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Assessment of Different Nutrient Sources on Production and Profitability of Barley (*Hordeum vulgare* L.) in Khairahani, Chitwan

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Abstract

Although nutrient management plays a crucial role in determining the productivity of barley (*Hordeum vulgare* L.), comparative information on the effectiveness of organic and inorganic nutrient sources under local conditions is still scarce. A field experiment was conducted during the 2024, Rabi season at Khairahani, Chitwan, to evaluate the effects of different nutrient sources on growth, yield, and profitability of barley *var*. Mustangey Jau. Using a randomized complete block design with five treatments-controls, chemical fertilizer NPK, poultry manure, farmyard manure, and vermicompost-each replicated four times, significant differences were observed in plant height, leaf area index, effective tillers, and grain yield. NPK fertilizer produced the highest plant height (94.80 cm), leaf area index (0.18), effective tillers (6.52), and grain yield (1.69 t/ha), followed by poultry manure and vermicompost. Organic sources improved growth over the control but yielded less than NPK. Economic analysis showed NPK achieved the highest net return and benefit-cost ratio (2.19), followed by poultry manure (1.34). Therefore, the application of recommended NPK fertilizer is suggested for maximizing barley yield and profitability, while poultry manure can be considered as a suitable organic alternative for improving productivity compared with other organic sources.

Keywords: Benefit-cost ratio, Chemical fertilizer, Grain yield, Organic manure

Introduction

Barley (*Hordeum vulgare* L.) is one of the earliest domesticated cereal crops and ranks as the world's fourth most important cereal after maize, rice, and wheat. In Nepal, it stands fifth after rice, maize, wheat, and millet, with an annual production of 24,931 Mt and an average yield of 1.34 Mt ha^{-1} (Ministry of Agriculture and Livestock Development [MoALD], 2024). Its wide adaptability-from drylands to humid subtropics (Martin et al., 2006) and from the Terai plains to high hills -makes barley a resilient crop capable of thriving under diverse agro-ecological conditions. Despite its potential, barley remains an underutilized crop in Nepal, although it holds significant promise for enhancing food and nutritional security, particularly in marginal and rainfed areas (Pandey et al., 2006).

The adaptability of barely to a wide range of environmental conditions makes it a crucial crop in both temperate and semi-arid regions (Verma, 2022). However, to optimize its yield potential and ensure profitability, effective nutrient management is essential. Nutrients play a pivotal role in plant growth, development, and productivity, influencing physiological processes such as photosynthesis, enzyme activation, and grain filling. However, maximizing its productivity and economic returns remains a key challenge, especially under nutrient-limited conditions. Efficient nutrient management plays a pivotal role in improving the productivity and profitability. The indiscriminate use of inorganic fertilizers has led to soil degradation, nutrient imbalance, and declining soil fertility (Agegnehu et al., 2014). On the other hand, balanced application of nitrogen (N), phosphorus (P), and potassium (K) enhances vegetative growth, tillering, and grain filling, thereby improving yield potential (Jat, 2021). Organic manures such as farmyard manure, poultry manure, and vermicompost contribute not only to nutrient supply but also to improved soil structure, microbial activity, and long-term sustainability (Singh & Kumar, 2015)

In Nepal, farmers commonly use both organic and inorganic nutrient sources in barley cultivation; however, scientific information on their comparative performance under the local conditions of Chitwan is limited. This study aims to evaluate the effect of different nutrient sources on the growth, yield, and economic performance of barley. The findings will help identify a balanced and profitable nutrient management approach, contributing to sustainable production and the revitalization of barley as a climate-resilient crop in Nepal.

Materials and Methods

The experiment was conducted in Khairahani municipality ward no-6, Chitwan with geographical co-ordinates of 27^0 37' N and 84^0 43' E which is 210 meter above sea level. The experiment was conducted during winter season of 2024. The soil type was silty loam. The climatic data of the experimental site during the cropping period (November-February) are presented in Figure 1. Maximum temperature ranged from about 25 to 30°C and minimum temperature from approximately 7 to 13°C, with a gradual decline from November to January and a slight increase in February. Relative humidity showed a decreasing trend during the period, declining from about 76% in November to around 38% in February. There were five treatments and four replications using Randomized Complete Block Design(RCBD) with 20 cm row to row spacing and 5 cm plant to plant sapcing. The individual plot size was 2×2 m^2 separated with 0.5 meter. The treatments were: control, poultry manure @ 3 tons/ha, vermicompost @ 2 tons/ha, farm yard manure @ 5 tons/ha and NPK @ 60:30:30 kg/ha as recommended by MoALD, 2024. The farm yard manure, poultry manure and vermicompost were thoroughly mixed and incorporated in the soil a day prior to sowing. Urea, DAP (Diammonium Phosphate) and MOP (Muriate of Potash) were used as inorganic fertilizers. Full dose of P and K and half of the N were applied as basal dose at the time of sowing and remaining dose of N was applied 35 days after sowing. Mustangey Jau (local) landrace of barley was sown on 19^{th} November, 2024 with seed rate of 100 kg/ha. Gap filling was done to ensure optimum plant population after 20 days of sowing. One hand weeding was done at 30 days after sowing.

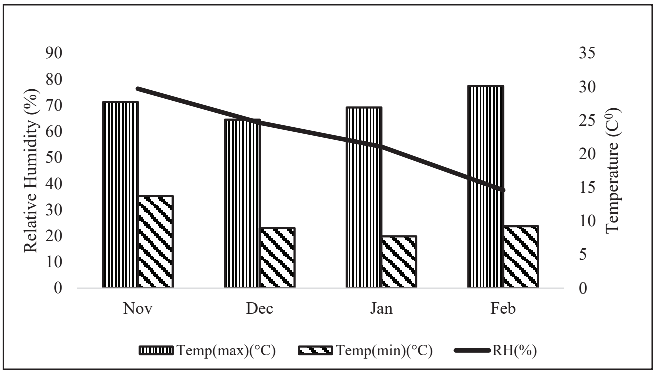

Figure 1: Climatic condition of the experimental site during November, 2024 to February, 2025

Different growth and yield attributes were taken at different time intervals. Plant height was measured at 30 day after sowing (DAS), 60 DAS and at harvest from the base of the plant to the top of the main branch of five randomly selected plants in each plot. The number of leaves and leaf area index was also measured at 30 and 45 DAS from the sampled plants and averaged. The number of spikes bearing tillers at harvest in each plot was counted by placing a meter scale along the crop row at five randomly selected sites, and the average was used to calculate the number of effective tillers per plant. Five spikes were selected at random from each plot and measured for spike length and filled and unfilled grains per spike. Plant was harvested on 21^{st} February, 2025 and after threshing, the grains were properly winnowed and cleaned and the grain and straw yield from each plot recorded by the help of weighing balance.

Economic analysis

The economic analysis was conducted to estimate the cost of cultivation, gross return, net return, and benefit-cost (B:C) ratio of buckwheat under different seed priming and fertilizer levels. The cost of cultivation was calculated based on total expenditures on labor, fertilizers, compost, pesticides, and other inputs. Gross return (Rs/ha) was determined from the economic yield at prevailing local market prices, while net return was obtained by subtracting the total cost from gross return. The benefit-cost ratio was computed as the ratio of gross return to total cost of cultivation.

Data analysis

The collected data were arranged and tabulated in MS Excel 2023. Then, the arranged data were analyzed using R studio software (version 4.4.1). Mean separation was carried out by using Duncan's Multiple Range Test (DMRT) at 5% level of significance (Gomez & Gomez, 1984).

Climatica data

Climatic data for the experimental site were obtained from the NASA Power online database. During the study period, the maximum temperature ranged between 20.09°C and 30.12°C, while the minimum temperature varied from 7.7°C to 13.74°C. Relative humidity fluctuated from 37.52% in February to 76.39% in November.

Results and Discussion

Growth attributes

The statistical analysis showed that at 30 days after sowing (DAS), plant height did not differ significantly among treatments ($p > 0.05$). At 60 DAS and at harvest, NPK recorded maximum plant height significantly differing with remaining treatments. The availability of essential nutrients, particularly nitrogen on meristematic activity that promotes cell elongation and vegetative growth compared to organic sources due to slower release of nutrients (Singh & Kumar, 2015). Similarly, Leaf number at 45 DAS was found significantly higher under vermicompost as compared to control. Similar finding was reported by Sunag et al. (2021), who noted that nutrient application enhanced leaf production with higher photosynthetic capacity contributing to higher leaf number. At 30 DAS, Leaf Area Index (LAI) was superior under poultry manure was statistically at par with all the treatments except control. The increases in growth parameters with nitrogen in nutrient sources have also been reported by Dekhane et al. (2017) and Kumari et al. (2023).

Yield attributes

The statistical analysis showed that spike length was not significantly influenced among treatments ($p>0.05$). The spike length is more due to genetical variability and less sensitive to environmental and soil condition. A highly significant difference among treatments on effective tillers per square meter was observed with highest under NPK application (6.52), followed by vermicompost (5.37), while the lowest was observed in the control (3.50). The balanced and immediate nutrient supply of NPK supports the initiation, survival, and strengthening of tillers and producing effective tillers in barley (Alam et al., 2007). The result agrees with the Prystupa et al., 2003 who reported that number of effective tillers per plant was directly affected by NPK fertilizer application. The thousand grain weight and filled and unfilled grains per spike resulted in non-significant results indicating these traits are primarily controlled by varietal characteristics rather than external nutrient supply (Samarah, 2005).

Table 1: Effect of different nutrient sources on growth attributes of barley in Khairahani, Chitwan during 2024/2025

Treatments	PH at 30 DAS	PH at 60 DAS	PH at Harvest	LN at 30 DAS	LN at 45 DAS	LAI at 30 DAS	LAI at 45 DAS
Control	36.10	48.17^{b}	66.95^{b}	9.90	15.95^{b}	0.16^{b}	1.96
Poultry manure	34.95	51.78^{b}	73.25^{b}	9.81	16.25^{ab}	0.20^{a}	2.12
NPK	36.28	70.35^{a}	94.80^{a}	11.0	17.0^{ab}	0.18^{ab}	2.08
FYM	33.35	49.75^{b}	73.45^{b}	9.80	16.50^{ab}	0.17^{ab}	1.75
Vermicompost	33.60	50.25^{b}	72.80^{b}	10.22	20.45^{a}	0.19^{a}	1.68
LSD(0.05)	4.37	5.88	7.38	1.75	4.08	0.025	0.50
SEm(±)	0.63	0.85	1.07	0.53	1.25	0.003	0.07
CV (%)	8.14	7.06	6.28	11.07	15.38	9.09	17.08
F-test	NS	***	***	NS	**	*	NS
Grand Mean	34.85	54.06	76.25	10.28	17.23	0.18	1.92

Note: *Significant at 0.05 probability level, **Significant at 0.01 probability level, ***Significant at 0.001 probability level, NS - Non-significant; LSD - Least Significant Difference; CV - Coefficient of Variation; SEm - Standard Error of Mean. Means within the column followed by common letter do not significantly different at 5% level by DMRT, PH-Plant Height; LN-LeafNumber; LAI-Leaf Area Index

Grain yield and straw yield

The statistical analysis showed that there was a highly significant difference among treatments on grain yield at $p<0.001$. Treatment NPK recorded significantly higher grain yield (1.69 t/ha) followed by vermicompost (1.45 t/ha) and poultry manure (1.29 t/ha). Control exhibited the lowest grain yield. Barley yield responded higher under NPK application due to immediate release of essential nutrient particularly nitrogen, which promotes tiller formation, leaf area expansion and ultimately higher assimilate partitioning into grains while other organic fertilizer slowly released nutrient. Different nutrient sources showed non-significant effect over straw yield may be due to nutrient distributing, crop naturally channels nutrients into grains than straw. Similar results were obtained by Kumar et al. (2022).

Correlation analysis of yield and yield attributes

The correlation analysis highlights a strong relationship between various yield components and the grain yield of barley (Figure 2). Positive correlations were observed for spike length, effective tillers per hill, and filled grains per spike with grain yield, whereas unfilled grains per spike showed a negative association. These findings indicate that higher numbers of tillers, longer spikes, and more filled grains per spike contribute to increased grain yield, while a lower number of unfilled grains per spike is associated with higher productivity (Table 2).

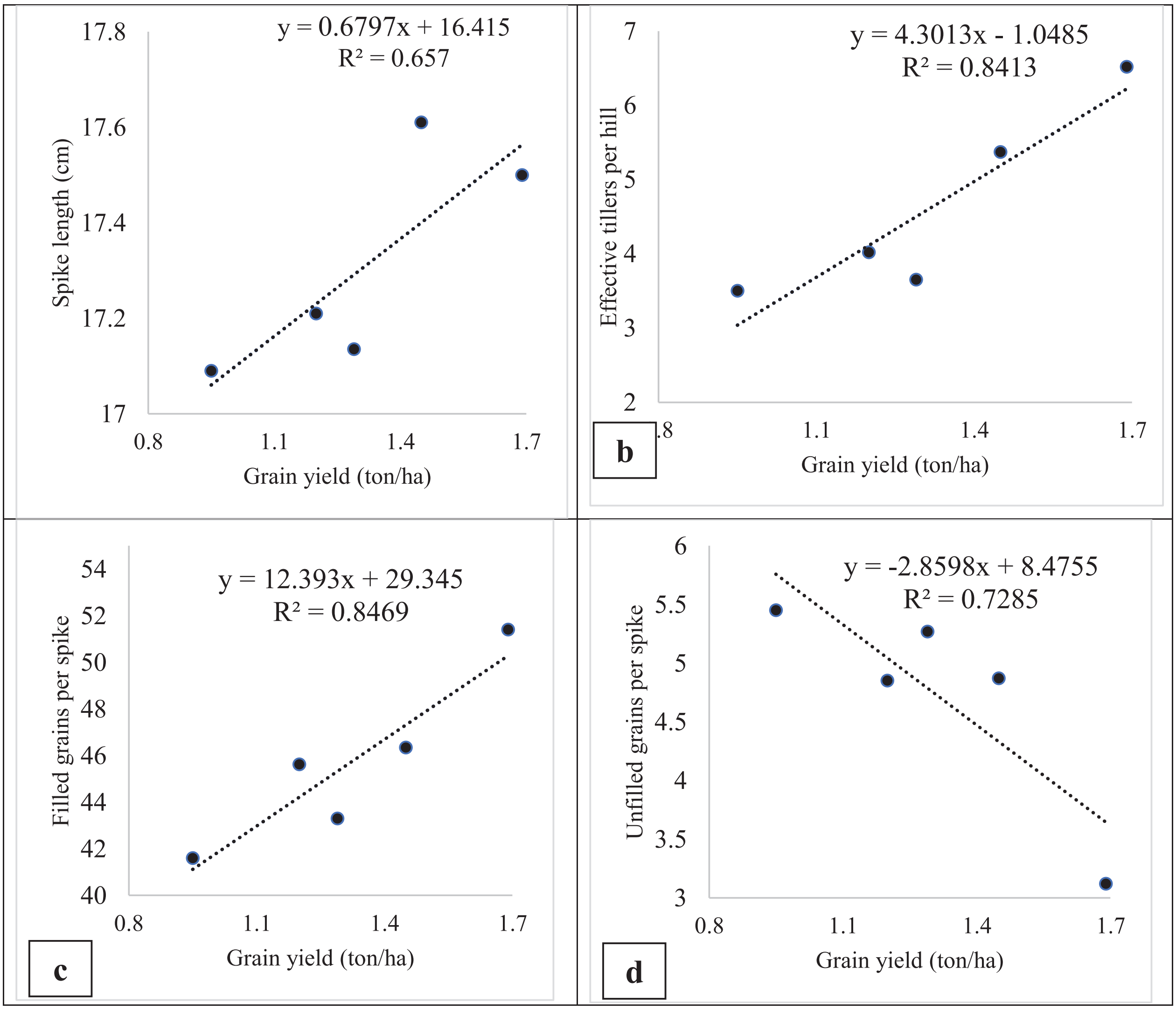

Figure 2: Correlation between spike length and grain yield; **(a)** Effective tiller per hill and grain yield; **(b)** Filled grains per spike and grain yield; **(c)** Unfilled grains per spike and grain yield; **(d)** of barley

Economics of barley

The highly significant variation was recorded in gross income, net income, and B:C ratio among the nutrient sources. The superiority of NPK treatments can be attributed to their higher grain yield, which directly translated into greater returns. In addition, the cost of cultivation was relatively lower under NPK, further improving profitability (Table 3). Similar findings have been reported by Jat et al. (2021) and Dinka et al. (2018). The reduced profitability of organic sources, especially vermicompost, was mainly due to its higher cost of cultivation. The maximum B:C ratio (2.16) was obtained with NPK application. NPK emerged as the most profitable nutrient source for barley production.

Conclusion

Different nutrient sources had a significant impact on the growth, yield, and economic performance of barley. Among the tested treatments, NPK fertilizer resulted in the highest growth, yield, and profitability, followed by vermicompost, poultry manure, and FYM. These results indicate that NPK was the most effective nutrient source for maximizing barley production. However, integrating organic and inorganic fertilizers could further improve soil health

Table 2: Effect of different nutrient sources on yield attributes and yield of barley in Khairahani, Chitwan during 2024/2025

Treatments	Spike Length (cm)	Effective tillers per hill	1000 Grain Weight (g)	Filled grains per spike	Unfilled grains per spike	Grain yield (t/ha)	Straw yield (t/ha)
Control	17.09	3.50^{b}	46.62	41.60	5.45	0.95^{d}	1.37
Poultry manure	17.14	3.65^{b}	47.62	43.30	5.27	1.29^{bc}	1.47
NPK	17.50	6.52^{a}	47.67	51.40	3.12	1.69^{a}	2.05
FYM	17.21	4.02^{b}	43.65	45.62	4.85	1.20^{c}	1.41
Vermicompost	17.61	5.37^{a}	48.25	46.35	4.87	1.45^{b}	1.76
LSD (0.05)	1.12	1.34	9.47	8.83	3.06	0.17	0.49
SEm(±)	0.34	0.48	1.37	2.27	0.44	0.02	0.07
CV (%)	4.20	18.91	13.15	24.02	12.56	8.84	19.76
F-test	NS	***	NS	NS	NS	***	NS
Grand mean	17.31	4.61	46.76	45.65	4.71	1.31	1.61

Note: ***Significant at 0.01 probability level; NS - Non-significant; LSD - Least Significant Difference; CV - Coefficient of Variation; SEm - Standard Error of Mean. Means within the column followed by common letter do not significantly different at 5% level by DMRT

Table 3: Effect of different nutrient sources on economics of barley in Khairahani, Chitwan during 2024/2025

Treatments	Cost of Cultivation (Nrs. Per ha)	Gross income (Nrs. Per ha)	Net income (Nrs. Per ha)	B:C ratio
Control	79000	106283^{d}	27283^{b}	1.35^{b}
Poultry manure	103000	138828^{c}	35828^{b}	1.35^{b}
NPK	83200	182865^{a}	99665^{a}	2.19^{a}
FYM	104000	129876^{c}	25876^{b}	1.25^{b}
Vermicompost	133000	157102^{b}	24102^{b}	1.18^{b}
LSD	-	23081.09	17828.55	0.20
SEM (±)	-	7300	7300	0.06
CV%	-	10.64	27.19	8.96
F-probability	-	***	***	***
Grand mean	-	142991	42551	1.46

Note: ***Significant at 0.001 probability level; LSD - Least Significant Difference; CV - Coefficient of Variation; SEm - Standard Error of Mean. Means within the column followed by common letter do not significantly different at 5% level by DMRT and maintain long-term productivity, suggesting a balanced nutrient management approach for optimal barley cultivation.

Author Contributions

A Gaire did conceptualization, methodology, formal data analysis, writing draft, and final editing. A Dawadi and S Aryal did field work, data collection, data curation, data analysis and lab work.

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References

Agegnehu, G., Van Beek, C., & Bird, M. I. (2014). Influence of integrated soil fertility management in wheat and tef productivity and soil chemical properties in the highland tropical environment. *Journal of Soil Science and Plant Nutrition*, *14*(3), 532-545. https://doi.org/10.4067/S0718-95162014005000042

Alam, M. Z., Haider, S. A., & Paul, N. K. (2007). Yield and yield components of barley (*Hordeum vulgare* L.) cultivars in relation to nitrogen fertilizer. *Journal of Applied Science Research*, *3*(10), 1022-1026.

Dekhane, S. S., Mangave, B. D., Patel, D. J., & Dumbre, R. B. (2017). Effect of organic products on plant growth and yield of wheat. *International Journal of Horticulture, Agriculture and Food Science*, *1*(4), 13-16. https://doi.org/10.22161/ijhaf.1.4.2

Dinka, T. B., Goshu, T. A., & Haile, E. H. (2018). Effect of integrated nutrient management on growth and yield of food barley (*Hordeum vulgare*) variety in Tokekutaye district, West Showa zone, Ethiopia. *Advances in Crop Science and Technology*, *6*(3), 1-8. https://doi.org/10.4172/2329-8863.1000365

Gomez, K.A., & Gomez, A.A. (1984). *Statistical procedures for agricultural research* (2nd ed.). John Wiley & Sons.

Jat, M. L., Chaplot, P. C., Bairwa, D. D., Meena, S. N., & Dhayal, B. C. (2021). Effects of integrated nutrient management on yield and economics of barley (*Hordeum vulgare*). *Indian Journal of Agronomy*, *66*(4), 425-429. https://doi.org/10.59797/ija.v66i4.2888

Kumar, D., Singh, M. M., Yadav, M. R., Makarana, G., Kushwaha, M., Dutta, S., Bhattacharjee, S., & Rajesh, R. (2022). Growth and yield performance of fodder oats (*Avena sativa*) grown under different nutrient management practices. *Indian Journal of Agricultural Sciences*, *92*(2), 267-272. https://doi.org/10.56093/ijas.v92i2.122250

Kumari, R., Alam, M. S., Patel, J. N., & Raj, Y. (2023). Influence of chemical fertilizer and organic manure on enhancing the production of barley (*Hordeum vulgare* L.) crop in Himachal Pradesh, India. *Journal of Scientific Research and Reports*, *30*(5), 1-10. https://doi.org/10.9734/jsrr/2023/v30i51813

Martin, J. H., Waldren, R. P., & Stamp, D. L. (2006). *Principles of field crop production*. Pearson Prentice Hall.

Ministry of Agriculture and Livestock Development. (2024). *Statistical information on Nepalese agriculture*. Government of Nepal.

Pandey, M., Wagner, C., Friedt, W., & Ordon, F. (2006). Genetic relatedness and population differentiation of Himalayan hulless barley (*Hordeum vulgare* L.) landraces inferred with SSRs. *Theoretical and Applied Genetics*, *113*, 715-729. https://doi.org/10.1007/s00122-006-0340-0

Prystupa, P., Slafer, G. A., & Savin, R. (2003). Leaf appearance, tillering and their coordination in response to N×P fertilization in barley. *Plant and Soil*, *255*, 587-594. https://doi.org/10.1023/A:1026018702317

Samarah, N. H. (2005). Effects of drought stress on growth and yield of barley. *Agronomy for Sustainable Development*, *25*(1), 145-149. https://doi.org/10.1051/agro:2004064

Singh, D., & Kumar, A. (2015). Effect of inorganic and organic sources of nutrients on yield and nutrient uptake by wheat and soil fertility. *Annals of Plant and Soil Research*, *17*(2), 146-149.

Sunag, M. N., Singh, R. P., Singh, R., & Singh, K. (2021). Effect of integrated nutrient management on the performance of barley (*Hordeum vulgare* L.). *The Pharma Innovation Journal*, *10*(9), 1492-1496. https://www.thepharmajournal.com

Verma, R. P. S., Lal, C., Malik, R., Kharub, A. S., & Kumar, L. (2022). Barley improvement: Current status and future prospects in changing scenario. In P. L. Kashyap et al. (Eds.), *New horizons in wheat and barley research* (pp. 221-245). Springer. https://doi.org/10.1007/978-981-16-4449-8_6