

Effect of integrated nutrient management on yield and economics of rice

Abstract

Two successive field experiments were conducted during kharif 2022 and 2023 at the Crop Research Centre of Chandra Shekhar Azad University of Agriculture and technology Kanpur, Uttar Pradesh. The experiment consisted of fourteen different treatments in randomized block design replicated thrice. Soil of the experimental field was sandy loam in texture and slightly alkaline in reaction. Result found that on the pool data basis higher grain yield (42.45q/ha) and was recorded with the treatment (T₈) consisting application of application of 75% NPK+FYM+Consortia+Nano zinc. During both the years higher straw yield 69.23 qha⁻¹ and 67.00 qha⁻¹ was recorded and on the pool data basis maximum straw yield obtained in T₈ which is followed by T₁₄. This treatment also resulted in comparatively higher (Benefit: Cost ratio) B:C ratio during both the years.

Keywords:Economics, Nano zinc, Consortia, FYM, B: C ratio, yield

Introduction:

Rice (*Oryza sativa L.*) is the staple food to feed over half of the world's population. Use of inorganic fertilizers has several negative impacts on soil fertility. Presently; use of organic sources is slowly mushrooming up over the globe due to its scientifically proven beneficial effects. In India, rice is grown in about 47.05 million hectares with a production level of 135.54 million tones and the productivity is about 2781 kg/ha .There is an ample scope to increase the productivity of rice. To increase the productivity of rice, it is important to maintain the fertility and organic matter status of soil. Integrated fertilizer and organic manure nutrient management is one of the viable options for preserving soil quality with regard to crop productivity (Bajpai *et al.*, 2006). Organic manures serve as the carbon and energy source for proliferation of microorganisms which may alter the activities of different enzymes. Incorporation of organic manures in the soil affects chemical and biological environment but also affects the nutrient availability to crop plants and microorganisms. A promising approach is to develop effective fertilization strategies that can encourage agricultural sustainability by promoting soil microbial

Comment [41]: Repeation???? Please check

Comment [42]: Re-write the sentence

Comment [43]: Check for spacing

Comment [44]: Re-write the sentence and check for grammar

biomass and operation by integrating organic modifications with reduced chemical fertilizer (Mandal *et al.*, 2007). The quality parameters of scented rice are improved by biofertilizers alone or in combination with organic manure (Dixit & Gupta, 2000; Quyen & Sharma, 2003). To supplement part of the nitrogen requirement with ecological and economic significance, blue green algae (BGA) and Azospirillum can be successfully used in wetland rice.

Comment [45]: Add reference

Farm yard manure (FYM) is the most commonly used organic manure in most countries of the world. Farm Yard Manure application leads to improves soil structure, nutrient exchange, and maintains soil health thus very useful for INM or organic farming. FYM is a heterogeneous composted organic material consisting of dung, crop residue, and household sweeping in various stages of decomposition. It also had effect on residual phosphorus and potassium in soil. Introduction 3 FYM is rich in nutrients and contains 0.5% Nitrogen, 0.2% Phosphorus and 0.5% Potassium. Application of FYM improves soil fertility and soil physical properties like soil structure, aeration, water holding capacity etc. Generally, the enzyme activities in the soil are closely related to the organic matter content and strongly influenced by the hydrothermal regimes. Enzyme catalyzes all biochemical reactions and are an integral part of nutrient cycling in soil and these are sensitive indicators of soil ecological stress or other environmental changes. The main microbial enzymes involved in the mineralization of soil organic matter are cellulases, dehydrogenases, acid and alkaline phosphatase activity, proteases; nitrogen fertilization is the most important management strategy for the improvement of agricultural crops.

Comment [46]: Check the sentence for grammatical mistakes

Comment [47]: What does this sentence means?? Its not understandable. Please re-write

Materials and Methods

Two successive field experiments were conducted during kharif 2022 and 2023 at the Crop Research Centre of Chandra Shekhar Azad University of Agriculture and technology Kanpur, Uttar Pradesh. The experiment consisted of fourteen different treatments in randomized block design replicated thrice. Soil of the experimental field was sandy loam in texture and slightly alkaline in reaction. The experiment consisted fourteenth (14) treatments of INM based like that's Control (T₁), 100% N P K (T₂), 75% NPK + FYM @ 5 ton/ha (T₃), 75% NPK + NPK Consortia (T₄), 75% NPK + FYM @ 5 ton /ha + Consortia (T₅), 75% NPK + FYM @ 5 ton/ha + Nanozinc (T₆), 75% NPK + Consortia + Nano zinc (T₇), 75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc (T₈), 50% NPK + FYM @ 5 ton/ha (T₉), 50% NPK + Consortia (T₁₀), 50% NPK + FYM @ 5 ton/ha + Consortia (T₁₁), 50% NPK + FYM @ 5 ton/ha + Nano zinc (T₁₂), 50% NPK + Consortia + nano zinc (T₁₃), 50% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc (T₁₄)

Comment [48]: Also this no objective of your study. Add objective to your study. As a study is baseless without objective

Comment [49]: No reference in this para. Add references

Comment [410]: Repeation of this line.

Comment [411]: Again mentioned?? Why??

were applied in randomized block design with three replications. Recommended dose of P and K was used in all the treatments with exception control. Rice variety (Pusa Basmati-1509) was transplanted in plant geometry on 16 July during 2022 and 2023. Recommended dose of fertilizer i.e. 120 kg N and 60 kg P and 40 kg / ha was applied through Urea, DAP and MOP with the FYM Consortia and Nano zinc. Whole of nitrogen, phosphorus and potassium and FYM was applied at planting while root of paddy nursery dipped in Consortia and transplanted in field. Nano zinc spray at 30,60 DAT. After threshing each plot individually, the grains were cleaned, and their weight was recorded in kg/plot. This yield was then converted to a per-hectare basis. The observations collected during the study were organized into tables and analyzed statistically to reach valid conclusions.

Comment [412]: Repetition ???

Comment [413]: Rewrite the sentence

Comment [414]: Mention the plant geometry used in the experiment

Comment [415]: Check the sentence for spacing

Comment [416]: Specify the plot size

Observation recorded

Grain yield ($q\ ha^{-1}$)

After cleaning and drying the grains, the grain yield was recorded in kg per plot. The moisture percentage in 100 g samples drawn from each treatment was determined with the help of moisture meter and grain yield per plot was adjusted to 14 per cent moisture. The yield of net plot, thus converted into $q\ ha^{-1}$.

Straw yield ($q\ ha^{-1}$)

The straw yield of each net plot will be worked out by deducting the grain yield from the biological yield of each plot. Finally, the straw yield will be computed on hectare basis and expressed in $q\ ha^{-1}$.

Economics of treatments

The cost of cultivation was calculated by taking into account the cost of seed, fertilizer, herbicide and the hiring charges of labour and machines for land preparation, irrigation, fertilizer application, plant protection, harvesting and threshing and the time required per hectare to complete an individual field operation. Cost of irrigation was calculated by multiplying time (h) required to irrigate a particular plot, consumption of diesel by the pump ($l\ h^{-1}$) and cost of diesel. Gross income is the minimum support price offered by the Government of India for rice. Net income was calculated as the difference between gross income and total cost.

Result and Discussion

Comment [417]: There is no discussion in your study please add some discussion paragraphs

Grain yield

The data presented in Table-1 indicate that all treatments significantly increased grain yield compared to the control. The highest grain yields, 43.53 q ha⁻¹ in the first year and 44.20 q ha⁻¹ in the second year, were recorded with treatment T8 (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc). The control plot (T₁) produced the lowest yields, with 18.29 q ha⁻¹ in the first year and 20.66 q ha⁻¹ in the second year. On a pooled data basis, the maximum grain yield was 43.6 q ha⁻¹, followed by 41.85 q ha⁻¹ in T₁₄ (50% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc), with the lowest yield of 19.79 q ha⁻¹ recorded in the control with application of FYM, Consortia, and Nano zinc obtained 52% more yield as compared to only NPK application. Similar findings were reported by **Sangeeta et al. (2020) and Sravan et al. (2020)**

Straw yield

The data in Table 1 show that straw yield was significantly affected by nutrient applications in both years of the study. In the first year, straw yield ranged from 41.84 to 73.41 q ha⁻¹, while in the second year it varied from 44.15 to 79.11 q ha⁻¹. The highest straw yield was recorded in T₈ (75% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc), with 73.41 q ha⁻¹ in the first year and 79.11 q ha⁻¹ in the second year, followed by T₁₄ (50% NPK + Consortia + FYM @ 5 tons/ha + Nano Zinc). The control plot produced the lowest straw yields, 41.84 q ha⁻¹ in 2022 and 44.15 q ha⁻¹ in 2023. Based on pooled data, the maximum straw yield was 76.26 q ha⁻¹ in T₈, while the minimum was 43.00 q ha⁻¹ in the control. Similar findings were reported by **Shahniet al. (2019) and Ruan et al., (2023)**

Economics

The economic analysis of any experimental research is an important **expect** for getting the most beneficial treatment combination from soil health **and farmer s point of view**. It is very obviously that a treatment with more chemical fertilizers may obtain a highest net return with minimum cost of cultivation in comparison to a treatment which includes organic sources but from soil health point of view its recommendation cannot be made. **The maximum cost of cultivation incurred under T₁₄, and T₈(Rs.50416.00/-) and (Rs.51560 .00/-) during 2022 and 2023, Highest gross return in cured with the application of 75% NPK + FYM @ 5 ton/ha + Consortia+ Nano zinc Net return was maximum under T₈ in 2022 and 2023. Although T₁₄ not gavemore return than during 2022 and 2023 but both are more beneficial from soil health point of view because it include FYM organic source Consortia biofertilizer and also application of Nano Zinc which improve the physical, chemical and biological properties. B:C ratio was found maximum under**

Comment [418]: Aspect will be the write word

Comment [419]: Check the grammer

Comment [420]: The statement is unclear

Comment [421]: ??? check the word

Comment [422]: Check spacing in the sentence

Comment [423]: Re-write the sentence

T₈ (3.42) on the pooled data basis because of comparatively lower cost of cultivation and minimum is T₁(1.45) and (1.67) during 2022-2023. Similar findings were reported by **Imadeet al. (2017) and Sharma et al. (2017)**

Conclusion

To achieve maximum yield of rice grain and straw yield during Kharif season, an integrated nutrient management system of application of 75% NPK + FYM @ 5 ton/ha + Consortia+ Nano zinc seems better one since grain and straw yield in these treatment was maximum and also maximum b:c ratio found which is more profitable compare to other.

References

1. Agricultural Statistics at a glance (2022). Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare Directorate of Economics and Statistics 2022.
2. **Verma, J. K., & Ali, A. (2017)**. Effect of various nutrient management modules on growth and yield traits of high yielding varieties of Rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry*, 6(5), 697-701.
3. **Godebo, T., Laekemariam, F., & Loha, G. (2021)**. Nutrient uptake, use efficiency and productivity of bread wheat (*Triticum aestivum* L.) as affected by nitrogen and potassium fertilizer in Keddida Gamela Woreda, Southern Ethiopia. *Environmental Systems Research*, 10(1), 12.
4. **SoKumar U, Panneerselvam P, Jambhulkar NN, Annapurna K. (2016)**. Effect of inoculation of rhizobacterial consortia for enhancement of growth promotion and nutrient uptake in Basmati rice. *Oryza* 53(3): 282-287. uthern Ethiopia. *Environmental Systems Research*. 2021;10(1):1-16.
5. **Kumar, Y., Tiwari, K. N., Singh, T., Sain, N. K., Laxmi, S., Verma, R. A. M. E. S. H., ... & Raliya, R. A. M. E. S. H. (2020)**. Nanofertilizers for enhancing nutrient use efficiency, crop productivity and economic returns in winter season crops of Rajasthan. *Annals of Plant and Soil Research*, 22(4), 324-335.
6. **Dutta, M. and Chauhan, B.S. (2010)**. Effect of nutrient management practice on the performance of upland rice in a newly developed terraced land. *Indian Agriculture* 54: (1/2): 13-21.2. 20.

Comment [424]: Add more references to your paper

7. **Tripathi, R.P. (1992).** Physical properties and tillage of rice soils in rice–wheat system. In: Pandey RK, Dwivedi BS, Sharma AK, editors. Rice-wheat cropping system. Modipuram(India): *PDCSR*. pp. 53–67. 21.
8. **Usman, M., Ullah, E., Warriach, E.A., Farooq, M. and Liaqat, A. (2003).** Effect of organic and inorganic manures on growth and yield of rice variety “Basmati-2000”. *International Journal of Agriculture Biology*, 5(4): 481-483
9. **Imade, S.R., Thanki, J.D., Phajage, S.K. and Nandapure, S.P. (2017).** Effect of Integrated Nutrient Management on Growth, Yield and Quality of Rice Bull. Env. *Pharmacol. Life Sci.*, 6 [3] :352-355.
10. **Sharma, S., Saini, J. P., Pathania, R., Kumar, A. and Singh, R. (2017).** Comparative Efficacy of Organic and Inorganic Sources of Nutrients in Paddy (*Oryza sativa* L.), *Current Journal of Applied Science and Technology*21[6]: 1-8.
11. **Shahni, N., Devi, K. N., Chongtham, M., Athokpam, H.S. and Singh, N. G. (2019).** Studies on Different Crop Establishment Techniques and Nitrogen Management on Basmati Rice Variety (*Pusa basmati* 1509), *International Journal of Current Microbiology and Applied Sciences* 8 Number [06]: 2421-29.
12. **Ruan, S., Luo, H., Wu, F., He, L., Lai, R., & Tang, X. (2023).** Organic cultivation induced regulation in yield formation, grain quality attributes, and volatile organic compounds of fragrant rice. *Food Chemistry*, 405, 13484
13. **Sravan, U. S., Singh, S. P., & Neupane, M. P. (2021).** Response of basmati rice varieties to integrated nutrient management. *Journal of plant nutrition*, 44(3), 351-365.
14. **Sangeetha, J., Habeeb, J., Thangadurai, D., Alabhai, J. M., Hospet, R., Maxim, S. S., ... & Kushwaha, U. K. S. (2020).** Potentiality of wild rice in quality improvement of cultivated rice varieties. *Rice Research for Quality Improvement: Genomics and Genetic Engineering: Volume 1: Breeding Techniques and Abiotic Stress Tolerance*, 61-85.

Treatment Symbol	Treatment Combination	Grain yield (q/ha)			Straw yield (q/ha)		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
T ₁	Control (Absolute)	18.92	20.66	19.79	41.84	44.15	43.00
T ₂	100% NPK	23.64	26.60	25.12	49.55	53.81	51.68
T ₃	75% NPK + FYM @ 5 ton/ha	27.31	30.74	29.02	54.24	58.92	56.58
T ₄	75% NPK + NPK Consortia	28.46	32.04	30.25	55.37	60.14	57.76
T ₅	75% NPK + FYM @ 5 ton /ha + Consortia	32.44	36.55	34.49	59.90	65.08	62.49
T ₆	75% NPK + FYM @ 5 ton/ha + Nano zinc	33.76	38.05	35.90	61.10	66.37	63.74
T ₇	75% NPK + Consortia + Nano zinc	35.68	40.46	38.07	62.59	68.38	65.49
T ₈	75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc	40.13	45.12	46.13	71.41	77.11	74.26
T ₉	50% NPK + FYM @ 5 ton/ha	24.49	27.55	26.02	50.71	55.08	52.90
T ₁₀	50% NPK + Consortia	25.95	29.20	27.58	52.63	57.16	54.89
T ₁₁	50% NPK + FYM @ 5 ton/ha + Consortia	29.67	33.42	31.55	56.57	61.45	59.01
T ₁₂	50% NPK + FYM @ 5 ton/ha + Nano zinc	31.35	35.32	33.33	58.56	63.61	61.08
T ₁₃	50% NPK + Consortia + nano zinc	34.90	39.34	37.12	62.45	67.84	65.15
T ₁₄	50% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc	38.34	43.36	39.85	67.66	73.48	70.57
	SEM(+/-)	1.12	1.30	0.86	1.30	1.40	0.96
	C.D.at 5% of level	3.25	3.77	2.43	3.79	4.08	2.72

Table-1: Effect of integrated nutrient management on yield of rice

S. No	Treatment Symbol	Treatment Combination	Total cost of cultivation (₹)	Gross Return (₹/ha)	Net Return (₹/ha)	B:C
-------	------------------	-----------------------	-------------------------------	---------------------	-------------------	-----

Table-2: Effect of integrated nutrient management on economics of rice

1	T ₁	Control (Absolute)	34312	87760	53448	1.56
2	T ₂	100% NPK	39883	126320	86437	2.17
3	T ₃	75% NPK + FYM @ 5 ton/ha	45982	144370	98388	2.14
4	T ₄	75% NPK + NPK Consortia	38916	149880	110964	2.85
5	T ₅	75% NPK + FYM @ 5 ton/ha + Consortia	46416	169205	122789	2.65
6	T ₆	75% NPK + FYM @ 5 ton/ha + Nano zinc	49982	175470	125488	2.51
7	T ₇	75% NPK + Consortia + Nano zinc	42916	185025	142109	3.31
8	T ₈	75% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc	50416	222650	172234	3.42
9	T ₉	50% NPK + FYM @ 5 ton/ha	44606	130530	85924	1.93
10	T ₁₀	50% NPK + Consortia	37540	137765	100225	2.67
11	T ₁₁	50% NPK + FYM @ 5 ton/ha + Consortia	45040	155705	110665	2.46
12	T ₁₂	50% NPK + FYM @ 5 ton/ha + Nano zinc	48606	163860	115254	2.37
13	T ₁₃	50% NPK + Consortia + nano zinc	41540	181055	139515	3.36
14	T ₁₄	50% NPK + FYM @ 5 ton/ha + Consortia + Nano zinc	51540	202685	151145	2.93