

Productivity of *kharif* transplanted rice (*Oryza sativa* L.) under different nitrogen management practices

ABSTRACT

A field experiment was conducted at the SOA University Bhubaneswar during *kharif* season 2022 in a well-drained sandy loam soil with pH 5.8, low in organic carbon, medium in available P and K and low in available S, Zn and B to study the effect of nutrient management practices on growth, yield, nutrient uptake and economics of rice under different organic and inorganic nutrient management practices. The experiment was laid out in a factorial randomized block design with ten set of treatments viz. T₁: 75% RDN, T₂: 100% RDN, T₃: 125% RDN, T₄: 50% N of T₁ as urea+50% N through FYM, T₅: 50% N of T₁ as urea+50% N through NOC, T₆: 50% N of T₂ as urea+50% N through FYM, T₇: 50% N of T₂ as urea+50% N through NOC, T₈: 50% N of T₃ as urea+50% N through FYM, T₉: 50% N of T₃ as urea+50% N through NOC, and T₁₀: Farmer's Practice (80:40:40 kg NPK/ha+ FYM 5 t/ha) and replicated thrice. Results revealed that maximum plant height, number of tillers per m² and dry matter production/m² was recorded with treatment T₆ (50% N of T₂ as urea+50% N through FYM) at harvest. The highest grain yield along with high yield attributing characters like panicle/m² filled grains/panicle and test weight was recorded with application of T₆ (50% N of T₂ as urea+50% N through FYM) than all other treatments. Nitrogen, phosphorus and potassium uptake was recorded highest under the treatment T₆ (Application of 50% N of T₂ as urea + 50% N through FYM).

INTRODUCTION

Fertilizers are the major source of nutrients for rice under intensive cultivation. However, continuous and extensive use mainly attributed to macronutrient imbalance, micro-nutrients deficiency and fertilizer related environmental pollution (Biswas *et al.*, 2019; Kumar *et al.*, 2018). Further, the produce of chemical farming are poor in quality that affects the market acceptability. Under such situation, the restoration of soil fertility and improvement in rice yield and its quality could only be achieved through integrated use of chemical fertilizers in combination with organic manures (Chowdhury *et al.*, 2015). Application of organics like farm yard manure, poultry manure, vermicompost, bio-fertilizers, and recycling of crop residues play a vital role in nutrients cycling, improves physical, chemical and biological

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properties of soil (Patel *et al.*, 2015). Nitrogen (N) is a yield-limiting nutrient for rice in India and its efficient use is crucial for economic and environmental sustainability. A synchrony of fertilizer application with crop demand along with various nitrogen losses in Eastern India leads to low fertilizer efficiency in *kharif* rice. Inefficient utilization of nitrogen is considered to be the most critical one among various reasons for this low productivity. Blanket application of N fertilizer is the prime cause of low nitrogen use efficiency, increased cost of cultivation, and environmental degradation. Due to substantial temporal and plot-to-plot unevenness in indigenous nitrogen supply of soil, broad-based N recommendations like state-recommended N application for rice cannot be helpful. Real-time nitrogen management and site-specific nitrogen management (SSNM) are recent scientific approaches that ensure both increases in rice productivity and sustainability of the rice ecosystem. Given the value and significance of rice as a crop for human consumption, it is imperative to limit the usage of chemical fertilizers by implementing management measures such as the combined use of organic and inorganic sources of nutrients. Combining the application of organic and inorganic fertilizers is one of the fertilizer management practices for successful rice culture, and it is not only a reliable method of increasing yields but also a concept that is ecologically sound for sustainable agriculture. Therefore, a balanced blend of chemical fertilizers and organic manures enhances soil health and increases sustainable production. The utilization of Farm Yard Manures (FYM), Neem oil cake (NOC), bio fertilizers, and inorganic fertilizers is contemplated by an integrated nutrient management system. Research results in recent past have shown that substituting a part of N through FYM and NOC has helped in increasing the nitrogen efficiency and yield to the extent of 25-30%. Information on integration of inorganic N with either FYM or NOC in East and South Eastern Coastal plain zone of Odisha is meagre. Hence the present experiment was conducted to study the growth, yield attributes and yield of rice under different nitrogen management practices.

MATERIALS AND METHODS

A field experiment was conducted during *kharif*, 2022 at Agricultural Research Station, Faculty of Agricultural Science, SOADU, Odisha, India. The experiment was laid in a randomized block design with three replications. The experiment was laid out in a factorial randomized block design with ten sets of treatments viz. T₁: 75% RDN, T₂: 100% RDN, T₃: 125% RDN, T₄: 50% N of T₁ as urea+50% N through FYM, T₅: 50% N of T₁ as urea+50% N through NOC, T₆: 50% N of T₂ as urea+50% N through FYM, T₇: 50% N of T₂ as urea+50% N

through NOC, T₈: 50%N of T₃ as urea+50% N through FYM, T₉:50%N of T₃ as urea+50% N through NOC, and T₁₀: Farmer's Practice (80:40:40 kg NPK/ha+ FYM 5 t/ha) and replicated thrice. The soil of the experimental field was sandy loam in texture with acidic in reaction (pH 5.80), low in organic C (0.44%). Rice was sown manually in line with a spacing of 20 cm x 10 cm. The seed rate was taken 60 kg/ha. The rice variety CR Dhan 314 was used in this experiment. Fertilizer was applied in accordance with the prescribed course of treatment. At the time of the last puddling, a full dose of P₂O₅ and 50% K₂O were added together with 25% N. The first top dressing of 50% N was applied 21 days after planting, and the remaining top dressing of 25% N and 50% K₂O was applied during the panicle initiation stage. During the trial year, sources of N, P₂O₅, and K₂O included urea, sulphur-free phosphatic fertilizer (DAP), and muriate of potash. Sulfur and zinc were treated as ZnSO₄ at a rate of 25 kg per hectare, and borax at a rate of 10 kg per hectare, according to the treatment. Plant protection measures were implemented based on necessity and all other suggested agronomic procedures were followed properly. The growth and yield components and yield of rice were also recorded and statistically analysed at 5% level of significance. For nutrient uptake tests of N, P, K, and B, composite plant samples from each treatment for three replications were obtained at the time the crop was harvested. For the purpose of conducting a chemical analysis on plant samples, the samples were oven dried, appropriately ground by a Willey mill grinder, and passed through a 2 mm screen.

Results and discussion

Results revealed that maximum plant height, number of tillers per m² and dry matter production/m² was recorded with treatment T₆ (50% N of T₂ as urea+50% N through FYM) at harvest. This is due to the positive effect of FYM over NOC in manipulating the soil physical condition and making availability of more nutrients. This findings are in conformity with the observation of Mankotia (2007) and Roulet *al*, 2007).

The highest filled grains /panicle, test weight and panicle/ m² was recorded with application of 50%N of T₂ as urea+50% N through FYM over other treatments T₇ (50%N of T₂ as urea+50% N through NOC), T₈ (50%N of T₃ as urea+50% N through FYM) and T₉ (50%N of T₃ as urea+50% N through NOC) had similar results. Conversely, using 75% of the recommended nitrogen dose (RDN) resulted in the lowest number of filled grains /panicle, test weight and panicle/ m². Replacing 50% of RDN with FYM and the rest with urea led to the highest number of filled grains, test weight and panicle/ m² compared to using urea and

neem oil cake at different RDN levels. This difference is attributed to FYM's positive impact on soil conditions and nutrient availability compared to neem oil cake (NOC). This findings are in confirmation with the observation of Singhet *al.* (2008). Panicle length varied significantly due to different nutrient management practices. Among the nutrient management practices maximum panicle length was observed with application of 50% N of T₂ as urea+50% N through FYM (T₆).

The highest grain yield was recorded with application of T₆ (50%N of T₂ as urea+50% N through FYM) than all other treatments. T₇ (50%N of T₂ as urea+50% N through NOC) T₈ (50%N of T₃ as urea+50% N through FYM) and T₉(50%N of T₃ as urea+50% N through NOC) recorded at par value of grain and straw yield of rice. However, application of 75% of the recommended nitrogen dose (RDN) resulted in the lowest grain and straw yield. The grain yield was increased by 14.49% under treatment T₆ as compared to treatment T₁.

Similar trend was followed in harvest index. Highest harvest index was recorded with application of T₆ (50 % N of T₂ as urea + 50 % N through FYM) than all other treatments. Singh *et al.* (2018) reported that the integrated nutrient management approach increased grain yield in rice, contributing to higher overall production.

Nutrient uptake

The highest nitrogen, phosphorus and potassium uptake was recorded under T₆ (50%N of T₂ as urea+50% N through FYM) resulted compared to all other treatments. Pandey *et al.* (2009) stated that the combined use of compost, crop residues with chemical fertilizers significantly increased the availability of N, P and K in soil over chemical fertilizer alone.

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Residual soil fertility

In the research, Table 4 serves as a repository of rich data concerning the residual soil fertility outcomes stemming from a multitude of treatment approaches. Among these varied treatments, T₆ (50% N of T₂ as urea+50% N through FYM), consistently emerged as the frontrunner in terms of nitrogen uptake across all growth stages. Notably, its performance surpassed that of all other treatments, making it a noteworthy stand out in the study's findings. In contrast, treatments T₇ (50% urea+ 50% neem oil cake or NOC), T₈ (50% urea+50% FYM), and T₉ (50% urea+50% NOC) showed relatively comparable levels of residual soil fertility, thus presenting a more homogeneous group in terms of outcomes.

An intriguing discovery throughout the study was that the application of only 75% of the recommended nitrogen dose (RDN) consistently led to the lowest plant height across all growth stages. This consistent pattern suggests that a lower nitrogen dose can have detrimental effects on plant height, reinforcing the importance of adhering to recommended nitrogen levels. A particularly noteworthy observation was that substituting 50% of the RDN with FYM and allocating the remaining 50% to urea consistently resulted in the highest levels of residual soil fertility. This trend held true even when compared to the use of urea and neem oil cake at varying RDN levels. This fascinating discrepancy in outcomes can be attributed to FYM's ability to positively influence soil conditions and enhance nutrient availability, setting it apart from neem oil cake (NOC) in terms of its impact on soil fertility. These findings robustly affirm the trends and observations that have been consistently documented throughout our study by Singh *et al.* (2014).

Conclusion

From this study it can be concluded that application of 50% N of T₂ as urea + 50% N through FYM was found to be superior in respect to growth, yield attributes and yield of rice.

References

- Singh F, Ravindra K and Samir P. 2008. Integrated nutrient management in rice-wheat cropping system for sustainable productivity. *Journal of the Indian Society of Soil Science*. **56**(2):205-208.
- Singh AK, Chakraborti M and Datta M. 2014. Improving rice-based cropping pattern through soil moisture and integrated nutrient management in mid-tropical plain zone of Tripura, India. *Rice Science*. **21**(5):299-304.
- Pandey A K, Vipin Kumar and Rajesh Kumar. 2009. Effect of long-term organic and inorganic nutrients on transplanted rice under rice-wheat cropping system. *Oryza*. **46**(3):209-212.
- Mankotia BS. 2007. Effect of fertilizer application with farm yard manure and in-situ green manures in standing rice (*Oryza sativa* L.) - wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agricultural Sciences*. **77**(8):512-514.
- Roul PK, Sarawgi SK, Deepak Kumar and Rout DP. 2007. Response of rice (*Oryza sativa*) to integrated nitrogen application in Inceptisols of Chhatisgarh. *Oryza*. **44**(1):39-43.

- Biswas, B., Nirola, R., Biswas, J. K., Pereg, L., Willett, I. R. and Naidu, R. (2019). Environmental Microbial Health Under Changing Climates: State, Implication and Initiatives for High-Performance Soils. In: Lal R., Francaviglia R. (eds) Sustainable Agriculture Reviews 29. Sustainable Agriculture Reviews, 29. Springer, Cham.
- Chowdhury, Md R., Roy, Choudhury, S., Brahmchari, K. and Kumar, V. (2015). Productivity and fertility build-up of the soil through INM under rice-onionresidualgreengram crop sequence. Green farming, 6(4): 716- 720.
- Chowdhury, Md R. (2015). Nutrient management through combined use of organic, inorganic and biological sources under rice-onion-greengram crop sequence. Ph.D. Thesis, Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia, West Bengal.
- Patel, L. C., Chakrabarty, S. and Googoi, A. K. (2015). Organic cultivation of chilli – an assessment in West Tripura district of Tripura. Journal of Eco-friendly Agriculture, 10(1): 15-19.
- Kumar, A. B., Prakash, C. H. and Brar, N. S. (2018). Potential of Vermicompost for Sustainable Crop Production and Soil Health Improvement in Different Cropping Systems. International Journal of Current Microbiology and Applied Science, 7(10): 1042-1055.

Table 1: Effect of nutrient management practices on growth attributes of rice

Treatment	Plant height(cm)	Tillers/hill	Dry matter production/plant
T1:75%RDN	124.5	13.29	24.76
T2:100%RDN	127.1	13.93	25.54
T3:125%RDN	134.6	13.88	25.85
T4:50%N of T1 as urea+50%N through FYM	131.5	13.46	25.83
T5:50%N of T1 as urea+50%N through NOC	133.7	13.89	25.19
T6:50%N of T2 as urea+50%N through FYM	140.7	14.97	27.44
T7:50%N of T2 as urea+50%N through NOC	138.1	14.64	26.86
T8:50%N of T3 as urea+50%N through FYM	136.8	14.39	25.44
T9:50%N of T3 as urea+50%N through NOC	134.3	14.63	25.08
T10:Farmer's Practice(80:40:40kgNPK/ha+FYM5 t/ha)	131.3	14.03	26.04
SE(m)	2.29	0.25	0.81
CDP=(0.05)	6.82	0.73	1.99

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Treatment	Panicle length(cm)	Panicle/m ²	Filled grains/panicle	Test weight (g)	Grain yield (t/ha)
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Table 2: Effect of nutrient management practices on yield attributes and yield of rice

T1:75%RDN	24.17	220	130	20.26	3.45
T2:100%RDN	24.30	236	142	21.23	3.68
T3:125%RDN	25.33	242	146	23.78	3.78
T4:50%NofT1asurea+50%NthroughFYM	24.47	223	138	23.12	3.62
T5:50%NofT1asurea+50%NthroughNOC	24.88	241	140	22.93	3.62
T6:50%NofT2asurea+50%NthroughFYM	26.00	263	165	25.58	3.95
T7:50%NofT2asurea+50%NthroughNOC	26.00	260	157	24.21	3.82
T8:50%NofT3asurea+50%NthroughFYM	25.70	266	160	24.93	3.72
T9:50%NofT3asurea+50%NthroughNOC	25.13	264	165	23.82	3.82
T10: Farmer's Practice (80:40:40 kgNPK/ha+FYM 5 t/ha)	25.20	248	146	23.11	3.58
SE(m)±	0.24	3.8	4.5	0.38	0.02
CDP=(0.05)	0.71	11	17	1.11	

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Table 3: Nutrient uptake by plants in accordance to the nutrient management practices

Treatment	Nitrogen(kg/ha)			Phosphorus(kg/ha)			Potassium(kg/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T ₁ :75%RDN	40.66	26.89	67.55	10.16	10.66	20.82	22.45	50.33	72.78
T ₂ :100%RDN	55.38	29.26	84.64	13.62	12.60	26.22	22.4	55.62	78.02
T ₃ :125%RDN	56.35	39.42	95.77	16.2	12.22	28.42	23.42	67.87	91.29
T ₄ :50%N of T ₁ as urea +50%N through FYM	54.32	36.77	91.09	14.22	14.44	28.66	25.33	75.45	100.78
T ₅ :50%N of T ₁ as urea +50%N through NOC	48.51	34.76	83.27	14.4	13.67	28.07	26.5	66.66	93.16
T ₆ :50%N of T ₂ as urea +50%N through FYM	68.67	43.71	112.38	16.30	17.19	33.49	27.9	127.54	155.44
T ₇ :50%N of T ₂ as urea +50%N through NOC	45.77	34.87	80.64	16.25	16.34	32.59	26.8	110.76	137.56
T ₈ :50%N of T ₃ as urea +50%N through FYM	45.88	32.45	78.33	16.2	16.43	32.63	24.4	78.54	102.94
T ₉ :50%N of T ₃ as urea +50%N through NOC	44.56	30.56	75.12	14.64	13.54	28.16	23.80	77.45	101.25
T ₁₀ :Farmer's Practice(80:40:40kgNPK/ha+FYM5t/ha)	42.54	34.56	77.1	12.05	12.56	24.6	22.20	67.65	89.85
SE(m)±	5.12	5.55		1.47	1.11		5.41	1.84	
CDP=(0.05)	12.56	13.60		3.61	2.45		2.1	4.51	

Table 4: Residual soil fertility

Treatment	Organic carbon(%)	AvailableN (kg/ha)	AvailableP (kg/ha)	Availablek (kg/ha)
T ₁ :75%RDN	0.53	227.87	21.80	237.23
T ₂ :100%RDN	0.54	242.37	22.67	239.50
T ₃ :125%RDN	0.54	242.47	23.87	240.23
T ₄ :50%N ofT ₁ asurea+50%NthroughFYM	0.55	230.27	23.17	247.17
T ₅ :50%N ofT ₁ asurea+50% Nthrough NOC	0.55	236.07	23.00	240.87
T ₆ :50%N ofT ₂ asurea+50%NthroughFYM	0.56	247.20	23.48	262.43
T ₇ :50%N ofT ₂ asurea+50% Nthrough NOC	0.51	234.27	23.05	247.93
T ₈ :50%N ofT ₃ asurea+50%NthroughFYM	0.56	244.40	23.47	240.53
T ₉ :50%N ofT ₃ asurea+50% Nthrough NOC	0.52	239.40	23.76	233.13
T ₁₀ :Farmer'sPractice(80:40:40kgNPK/ha+FYM5t/ha)	0.53	243.43	22.16	218.17
SE(m)±	0.01	7.11	0.89	9.36
CDP=(0.05)	0.04	17.43	2.18	22.94
Initialvalues	0.54%	245	23.58	185.50