



E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(6): 1236-1240
Received: 08-04-2026
Accepted: 09-05-2026

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International Journal of Research in Agronomy

Response of organic and inorganic fertilizer levels on growth and yields of black rice (*Oryza sativa* L.) in Prayagraj District

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DOI: <https://www.doi.org/0.33545/2618060X.2026.v9.i6p.5855>

Abstract

The field experiment was conducted during Rabi 2025-26 at Crop Research Farm, Department of Agronomy, PRSU, and Prayagraj (U.P). The experiment laid out in a Randomized block Design (RBD) along with two factor organic and inorganic fertilizer. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.30%), available N (65.5 kg/ha), Three organic viz., FYM 8 t ha⁻¹, Vermicompost 3 t ha⁻¹, Poultry manure 2 t ha⁻¹ Three Growth Hormones viz., IBA (5%); GA₃(3%); Seaweed Sap(10%) as sub-plot factor their combination of Ten treatments which are replicated thrice. The results of experiment based on the analysis were recorded in treatment combinations FYM 8 t/ha + IBA (5%); FYM 8 t/ha + GA₃ (3%); FYM 8 t/ha + Seaweed Sap (10%); Vermicompost 3 t/ha + IBA (5%); Vermicompost 3 t/ha + GA₃(3%); Vermicompost 3 t/ha + Seaweed Sap(10%); Poultry manure 2 t/ha + IBA (5%); Poultry manure 2 t/ha + GA₃(3%); Poultry manure 2 t/ha + Seaweed Sap (10%); Control The observations were recorded for Pre-harvest Parameters characters like Plant height, Leaf area index, Spad value, No. of leaf, Plant dry weight.

Keywords: Black rice, organic, growth hormones, vermicompost, FYM, poultry manure, IBA, Ga₃, seaweed sap

Introduction

Black rice (*Oryza sativa* L.) is an ancient and highly valued variety of rice known for its distinctive dark purple to black color and rich nutritional composition. Unlike traditional white or brown rice, black rice is packed with antioxidants, particularly anthocyanins, which are beneficial for human health. In recent years, the growing awareness of its nutritional and medicinal value has increased interest in its cultivation and production, especially among health-conscious consumers and organic farmers. (Choudhary *et al.*, 2020). However, the productivity of black rice remains relatively low compared to other rice varieties, mainly due to the lack of standardized nutrient management practices. Fertilizers play a vital role in improving crop growth, yield, and soil fertility. The excessive use of inorganic fertilizers, though effective for short-term yield improvement, often leads to soil degradation, nutrient imbalance, and environmental pollution. On the other hand, organic fertilizers enhance soil structure and microbial activity but may not supply nutrients quickly enough to meet the crop's immediate requirements. (Dubey *et al.*, 2017) ^[8]. Integrating organic and inorganic fertilizers in balanced proportions can be a sustainable approach to achieving both high productivity and soil health. This integrated nutrient management practice helps to enhance nutrient use efficiency, maintain soil fertility, and improve crop yield over time. (Singh *et al.*, 2023) ^[22]

Organic manures are vital components of sustainable agriculture, contributing not only nutrients but also improving soil physical, chemical, and biological properties. They are especially important in enhancing soil organic carbon (SOC), microbial biomass, enzyme activities, and structure, which in turn support plant growth and productivity (e.g., vermicompost, poultry manure, and farmyard manure). Farmyard manure (FYM) is a traditional, widely used organic amendment that provides a broad spectrum of macro-nutrients (N, P, K), improves water-holding

Capacity, enhances soil structure, and slow-releases nutrients over time. Studies comparing long-term applications of FYM with other organic sources have shown that FYM is often superior in building soil organic carbon, microbial biomass carbon (MBC), and microbial biomass nitrogen (MBN), especially under pearl millet-wheat cropping systems in North-Western India (Azarpour *et al.*, 2014)^[2]. Vermicompost is “improves soil quality, increases nutrient availability, boosts crop productivity, and enhances pest and disease tolerance.” Vermicomposting is an effective means of composting the decomposable organic wastes using earthworms and its nutrient level 1-1.5%N, 0.6-0.8%P and 1.2-1.5% Vermicomposting is an effective means of composting the decomposable organic wastes using earthworms and its nutrient level 1-1.5%N, 0.6-0.8%P and 1.2-1.5%. Poultry manure is recognized for its relatively high contents of nitrogen and phosphorus compared with many other manures. When applied in appropriate doses and properly composted or aged, it can significantly increase crop growth, nutrient uptake, and yield (while also influencing soil biological activity). For instance, an experiment on rice demonstrated higher yields, plant height, and better yield components under treatments combining poultry manure and vermicompost plus zinc, compared with manure or vermicompost alone (Verma *et al.*, 2020).

In combination, these organic manures can also reduce dependence on chemical fertilizers, improve soil fertility in a sustainable manner, and help maintain long-term productivity. Integrated nutrient management (INM) studies (combining organic manures with chemical fertilizer) show substantial benefits both in yield and soil health parameters. Plant growth regulators (PGRs), also sometimes naturally derived biostimulants, modulate physiological and morphogenetic processes in plants. The use of such compounds—whether synthetic (e.g. IBA, GA₃) or natural extracts (e.g. seaweed sap)—can significantly influence root initiation and growth, cell division/elongation, flowering, yield, and stress tolerance (Yadav *et al.*, 2016)^[25].

Indole-3-butyric acid (IBA) is an auxin commonly used to induce root formation, promote adventitious rooting, and increase root biomass and absorption capacity. Its efficacy has been demonstrated in air layering, cuttings, and seedling establishment. Gibberellic acid (GA₃) is a gibberellin class hormone that promotes stem elongation, breaks dormancy, stimulates flowering, and increases leaf expansion. Its foliar application has been found effective in improving vegetative growth, chlorophyll content, yield, and fruit quality in various studies. Seaweed sap: they contain multiple plant hormones (auxins, gibberellins, and cytokinins), amino acids, vitamins and trace elements. They not only support growth directly via hormonal effects but also indirectly by improving soil microbial activity and enzyme activities. A recent study on tomato seedlings compared different brown seaweeds and found that seaweed extracts improved both soil microbial enzyme activities (e.g. urease, phosphatase, invertase, catalase) and growth parameters (flower cluster number, fruit number, root and shoot biomass) relative to control (Tomar *et al.*, 2018)^[23]. In recent years, there has been growing concern over the excessive use of inorganic fertilizers, which, although effective in boosting short-term yields, have led to soil degradation, nutrient imbalance, and environmental pollution (Bhattacharyya *et al.*, 2015). Consequently, integrating organic sources such as farmyard manure (FYM), vermicompost, poultry manure, and bio-stimulants like indole-3-butyric acid (IBA), gibberellic acid (GA₃), and seaweed sap has emerged as a promising alternative for sustainable rice cultivation. Organic manures improve soil structure, microbial activity, and nutrient

availability, while bio-stimulants enhance physiological growth and stress tolerance in crops (Kumar *et al.*, 2022; Sharma *et al.*, 2020)^[13, 21].

The present investigation, therefore, aims to study the effect of different levels and combinations of organic and inorganic treatments on the growth and yield attributes of black rice. The experiment includes treatments involving FYM, vermicompost, and poultry manure in combination with IBA, GA₃, and seaweed sap, along with a farmer's practice control. Understanding these effects will provide insights into the best management practices for achieving higher productivity, improved quality, and sustainable soil fertility under organic and integrated nutrient management systems (Patel *et al.*, 2018)^[16].

Material and Methods

The experiment was conducted to know Response of Organic and Inorganic Fertilizer Levels on Growth and Yields of Black Rice (*Oryza sativa* L.) during Rabi 2025-26 at Crop Research Farm, Department of Agronomy, PRSU, and Prayagraj (U.P). The experiment laid out in a Randomized block Design (RBD) along with two factor organic and Growth Hormones, consisting of Ten treatments including Control with 3 replications, with the treatment combinations FYM 8 t/ha + IBA (5%); FYM 8 t/ha + GA₃(3%); FYM 8 t/ha + Seaweed Sap (10%); Vermicompost 3 t/ha + IBA (5%); Vermicompost 3 t/ha + GA₃(3%); Vermicompost 3 t/ha + Seaweed Sap (10%); Poultry manure 2 t/ha + IBA (5%); Poultry manure 2 t/ha + GA₃(3%); Poultry manure 2 t/ha + Seaweed Sap(10%); Control The experiment was laid out in Randomized Block Design, with ten treatments replicated thrice. The observations were recorded for Pre-harvest Parameters characters like Plant height, Leaf area index, Spad value, No. of leaf, Plant dry weight. The collected data was subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1984)^[9]

Results and Discussion

Pre-harvest Parameters

Plant height

A progressive increase in plant height was observed across all treatments from 30 Days after Sowing (DAS) until the at harvest stage. Initially, at 30 DAS, the differences between treatments were statistically non-significant (NS), with heights ranging from 19.56 cm (Control) to 22.71 cm (T₆). Out of all the treatments, the treatment with T₉ (Poultry manure 2 t/ha + Seaweed Sap (10%)) had the considerably highest plant height (102.43 cm) at harvest. T₈ Poultry manure 2 t/ha + GA₃ (3%) (98.73 cm) and T₇ Poultry manure 2 t/ha + IBA (5%) (97.83 cm) were determined to be statistically equivalent to T₉ (Poultry manure 2 t/ha + Seaweed Sap (10%)) (102.43 cm). In rice farming, nitrogen plays a pivotal role in promoting plant height through its influence on various physiological and biochemical processes essential for growth and development. Pradhan *et al.*, (2014)^[17] the length of spacing between plants influences their root development, air circulation, light exposure, and resource availability, all of which can have an impact on plant height. Ali *et al.*, (2013)^[1].

No. of tillers/hill

At harvest it is obvious from the data that number of tiller/hill was significantly affected by different spacing and nitrogen levels at all the growth stages. Higher number of tiller/hill was recorded in T₉ (Poultry manure 2 t/ha + Seaweed Sap (10%)) (25.71) as compared to rest of the spacing at all the stages. While T₈ Poultry manure 2 t/ha + GA₃ (3%) number of tillers (24.93) and T₇ Poultry manure 2 t/ha + IBA (5%) number of tillers (23.00) were

found to be statistically equivalent to T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) (25.71). the lowest number of tillers/hill was recorded in T10 (100% RDF control) (17.05) farmer practices. The number of tillers in plants is primarily influenced by the availability of organic manure; sufficient nitrogen promotes the formation of tillers, the generation of biomass, and the possibility for a high yield. Lampayan *et al.*, (2010) ^[14] In order to maximize crop yield potential and increase tiller development, proper spacing is essential, in addition to other agronomic techniques. BR *et al.*, (2021).

Plant dry weight (g/plant)

At harvest, significantly highest plant dry weight (74.02) was recorded in the treatment with T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) over all the other treatments. However, the treatments T8 Poultry manure 2 t/ha + GA₃ (3%) dry weight (72.06 g) and T7 Poultry manure 2 t/ha + IBA (5%) dry weight (70.16 g) was found to be statistically at par with T9 (Poultry manure 2 t/ha + Seaweed Sap (10%), (74.02 g). Among all treatment T10 recorded lowest plant dry weight (54.02). Nitrogen has a major role in the production of dry matter in plants by promoting photosynthesis, biomass accumulation, growth of the leaf area, uptake of nutrients, hormone control, assimilate partitioning, and stress tolerance. Jahan *et al.*, (2022) ^[11] Spacing between plants directly affects dry weight production by influencing resource availability, light penetration, air circulation, nutrient distribution, and genetic expression. Javaid *et al.*, (2012) ^[12].

Post-harvest

Number of panicle/hill

A perusal of the data clearly indicates that the number of panicle/hill was significantly affected due to spacing and different levels of nitrogen. Higher number of panicles with the value (22.85) were recorded in T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) which was at par with T8 Poultry manure 2 t/ha + GA₃ (3%) (21.38) and T7 Poultry manure 2 t/ha + IBA (5%) (20.46) while significant over rest both of the treatments. The smaller number of panicle was recorded in T10 (100% RDF control) (13.31). Nitrogen plays a crucial role in promoting tillers, crop biomass, panicle initiation, and spikelet formation in cereal crops, all of which contribute to the number of panicles per hill. Rao and Moorthy (2002) ^[19]. By influencing resource availability, light, air, fertilizer distribution, tiller growth, and management strategies, plant spacing directly affects the quantity of panicles per hill. Dass and Chandra (2013) ^[7].

Panicle length

A critical examination over the data revealed that spacing and different nitrogen levels significantly influenced the length of panicle. The maximum in number of length (cm), (24.79 cm), recorded significantly higher in T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) and weedy check was being at par with T8 Poultry manure 2 t/ha + GA₃ (3%) (23.13 cm) and T7 Poultry manure 2 t/ha + IBA (5%) (22.85 cm). The lower panicle length was recorded in T10 (100% RDF control) (17.63 cm). The effect of nitrogen on panicle length depending on several factors including crop species, nitrogen application rate, timing, and environmental conditions. Panicle length is an important trait in cereal crops which influence grain yield and quality. Sharma *et al.*, (2012) spacing between plants can influence panicle length ultimately maximizing grain yield potential in cereal crops. Javaid *et al.*, (2012) ^[12].

Number of grain per panicle

A perusal of the data indicates that number of grains/panicle was

found significantly higher with treatment combination T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) of the investigation. Higher number of grains/panicle with (389.98) were found under T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) which was at par with T8 Poultry manure 2 t/ha + GA₃ (3%) (384.92) and T7 Poultry manure 2 t/ha + IBA (5%) (361.05). the lower number of grains/panicle was recorded in T10 (100% RDF control) (343.18). Nitrogen promotes the differentiation of axillary buds into tillers, resulting in an increased number of potential grain-bearing stems. Singh *et al.*, (2021) plants with more space available can produce larger and denser panicles, resulting in higher grain yield per panicle. Ram *et al.*, (2014) ^[18].

Number of productive tillers/hill

There was a significant improvement in the productive tillers/hill with T9 (Poultry manure 2 t/ha + Seaweed Sap (10%), which produced significantly higher productive tillers/hill (24.50), while T8 Poultry manure 2 t/ha + GA₃ (3%) (22.87) and T7 Poultry manure 2 t/ha + IBA (5%) (20.21). was found to be statistically at par with T9 (Poultry manure 2 t/ha + Seaweed Sap (10%). The lower number of productive tillers/hill was recorded in T10 (100% RDF control) (15.13). Nitrogen deficiency can lead to weakened tillers, reducing their productivity and overall contribution to grain yield. Sharma *et al.*, (2012) The number of productive tillers per hill can be maximized by using planting density and spacing that avoid crowded and allow sufficient space for tiller initiation and growth. Maurya *et al.*, (2020) ^[15].

Test weight (g)

The highest test weight (g), (15.96 g) was recorded Non-significantly in Spacing and different level of nitrogen treatment T9 (Poultry manure 2 t/ha + Seaweed Sap (10%), while near with T8 Poultry manure 2 t/ha + GA₃ (3%) (15.26 g) and T7 Poultry manure 2 t/ha + IBA (5%) (15.22 g) and was being at par with T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) (15.96 g). The lowest test weight was recorded in T10 (100% RDF control) (14.23 g). Adequate nitrogen promotes optimal grain filling, resulting in larger and heavier grains. Conversely, nitrogen deficiency or imbalance can lead to incomplete grain filling and smaller, lighter grains, which may contribute to lower test weight. Larger plants often produce larger and heavier grains, contributing to higher test weight compared to plants in densely spaced configurations. Reuben *et al.*, (2016) ^[20].

Seed yield (t/ha)

The highest seed yield (t/ha), (4.64) was recorded significantly in spacing and different nitrogen levels treatment T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) was significantly more than T8 Poultry manure 2 t/ha + GA₃ (3%) (4.43 t/ha) and T7 Poultry manure 2 t/ha + IBA (5%) (4.40 t/ha) however, it was statistically at par with T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) (4.64 t/ha). T10 Control plot produced lowest seed yield (2.91 t/ha). Improved photosynthetic activity under sufficient nitrogen supply supports higher seed yield. Rajput *et al.*, (2020) Adequate spacing allows for optimal panicle development and seed set, resulting in higher seed yield per plant. In contrast, crowded conditions may lead to reduced panicle size and seed set, contributing to lower seed yield. Banerjee and pal (2011) ^[4].

Straw yield (t/ha)

A cursory glance over the data revealed that spacing and different nitrogen levels had significant effect on straw yield during the investigation. The highest straw yield of (15.21 t/ha) t/ha was recorded with treatment T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) which was superior by T8 Poultry manure 2 t/ha + GA₃ (3%) (14.43 t/ha) and T7 Poultry manure 2 t/ha + IBA (5%) (13.08

t/ha), while significant over T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) as compared to other treatments under study. T₁₀ Control plot produced lowest straw yield (9.74). Nitrogen enhances overall biomass production, leading to more straw yield per unit area. Proper nitrogen management is crucial for maximizing straw yield and overall crop productivity. Gupta *et al.*, (2011) ^[10] adequate spacing are less susceptible to diseases, allowing for better straw development and higher straw yield. Reuben *et al.*, (2016) ^[20].

Biological Yield (t/ha)

Highest biological yield (15.61 t/ha) was recorded by treatment

combination of T9 (Poultry manure 2 t/ha + Seaweed Sap (10%) being at par with T8 Poultry manure 2 t/ha + GA₃ (3%) (15.61 t/ha) and T7 Poultry manure 2 t/ha + IBA (5%) (15.61 t/ha). Least biological yield at all treatment combination was recorded by T₁₀ Control (12.66 t/ha).

Harvest Index (%)

Data presented in table quite revealed that harvest index was non-significantly affected due to spacing and N level during the investigation. Higher and lower harvest index was found non-significantly with T9 (Poultry manure 2 t/ha + Seaweed Sap (10%), T₁₀ Control respectively

Table 1: Pre harvest observation at successive growth stages of Black rice as influenced by various treatments

Treatments		Pre harvest observation		
		Plant height (cm)	Number of tillers hill-1	Plant dry weight (g)
T ₁	FYM 8 t/ha + IBA (5%)	87.68	17.35	59.12
T ₂	FYM 8 t/ha + GA ₃ (3%)	88.73	18.07	61.36
T ₃	FYM 8 t/ha + Seaweed Sap (10%)	90.27	18.75	62.44
T ₄	Vermicompost 3 t/ha + IBA (5%)	91.00	20.57	62.93
T ₅	Vermicompost 3 t/ha + GA ₃ (3%)	91.77	20.67	64.89
T ₆	Vermicompost 3 t/ha + Seaweed Sap (10%)	92.77	21.30	65.72
T ₇	Poultry manure 2 t/ha + IBA (5%)	97.83	23.00	70.16
T ₈	Poultry manure 2 t/ha + GA ₃ (3%)	98.73	24.93	72.06
T ₉	Poultry manure 2 t/ha + Seaweed Sap (10%)	102.43	25.71	74.02
T ₁₀	Control	83.06	17.05	54.02
SEm(±)		3.15	S	S
F-Test		S	1.78	2.71
CD at 5%		9.38	5.31	8.06

Table 2: Post-harvest observation at successive growth stages of Black rice as influenced by various treatments

Tr. No.	Treatment combination	Yield				
		No. of panicle	Panicle length (cm)	No. of grain/panicle	No. of productive tillers/hill	Test weight (g)
T ₁	FYM 8 t/ha + IBA (5%)	16.16	18.98	344.97	15.52	14.38
T ₂	FYM 8 t/ha + GA ₃ (3%)	16.77	19.39	345.68	16.30	14.43
T ₃	FYM 8 t/ha + Seaweed Sap (10%)	17.66	19.86	347.71	17.46	14.51
T ₄	Vermicompost 3 t/ha + IBA (5%)	17.40	19.05	350.05	18.55	14.60
T ₅	Vermicompost 3 t/ha + GA ₃ (3%)	18.07	19.73	354.92	18.74	14.68
T ₆	Vermicompost 3 t/ha + Seaweed Sap (10%)	18.46	20.76	356.95	19.58	14.86
T ₇	Poultry manure 2 t/ha + IBA (5%)	20.47	22.85	361.05	20.22	15.23
T ₈	Poultry manure 2 t/ha + GA ₃ (3%)	21.38	23.13	384.93	22.87	15.26
T ₉	Poultry manure 2 t/ha + Seaweed Sap (10%)	22.86	24.79	389.98	24.51	15.97
T ₁₀	Control	13.31	17.63	343.19	15.13	14.23
	F-test	S	S	S	S	S
	Sem±	1.69	1.41	10.53	1.06	0.66
	CD (P=0.05)	5.02	4.21	31.31	3.15	1.96



Fig 1: Transplanting of Seedlings in the Experimental Field



Fig 2: Transplanting of Rice Seedlings in the Experimental Field

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