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EFFECTS OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD ATTRIBUTES PARAMETERS OF KALA NAMAK RICE IN NORTHERN INDIA

Veerendra Singh[1*], Ravindra Kumar[1], Mahendru Kumar Gautam[1], Abhishek Singh Yadav[1], Kapil Kumar Yadav[1], Krishna kumar Singh[1], Dheerendra Kumar[1], Sumit Kumar[1], Deepak Kumar[2], Yogesh Kumar[3] and Sanjay Yadav[3]

[1]Department of Soil Science and Agricultural Chemistry, College of Agriculture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208002, U.P. India

[2]Department of Agronomy, College of Agriculture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208002, U.P. India

[3]Department of Soil Conservation and Water Management, College of Agriculture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208002, U.P., India

*Corresponding Author E-mail: Vr76075@gmail.com

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ABSTRACT

Integrated Nutrient Management (INM) is a holistic approach to optimizing the use of various sources of nutrients to enhance soil fertility and crop productivity while maintaining environmental sustainability. Integrated Nutrient Management increases Kalanamak rice yield by optimizing the balanced application of organic and inorganic fertilizers to enhance soil fertility and nutrient availability, thus supporting better crop growth and productivity. The present investigation is based Effects of Integrated Nutrient Management on Yield attribute parameters of Kala Namak Rice in Northern India. The treatments laid out in a Randomized Block Design and replicated thrice using the rice variety Kalanamak Kiran Among the 11 integrated nutrient management practices, the application of 100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})] in both years registered significantly the highest yield attributes and these treatments also increase following, The grain yield 28.40 q ha^{-1} in the first year and 29.28 q ha^{-1} in the second year, The highest number of effective tillers, 498.24 in the first year and 526.26 in the second year, Number of filled grain (140.83 and 147.50) Straw yield in the first and second years, respectively, 52.50 q ha^{-1} and 54.12 q ha^{-1}, Biological yield 80.90 q ha^{-1} in the first year and 83.39 q ha^{-1} in the second year, the harvest index was 35.10 in both years and also increase the Test weight of Kalanamak Kiran rice.

Introduction

Kalanamak rice is a native landrace from the northeastern plains zone (NEPZ) of eastern Uttar Pradesh, near the Nepal border. This region includes the districts of Gorakhpur, Mahrajganj, Deoria, Kushinagar, Basti, Siddharthnagar, Sant Kabir Nagar, Gonda, Balrampur, Bahraich, and Shrawasti. It has been cultivated in these areas for a long time due to favourable environmental conditions (Singh *et al.*, 2005a). Kalanamak rice holds significant social and economic value within the household livelihood systems of the region. Renowned for its aroma and the quality of its cooked grains, no other local rice variety can rival its excellence. (Singh *et al.*, 2005b). Integrated nutrient management involves the use of inorganic fertilizers, organic manures, and bio-fertilizers, which collectively contribute to maintaining soil fertility, ensuring sustainable agricultural productivity, and enhancing farmers' profitability. The positive impact of farmyard manures on Kalanamak rice cultivation, whether used alone or in combination with fertilizers, has been well documented (Kumar *et al.* (2001). The response of rice varieties can vary under different fertility management practices. Therefore, the yield potential of traditional kalanamak rice varieties can be maximized by adopting integrated nutrient management practices. It is essential to evaluate these kalanamak rice varieties under various fertility management practices to fully exploit their yield potential and achieve higher profitability in lowland areas. Consequently, the present study was conducted to assess the impact of INM on Kalanamak rice varieties in Northern India.

Material and Method

The current experiment was conducted at the Student Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during the Kharif seasons of 2022-23 and 2023-24. The soil of experimental site is silt clay loam in texture, low in Organic carbon 3.5(g kg^{-1}) in (2022-23) and 3.4 (g kg^{-1}) in (2023-24), Available Nitrogen was 179.16 (kg ha^{-1}) During 2022-23 and 180.56 (kg ha^{-1}) in (2023-24), Available Phosphorus was 13.04 (kg ha^{-1}) during 2022-23 and 13.23(kg ha^{-1}) in 2023-24, Available Potassium was 129.54 (kg ha^{-1}) during 2022-23 and 132.42(kg ha^{-1}) 2023-24, Available Zn 0.40 (mg kg^{-1}) during (2022-23) and 0.41(mg kg^{-1}) in (2023-24) the Integrated nutrient management in Kiran variety of Kalanamak rice with 11 fertility management practices, The treatments were laid down by the treatments were laid out in a Randomized Block Design and replicated thrice. The treatments were: T_1- Control, T_2 - 100% RDF (N:P: K) : (120:60:60) kg T_3 - 100%RDF + 5 ton ha^{-1} FYM, T_4 - 75% RDF + 5 ton ha^{-1} FYM, T_6- 100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) T_7- 75% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) T_8- 50% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) T_9- 100% RDF + 5 ton ha-1 FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}) T_{10}- 75 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}) T_{11}- 50 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}). The recommended dose of fertilizer (RDF) i.e., 120:60:60 kg NPK ha^{-1} was applied to the Kalanamak rice crop. All treatments, including FYM, poultry manure, and neem cake, were randomly assigned to the plots and uniformly incorporated into the soil 15 days before transplanting the rice seedlings to a depth of 10 cm, followed by submergence. One-third of the nitrogen dose (via urea), along with the full doses of phosphorus and potash, was applied as a basal treatment before puddling and incorporated to a depth of 15 cm in the soil. The remaining nitrogen was applied as a top-dressing using urea in two split doses, at the tillering and panicle initiation stages. The rice variety used for the trial was Kiran with a spacing of 20 × 10 cm, and the crop was harvested manually from each plot after the grains had reached physiological maturity. Harvesting was done using serrated-edge sickles when approximately 85% of the panicles had about 85% ripened spikelets, and the upper portion of the spikelet's had turned a straw colour.

Result and Discussion

Yield attributes and yield

Effective tillers (m^{-2}): The findings of this study are presented in Table 1 and the phrase "the number of effective tillers at the harvest stage" specifically denotes the tillers that successfully bear grains. As the crop reaches maturity, some tillers perish and fail to produce any grain. the number of effective tillers ranged from 214.47 to 498.24 in the first year and from 227.84 to 526.26 in the second year of the experiment. The highest number of effective tillers, 498.24 in the first year and 526.26 in the second year, was recorded in treatment T_9 [100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})], which was significantly higher than all other treatments. The results showed that applying a combination of 100% RDF, FYM, zinc and BGA resulted in about highest the number of tillers per plant compared to other treatments. In both years, the treatment with 100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}) was the most effective, followed closely by the treatment with 75 % RDF + 5 ton ha-1 FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}).

Unproductive tillers (m^{-2}): The phrase "number of unproductive tillers" specifically refers to tillers that do not produce grain at the harvest stage. During the maturation phase, some tillers die and do not yield any grain. the number of unproductive tillers ranged from 126.66 m^{-2} to 165.33 m^{-2} in the first year and from 123.53 m^{-2} to 162.16 m^{-2} in the second year. The highest number of unproductive tillers, 165.33 m^{-2} in the first year and 162.16 m^{-2} in the second year was observed in treatment T_1 [Control], and the lowest number of unproductive tillers, 126.66 m^{-2} in the first year and 123.53 m^{-2} in the second year was recorded in treatment T_9 which was significantly lower compared to all other treatments. The application of 100% RDF + 5 tons per hectare FYM + Zn (5 kg per hectare) + BGA (10 kg per hectare) demonstrated the highest level of effectiveness in both years. This was closely followed by the treatment comprising 75% RDF + 5 tons per hectare FYM + Zn (5 kg per hectare) + BGA (10 kg per hectare).

Table 1 : Effect of Integrated nutrient management on effective tillers and unproductive tillers

Treatment Symbol	Treatment Combination	Effective tillers			Unproductive tillers		
		2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T1	Control	214.47	227.84	221.15	165.33	162.16	163.74
T2	100% RDF	277.24	292.27	284.75	152.66	147.53	150.09
T3	100%RDF + 5 ton ha^{-1} FYM	359.80	395.64	377.72	140.00	139.26	139.63
T4	75% RDF + 5 ton ha^{-1} FYM	331.37	358.30	344.83	143.53	141.50	142.51
T5	50% RDF + 5 ton ha^{-1} FYM	303.74	320.64	312.19	146.263	144.36	145.310
T6	100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	426.47	462.74	444.60	133.33	132.15	132.74
T7	75% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	404.84	435.66	420.25	135.16	134.33	134.74
T8	50% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	388.40	422.97	405.68	137.50	136.83	137.16
T9	100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	498.24	526.26	512.25	126.66	123.53	125.09
T10	75 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	471.67	509.14	490.40	128.33	125.66	126.99
T11	50 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	454.00	485.84	469.92	131.00	129.15	130.08
	S.E. (m) (±)	7.145	6.417	3.626	2.145	1.786	1.503
	C.D. (p = 0.05)	21.227	19.064	10.773	6.371	5.304	4.465

Number of filled grain and unfilled grain:

The findings of this study are presented in Table 2 and the terms "number of filled grains" and "number of unfilled grains" specifically refer to a panicle where some grains are fully developed, while others remain unfilled. The number of filled grains ranged from 88.0 to 140.83 in the first year and from 94.49 to 147.50 in the second year of the experiment. The number of unfilled grains ranged from 16.50 to 33.66 in the first year and from 13.66 to 31.50 in the second year. Treatment T_9 [100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})] recorded the highest number of filled grains (140.83 and 147.50) in the first and second years, respectively, and the lowest number of unfilled grains (16.50 and 13.66) during the same years. The results indicated that the application of a combination of 100% RDF, FYM, zinc, and BGA led to the highest number of filled grains per panicle. The highest number of unfilled grains was observed in the control treatment, likely due to the lack of nutrient availability during the grain-filling stage, which adversely affected plant physiology. The data on filled and unfilled grains align with the findings of Deshpande and Devsenapathy (2011).

Test Weight (gm)

The findings of this study are presented in Table 2 and Test weight is a unit of measurement used to assess the plumpness or weight of grain. This trait is considered a contributor to yield, as larger seeds are associated with increased seed weight, ultimately leading to a higher overall yield. The test weight ranges between 10.36 g to 15.25 g during first year and 10.99 g to 15.80 g during the second year of the experiment. The application Treatment T_9- consisting of 100% RDF + 5 ton ha-1 FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}) showed the highest effectiveness. The minimum test weight i.e. 10.36 g during the first year and 10.99 g during second year were recorded in the control treatment followed by the (10.99 g and 11.72 g) test weights during both years in the treatment T_2. The test weight results were consistent with the findings of Awang *et al.* (2016).

Table 2 : Effect of Integrated Nutrient Management on Grains per Panicle and Test Weight (gm)

Treatment	Number of filled grain			Number of unfilled grain			Test Weight (gm)		
	2021-2022	2022-2023	Pooled	2021-2022	2022-2023	Pooled	2021-2022	2022-2023	Pooled
T1	88.00	94.49	91.25	33.66	31.50	32.58	10.36	10.99	10.68
T2	91.17	97.33	94.25	32.33	30.50	31.42	10.99	11.72	11.35
T3	103.17	111.17	107.17	29.33	25.66	27.50	12.15	13.40	12.78
T4	98.66	105.63	102.15	30.5	27.53	29.02	11.88	13.00	12.44
T5	95.84	102.50	99.17	31.16	28.50	29.83	11.40	12.84	12.12
T6	120.67	128.84	124.76	24.33	20.16	22.25	14.62	14.90	14.76
T7	115.66	123.13	119.40	25	21.53	23.27	14.22	14.55	14.38
T8	110.00	117.83	113.92	26.83	22.83	24.83	13.82	14.10	13.96
T9	140.83	147.50	144.17	16.5	13.66	15.08	15.25	15.80	15.52
T10	137.00	142.99	140.00	17.66	15.50	16.58	15.10	15.45	15.27
T11	129.50	136.13	132.82	20.33	17.53	18.93	14.96	15.14	15.05
SE(m) ±	1.75	1.84	1.33	0.39	0.23	0.23	0.227	0.214	0.139
C.D. at (p=0.05)	**5.15**	**5.44**	**3.91**	**1.16**	**0.67**	**0.69**	0.675	0.635	0.413

Grain yield (q/ha)

The findings of this study are presented in Table 3 and Fig. 1, the grain yield ranged from 14.23 to 28.40 q ha^{-1} in the first year and from 15.39 to 29.28 q ha^{-1} in the second year of the experiment. The highest grain yields, 28.40 q ha^{-1} and 29.28 q ha^{-1}, were achieved with treatment T_9 [100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})] in both years, respectively, which were comparable to all other treatments. Grain yield increases due to the presence of certain yield-boosting traits, such as longer panicle length (measured in centimetres). The lowest grain yields were observed in the control treatment, with 14.23 q ha^{-1} in the first year and 15.39 q ha^{-1} in the second year, The current results are consistent with those reported by Kumar *et al.* (2007), Bhowmick *et al.* (2011), Sangeeta *et al.* (2013), and Sharma *et al.* (2014).

Straw yield (q/ha)

The straw yield ranged from 33.32 to 52.50 q ha^{-1} in the first year and from 35.17 to 54.12 q ha^{-1} in the second year of the study. The highest straw yields, 52.50 q ha^{-1} in the first year and 54.12 q ha^{-1} in the second year, were recorded in treatment T_9 [100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})], which was significantly higher than all other treatments. The availability of nutrients during the growth stage, which supports better plant development such as increased plant height, number of tillers, leaf area index, and dry matter accumulation, has resulted in higher straw production. The lowest straw yields were observed in the control treatment T_1, with 33.32 q ha^{-1} in the first year and 35.17 q ha^{-1} in the second year. The current results are consistent with the findings of Sharma *et al.* (2014) and Thulasi *et al.* (2016).

Table 3 : Effect of Integrated Nutrient Management on Grain Yield (q/ha) and Straw Yield (q/ha)

Treatment Symbol	Treatment Combination	Grain yield (q/ha)			Straw yield (q/ha)		
		2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T1	Control	14.23	15.39	14.81	33.32	35.17	34.25
T2	100% RDF	17.33	18.27	17.80	35.47	37.80	36.63
T3	100%RDF + 5 ton ha^{-1} FYM	22.08	22.78	22.43	41.49	43.20	42.35
T4	75% RDF + 5 ton ha^{-1} FYM	20.82	21.00	20.91	39.86	41.53	40.69
T5	50% RDF + 5 ton ha^{-1} FYM	19.36	20.15	19.75	37.67	39.20	38.43
T6	100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	25.00	26.06	25.53	47.33	49.47	48.40
T7	75% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	24.30	25.29	24.79	45.19	47.45	46.32
T8	50% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	23.17	24.60	23.88	43.61	45.59	44.60
T9	100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	28.40	29.28	28.84	52.50	54.12	53.31
T10	75 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	27.18	28.50	27.84	50.28	52.27	51.28
T11	50 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	26.32	27.44	26.88	48.33	50.30	49.31
	S.E. (m) (±)	0.327	0.409	0.240	0.571	0.583	0.409
	C.D. (p = 0.05)	0.971	1.215	0.714	1.697	1.732	1.214

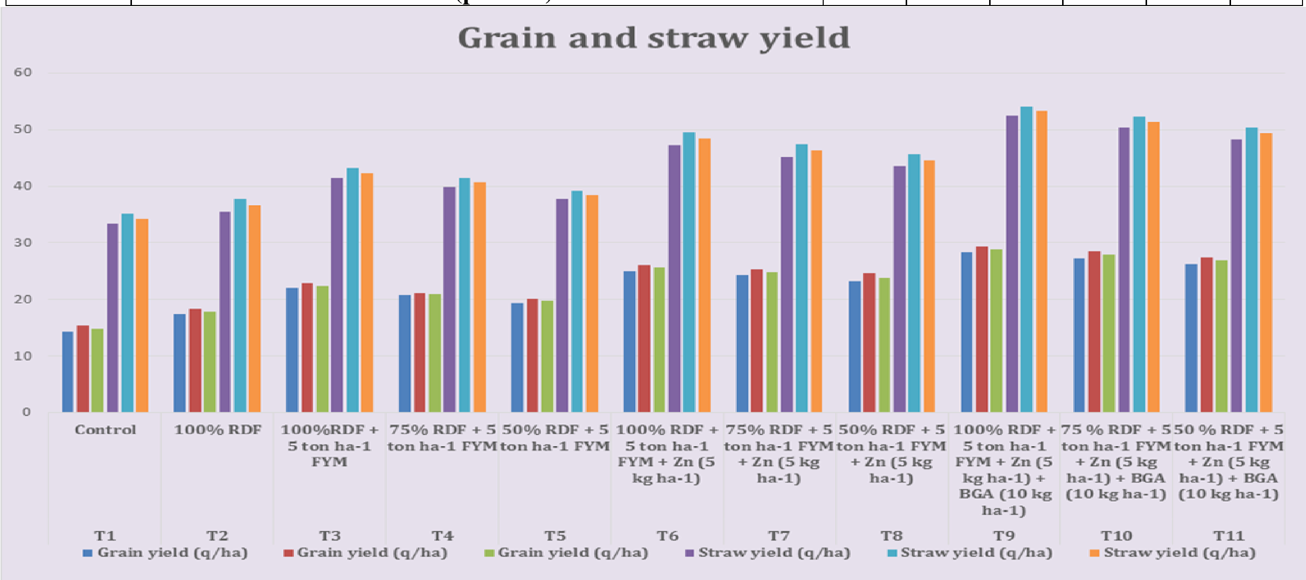

Fig. 1 : Effect of Integrated Nutrient Management on grain yield (q ha^{-1}) and straw yield (q ha^{-1})

Biological yield (q/ha)

The findings of this study are presented in Table 4 and the biological yield ranged from 47.57 to 80.90 q ha^{-1} in the first year and from 50.56 to 83.39 q ha^{-1} in the second year of the study. The highest biological yields were observed in treatment T_9 [100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})], with 80.90 q ha^{-1} in the first year and 83.39 q ha^{-1} in the second year, which were significantly higher than all other treatments. The lowest biological yields were recorded in the control treatment T_1, with 47.57 q ha^{-1} in the first year and 50.56 q ha^{-1} in the second year.

Harvest Index

The harvest index is a reliable indicator of the ratio between the grain yield (sink) and the total biological yield (source). The current study found that the harvest index ranged from 30.18 to 35.28 when data from both years were analyzed together. The harvest index of Kalanamak rice did not show significant differences among treatments. For treatment T_9 [100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})], the harvest index was 35.10 in both years of the experiment. In contrast, the control treatment recorded a harvest index of 29.93 in the first year and 30.44 in the second year.

Table 4 : Effect of Integrated nutrient management on Biological yield (q/ha) and Harvest Index

Treatment Symbol	Treatment Combination	Biological yield (q/ha)			Harvest Index		
		2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T1	Control	47.57	50.56	49.06	29.93	30.44	30.18
T2	100% RDF	52.80	56.07	54.43	32.82	32.58	32.70
T3	100%RDF + 5 ton ha^{-1} FYM	63.57	65.98	64.78	34.73	34.52	34.62
T4	75% RDF + 5 ton ha^{-1} FYM	60.68	62.52	61.60	34.31	33.58	33.94
T5	50% RDF + 5 ton ha^{-1} FYM	57.03	59.34	58.19	33.94	33.95	33.95
T6	100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	72.33	75.53	73.93	34.56	34.50	34.53
T7	75% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	69.49	72.74	71.12	34.97	34.76	34.86
T8	50% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1})	66.77	70.20	68.49	34.69	35.04	34.87
T9	100% RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	80.90	83.39	82.15	35.10	35.10	35.10
T10	75 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	77.45	80.78	79.12	35.09	35.28	35.18
T11	50 % RDF + 5 ton ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1})	74.65	77.75	76.20	35.25	35.30	35.28
	S.E. (m) (±)	1.093	1.230	0.934	0.466	0.533	0.332
	C.D. (p = 0.05)	3.246	3.654	2.774	1.385	1.583	0.986

Summary and Conclusion

The treatment T_9 with 100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}) showed the highest values for yield-contributing characteristics, including the number of effective tillers, unproductive tillers, filled and unfilled grains, and test weight. The highest grain yields (28.40 q ha^{-1} and 29.28 q ha^{-1}) and straw yields (52.50 q ha^{-1} and 54.12 q ha^{-1}) were recorded in the first and second years, respectively. The treatment that achieved these top yields was 100% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}), making it the most effective treatment. The next best treatment was 75% RDF + 5 tons ha^{-1} FYM + Zn (5 kg ha^{-1}) + BGA (10 kg ha^{-1}).

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Conflict of interest: None

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