fertilizer application, herbicide usage and effective irrigation management in paddy fields (Singh *et al.*, 2012). The current significant transition towards Direct Seeded Rice (DSR) requires the integration of breeding, agronomic, and other strategies to ensure its sustainability and harness the associated natural resources and environmental advantages. It is crucial to carefully consider the appropriate combinations of well-suited DSR varieties and technologies (Sandhu *et al.*, 2021).

Haryana is predominantly an agrarian state, with approximately 70% of its population involved in agriculture. The state achieves self-sufficiency in food production and stands as the second-largest contributor to India's central reserve of food grains (Anonymous, 2023). The majority of farmers, accounting for 70 per cent, exhibited a low to medium level of adoption, indicating that they did not fully embrace the recommended set of practices outlined by CCSHAU, Hisar. This tendency might stem from a lack of awareness about Direct Seeded Rice (DSR) and a strong adherence to traditional cultivation methods (Kumar *et al.*, 2018). Numerous awareness programs on direct seeded rice were conducted in various districts, covering different adopted villages by Krishi Vigyan Kendra's, namely Karnal, Kaithal, Yamuna Nagar, Fatehabad, Kurukshetra, Panipat and Jind in the state. The reports indicate that a collective total of 3981 farmers/farm women (3705 male and 276 female) actively participated in these village-level awareness programs (Singh and Mandal, 2023).

Objectives

The study had three primary objectives.

1. To compare quality parameters across different INM Treatments.
2. To identify the most suitable doses of vermicompost and inorganic fertilizers in DSR.
3. The Compare Varietal Responses to INM.

Materials and Methods

Site specifications

The study was carried out at the agricultural research farm of Maharishi Markandeshwar (Deemed to be University) in Mullana, Ambala, Haryana, India. The farm is situated at a latitude of 30° 17' 0" North, a longitude of 77° 03' 0" East and an elevation of 264 meters above mean sea level.

Soil Sample analysis

Randomly collected soil samples within the 0 to 15 cm depth range were utilized for a thorough examination of the experimental site. The soil at the research site possesses a sandy loam texture and displays alkaline characteristics, as indicated by a measured pH of 7.9, determined using a Glass electrode pH meter (Jackson, 1973). A detailed assessment of soil composition exposed a low organic carbon content of 0.31, determined through the Walkley and Black method (1934). The soil's electrical conductivity was registered at 0.89 dSm², measured using a Conductivity meter (Richards, 1954). Additionally, nutrient evaluations unveiled a medium availability of nitrogen at 260.23 kg N ha⁻¹, determined via the Permanganate method (Subbiah and Asija, 1956). Furthermore, a low phosphorous content of 5.46 kg P ha⁻¹ was established using Olsen's method (Jackson, 1973), while a high potassium availability at 469.73 kg K ha⁻¹ was recorded employing the Flame photometric method (Piper, 1966). Soil texture analysis indicated proportions of 54.4%, 28.6% and 17% for sand, silt, and loam, respectively, determined meticulously through the International Pipette method (Piper, 1966). These findings collectively contribute to a comprehensive comprehension of the soil composition within the specified depth range.

Factors and treatments

Three non-scented rice varieties were selected for the study: HKR-47 (mid-early duration), HKR-48 (early duration), and PR-126 (early duration). The experiment included five treatments: T₁ (Control), T₂ (100% recommended dose of nitrogen through urea), T₃ (75% recommended dose of nitrogen through urea + 25% remaining nitrogen through vermicompost), T₄ (50% recommended dose of nitrogen through urea + 50% remaining nitrogen through vermicompost) and T₅ (25% recommended dose of nitrogen through urea and 75% remaining nitrogen through vermicompost). The research followed a randomized block design, with the three non-scented varieties in the main plots and the five treatments in sub-plots, each replicated three times. The sowing of paddy seeds was directly done in the field using a tractor-

drawn seed drill with a spacing of (20 × 10 cm).

Weather conditions

The weather conditions during the vegetative phase of the rice crop were favourable, with satisfactory rainfall of 522 mm throughout the agricultural season. The highest rainfall (90 mm) occurred during the 31st standard week (30 July to 05 August). The maximum temperature, 37.20°C, was recorded during the 28th standard week (09 July to 15 July), while the minimum temperature (14.20°C) was observed during the 45th standard week (05 November to 11 November). The highest morning relative humidity (95%) was noted during the 37th standard week (10 September to 16 September) and the highest evening relative humidity (83%) occurred during the 35th standard week (27 August to 02 September). The maximum sunshine hours (8.9) were observed during the 38th standard week (17 September to 23 September), while the minimum sunshine hours (3.4) were recorded during the 32nd standard week (06 August to 12 August). Overall, the meteorological conditions were favourable for the study. The mud lumps, rice stalks, leaves and other foreign materials from the sample were removed, and 100 g of grain sample was weighed. The freshly prepared samples were shelled using the Satake Sheller. The samples were hulled, and the weights of the dehulled grains have been provided.

Statistical analysis

The data obtained from the experiment demonstrated a normal distribution ($p > 0.05$) as per the factorial randomized block design. The design consisted of three primary plots representing the three non-scented varieties, and within each plot, five treatments were assigned to sub-plots, each replicated three times. To analyze the comprehensive dataset, the statistical method applied was ANOVA (Panse and Sukhatme, 1978). The calculation of the critical difference (CD) was conducted using the OPSTAT software, developed by CCS HAU, Hisar, India. This meticulous application of statistical analysis ensures the robustness and reliability of the conclusions drawn from the experimental data.

Hulling percentage

The "hulling process" in rice production refers to the removal of the outer husk or hull from the rice grains. It transforms rough rice (paddy) into edible white rice. The hulling process typically involves the use of a rice huller or hulling machine. A rubber roll huller is used in this research.

The following formula has been used for the estimation of hulling percentage:

$$\text{Hulling (\%)} = \frac{\text{Weight of brown rice (g)}}{\text{Weight of paddy (g)}} \times 100$$

Milling percentage

The milling process in rice production involves the transformation of rough or brown rice into polished white rice ready for consumption. Milling was performed on the hulled samples and the weight of the milled grains was reported.

The following formula was used for the estimation of milling percentage:

$$\text{Milling (\%)} = \frac{\text{Weight of milled rice (g)}}{\text{Weight of paddy (g)}} \times 100$$

Head rice recovery

Whole and broken grains had been separated after milling. The percentage of head rice or unbroken rice grain was calculated using the starting weight of the rough rice as a percentage of total rice or the total of head rice and all classes of broken rice.

The following formula was used to calculate the head rice recovery:

$$\text{Head rice recovery (\%)} = \frac{\text{Weight of headed rice (g)}}{\text{Weight of paddy (g)}} \times 100$$

Results and Discussion

Hulling percentage

The data pertaining to grain quality metrics reveal significant variations among the three non-scented rice varieties. Punjab's early duration variety, PR-126, displayed the highest hulling percentage at 74.03%. Following closely was the early duration variety, HKR-48, with a hulling percentage of 72.81%, a figure statistically comparable to the mid-early duration variety, HKR-47, which recorded 72.58% (Table 1 and Fig. 1).

Examining the treatments, T₃, which involved 75% of the recommended nitrogen dose through urea and the remaining 25% through vermicompost, exhibited the highest hulling percentage at 76.38%. In contrast, treatment T₁, the control group, displayed the lowest hulling percentage at 68.42%. Another noteworthy treatment was T₄, with 50% recommended urea and 50% remaining nitrogen through vermicompost, recording a hulling percentage of 75.21% (Fig. 2).

The variations in hulling percentage can be attributed to factors such as genetic potential and moisture content. The genetic makeup of each rice variety plays a role in determining the hulling percentage and the moisture content of the grains also influences the hulling process.

Table 1 : Impact of combinations of both organic and inorganic sources on quality studies.

Quality studies (%)			
Factor A varieties	Hulling (%)	Milling (%)	Head rice recovery (%)
V ₁	72.58	61.76	51.60
V ₂	72.81	63.00	51.65
V ₃	74.03	63.02	52.69
SE(m) ±	0.15	0.21	0.01
C.D. (P=0.05)	0.44	0.62	0.03
Factor B treatments			
T ₁	68.42	58.07	49.73
T ₂	73.35	62.42	52.28
T ₃	76.38	67.43	54.03
T ₄	75.21	65.2	53.42
T ₅	72.34	59.85	52.11
SE(m) ±	0.2	0.27	0.01
C.D. (P = 0.05)	0.57	0.8	0.04

These findings align with prior research, as reported by Saha *et al.* (2007), who concluded that incorporating 25% of the recommended nitrogen dose through organic manure had a positive impact on the quality aspects of rice. This underscores the significance of nutrient management practices in influencing not only yield-related parameters but also the overall quality of the harvested grains.

Milling percentage

There was considerable variation in the milling percentage among the three non-scented rice varieties revealed in Table 1 and Fig. 1, PR-126 demonstrated the highest milling percentage at 63.02%, a figure comparable to the second early duration variety, HKR-48, which recorded 63.00%. In contrast, the mid-early duration variety, HKR-47, exhibited the lowest milling percentage at 61.76%. Across all treatments (Table 1 and Fig. 2), the maximum milling percentage, reaching 67.43%, was observed in crops that received 75% of the recommended nitrogen dose through urea and the remaining 25% through vermicompost (T₃). Following closely, treatment T₄, which included 50% recommended urea and 50% remaining nitrogen through vermicompost, showed a milling percentage of 65.20%. Conversely, the lowest milling percentage was recorded in the control group (T₁) at 58.07%.

It is noteworthy that these results align with previous findings, as reported by Sravan *et al.* (2019). The

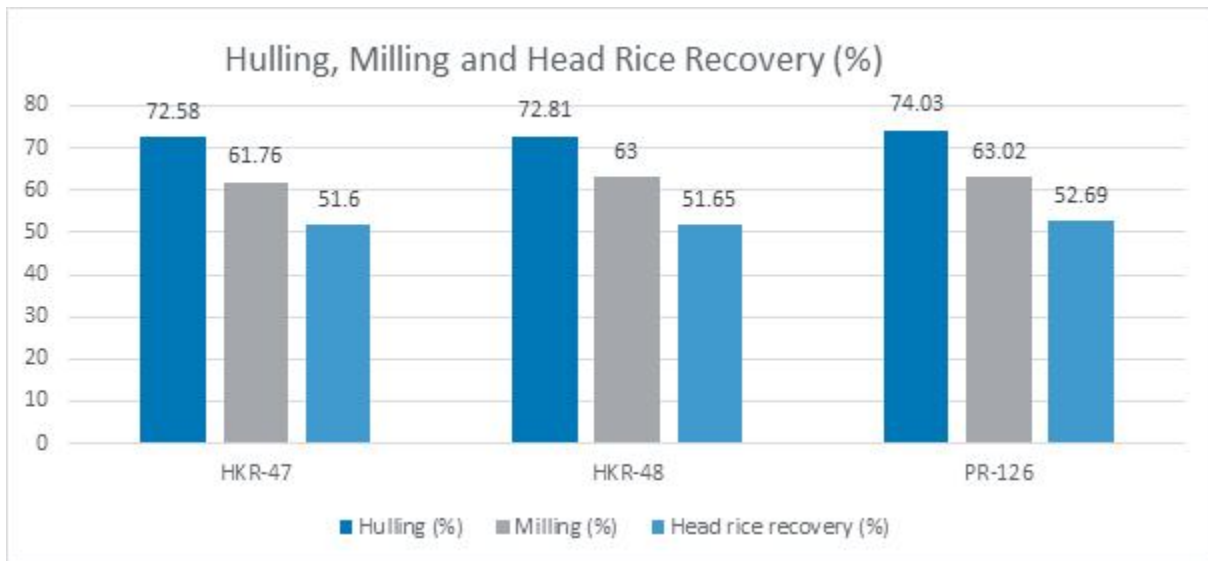


Fig. 1 : Impact of different sources of nutrients (Organic and Inorganic) on the quality parameters of three non-scented rice (*Oryza sativa* L.) varieties under DSR (Direct Seeded Method).

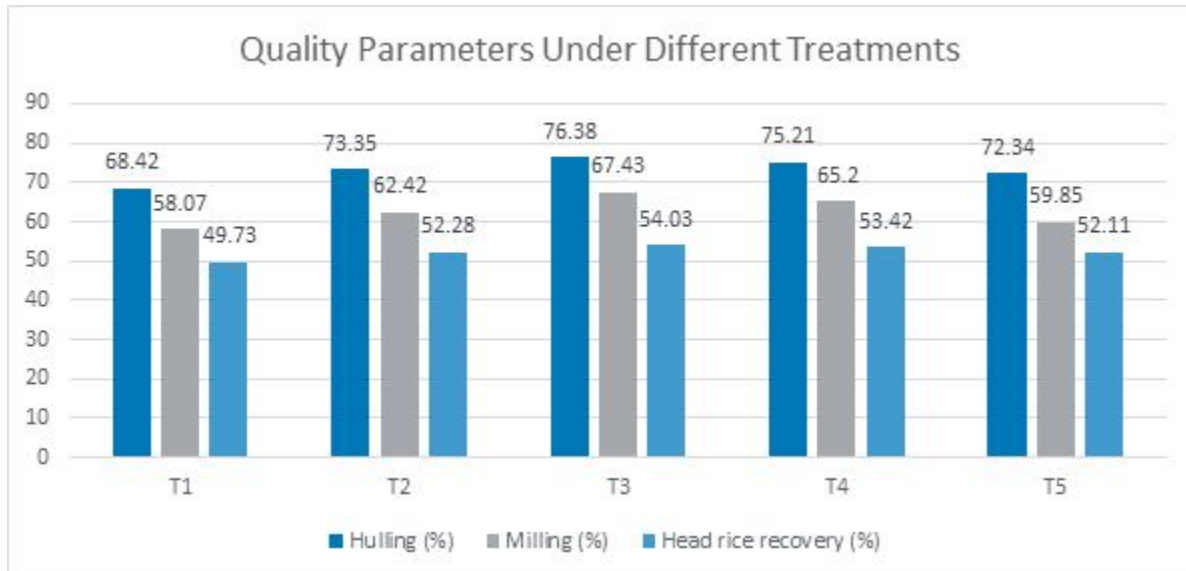


Fig. 2 : Impact of different treatment levels on the quality parameters of non-scented rice (*Oryza sativa* L.) under direct seeded condition.

variations in milling percentage underscore the influence of nutrient management practices on the milling outcomes, emphasizing the importance of tailored approaches for achieving optimal milling efficiency in non-scented rice varieties. These findings contribute valuable insights for farmers and researchers seeking to enhance the milling characteristics of rice crops through strategic nutrient application.

Head rice recovery

The data presented in Table 1 and Fig. 1 revealed that the non-scented rice variety PR-126 exhibited the highest head rice recovery at 52.69%, surpassing other cultivars. In contrast, HKR-48 showed the lowest head rice recovery at 51.65%, similar to the mid-early duration

variety HKR-47, which recorded 51.60%.

The application of 75% of the recommended nitrogen dose through urea and the remaining 25% through vermicompost resulted in the maximum head rice recovery at 54.03% in the crop field. The second-highest recovery, at T₄ with 50% recommended urea and 25% vermicompost was also notable (Table 1 and Fig. 1).

It's crucial to recognize that the variations in head rice recovery among different treatments are closely associated with factors such as moisture content and the force applied by the milling machine. These findings align with previous research, as indicated by (Yadav *et al*, 2021). This underscores the significance of nutrient management strategies, particularly the balanced use of

nitrogen from both urea and vermicompost, in optimizing head rice recovery. These results not only contribute to understanding the performance of specific rice varieties but also provide practical insights for improving crop yield and quality through informed nutrient application in agriculture.

Conclusion

The findings of the present study highlight the superior performance of the developed non-scented rice variety PR-126 in comparison to other non-scented cultivars, namely HKR-48 and HKR-47. Notably, the application of 75% of the recommended dose of nitrogen through urea and the remaining 25% through Vermicompost has demonstrated significant superiority over alternative treatments.

This suggests that adopting a strategy that combines readily available natural resources with inorganic fertilizers can yield favourable outcomes. By harnessing the benefits of Vermicompost, a sustainable and organic source of nutrients, in conjunction with conventional fertilization practices, it becomes possible to cultivate fertile soil, promote the growth of healthy crops and produce high-quality food.

This approach not only optimizes agricultural productivity but also aligns with the principles of natural farming, ensuring the well-being of the environment. Ultimately, such practices contribute to a sustainable agricultural system that preserves the fertility of the soil for future generations, allowing them to continue reaping the benefits of natural and resource-efficient agriculture.

Conflict of interest

The authors, affiliated with Maharishi Markandeshwar (Deemed to be University), declare no conflicts related to the research on non-scented rice quality.

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