Response of Macronutrients, Micronutrient and Biofertilizer on the Growth and Yield Attributes of Kalanamak Rice (*Oryza sativa* L.) in Central Uttar Pradesh, India

ABSTRACT

A field experiment was conducted on the combined application of macronutrients and micronutrient along with biofertilizer significantly improved the growth and yield attributes of Kalanamak rice over two *kharif* seasons, 2022 and 2023. The most effective treatment, T_7 [100 per cent RDF (Recommended Dose of Fertilizer) + 25 per cent N through FYM (Farm Yard Manure) + S (Sulphur) @ 40 kg ha^{-1} + ZnO (Zinc oxide) @ 5 kg ha^{-1} + BGA (Blue Green Algae) @ 10 kg ha^{-1}] gave maximum increase in growth and yield attributing characteristics viz. plant height (96.80 cm & 97.82 cm), number of tillers $hill^{-1}$ (11.23 & 11.25), number of effective tillers $hill^{-1}$ (10.81 & 10.94), panicle length (35.16 cm & 35.43 cm), number of grains $panicle^{-1}$ (175.82 & 179.45), number of filled grains $panicle^{-1}$ (159.89 & 161.02), number of unfilled grains $panicle^{-1}$ (15.93 & 18.43) and test weight (14.9 g & 15 g). This indicates that integrated nutrient management including the integration of organic manures, i.e., FYM, inorganic nutrients (N, P, K, S and Zn) and bio-fertilizers, i.e., BGA enhances rice growth and yield. The positive impact of BGA on nitrogen fixation, combined with the role of Zn and S in grain formation, contributed to higher grain numbers, greater panicle length and increased test weight leading to improved grain yield. Overall, the study highlights the importance of integrated nutrient management, demonstrating that the synergetic use of biofertilizer and balanced fertilization can optimize nutrient availability, improve soil health, reduce unfilled grains and increase crop productivity in Kalanamak rice cultivation.

Keywords: Integrated Nutrient Management, Kalanamak Rice, Biofertilizer, Macronutrients, Micronutrient , crop yield.

1. INTRODUCTION

Kalanamak rice (*Oryza sativa* L.) is one of the finest quality aromatic rices of Nepal and India. In India, it is cultivated primarily in the Terai region of Uttar Pradesh and is known as the scented black pearl of Uttar Pradesh. It is valued for its distinct flavour, fragrance, and high nutritional content. Despite its cultural and economic significance, Kalanamak rice cultivation often suffers from low yields and suboptimal growth due to nutrient deficiencies, lodging problems and outdated agronomic practices. Addressing these issues is crucial for enhancing the productivity and sustainability of Kalanamak rice farming.

Nutrient management is a fundamental aspect of rice cultivation that significantly impacts plant growth, development and yield. Macronutrients are considered primary and secondary nutrients. Primary nutrients, including nitrogen (N), phosphorus (P) and potassium (K), are essential for various physiological functions in rice plants. Nitrogen is crucial for vegetative growth and grain filling; phosphorus supports root development, seed formation, and energy transfer; and potassium regulates osmotic pressure, water uptake and disease resistance. However, secondary nutrient i.e. sulphur (S) is the fourth major (macro) plant nutrient (after N, P, and K) which helps in chlorophyll formation, enzyme activation and protein synthesis. Several studies highlight the importance of balanced nutrient application of these nutrients for improving rice yields and observed that optimized nitrogen and potassium levels significantly enhanced the growth and yield of Kalanamak rice (Sharma *et al.*, 2023).

Micronutrients, although required in smaller quantities, play a vital role in maintaining plant health and improving productivity. Zinc (Zn) plays a fundamental role in various metabolic functions, which are essential for several biochemical processes in the rice plant, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation and membrane integrity. Deficiencies of Zinc nutrient can lead to reduced crop yields and poor grain quality. A study demonstrated that micronutrient application improved the physiological performance and yield of rice, emphasizing the need for adequate micronutrient management in rice cultivation (Singh & Gupta, 2024).

Biofertilizers are preparations of microorganisms that supply essential major plant nutrients especially nitrogen and phosphorus. They are applied to seeds, soil or composting areas with the objective of increasing the number of such microorganisms which enhance soil fertility, increase nutrient availability, and promote plant growth through various mechanisms. A recent study highlighted the positive effects of biofertilizers on rice yield and nutrient uptake. The study found that integrating biofertilizers with conventional nutrient management practices resulted in improved growth, yield, and soil health (Patel *et al.*, 2023). While the benefits of macro and micro nutrient management along with biofertilizers have been well documented in modern rice varieties, there is a noticeable gap in research focusing on traditional varieties such as Kalanamak rice. This research aims to address this gap by investigating the combined effects of organic manure, inorganic including macro and micro nutrients, along with biofertilizer treatments, on the growth and yield attributes of Kalanamak rice. Understanding how these factors influence Kalanamak rice will provide valuable insights for optimizing cultivation practices and improving productivity.

The primary objectives of this study are to evaluate the impact of different macronutrient combinations, micronutrient supplements, and biofertilizer applications on various growth parameters such as plant height, number of tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length as well as yield attributes namely number of grains panicle^{-1}, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1} and test weight. By analyzing these factors, the research seeks to offer valuable suggestions for improving the cultivation of Kalanamak rice, thereby enhancing the sustainability and profitability of this traditional crop.

2. MATERIALS AND METHODS

2.1 Study Site

The field experiment was conducted at farmer's field in Kishorpur village, Kanpur Dehat, under the guidance of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during the kharif seasons of 2022 and 2023. The experiment was conducted in a well levelled field with homogeneous fertility, equipped with adequate irrigation through a tube well.

2.2 Geographical Location

The experimental site lies in the subtropical region, between the parallel of 26º06' and 26º50' north latitudes and 79º30' and 81º10' east longitudes with an elevation of 131 meters above sea level in the alluvial belt of the Indo-Gangetic plains of central Uttar Pradesh.

2.3 Soil Preparation and Fertilizer Application

A composite soil sample was taken prior to the experiment, ranging in depth from 0 to 15 cm. The purpose of the sample was to examine the physicochemical features of the soil, such as pH, organic carbon, available nitrogen, phosphorus, potassium levels. This analysis of these physicochemical features was used to determine the initial fertility status of the experimental field. The field was prepared using conventional ploughing, harrowing, and levelling methods to ensure uniformity. Transplanting of 25-day-old Kalanamak rice seedlings was done at a spacing of 20 cm × 15 cm.

Fertilizers were applied in split doses. Nitrogen was applied in three equal splits: 1/3rd during transplanting, 1/3rd during tillering and 1/3rd at the panicle initiation stage. FYM was applied before sowing of seed and phosphorus, potassium, sulphur and micronutrients were applied as a basal dose during transplanting. Biofertilizers, i.e., BGA was applied as soil based flakes and broadcast directly in the rice fields one week after transplanting the seedlings.

2.4 Experimental Details

A randomized block design (RBD) was adopted for the study, with 12 treatments replicated three times. The experiment consisted of various treatment combinations involving the application of macronutrients (N, P, K & S), micronutrients, i.e. zinc (Zn), organic manure (FYM) and biofertilizer (BGA). These were compared against a control treatment (no nutrient application) to assess their effect on the growth and yield of Kalanamak rice. The details of the treatment and their combinations are mentioned in the table 2. These treatments were applied to assess their individual and combined effects on plant growth and grain yield.

2.5. Observations and Data Collection

Growth parameters such as plant height and number of tillers per hill were recorded at various growth stages [30, 60, 90 days after sowing (DAS) and at harvest]. Yield attributes viz. number of grains panicle^{-1}, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1} and test weight (1000-grain weight) were recorded at harvest.

2.6. Statistical Analysis

The experiment was laid out in randomized block design (RBD) and replicated thrice. The data on various growth and yield attributing were statistically analyzed for randomized block design (RBD). The collected data were subjected to statistical analysis using analysis of variance (ANOVA) techniques. The effect of different nutrient combinations on the growth and yield of Kalanamak rice was assessed by conducting an "F" test. Critical differences (CD) were calculated at a 5% level of significance to evaluate treatment variations.

3. RESULTS AND DISCUSSION

The field experiment evaluated the impact of macronutrients and micronutrient, along with biofertilizer on growth and yield attributes of Kalanamak rice during the 2022 and 2023 kharif seasons. Key growth parameters such as plant height [30, 60, 90 days after sowing (DAS) and at harvest], number of tillers per hill [30, 60, 90 days after sowing (DAS) and at harvest] and number of effective tillers per hill were recorded. Yield attributes included panicle length, total grains per panicle, filled grains per panicle, unfilled grains per panicle, test weight were recorded at harvest. The data from the experiment provided insights into how nutrient management affected both growth and yield of Kalanamak rice.

3.1 Plant height (cm)

The application of macronutrients and micronutrient as well as biofertilizer, significantly influenced the plant height of Kalanamak rice across different growth stages during both years of the experiment (2022 and 2023). The plant height varied from 32.50 cm to 34.51 cm in the first year and from 33.80 cm to 35.00 cm in the second year and did not show significant differences at 30 (DAS). The maximum plant height was observed in treatment T_7 (100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1} + BGA @ 10 kg ha^{-1}) in both years, with the lowest in the control (T_1). A similar trend was observed at 60 DAS, where plant height ranged from 56.10 cm to 84.10 cm in 2022 and 57.23 cm to 85.23 cm in 2023, with T_7 consistently outperforming the other treatments, followed by T_6 (100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1}). At 90

DAS and harvest, plant height continued to show significant differences, with T_7 producing the tallest plants (96.32 cm and 97.31 cm in pooled analysis), while the control treatment showed the lowest values at all growth stages. These findings highlight the beneficial impact of combined applications of macronutrients and micronutrient along with biofertilizer, i.e., BGA on promoting growth in Kalanamak rice. This result is in line with earlier studies, where nutrient management significantly enhanced plant growth parameters in rice crops (Singh *et al.*, 2020; Sharma and Dubey, 2019).

3.2 Number of tillers per hill

The effect of macronutrients and micronutrients along with biofertilizer on the number of tillers per hill at various growth stages of Kalanamak rice was significant across both the 2022 and 2023 growing seasons. At 30 days after sowing (DAS), the number of tillers varied from 7.40 to 7.65 in both years, with no significant differences among treatments. The highest tiller count was observed in T_7 (100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1} + BGA @ 10 kg ha^{-1}) followed by T_6 (100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1}), while the lowest tiller count occurred in the control (T_1). However, by 60 DAS, the treatments showed a significant impact, with tiller numbers ranging from 7.75 to 11.10. Treatment T_7 consistently recorded the highest number of tillers, followed by T_6 with both treatments significantly outperforming the control in both years.

At 90 DAS, tiller counts varied from 7.77 to 11.20. Treatment T_7 achieved the highest number of tillers, followed closely by T_6, while the control treatment recorded the lowest tiller counts. Similarly, at harvest, the number of tillers varied from 7.81 to 11.25, with treatment T_7 yielding the highest tiller number, followed by T_6. These results suggest that the combined application of macronutrients and micronutrients, particularly the inclusion of biofertilizer like blue green algae (BGA), enhances tillering in rice, contributing to overall yield improvement. Previous research corroborates these findings, as nutrient management, especially with biofertilizers, is known to enhance tillering and yield attributes in rice crops (Kumar *et al.*, 2020; Singh and Meena, 2018).

3.3 Number of effective tillers per hill

The data on the number of effective tillers $hill^{-1}$ during two years (2022 and 2023) show a significant variation between treatments. The number of effective tillers ranged from 6.21 to 10.81 in the first year and from 6.34 to 10.94 in the second year, indicating the consistent influence of different treatments on tillers production. The highest number of effective tillers $hill^{-1}$ was recorded with the treatment T_7 (100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1} + BGA @ 10 kg ha^{-1}), which yielded 10.81 and 10.94 tillers per hill in 2022 and 2023, respectively. In comparison, the lowest number of effective tillers was observed in T_1 (control), with 6.21 and 6.34 tillers $hill^{-1}$. This result indicates that integrating organic components (FYM and BGA) with inorganic nutrients (N, P, K, S and Zn) enhances the number of effective tillers. Nutrient management, particularly the incorporation of organic manures like FYM and biofertilizers, has been enhancing tillering in rice and other cereals. A study found that organic amendments improve soil health, which positively impacts tillering and overall crop productivity (Saha *et al.,* 2022).

3.4 Panicle length (cm)

Panicle length is a crucial factor that correlates with grain yield. The study found a significant increase in panicle length across all treatments compared to T_1 (control). Treatment T_7 showed the highest panicle length, with 35.16 cm and 35.43 cm during both years, followed closely by treatment T_6. On the other hand, T_1 (control) recorded the shortest panicle length, with 27.19 cm and 27.45 cm. Pooled data further confirmed the superior performance of treatment T_7, which produced an average panicle length of 35.30 cm, reinforcing the benefits of combining RDF with FYM, S, ZnO and BGA for improved growth. Panicle length is a critical determinant of yield in rice. An integrated nutrient management, particularly with balanced application of macronutrients, i.e., sulphur and micronutrients, i.e., Zinc significantly improves panicle length and ultimately crop yield (Chaudhary *et al.* 2023).

3.5 Number of grains per panicle

A similar trend was observed in the number of grains panicle^{-1}, where T_7 outperformed all other treatments with 175.82 and 179.45 in the first and second years, respectively. T_6 followed closely, while T_1 (control) had the fewest, with 130.55 and 134.81. The pooled analysis confirmed T_7 superiority with 177.63, demonstrating the positive impact of balanced nutrient application, including RDF, FYM, S, ZnO and BGA. The application of nutrients like Zn and S improves grain formation, while FYM enhances nutrient availability, leading to higher grain counts per panicle (Kumar *et al.* 2021).

3.6 Number of filled grains per panicle

Filled grains panicle^{-1} reflects grain-filling efficiency, which is directly influenced by nutrient management. Treatment T_7 showed the best performance, with 159.89 and 161.02 filled grains panicle^{-1} across two years, while T_1 recorded the fewest, with 90.23 and 91.36 filled grains panicle^{-1}. The pooled data analysis confirmed the superiority of treatment T_7 with 160.46 filled grains panicle^{-1}. The integration of biofertilizer (BGA) with RDF and FYM was shown to enhanced nutrient uptake, thus improving grain-filling rates. Biofertilizer like BGA significantly enhance nitrogen fixation and nutrient uptake, leading to an increase in the number of filled grains in rice, confirming the results observed in this study (Singh *et al.* 2022).

3.7 Number of Unfilled Grains per panicle

The number of unfilled grains panicle^{-1} was lowest in T_7 (15.93 and 18.43 in the first and second years) and highest in T_1 (control), with 40.32 and 43.45 unfilled grains panicle^{-1}.

Pooled analysis also showed T_7 as the most effective treatment for minimizing unfilled grains, confirming the positive effects of balanced nutrient application in enhancing grain quality and reducing grain sterility. The application of FYM and biofertilizers significantly reduces the number of unfilled grains by improving nutrient availability and plant health, like the findings in this study (Rahman *et al*., 2023).

3.8 Test Weight (g)

Test weight expressed as the weight of 1000 grains, showed a significant increase with T_7 (14.96 g and 15 g) in the first and second years, compared to T_1 (control), which had the lowest test weight (11.44 g and 11.46 g). The pooled analysis indicated that T_7 resulted in the highest test weight (14.98 g), further demonstrating the advantages of combining RDF, FYM and nutrients like Zn and S for improving grain size and weight. Test weight is an important yield determinant. A study noted that balanced fertilization, especially with micronutrients, and biofertilizers significantly improved the test weight of grains by enhancing nutrient absorption and grain development (Sharma *et al*. 2023).

4. CONCLUSION

The combined application of macronutrients and micronutrients, i.e., Zn along with biofertilizers, significantly improves the growth and yield of Kalanamak rice. Treatment T_7 (100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1} + BGA @ 10 kg ha^{-1}) consistently outperformed other treatments across various growth stages in both years of the experiment. Key growth parameters such as plant height, number of tillers, and effective tillers $hill^{-1}$ were significantly enhanced by treatment T_7. This treatment also improved important yield attributes such as panicle length, number of grains $panicle^{-1}$, the number of filled grains $panicle^{-1}$ and test weight, while reducing the number of unfilled grains. These results underscore the beneficial effects of integrated nutrient management, particularly the combination of organic source, i.e., FYM, inorganic source such as N, P, K, (RDF) and S fertilizers, micronutrient like Zn, along with biofertilizers, i.e., blue green algae (BGA). The findings are consistent with previous research, confirming that balanced nutrient applications promote growth and enhance yield in Kalanamak rice cultivation.

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Table. 1 Initial soil properties of the experimental field

1.	Particulars	Values	Method employed
A.	**Mechanical separates**		Hydrometer method (Bouyoucos, 1962)
	Sand (%)	56.92	
	Silt (%)	28.25	
	Clay (%)	14.83	
	Textural class	Sandy loam	Triangular method (Jackson 1973)
	Bulk density (Mg m^{-1})	1.34	Jackson (1973)
	Particle density (Mg m^{-1})	2.69	Richards (1954)
B.	**Physicochemical parameters**		
	pH (1:2.5)	7.8	Glass electrode pH meter (Jackson, 1973)
	EC (1:2.5) (dSm^{-1} at 25ºC)	0.35	Conductivity meter (Jackson, 1973)
C.	**Chemical parameters**		
	Organic Carbon (%)	0.43	Walkley & Black's rapid titration method (Walkley & Black, 1934)
	Available Nitrogen (Kg ha^{-1})	190.20	Alkaline permanganate method (Subbiah and Asija, 1956)
	Available Phosphorus (Kg ha^{-1})	11.80	Olsen's method (Olsen *et al.*, 1954)
	Available Potassium (Kg ha^{-1})	170.76	Flame photometer (Jackson, 1973)
	Available Sulphur (Kg ha^{-1})	12.54	Turbidimetric method (Chesnin and Yien, 1950)
	Available Zinc (ppm)	0.42	DTPA extraction (AAS), Lindsay and Norvell (1978)

Table. 2 Details of treatments applied in Kalanamak rice

S.No.	Treatment combinations	Symbol
1.	Control	T_1
2.	125 per cent RDF	T_2
3.	100 per cent RDF	T_3
4.	100 per cent RDF + 25 per cent N FYM	T_4
5.	100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1}	T_5
6.	100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1}	T_6
7.	100 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1} + BGA @ 10 kg ha^{-1}	T_7
8.	75 per cent RDF	T_8
9.	75 per cent RDF + 25 per cent N FYM	T_9
10.	75 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1}	T_{10}
11.	75 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1}	T_{11}
12.	75 per cent RDF + 25 per cent N FYM + S @ 40 kg ha^{-1} + ZnO @ 5 kg ha^{-1} + BGA @ 10 kg ha^{-1}	T_{12}

RDF - Recommended dose of fertilizer

Table 3: Effect of macronutrients, micronutrient and biofertilizer on plant height at different stages of Kalanamak rice

Treatments	Plant height (cm)											
	30 DAT			60 DAT			90 DAT			At harvesting stage		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	32.50	33.80	33.15	56.10	57.23	56.67	84.60	85.63	85.12	85.40	85.41	85.41
T_2	33.70	34.00	33.85	71.10	72.23	71.67	93.60	94.73	94.17	94.40	94.80	94.60
T_3	33.60	33.80	33.70	70.00	71.13	70.57	90.50	92.63	91.57	91.30	92.82	92.06
T_4	34.30	34.40	34.35	72.70	73.83	73.27	93.20	94.33	93.77	94.00	95.13	94.57
T_5	34.20	34.50	34.35	76.50	77.63	77.07	94.00	95.13	94.57	94.80	95.81	95.31
T_6	34.27	34.60	34.44	82.10	83.23	82.67	95.60	96.70	96.15	96.40	97.78	97.09
T_7	34.51	35.00	34.76	84.10	85.23	84.67	95.90	96.73	96.32	96.80	97.82	97.31
T_8	33.00	33.50	33.25	61.90	63.03	62.47	87.40	88.53	87.97	88.20	89.21	88.71
T_9	33.30	33.40	33.35	64.70	65.83	65.27	90.20	91.33	90.77	91.00	91.52	91.26
T_{10}	32.50	32.90	32.70	67.90	69.03	68.47	91.40	92.53	91.97	92.20	92.62	92.41
T_{11}	34.10	34.20	34.15	74.40	75.53	74.97	93.90	95.03	94.47	94.70	95.53	95.12
T_{12}	34.70	34.50	34.60	78.70	79.83	79.27	94.40	95.53	94.97	95.20	96.64	95.92
SEm ±	1.363	1.284	1.206	1.682	1.729	1.616	2.007	2.066	1.876	1.963	1.956	2.025
C.D. at 5%	NS	NS	NS	4.966	5.103	4.77	5.926	6.1	5.537	5.794	5.773	5.979

Table 4: Effect of macronutrients, micronutrient and biofertilizer on number of tillers per hill at different stages of kalanamak rice

Treatments	Number of tillers per hill											
	30 DAT			60 DAT			90 DAT			At harvesting stage		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	7.40	7.50	7.45	7.75	7.76	7.76	7.77	7.78	7.78	7.81	7.83	7.82
T_2	7.36	7.37	7.37	9.59	9.61	9.60	9.64	9.66	9.65	9.68	9.70	9.69
T_3	7.31	7.32	7.32	9.57	9.59	9.58	9.58	9.60	9.59	9.62	9.64	9.63
T_4	7.46	7.47	7.47	9.76	9.78	9.77	9.80	9.82	9.81	9.83	9.85	9.84
T_5	7.60	7.61	7.61	10.25	10.27	10.26	10.29	10.31	10.30	10.32	10.35	10.33
T_6	7.62	7.64	7.63	10.86	10.89	10.88	10.93	10.95	10.94	10.96	10.98	10.97
T_7	7.63	7.65	7.64	11.09	11.10	11.10	11.18	11.20	11.19	11.23	11.25	11.24
T_8	7.11	7.12	7.11	8.39	8.41	8.40	8.59	8.61	8.60	8.64	8.66	8.65
T_9	7.19	7.20	7.20	9.29	9.31	9.30	9.49	9.51	9.50	9.54	9.56	9.55
T_{10}	7.24	7.26	7.25	9.47	9.49	9.48	9.67	9.69	9.68	9.72	9.74	9.73
T_{11}	7.51	7.52	7.52	9.96	9.98	9.97	10.36	10.38	10.37	10.41	10.43	10.42
T_{12}	7.83	7.85	7.84	10.51	10.52	10.52	10.58	10.60	10.59	10.63	10.65	10.64
SEm ±	0.252	0.251	0.25	0.233	0.22	0.24	0.24	0.233	0.251	0.234	0.205	0.211
C.D. at 5%	NS	NS	NS	0.686	0.648	0.709	0.708	0.688	0.741	0.704	0.615	0.623

Table 5: Effect of macronutrients, micronutrient and biofertilizer on number of effective tillers per hill, Panicle length and number of grains per panicle of kalanamak rice

Treatments	No. of effective tillers per hill			Panicle length (cm)			No. of grains per panicle		
	2022	**2023**	**Pooled**	**2022**	**2023**	**Pooled**	**2022**	**2023**	**Pooled**
T_1	6.21	6.34	6.28	27.19	27.45	27.32	130.55	134.81	132.68
T_2	7.88	8.01	7.95	31.80	32.16	31.98	159.46	163.05	161.25
T_3	7.76	7.90	7.83	31.67	32.01	31.84	151.98	155.55	153.76
T_4	8.09	8.22	8.16	32.10	32.46	32.28	160.64	164.55	162.60
T_5	8.80	8.93	8.87	32.80	33.18	32.99	168.85	172.75	170.80
T_6	10.20	10.33	10.27	33.43	33.80	33.62	174.82	178.58	176.70
T_7	10.81	10.94	10.88	35.16	35.43	35.30	175.82	179.45	177.63
T_8	6.87	7.00	6.94	28.50	28.81	28.66	135.27	139.25	137.26
T_9	7.72	7.85	7.79	31.04	31.38	31.21	145.07	148.95	147.01
T_{10}	7.93	8.06	8.00	31.47	31.80	31.64	150.37	154.90	152.63
T_{11}	8.85	8.98	8.92	32.24	32.61	32.43	164.24	168.41	166.32
T_{12}	9.70	9.83	9.77	33.13	33.52	33.33	172.52	176.42	174.47
SEm ±	0.202	0.195	0.187	0.701	0.64	0.674	5.563	5.701	5.633
C.D. at 5%	0.595	0.574	0.551	2.071	1.89	1.988	16.42	16.829	16.627

Table 6: Effect of macronutrients, micronutrient and biofertilizer on number of filled grains per panicle, Number of unfilled grains per panicle and Test weight of kalanamak rice

Treatments	No. of filled grains per panicle			No. of unfilled grains per panicle			Test weight (g)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	90.23	91.36	90.80	40.32	43.45	41.88	11.44	11.46	11.45
T_2	138.78	139.91	139.35	20.68	23.14	21.91	12.23	12.25	12.24
T_3	131.45	132.58	132.02	20.53	22.97	21.75	12.05	12.07	12.06
T_4	141.67	142.80	142.24	18.97	21.75	20.36	12.39	12.41	12.4
T_5	148.89	150.02	149.46	19.96	22.73	21.34	13.62	13.66	13.64
T_6	156.00	157.13	156.57	18.82	21.45	20.13	14.68	14.7	14.69
T_7	159.89	161.02	160.46	15.93	18.43	17.18	14.96	15	14.98
T_8	101.23	102.36	101.80	34.04	36.89	35.46	11.45	11.47	11.46
T_9	124.13	125.26	124.70	20.94	23.69	22.31	11.54	11.56	11.55
T_{10}	129.78	130.91	130.35	20.59	23.99	22.29	11.75	11.8	11.77
T_{11}	145.01	146.14	145.58	19.23	22.27	20.75	12.56	12.57	12.57
T_{12}	153.56	154.69	154.13	18.96	21.73	20.34	14.42	14.46	14.44
SEm ±	2.861	2.953	3.033	0.808	0.906	0.856	0.449	0.45	0.45
C.D. at 5%	8.444	8.717	8.954	2.386	2.673	2.528	1.326	1.328	1.328