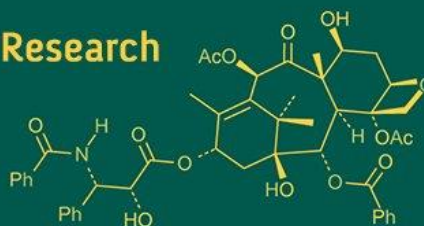


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## Nutrient management strategies in transplanted rice (*Oryza sativa* L.) for optimal growth and yield

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### Abstract

The experiment was laid out during *Kharif*-2017 at Genetics & Plant Breeding Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya, Uttar Pradesh, India. The study was laid out in a Randomized Block Design (RBD) with three replications. The experiment comprised eight treatments, integrating different combinations of organic and inorganic fertilizers. Among the integrated nutrient management practices under different treatments T<sub>1</sub>: Control, T<sub>2</sub>: 100% RDF (120 kg N:60 kg P<sub>2</sub>O<sub>5</sub>:40 kg K<sub>2</sub>O), T<sub>3</sub>: 75% RDF +25% N substitution through pressmud, T<sub>4</sub>: 75% RDF+ 25% N substitution through green manure (Dhaincha), T<sub>5</sub>: 75% RDF +25% N substitution through crop residue, T<sub>6</sub>: 50% RDF +50% N substitution through pressmud, T<sub>7</sub>: 50% RDF + 50% N substitution through green manure Dhaincha, T<sub>8</sub>: 50% RDF +50% N substitution through crop residue. The results observed that T<sub>2</sub>: 100% RDF (120 kg N:60 kg P<sub>2</sub>O<sub>5</sub>:40 kg K<sub>2</sub>O) the highest plant height, total number of tiller m<sup>-2</sup>, leaf area index, panicles m<sup>-2</sup>, panicle length (cm), number of grains panicle<sup>-1</sup>, test weight (g), grain yield (kg ha<sup>-1</sup>), straw yield (kg ha<sup>-1</sup>) and harvest index (%).

**Keywords:** RDF, Dhaincha, Pressmud, rice, growth, yield

### Introduction

Rice (*Oryza sativa* L.) is a staple food crop in south, south-east and East Asia where about 90% of world rice is grown and consumed. Rice supplies 20% and 31% of the total calories required by world and Indian population, respectively (Rijal & Yuvraj Devkota, 2020) [8]. Rice is the bulk of food security of the global population. In the 21<sup>st</sup> century there will be the need of about 250 million tons of food grains to feed the rapidly increasing population. Rice is a crop that significantly depletes soil nutrients, leading to substantial nutrient deficits. To address this challenge and maintain soil fertility, it is essential to integrate both organic and inorganic nutrient sources. This approach not only supports sustainable production but also promotes higher crop yields (Shankar *et al.*, 2020) [6]. Integrated nutrient management (INM), which combines organic and inorganic nutrient sources, plays a crucial role in rice production. A significant factor contributing to declining productivity is the improper and inefficient use of nutrients, leading to imbalances where some nutrients are in excess while others are depleted. Adopting INM practices enables farmers to enhance agricultural productivity while protecting the environment through the efficient use of fertilizers (Chaurasiya *et al.*, 2025) [1]. Rice crops require significant amounts of mineral nutrients, particularly nitrogen, for growth and grain production. For every tone of harvested grain, approximately 10-31 kg N, 1-5 kg P, 8-35 kg K and 1-3 kg S ha<sup>-1</sup> are removed from the soil. Recently, Indian farmers have increasingly used nitrogenous fertilizers to maximize yields. However, excessive nitrogen without balanced phosphorus and potassium can negatively impact soil health. Phosphorus supports root development and cell division, while potassium aids enzymatic functions and stress resistance, both enhancing nitrogen uptake efficiency. Recycling crop residues before transplanting rice is an effective strategy for improving productivity, nutrient use efficiency, and sustainability. Integrating inorganic fertilizers with or without crop residue incorporation enhances nutrient use and the productivity of rice-based systems (Chaudhary *et al.*, 2020) [2]. *Sesbania rostrata* (Dhaincha) is used as a green manure crop before the rainy rice season, broadcasted in mid-May and incorporated into the soil after 45-50 days. Rice is transplanted 2-3 days later.

The organic matter and nitrogen from *Sesbania rostrata* (Dhaincha) improve soil health and boost crop growth, producing up to 80-100 kg N ha<sup>-1</sup>. Decomposition takes 30-50 days under favorable moisture conditions. Pressmud, containing about 70% organic matter and 29% minerals, is a valuable organic manure and effective soil ameliorant, providing essential plant nutrients in organic form (Ramaswami, 1999) [7].

Hence, considering the economy, environment friendliness and maintaining better soil health, it is imperative that plant nutrients are to be used effectively by adopting the integrated nutrient management practices.

### Experimental site & Materials

The experiment was laid out during *Kharif*-2017 at Genetics

& Plant Breeding Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya, Uttar Pradesh, India. The field was well leveled having good soil conditions. Geographically, Ayodhya (Kumarganj) falls in subtropical climate and is situated at 26°47' North latitudes, 82°12' East longitudes with an altitude of 113 meters above mean sea level. The experimental site is situated in the main campus of the university on the left side of Ayodhya-Raebareilly road at a distance of 42 km from Ayodhya district headquarter.

### Experimental design and crop management:

The experiment was laid out in Randomized Block Design (RBD) with 8 treatments replicated thrice. It is illustrated in table 1.

**Table 1:** Treatment details with their symbol.

S. No.	Treatments	Symbols
1.	Control	T <sub>1</sub>
2.	100% RDF (120 kg N:60 kg P <sub>2</sub> O <sub>5</sub> :40 kg K <sub>2</sub> O)	T <sub>2</sub>
3.	75% RDF +25% N substitution through pressmud	T <sub>3</sub>
4.	75% RDF +25% N substitution through green manure (Dhaincha)	T <sub>4</sub>
5.	75% RDF +25% N substitution through crop residue	T <sub>5</sub>
6.	50% RDF +50% N substitution through pressmud	T <sub>6</sub>
7.	50% RDF +50% N substitution through green manure (Dhaincha)	T <sub>7</sub>
8.	50% RDF +50% N substitution through crop residue	T <sub>8</sub>

The crop was harvested manually by serrated edged sickles at physiological maturity when panicles had about 85% ripened spikelet's and the upper portion of spikelet looked straw colored. At the time of harvesting the grains were subjected to hard enough, having less than 16% moisture in the grains.

### Statistical analysis

A two-way analysis of variance (ANOVA) was conducted at a significance level of 5% to investigate the different INM practices in Rice crops. The significance of the difference between treatment means was assessed using an 'F' test. The critical difference (CD) was calculated when the 'F' value indicated a significant treatment impact.

## Results and Discussion

### Growth parameters

The observation of plant height, number of tillers hill<sup>-1</sup> and leaf area index at 30, 60, 90 days after transplanting (DAT) and at harvest stage, were statistically analyzed and are presented in Table 2. Nutrient management significantly influenced the growth characteristics of rice. There was progressive increase in plant height with an increase in age of crop up to 90 DAT and slowed down thereafter indicating that the grand growth period lies between 30-90 DAT. Scanning of Table 2 clearly reveals that there was a linear increase in plant height of rice, due to different nutrient management treatments. The effect of various nutrient management treatments on plant height was found significantly superior to control at all the growth stages except 30 DAT during the course of investigation. Treatment T<sub>2</sub> (100% RDF 120:60:40) produced significantly taller plants which was at par with 75% RDF + 25% N through Dhaincha/Press mud/crop residue and 50% RDF + 50% N through Dhaincha/Pressmud/Crop residue at 60 DAT, 90 DAT and at harvest stage. However, the maximum plant height was noted with the T<sub>2</sub> (100% RDF 120:60:40)

and minimum under control, respectively. The results align with the findings of Shankar *et al.*, (2014) [10]. It clearly reveals that the number of tillers m<sup>-2</sup> was influenced significantly by all treatments at all growth stages except 30 DAT. Number of tillers increased with increase in age of crop and rate of increase was slowed down after 60 DAT. It clearly indicates that the grand growth period lies between 30 and 60 DAT in rice. Further, scrutiny of Table 2 indicates that there was significant increase in the number of tillers m<sup>-2</sup> in T<sub>2</sub> (100% RDF 120:60:40) either fertilizer alone or combination with organic sources T<sub>4</sub> and T<sub>7</sub>. Maximum number of tillers m<sup>-2</sup> recorded with T<sub>2</sub> (100% RDF 120:60:40) which was significantly superior to all treatment but at par with T<sub>4</sub> (75% RDF +25% N through Dhaincha) and T<sub>7</sub> (50% RDF + 50% N through Dhaincha) at 60 DAT, 90 DAT and at harvest stage. The maximum number of tillers m<sup>-2</sup> was noted with T<sub>2</sub> (431.3) and minimum under control (238.45). Reported increase in the number of tillers in rice plants due to influence of different fertilizers combinations. Higher number of tillers might be due to more availability of nitrogen which plays a vital role in cell division. Organic sources after more balanced nutrition to the plants especially micronutrients which positively affect number in plants (Shrivastava & Singh, 2017) [11].

The LAI increases with increase in the age of the crop up to 90 DAT. The rate of increase was rather slow down during the initial crop growth period *i.e.*, up to 30 DAT and increase up to 90 DAT. It indicates that active lies between 30-90 DAT. There was a significant increase in LAI with 100% RDF and combination of organic with inorganic fertilizer. Further, it was noted that all treatments produced higher LAI over control at all the growth stages. Treatment T<sub>2</sub> (100% RDF 120:60:40) recorded significantly higher LAI over all the treatment but remained at par with T<sub>3</sub>, T<sub>4</sub> and T<sub>7</sub> at 30, 60 and 90 DAT. Maximum LAI (4.55) was noted with T<sub>2</sub> and minimum under T<sub>1</sub> control (3.02). Similar results

reported with application of organic manure alone and in combination with fertilizer. The available nutrients might have helped in enhancing leaf area index; these results are

supported by the findings of Kumar *et al.*, (2012) <sup>[4]</sup> and Sultana *et al.*, (2015) <sup>[12]</sup>.

**Table 2:** Nutrient management strategies in transplanted on rice plant height, total number of tiller m<sup>-2</sup> and leaf area index.

Treatment	Plant height (cm)				Tillers (m <sup>-2</sup> )				Leaf Area Index (LAI)		
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT
T <sub>1</sub> -Control	27.90	66.52	83.40	85.7	171.37	248.36	253.12	238.45	1.08	2.65	3.02
T <sub>2</sub> -100% RDF (120:60:40) NPK	31.68	78.89	108.90	112.4	192.25	415.76	455.36	431.3	1.65	3.48	4.55
T <sub>3</sub> -75% RDF + 25% N through Pressmud	30.22	76.50	104.55	106.6	184.35	374.01	405.52	383.83	1.52	3.24	4.12
T <sub>4</sub> -75% RDF + 25% N through Dhaincha as Green manure	30.67	77.19	105.80	110.7	188.35	410.45	450.61	426.55	1.58	3.39	4.38
T <sub>5</sub> -75% RDF + 25% N through Crop residue (Oat)	29.22	75.73	103.15	104.0	177.68	361.48	390.15	369.55	1.41	3.14	3.91
T <sub>6</sub> -50% RDF + 50% N through Pressmud	30.15	76.39	104.35	105.8	180.68	362.32	392.51	71.78	1.42	3.21	4.08
T <sub>7</sub> -50% RDF + 50% N through Dhaincha as Green manure	30.51	76.94	105.35	108.3	186.35	385.48	421.42	396.9	1.56	3.35	4.28
T <sub>8</sub> -50% RDF + 50% N through Crop residue (Oat)	28.20	73.39	101.35	102.3	178.35	350.84	376.48	356.25	1.38	3.09	3.82
SEm±	1.05	1.59	2.93	3.78	6.57	12.15	14.14	13.98	0.06	0.10	0.14
CD at 5%	NS	4.84	8.89	11.47	NS	36.86	42.88	42.40	0.18	0.32	0.44

### Yield attributing characters

The study examined yield-attributing traits, including the number of panicles, panicle length, grains per panicle, and test weight (Table 3).

Observations to be recorded on T<sub>2</sub> (100% RDF 120:60:40) was the significantly highest number of panicles 345.2 m<sup>-2</sup> which was significantly superior over all the treatments but it remained at par with T<sub>4</sub> and T<sub>7</sub>, respectively. This result is collaborating with the finding of Neti *et al.*, (2022) <sup>[5]</sup>. The maximum number of grain panicle<sup>-1</sup> (156.1) was recorded in T<sub>2</sub> (100% RDF 120:60:40). Further T<sub>2</sub> (100% RDF 120:60:40) was found to be significantly higher over all the treatment but it remained at par with T<sub>3</sub>, T<sub>4</sub> and T<sub>7</sub>, respectively, during the course of investigation. The results align with the findings of previous studies, such as those conducted by Hayat *et al.*, (2019) <sup>[3]</sup>. Though; there was variation in test weight with different treatments but it could not reach the level of significance. The highest test weight of 23.00 g was recorded with T<sub>2</sub> followed by T<sub>4</sub> and T<sub>7</sub> and

lowest under control (19.70). The results are consistent with the outcomes of prior research, including the study by Shankar *et al.*, (2020) <sup>[6]</sup>.

The maximum grain (4160 kg ha<sup>-1</sup>) and straw (5492 kg ha<sup>-1</sup>) yields were recorded with the treatments T<sub>2</sub> (100% RDF 120:60:40), followed by T<sub>4</sub>-75% RDF + 25% N through dhaincha (4013 kg ha<sup>-1</sup> and 5336 kg ha<sup>-1</sup>), respectively. The minimum grain and straw yield were recorded in control (1892 kg ha<sup>-1</sup> and 2777 kg ha<sup>-1</sup>) during investigation. Similarly, the grain and straw yields of the rice crop were noted among different INM treatments (Neti *et al.*, 2022) <sup>[5]</sup>. The maximum harvest index was recorded with T<sub>2</sub> (43.10) and minimum under the control (40.52). Integration of inorganic fertilizer with organic sources could not reach the level of significance in increasing the harvest index during the course of investigation. The effect of different nutrient management on harvest index was found non-significant. These results corroborated with the findings of Sarkar *et al.*, (2014) <sup>[10]</sup>.

**Table 3:** Nutrient management strategies in transplanted on rice of Panicles m<sup>-2</sup>, panicle length (cm), number of grains per panicle, test weight (g), grain yield (kg ha<sup>-1</sup>), straw yield (kg ha<sup>-1</sup>), and harvest index (%).

Treatments	Panicles (m <sup>-2</sup> )	Panicle length (cm)	Grains panicle <sup>-1</sup>	Test weight (g)	Grain yield (kg ha <sup>-1</sup> )	Straw yield (kg ha <sup>-1</sup> )	Harvest Index (%)
T <sub>1</sub> -Control	225.90	22.11	98.60	20.70	1892.00	2777.00	40.52
T <sub>2</sub> -100% RDF (120:60:40) NPK	345.20	24.81	156.10	23.00	4160.00	5492.00	43.10
T <sub>3</sub> -75% RDF + 25% N through Press mud	310.80	24.14	138.20	21.90	3470.00	4720.00	42.36
T <sub>4</sub> -75% RDF + 25% N through Dhaincha as green manure	332.80	24.50	150.50	22.90	4013.00	5336.00	42.92
T <sub>5</sub> -75% RDF + 25% N through Crop residue (Oat)	292.70	23.91	136.50	20.75	3290.00	4666.00	41.35
T <sub>6</sub> -50% RDF + 50% N through Press mud	304.70	23.84	141.60	21.25	3212.00	4593.00	41.15
T <sub>7</sub> -50% RDF + 50% N through Dhaincha as Green manure	321.70	24.06	145.50	22.20	3332.00	4707.00	41.45
T <sub>8</sub> -50% RDF + 50% N through Crop residue (Oat)	290.00	23.41	127.70	20.85	3093.00	4427.00	41.13
SEm±	10.74	0.81	4.92	0.78	121.12	163.07	1.45
CD at 5%	32.59	2.26	14.94	NS	367.38	494.63	NS

### Conclusion

The results observed that T<sub>2</sub>: 100% RDF (120 kg N:60 kg P<sub>2</sub>O<sub>5</sub>:40 kg K<sub>2</sub>O) produced the highest plant height, total number of tiller m<sup>-2</sup>, leaf area index, panicles m<sup>-2</sup>, panicle

length (cm), number of grains panicle<sup>-1</sup>, test weight (g), grain yield (kg ha<sup>-1</sup>), straw yield (kg ha<sup>-1</sup>) and harvest index (%).

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