



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating: 5.20
www.agronomyjournals.com
2025; 8(7): 209-212
Received: 21-05-2025
Accepted: 23-06-2025

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Effect of integrated nutrient management practices on growth of rice (*Oryza sativa* L.)

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DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i7c.3203>

Abstract

A field experiment was conducted during *Kharif* season of 2024 at Agronomy Research Farm of Rama University (U.P.) to assess the effect of integrated nutrient management practices on growth, yield and soil fertility in rice (*Oryza sativa* L.) Experiment was conducted with 11 treatments Randomized Block Design with three replications was used. The results revealed that all the growth parameters were significantly influenced due to different treatments. Application of 100% RDF through (IF) + 25% RDN through Neem Cake significantly increased the growth parameters, of rice.

Keywords: Integrated nutrient management, INM, rice

Introduction

With a chromosome number of $2n = 24$, rice (*Oryza sativa* L.) is a member of the genus *Oryza* and the poaceae family. It is among the world's most significant and reliable food crops. A crop of the moist tropical environment, rice is also produced in humid subtropical areas. It is a self-pollinating crop, or C3. With 75% carbohydrate, 6-7 percent protein (in white rice and 7-9 percent in brown rice), 2-2.5 percent fat, 0.8% cellulose, and 5-9% ash, it is a high-calorie meal. In addition to being a great source of carbohydrates, rice also contributes somewhat to the daily human diet in the form of protein. In addition, rice is important for industry and commerce in addition to grains. Rice hulls and straw are used for packaging, mulching, feed, insulation, and other purposes. More than half of the world's population depends on rice as their primary food supply, particularly in southeast Asia, where 90% of the world's rice output is cultivated and consumed. Since rice is essential to our country's food security, the motto "Rice is Life" is ideal. From below sea level (Kerala) to roughly 200 meters above sea level (Himalayan region), from 80° latitude (Kanyakumari) to 350° latitude (Kashmir), and with annual rainfall ranging from 1250 mm (Assam) to 250 mm (Rajasthan), rice is grown in a variety of soil types, including sandy loams, heavy black cotton soils, normal to saline alkaline soils, and more.

Around 158.80 million hectares of rice are grown globally, with an average yield of 4.20 tonnes per hectare and an annual production of roughly 700.00 million tons (Anonymous, 2024) ^[1]. Of all the food crops grown worldwide, rice is produced in India with pride. India is the country with the largest area and the second-highest output, behind China. With an average yield of 2578 kg/ha and a production of 115.60 million tons, it is cultivated on 43.79 million hectares in India. Punjab has the greatest productivity, West Bengal is the state that produces the most, and Uttar Pradesh has the largest area under rice cultivation. With a yield of 13.27 million tons and a productivity of 2230 kg ha⁻¹, rice is cultivated on 5.95 million hectares in Uttar Pradesh. (Anonymus, 2024) ^[1]. A key factor in maintaining rice output and productivity is integrated nutrient management (INM), which increases the effectiveness of applied nutrients. In order to preserve crop production sustainability and meet the growing need for rice grain production, an integration of organic and inorganic fertilizers must be used (Datta and Singh, 2010) ^[4]. The flexible integrated nutrient management strategy maximizes usage efficiency and improves soil health while using fewer chemicals. The greatest way to fulfill the growing population's demands is through integrated nutrition management. By controlling the fertilizer delivery and

reducing nutrient losses to the environment, INM has been demonstrated to significantly increase rice yields and achieve high nutrient use efficiency (Parkinson *et al.*, 2013)^[8] Das *et al.* (2024)^[5].

In the majority of nations worldwide, farm yard manure, or FYM, is the most often utilized organic manure. Applying farm yard manure increases soil structure, nitrogen exchange, and soil health, making it ideal for organic or INM farming. FYM is a diverse composted organic material that includes household sweeping, agricultural residue, and manure at different stages of decomposition. It also affected the soil's remaining potassium and phosphorus. With 0.5% nitrogen, 0.2% phosphorus, and 0.5% potassium, FYM is nutrient-dense. Applying FYM enhances the physical characteristics of the soil, such as its structure, aeration, and water-holding capacity, as well as its fertility. Poultry manure, which is the urine of poultry, includes 0.8% potassium, 0.5% phosphorus, and 0.9% to 1.5% nitrogen. It has the most N, P, and K of any animal dung. Chicken excrement, or poultry dung, is utilized as an organic fertilizer, particularly for soil that lacks nitrogen. Every month, one chicken generates around 8-11 pounds of excrement. The by-product of the solvent extraction procedure for neem oil cake and the cold pressing of neem tree fruits and kernels is neem cake organic manure. In addition to being high in plant nutrients, it also includes alkaloids like Nimbodin and Nimbin, which have the ability to prevent nitrification and release nitrogen gradually. In addition to other micronutrients including nitrogen (2.0% to 5.0%), phosphorus (0.5% to 1.0%), and potassium (1.0% to 2.0%), it provides 100% natural NPK in organic form. The cake is also high in liminoids and sulfur compounds. Neem cake is a preferred input due to its dual use as manure and a biopesticide. It supplies the macronutrients needed for all plant growth, aids in boosting plant production over time, is biodegradable, environmentally benign, and a great soil conditioner. Therefore, for long-term production and improved usage in organic rice cultivation, the use of organic sources such as FYM, chicken manure, and neem cake should be prioritized. The goal of integrated nutrient management (INM) is to employ all of the main plant nutrient sources wisely and effectively in a coordinated way (Farouque & Takeya, 2007)^[6].

Methods and Materials

A field experiment was conducted during kharif season of 2024-25 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Effect of Integrated nutrient management practices on growth and yield of rice (*Oryza sativa* L.) crop. The soil was normal in pH of 7.65, electrical conductivity (EC) of 0.27 dSm⁻¹, organic carbon content of 0.41%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 217.0, 19.5, and 149.50 kg ha⁻¹, respectively. Experiment was conducted with 11 treatments viz., T1- 100% RDF (Inorganic fertilizer) (150N + 60P2O5 + 40K2O Kg/ha.) + 25 kg/ha ZnSO4, T2- 50% RDF through (IF)+ 50% RDN through FYM, T3- 50% RDF through (IF) + 50% RDN through Poultry Manure, T4- 50% RDF through (IF) + 50% RDN through Neem Cakes, T5- 75% RDF through (IF) + 25% RDN through FYM, T6- 75% RDF through (IF) + 25% RDN through Poultry Manure, T7- 75% RDF through (IF) + 25% RDN through Neem Cakes, T8- 100% RDF through (IF) + 25% RDN through FYM, T9- 100% RDF through (IF) + 25% RDN through Poultry Manure, T10- 100% RDF through (IF) + 25% RDN through Neem Cakes, T11- 100% RDF through FYM (Organic source).

Randomized Block Design with three replications was used. data were gathered on five plants chosen from each plot.

Results

Growth Characters

1. Plant height (cm)

The results clearly show that differing INM techniques had no discernible impact on plant height at 30 DAT, but that they had a considerable impact at the remaining stages. The results show that T₁₀ (100% RDF through (IF) + 25% RDN through Neem Cakes) at 60 DAT had higher plant height, which was significant over the other treatments but comparable to T₉ (100% RDF through (IF) + 25% RDN through Poultry Manure), T₈ (100% RDF through (IF) + 25% RDN through FYM), and T₁ (100% RDF (inorganic fertilizer) (150 N + 60 P2O5 + 40 K2O Kg/ha.) + 25 Kg/ha. ZnSO4). T₉ (100% RDF via (IF) + 25% RDN through Neem Cakes) and T₁₀ (100% RDF through (IF) + 25% RDN through) both had greater plant counts at 90 DAT. T₁ (100% RDF (inorganic fertilizer) (150N + 60P2O5 + 40K2O Kg/ha.) + 25 Kg/ha. ZnSO4), T₈ (100% RDF via (IF) + 25% RDN through FYM), and T₇ (75% RDF through (IF) + 25% RDN through Neem Cakes) were significant in comparison to the other treatments. T₁₁ had the lowest plant height (98.36 cm) and the highest (119.82 cm) at harvest. Similar result reported by Awang *et al.* (2016) & Babu *et al.* (2017)^[2].

2. Number of tillers(m⁻²)

In Table 2 shows that with the exception of 30 DAT, it is obvious that all treatments had a considerable impact on the number of tillers m⁻² at all growth phases. The number of tillers rose as the crop became older, but around 30 DAT, the pace of growth halted. It makes it abundantly evident that the rice great growth phase occurs between 30 and 60 DAT. The treatment T₁₀ (100% RDF through (IF) + 25% RDN through Neem Cakes) produced a higher number of tillers m⁻² than the other treatments. This was significant at the 60 DAT, 90 DAT, and harvest stages, and it was comparable to treatment T₉ (100% RDF through (IF) + 25% RDN through Poultry Manure). Treatment T₁₀ (100% RDF through (IF) + 25% RDN through Neem Cakes) had the most tillers m⁻² (457.83 m⁻²), whereas treatment T₁₁ (100% RDF through FYM (Organic source)) had the fewest (254.12 m⁻²). Similar result reported by Choudhary *et al.* (2009)^[3] & Devi *et al.* (2012)^[11] Sharma *et al.* (2021)^[10].

3. Dry matter accumulation (gm⁻²)

With the exception of the 30 DAT stage, all treatments resulted in a marked increase in dry matter buildup. Higher dry matter accumulation was observed by T₁₀ (100% RDF via (IF) + 25% RDN through Neem Cakes) at 60 DAT, which was significant above the other treatments but comparable to T₉ (100% RDF through (IF) + 25% RDN through Poultry Manure) and T₈ (100% RDF through (IF) + 25% RDN through FYM). Treatment T₁₀ (100% RDF via (IF) + 25% RDN through Neem Cakes) provided the highest dry matter accumulation, outperforming all other treatments by a large margin. At 90 DAT and harvest stage, treatment T₉ (100% RDF through (IF) + 25% RDN through Poultry Manure) was comparable. T₁₀ (100% RDF via (IF) + 25% RDN through Neem Cakes) had the highest dry matter accumulation (996.50 gm⁻²) at harvest, followed by T₉ (100% RDF through (IF) + 25% RDN through Poultry Manure) (947.86 gm⁻²) and T₈ (100% RDF through (IF) + 25% RDN through FYM) (898.72 gm⁻²). Similar result reported by Khan *et al.* (2019) & Kumar *et al.* (2018)^[7], Sanjay *et al.* (2014)^[9].

Table 1: Effect of integrated nutrient management on plant height (cm) at various growth stages of rice

Treatments		Plant height (cm)			
		30 DAT	60 DAT	90 DAT	At harvest
T1	100%RDF(inorganicfertilizer) (150N + 60P2O5 + 40K2OKg/ha.)+25Kg/ha.ZnSO4	51.90	97.45	114.10	114.25
T2	50%RDFthrough (IF) +50% RDNthroughFYM	48.58	88.73	100.91	101.02
T3	50%RDFthrough (IF)+ 50% RDNthrough PoultryManure	49.13	90.04	102.46	102.95
T4	50%RDFthrough(IF)+50% RDN through Neem Cakes	49.70	91.65	104.65	104.85
T5	75%RDFthrough(IF)+25% RDN through FYM	50.23	92.75	107.45	107.71
T6	75%RDFthrough(IF)+25% RDNthrough PoultryManure	50.81	95.01	109.92	110.01
T7	75%RDFthrough (IF)+ 25% RDNthroughNeemCakes	51.34	95.95	111.87	112.00
T8	100%RDFthrough (IF) +25% RDNthroughFYM	52.51	101.05	115.42	115.51
T9	100%RDFthrough(IF)+25% RDN through Poultry Manure	53.04	101.88	117.12	117.44
T10	100%RDFthrough (IF) +25% RDNthroughNeemCakes	53.61	103.67	119.63	119.82
T11	100%RDFthroughFYM (Organicsource)	48.00	85.97	98.10	98.36
SEm±		1.28	2.40	2.75	2.76
C.D. (5%)		NS	7.14	8.19	8.21

Table 2: Effect of integrated nutrient management on numbers of tillers (m⁻²) at various growth stages of rice

Treatments		Numbers of tillers (m ⁻²)			
		30 DAT	60 DAT	90 DAT	At harvest
T1	100%RDF(inorganicfertilizer) (150N + 60P2O5 + 40K2OKg/ha.)+25Kg/ha.ZnSO4	189.67	365.07	399.97	370.12
T2	50%RDFthrough (IF) +50% RDNthroughFYM	176.42	264.74	276.72	261.02
T3	50%RDFthrough (IF)+ 50% RDNthrough PoultryManure	178.75	279.01	296.21	277.45
T4	50%RDFthrough (IF)+ 50% RDNthroughNeemCakes	181.13	296.63	316.51	294.84
T5	75%RDFthrough (IF)+ 25% RDNthroughFYM	183.60	315.80	340.11	317.61
T6	75%RDFthrough (IF)+25% RDNthrough PoultryManure	186.06	331.18	359.18	333.51
T7	75%RDFthrough (IF)+ 25% RDNthroughNeemCakes	188.52	345.35	376.01	350.26
T8	100%RDFthrough (IF) +25% RDNthroughFYM	190.90	383.87	421.32	391.80
T9	100%RDFthrough(IF)+25% RDN through Poultry Manure	192.10	400.64	439.74	411.16
T10	100%RDFthrough(IF)+25% RDN through Neem Cakes	194.11	416.51	457.83	430.47
T11	100%RDFthroughFYM (Organic source)	173.90	249.44	254.12	238.90
SEm±		4.69	8.32	8.98	8.38
C.D. (5%)		NS	24.72	26.69	24.92

Table 3: Effect of integrated nutrient management on dry matter accumulation (g m⁻²) at various growth stages of rice

Treatments		Dry matter accumulation (gm ⁻²)			
		30 DAT	60 DAT	90 DAT	At harvest
T1	100% RDF (inorganic fertilizer)(150N +60P2O5+40K2OKg/ha.)+25Kg/ha. ZnSO4	234.10	365.80	618.97	843.15
T2	50%RDFthrough (IF) +50% RDNthroughFYM	220.17	301.06	402.36	542.38
T3	50%RDFthrough (IF)+ 50% RDNthrough PoultryManure	222.72	312.83	437.58	593.54
T4	50%RDFthrough (IF)+ 50% RDNthroughNeemCakes	224.81	320.46	473.27	643.33
T5	75%RDFthrough (IF)+ 25% RDNthroughFYM	226.09	328.20	515.22	696.21
T6	75%RDFthrough (IF)+ 25% RDNthrough PoultryManure	228.93	340.03	546.86	741.43
T7	75%RDFthrough (IF)+ 25% RDNthroughNeemCakes	231.77	352.78	581.24	793.03
T8	100%RDFthrough (IF) +25% RDNthroughFYM	235.10	379.61	656.11	898.72
T9	100%RDFthrough(IF)+25% RDN through Poultry Manure	238.85	392.18	689.62	947.85
T10	100%RDFthrough(IF)+25% RDN through Neem Cakes	240.43	404.76	721.74	996.50
T11	100%RDFthroughFYM (Organic source)	218.75	293.87	370.26	492.83
SEm±		5.81	8.68	13.71	18.69
C.D. (5%)		NS	25.78	40.75	55.54

Conclusion

The study revealed that different Integrated Nutrient Management (INM) practices significantly influenced plant height, tiller number, and dry matter accumulation beyond 30 DAT. Treatment T10 (100% RDF through inorganic fertilizer + 25% RDN through neem cake) consistently outperformed other treatments, recording the highest plant height, tillers m⁻², and dry matter accumulation, particularly at 60, 90 DAT, and harvest. It was statistically at par with T9 (RDF + poultry manure) and T8 (RDF + FYM). Minimal performance was observed with T11 (100% RDF through FYM). These results underscore the effectiveness of combining inorganic fertilizers with organic sources like neem cake in enhancing rice growth.

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