Received Date: 20 September 2025
Accepted Date: 27 December 2025
DOI: https://doi.org/10.3126/jiaas.v39i1.88272

NUTRIENT MANAGEMENT IN SPRING RICE (*Oryza sativa* L.) AT GAURADHA, JHAPA, NEPAL

Sadikshya Ghimire[1*], Ganesh Lamsal[2], Sony Bhattarai[2], and Suman Ghimire[2*]
[1]Nepal Polytechnic Institute, Purbanchal University, Nepal
[2]Agriculture and Forestry University, Rampur, Chitwan, Nepal
*Corresponding author: ghimiresadikshya0099@gmail.com
Sadikshya Ghimire: 0009-0006-0830-094X
Ganesh Lamsal: 0000-0001-6218-5598
Sony Bhattarai: 0009-0005-9089-5083
Suman Ghimire: 0009-0005-0024-9134

ABSTRACT

Rice is a major crop in eastern Nepal, but huge yield gaps were recorded, and nutrient management was ranked the major reasons behind it. A field experiment was carried out in Nepal Polytechnic Institute, in eastern Nepal, during the spring of 2023 to evaluate the effect of different nutrient management practices on the growth and yield of spring rice (*Oryza sativa* L. cv. Hardinath-1). Altogether six treatments: T1: Farmers' practice (150:50:25 NPK kg/ha), T2: Phosphorus only (50 kg/ha), T3: Nitrogen only (150 kg/ha), T4: Potassium only (40 kg/ha), T5: Government recommendation with FYM+NPK (15 t/ha FYM + 150:50:40 NPK kg/ha), and T6: NPK only (150:50:40 NPK kg/ha) were allocated in Randomized Complete Block Design (RCBD) with four replications. Concerning plant height (96.89 cm), number of tillers (463.57/m2), grains per panicle (170), and grain production (7.08 t/ha), the Government-recommended FYM + NPK treatment performed noticeably better results, whereas the Phosphorus-only treatment showed the lowest values. Hence, rice cultivation with integrated nutrient management, i.e., government-recommended FYM together with NPK (15 t/ha FYM + 150:50:40 NPK kg/ha), is a promising practice and has to be promoted in similar agro-ecological zones to maximize rice productivity in Nepal.

Key words: *FYM, hardinath-1, NPK, nutrient management, spring rice, yield*

INTRODUCTION

For more than half of the world's population, rice (*Oryza sativa* L.), the most intensively grown grain crop worldwide, is a staple food that provides 20% of protein and 27% of dietary energy in many nations (Gurung, 2006). Asian rice (*O. sativa*) is the most commercially important species out of the 23 species of rice that are known to exist. Although rice is grown in many different agroecological zones in Nepal, 70% of the country's rice is produced in the Terai region. The crop makes up over 47.5% of Nepal's total cultivated area and makes a significant contribution to both agricultural GDP and food security (AITC, 2021).

Due to inadequate nutrition management techniques, rice yield in Nepal is still much below its potential yield of 9.08 t/ha (Regmi, 2003), despite its significance (Gaire et al., 2016). Traditional techniques of puddling and transplanting affect soil structure and raise cultivation costs. In comparison to the main-season crop, spring rice, which is grown from February to July, benefits from increased sun radiation and is more productive (Pokharel, 2006). To increase productivity, effective nutrient management that is adapted to the soil and climate of the area is essential. The goal of this study was to determine the best method for nutrient management in the spring season at Gauradha, Jhapa.

MATERIALS AND METHODS

Experimental site

The study was conducted in Gauradha Municipality Ward-5, Jhapa, which is located in Koshi province of Nepal. The area of Jhapa district is 1606 sq. km. It lies on the geographical coordinates of $87^{\circ}39'$ East to $88^{\circ}12'$ East longitude and $26^{\circ}20'$ North to $26^{\circ}50'$ North latitude. The maximum and minimum temperatures of the district are 42°C in summer and 10°C in winter, respectively, and it receives 250 to 300 mm of rainfall a year.

The soils of Jhapa District, including the Gauradha area, are typical of the eastern Terai region of Nepal and are generally characterized by sandy loam texture with slightly acidic to near-neutral reaction. Previous studies from nearby locations in Jhapa report moderate organic carbon content and variable nutrient status, reflecting soil conditions suitable for rice cultivation. The general soil characteristics of the study area, based on published studies, are summarized in Table 1.

Table 1: General soil characteristics of Jhapa District and nearby areas of the eastern Terai region of Nepal

Soil property	Reported range/description	Study area (reference site)
Soil texture	Sandy loam (dominant)	Bhimsen Pokhari, Jhapa
Soil pH	Slightly acidic to near neutral	Bhimsen Pokhari, Jhapa
Organic carbon (%)	1.72 - 2.31	Bhimsen Pokhari, Jhapa
Soil texture	Sandy loam	Bhadrapur Municipality, Jhapa
Soil pH	Slightly acidic	Bhadrapur Municipality, Jhapa
Available nutrients (N, P, K)	Variable; influenced by land use and management	Eastern Terai, Nepal

Source: Bhattarai et al., 2017; Rai et al., 2024

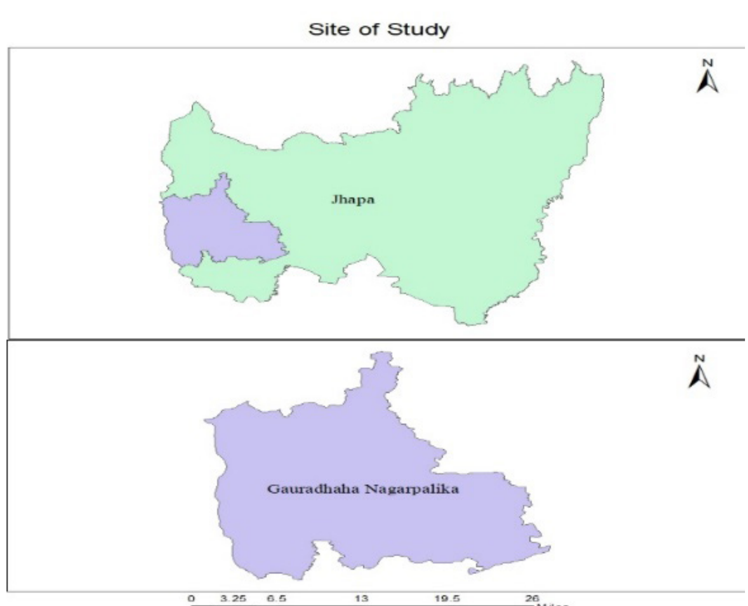

Figure 1: Location map of the experimental site

Experimental design and treatment details

The experiment was carried out in RCBD design with four replications and six treatments (Table 2):

Table 2: Details of the treatments used in the experiment.

SN	Treatments	Doses (kg/ha N, P_2O_5, K_2O)
T1	Farmers' practice	150:50:25
T2	Phosphorous only	00:50:00
T3	Nitrogen only	150:00:00
T4	Potassium only	00:00:40
T5	Government recommended (FYM + NPK)	15 tons/ha + 150:50:40
T6	Government recommended (NPK only)	150:50:40

Cultural operations

Seedlings were raised on well-prepared, raised nursery beds measuring 3 meters in length and 1 meter in breadth during the first week of February. To ensure sufficient soil pulverization and effective puddling, the main field was ploughed a total of three times, once in the first week and twice in the second week of February. Following the requirements of the experimental design, 24 plots were laid out and carefully leveled during preparation for transplanting.

During the first week of February, healthy seedlings bearing two to four leaves were selected from the nursery beds and transplanted into the main field on the same day. Proper water management was maintained throughout the growing period by ensuring adequate flooding whenever necessary to support healthy crop growth.

Manual weeding was carried out twice to control weed growth and improve soil aeration and drainage, first in 16 days after transplanting (DAT), and again in 43 DAT. Physiological maturity was reached by the end of June, and was harvested and threshed manually.

Observations and measurements

The stages of crop growth were observed when 75% of the plants in each plot attained heading, flowering, and physiological maturity. Five tagged plants per plot were used to measure plant height at 20-day intervals. Within each plot, the number of tillers and the number of productive tillers per square meter were counted. The spacing between treatments was maintained at 1 m, while the spacing between crops within a plot was 20 cm. By counting the filled and unfilled grains from five sampling panicles, the number of grains per panicle was determined. This also made it possible to determine the sterility percentage.

Grains from randomly selected panicles were used to calculate the thousand-grain weight, which was measured using an electronic scale. Threshed grains were sun-dried for two days and maintained at 14% moisture content before the grain yield was calculated from 3×2 m² net plots. Straw yield was measured after four days of sun-drying.

Harvest Index (%) was calculated using the formula:

$$\text{Harvest Index} = (\text{Economic Yield} / \text{Biological Yield}) \times 100$$

R software 4.4.2 and Microsoft Excel 2016 were used to analyze the data. Duncan's Multiple Range Test (DMRT) was used to compare treatment means at a significance level of 5%.

RESULTS AND DISCUSSION

Plant height and tillers

Significant variations in plant height were observed among treatments at each growth stage, highlighting the importance of nutrient balance in crop development (Table 3). The tallest plants (96.89 cm at 80 DAT) were recorded in the government-recommended treatment (FYM+NPK), while the phosphorus-only plots consistently produced the shortest plant height (81.42 cm). This trend reinforces the concept that balanced fertilizer application, particularly with adequate nitrogen, is essential for promoting vegetative growth and achieving optimal plant stature. The superiority of the combined FYM+NPK treatment can be attributed to the complementary role of organic and inorganic nutrient sources, which improve nutrient availability and soil health simultaneously. Similar results were reported by Haq et al. (2002), who found that integrated nutrient management significantly increased plant height, and by Tadesse et al. (2013), who noted that the use of farmyard manure with inorganic fertilizers sustained vegetative growth through improved soil fertility and nutrient uptake efficiency.

Tillering capacity also showed significant differences among treatments, beginning from 40 DAT (Table 4). Nitrogen-only plots recorded the maximum tiller count at 40 DAT (637/m²),

Table 3: Plant height of rice (*Oryza sativa* L.) as influenced by different nutrient management practices at Gauradha, Jhapa, Nepal, 2023

Treatments	Plant Height (cm)			
	20 DAT	40 DAT	60 DAT	80 DAT
Farmers Practice	30.68[a]	44.72[a]	67.23[a]	94.28[a]
Phosphorus only	24.24[b]	36.93[b]	52.89[b]	81.42[b]
Nitrogen only	33.58[a]	45.15[a]	65.99[a]	93.08[a]
Potassium only	29.16[a]	42.06[b]	61.63[ab]	90.75[a]
GR (FYM + NPK)	33.52[a]	47.63[a]	69.08[a]	96.89[a]
GR (NPK only)	30.12[a]	45.95[a]	63.43[ab]	92.85[a]
LSD (0.05)	3.1	4.84	8.15	6.91
CV (%)	7.01	7.84	8.65	5.07
Grand Mean	29.34	42.96	62.53	90.5
F test	**	*	*	*

Note: Means in each column followed by the same letter are not significantly different at p ≤ 0.05 (DMRT).; GR, Government-Recommended

Indicating that nitrogen availability plays a critical role in initiating tiller formation during the early vegetative phase. However, at later stages (60 and 80 DAT), the government-recommended treatment (FYM + NPK) produced the highest tiller numbers (573 and 464/m², respectively). This suggests that while nitrogen alone can stimulate initial tillering through enhanced photosynthetic activity and chlorophyll production, sustained tiller development and survival require a balanced nutrient supply. In contrast, potassium-only plots consistently produced fewer tillers, underscoring the limited role of potassium in tiller initiation compared to nitrogen. These findings are consistent with those of Singh et al. (2000), who reported that balanced fertilization improved tiller persistence and yield attributes, and with studies such as Lamichhane et al. (2022), which demonstrated that the integration of organic manure with

NPK fertilizers enhanced both tiller number and survival, ultimately improving overall crop productivity.

Table 4: Number of tillers/m² of rice (*Oryza sativa L.*) as influenced by different nutrient management practices at Gauradha, Jhapa, Nepal, 2023

Treatments	Tillers per m²			
	20 DAT	40 DAT	60 DAT	80 DAT
Farmers Practice	364[a]	568[a]	533[a]	436[a]
Phosphorus only	271[a]	283[a]	451[a]	388[a]
Nitrogen only	365[a]	637[a]	537[a]	398[a]
Potassium only	175[b]	239[b]	294[b]	263[b]
GR (FYM + NPK)	272[a]	540[a]	573[a]	464[a]
GR (NPK only)	283[a]	576[a]	523[a]	378[a]
SEM (±)	31.69	76.91	48.46	33.82
LSD (0.05)	95.5	232	127	102
CV (%)	22.1	30.4	19.4	17.5
Grand Mean	287.12	506	62.53	386.38
F test	**	*	*	*

Note: Means in each column followed by the same letter are not significantly different at $p \leq 0.05$ (DMRT).; GR, Government-Recommended

Phenology and yield attributes

Phenological and yield attributes also responded positively to balanced fertilization. The government-recommended treatment (FYM+NPK) produced the highest number of effective tillers per m² (430), followed closely by NPK-only (371/m²) and farmers' practice treatments (405/m²) (Table 5). This clearly demonstrates the advantage of integrated nutrient management in sustaining tiller survival and enhancing the proportion of effective tillers that contribute directly to yield. The observed trend aligns with the findings of Ntanos and Koutroubas (2002), who reported that nitrogen and potassium application increased the number of productive tillers through improved leaf expansion, tiller initiation, and photosynthetic activity. Similar results were also reported by Shrestha et al. (2022), who noted that balanced fertilization enhanced the number of effective tillers in rice, and by Tadesse et al. (2013), who emphasized the role of integrated nutrient sources in stabilizing tiller survival and yield formation.

Combined nutrient application tended to produce longer panicles compared to individual fertilizer treatments, which is consistent with the findings of Lamichhane et al. (2022), who observed that panicle length was generally improved under balanced NPK application. Thousand-grain weight showed no significant variation across treatments, indicating that this trait is more strongly governed by genetic factors rather than nutrient management. However, the highest number of grains per panicle (170) was recorded under the FYM+NPK treatment, highlighting the role of integrated fertilization in improving reproductive development and sink capacity (Table 5). Comparable findings were reported by Haq et al. (2002) and Tadesse et al. (2013), who demonstrated that integrated nutrient management not only sustains vegetative growth but also contributes to superior grain filling and yield attributes. Together, these results suggest that balanced fertilization with both organic and inorganic inputs enhances crop performance by improving both vegetative vigor and reproductive efficiency, thereby ensuring higher yield potential.

Table 5: Yield attributing characters of rice (*Oryza sativa* L.) as influenced by different nutrient management practices at Gauradha, Jhapa, Nepal, 2023

Treatments	Number of effective tillers/m^2	Panicle length (cm)	Number of grains per panicle	1000 grain weight (g)
Farmers practice	405[a]	22.23	153[ab]	22.07
Phosphorous only	353[a]	21.3	145[abc]	21.9
Nitrogen only	358[a]	21.08	143[bc]	21.96
Potassium only	237[b]	20.93	120[c]	22.38
GR (FYM + NPK)	430[a]	22.58	170[a]	22.88
GR (NPK only)	371[a]	22.18	144[abc]	22.63
SEM (±)	27.03	0.578	9.1	0.338
LSD (0.05)	81.5	43.2	27.4	32.6
CV (%)	15.1	5.45	12.5	1.01
Grand mean	357.04	21.22	145	21.1
F test	**	ns	*	ns

Note: Means in each column followed by the same letter are not significantly different at $p \leq 0.05$ (DMRT).; GR, Government-Recommended

Although the effect of treatments on panicle length was not statistically significant, the Grain yield, straw yield, and harvest index

Table 6 shows that the grain yield varied significantly among treatments, with the highest production (11.8 ton/ha) recorded under the government-recommended FYM+NPK treatment, followed by NPK-only (10.18 ton/ha) and nitrogen-only (9.98 ton/ha) plots. In contrast, phosphorus-only plots produced the lowest grain yield (5.1 ton/ha), clearly highlighting the importance of balanced nutrient supply for maximizing productivity. The superior performance of the FYM+NPK treatment can be attributed to the synergistic effect of organic manure and inorganic fertilizers, which improve nutrient availability, soil structure, and microbial activity, ultimately enhancing crop growth and assimilate partitioning. These findings are in line with the results of Haq et al. (2002), Shrestha et al. (2022), and Tadesse et al. (2013), who reported significant improvements in grain yield with integrated nutrient management compared to sole fertilizer applications.

Straw yield followed a similar trend, with the highest biomass (13.27 ton/ha) obtained from FYM+NPK, closely followed by nitrogen-only (11.88 ton/ha) and NPK-only (11.52 ton/ha) treatments (Table 6). This parallel pattern between grain and straw yield indicates that balanced fertilization not only supports grain production but also enhances total biomass accumulation. Comparable results were reported by Tadesse et al. (2013) and Lamichhane et al. (2022), where combined organic and inorganic fertilization significantly improved both straw and biological yield by sustaining nutrient release throughout the growing season.

Harvest index (HI) values ranged from 39.03% to 47.96%, but no significant differences were observed across treatments (Table 6). This suggests that while fertilization influenced absolute yield levels, the proportion of assimilates partitioned to grain versus straw remained relatively stable. Similar observations were made by Esfehani et al. (2005), who found that

HI was largely unaffected by fertilizer treatments, as it is more dependent on genotype than on external nutrient supply. Thus, while integrated nutrient management improves overall productivity, it may not substantially alter the harvest index, indicating that yield gains are primarily driven by greater biomass accumulation rather than changes in partitioning efficiency.

Table 6: Yield parameter of rice (*Oryza sativa* L.) as influenced by different nutrient management practices at Gauradha, Jhapa, Nepal, 2023.

Treatments	Grain Yield (ton/ha)	Straw Yield (ton/ha)	Harvest Index
Farmers practice	10.05[ab]	11.63[a]	46.23
Phosphorous only	5.1[c]	8.62[b]	38.68
Nitrogen only	9.98[ab]	11.88[a]	45.73
Potassium only	8.1[b]	11.47[b]	42.56
GR (FYM + NPK)	11.8[a]	13.27[a]	48.99
GR (NPK only)	10.18[ab]	11.52[a]	45.28
SEM (±)	0.41	6.24	1.9
LSD (0.05)	1.26	1.47	6.8
CV (%)	17	15.7	8.7
Grand mean	8.18	10.4	43.75
F test	**	*	ns

Note: Means in each column followed by the same letter are not significantly different at p ≤ 0.05 (DMRT).; GR, Government-Recommended

CONCLUSION

The growth and production of spring rice at Gauradha, Jhapa, were significantly improved by the integrated nutrient management technique that combined FYM with the recommended dose of NPK. The government-recommended FYM+NPK treatment exceeded the other treatments with regard to enhancing both vegetative and reproductive parameters. According to these results, FYM-integrated fertilization should be promoted for sustainable rice production in Nepal's comparable agroclimatic regions. Based on the research findings, for better rice production, it is recommended to use the government-recommended dose (NPK+FYM), i.e., 150:50:40 kg/ha NPK and 15 tons per ha FYM.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Nepal Polytechnic Institute (NPI), Chitwan, for providing the necessary facilities and support. Field experiments were conducted in Jhapa, and the authors appreciate the cooperation of the local community.

REFERENCES

Agriculture Information and Training Center. (2021). *Krishi Diary 2021*. Government of Nepal, Ministry of Agriculture and Livestock Development.

Bhattarai, K. P., Shrestha, P. K., & Koirala, O. (2017). Physico-chemical properties of water and soil of Bhimsen Pokhari Wetland, Jhapa District, Eastern Nepal. *Nepalese Journal of Biosciences*, *7*(1), 72–76. https://doi.org/10.3126/njbs.v7i1.41785

Datta, D. S. (1981). Principles and practices of rice production. *John Wiley and Sons, New York.*

Esfahani, M., Sadrzadelr, S., Kavoossi, M., & Dabaghm, M.N.A. (2006) Study the Effect of Different Levels of Nitrogen and Potassium Fertilizers on Growth and Grain Yield Components of Rice Cultivar Khazar. *Iranian Journal of Crop Sciences*, 3, 226-242.

Gaire, A., Koirala, S., Shrestha, R. K., & Amgain, L. P. (2016). Growth and productivity of different cultivars of rice under nutrient expert© and other fertilizer management practices at Lamjung. International Journal of Applied Sciences and Biotechnology, 4(2), 178-182.

Gurung, D. B. (2006). Performance of rice as influenced by planting method, mulch and nitrogen management using leaf color chart (LCC) (Doctoral dissertation, M. Sc. Thesis submitted to Tribhuvan University, Institute of Agriculture and Animal Science, Rampur, Chitwan).

Haq, M. T., Sattar, M. A., Hossain, M. M., & Hasan, M. M. (2002). Effects of fertilizers and pesticides on growth and yield of rice. *Online Journal of Biological Sciences* (Pakistan), 2(2).

Lamichhane S, Khanal, B.R., Jaishi, A., Bhatta, S., Gautam, R. & Shrestha J. (2022). Effect of integrated use of farmyard manure and chemical fertilizers on soil properties and productivity of rice in Chitwan. *Agronomy Journal of Nepal*. 6(1):200-212. doi: https://doi.org/10.3126/ajn.v6i1.47994

Mannan, A. (2005). Effect of planting date, N fertilization and water stress on growth, yield and quality of fine rice (Doctoral dissertation, Ph. D Thesis, Department of Agronomy BAU, Mymenshing).

Marahatta, S. (2017). Increasing productivity of an intensive rice based system through site specific nutrient management in western terai of Nepal. *Journal of Agriculture and Environment*, 18, 140-150.

Ntanos, D. A., & Koutroubas, S. D. (2002). Dry matter and N accumulation and translocation for Indica and Japonica rice under Mediterranean conditions. *Field Crops Research*, *74*(1), 93-101.

Olk, D. C., Cassman, K. G., Simbahan, G., Sta. Cruz, P. C., Abdulrachman, S., Nagarajan, R., Pham Sy Tan, & Satawathananont, S. (1998). Interpreting fertilizer-use efficiency in relation to soil nutrient-supplying capacity, factor productivity, and agronomic efficiency. *Nutrient Cycling in Agroecosystems*, 53(1), 35-41.

Pokharel R., (2006). Spring rice proves more productive. *The Himalayan Times*.

Rai, M., Bhattarai, K. P., Khatiwada, H., & Neupane, A. (2024). Relationship between fine root biomass and soil physico-chemical properties of grassland ecosystem in Bhadrapur Municipality of Jhapa district, Eastern Nepal. *Adhyayan Journal*, *11*(11), 81–92. https://doi.org/10.3126/aj.v11i11.67081

Regmi, A. P., (2003). Improving the productivity of rice-wheat system through field specific nutrient management in Nepal. PhD dissertation submitted to University of the Philippines at Los Banos (UPLB), Los Banos, Laguna, Philippines.

Shrestha, J., Karki, T. B., & Hossain, M. A. (2022). Application of nitrogenous fertilizer in rice production: A review. *Journal of Nepal Agricultural Research Council*, *8*, 16-26.

Singh, G., Ganeshamurthy, A. N., Dubey, R. P., Nair, A. K., & Dinesh, R. (2000). Response of rice (Oryza sativa) to applied phosphorus in soils of School line series in Andaman and Nicobar Islands. *The Indian Journal of Agricultural Sciences*, 70(4).

Tadesse, T. , Dechassa, N. , Bayu, W., & Gebeyehu, S. (2013) Effects of Farmyard Manure and Inorganic Fertilizer Application on Soil Physico-Chemical Properties and Nutrient Balance in Rain-Fed Lowland Rice Ecosystem. *American Journal of Plant Sciences*, 4, 309-316. doi: 10.4236/ajps.2013.42041.