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RESEARCH ARTICLE

EFFECT OF ORGANIC AMENDMENTS ON SOIL FERTILITY AND CABBAGE YIELD IN KARNALI PROVINCE

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ABSTRACT

This study assessed the impact of various organic amendments on soil fertility and cabbage yield in Bheriganga Municipality, Surkhet, Karnali Province, Nepal. Despite being declared an organic province, Karnali still lacks adequate adoption of organic farming due to infrastructural and technological limitations. A field experiment was conducted in winter 2024 using a randomized complete block design with five treatments: farmyard manure, Vermicompost, poultry manure, goat manure, and a control (no amendment). The soil at the experimental site was initially low in fertility, characterized by poor organic matter, nitrogen, phosphorus, and micronutrient levels. Results indicated that organic amendments significantly enhanced soil nutrient status and improved cabbage growth and yield. Poultry manure produced the tallest plants (29.93 cm), the highest number of leaves per head (18.83), and the heaviest heads (1.32 kg), followed by Vermicompost. All organic treatments performed better than the control, but poultry manure and Vermicompost showed the most promising outcomes. These findings demonstrate that organic inputs, particularly poultry manure, and Vermicompost, can be effective alternatives to synthetic fertilizers in improving soil health and crop productivity. The study supports the potential for sustainable vegetable production and the promotion of organic agriculture in Karnali Province.

KEYWORDS

Organic Amendments, Cabbage Yield, Poultry Manure, Vermicompost, Soil Fertility, Karnali Province

1. INTRODUCTION

Agriculture serves as the cornerstone of Nepal's economy, providing employment opportunities and ensuring food security. However, Karnali Province remains one of the least developed regions in the country, facing persistent challenges such as inadequate infrastructure, low agricultural productivity and food insecurity. According to the study, only about 30 percent of households in the province can meet their annual food requirements through their agricultural production (National Statistical Office, 2023). Although Karnali Province was officially declared an Organic Province in 2018, the practical implementation of organic farming remains limited. This is primarily due to a lack of laboratory facilities for pesticide residue testing and the continued importation of chemically grown vegetables from other regions of the country (Kathmandu Post, 2024). Different organizations such as the Food and Agriculture Organization (FAO) and LI-BIRD have initiated farmer education programs and promoted climate-resilient agricultural models to encourage the use of locally available organic resources (FAO, 2022; LI-BIRD, 2022).

Surkhet District, the administrative center of Karnali Province, possesses favorable agro-climatic conditions and fertile soils, making it well-suited for agricultural production. Among various crops, cabbage stands out as a key winter vegetable, contributing significantly to household nutrition and income generation. However, the excessive use of chemical fertilizers and pesticides has resulted in soil degradation and environmental concerns, limiting the adoption of sustainable farming practices (Bhattarai et al., 2023). To address these challenges, the use of organic soil amendments such as farmyard manure, vermicompost, poultry manure and compost has gained increasing attention. These organic inputs enhance the physical, chemical and biological properties of the soil by improving nutrient availability, increasing moisture retention and promoting beneficial microbial activity (Adhikari et al., 2023). Healthier soils support better root development in cabbage, which is crucial for efficient nutrient uptake and overall plant stability (Bhattarai et al., 2023). In this context, the present study aims to evaluate the effects of different organic amendments on soil quality and cabbage yield in Bheriganga Municipality of Surkhet District. The findings are expected to contribute to the development of sustainable soil fertility management strategies and support the broader goal of promoting organic agriculture in Karnali Province.

2. MATERIALS AND METHODS

2.1 Experimental Site and Condition

The field experiment was conducted during the winter season of 2024–2025 at the research farm of the Graduate School of Agriculture and Forestry (GSAF) located in Bheriganga Municipality, Surkhet, Karnali Province, Nepal. Situated at approximately 600 meters above sea level (28.6° N latitude and 81.6° E longitude), the site experiences a tropical climate characterized by warm summers and mild winters. The area receives an average annual rainfall of 1,500 mm, primarily during the monsoon season. During the study period, mean daily temperatures ranged from 10°C to 28°C. The soil at the experimental site was loamy and slightly acidic (pH 6.12) with low levels of available nitrogen, and organic matter and became very hard when dry. The field had been prepared by clearing forest land two years prior to conducting this field experiment.

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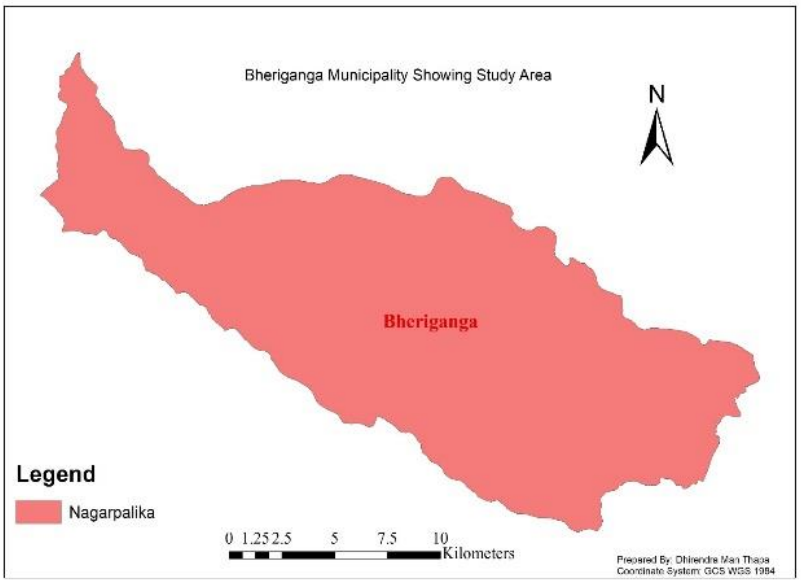

Figure 1: Map of Bheriganga Municipality, Surkhet, Nepal

2.2 Treatments and Experimental Design

The experiment was conducted using a Randomized Complete Block Design (RCBD) with four replications. Each plot measured 3 m × 2 m with 0.5 m spacing between plots to minimize edge effects and prevent treatment interference. All organic amendments were thoroughly decomposed and uniformly incorporated into the top 20 cm of soil two weeks prior to transplanting, allowing sufficient time for mineralization and ensuring nutrient availability during crop establishment.

Table 1: Organic Amendment Treatments

Treatments	Details
T_1	Farmyard manure (FYM)
T_2	Vermicompost
T_3	Poultry manure
T_4	Goat manure
T_5	Control (no amendment)

2.3 Application of Organic Amendments

Farmyard Manure (FYM) and compost were applied during land preparation at rates of 28 kg per plot and 1 kg per pit respectively. Vermicompost was applied in two split doses: 35.7 g per pit at transplanting and 37.7 g per plant at 30 days after transplanting (DAT). Jholmol, a fermented liquid organic bio-fertilizer was applied at 500 ml per plot diluted 1:4 with water during transplanting, followed by 1 liter per plant at 30 DAT diluted 1:2 with water. Control plots received no organic amendments throughout the experimental period.

2.4 Soil Collection and Parameter Test

The soil samples were collected from the trial field at a depth of 0–20 cm which represents the effective root zone for most crops. A composite sample of approximately 500 grams was prepared from the experimental area for laboratory analysis. Various soil parameters were analyzed using standard methods to determine the fertility status and chemical composition of the soil.

Table 2: Soil Parameters and Their Analytical Methods

Parameter	Test Method
Organic Matter (%)	Walkley-Black Method (Walkley and Black, 1934)
Total Nitrogen (%)	Kjeldahl Method (Bremner and Mulvaney, 1982)
Available Phosphorous (kg/ha)	Olsen Method (Olsen et al., 1954)
Available Potash (kg/ha)	Flame Photometry (Jackson, 1973)
pH	pH Meter (Thomas, 1996)
Zn (ppm)	DTPA Extraction and AAS (Lindsay and Norvell, 1978)
Cu (ppm)	DTPA Extraction and AAS (Lindsay and Norvell, 1978)
Fe (ppm)	DTPA Extraction and AAS (Lindsay and Norvell, 1978)
Mn (ppm)	DTPA Extraction and AAS (Lindsay and Norvell, 1978)

2.5 Crop Establishment and Agronomic Practices

The Green Coronet variety, widely cultivated in the mid-hill regions of Nepal, was selected. Seedlings were raised and transplanted at the 3–4 leaf stage, maintaining a spacing of 60 cm × 45 cm to ensure uniform plant population density. Five plants were randomly selected from the central area of each plot and tagged with red thread. Field management practices, including irrigation, manual weeding and Integrated Pest Management (IPM) were consistently applied across all plots throughout the growing period. No synthetic fertilizers and chemical pesticides were used to this entire area.

2.6 Measurement of Growth and Root Parameters

Growth parameters were recorded at 30, 45 and 60 days after transplanting to monitor the developmental stages of cabbage. These parameters included plant height, number of leaves per plant, leaf breadth and leaf width. Root parameters were assessed carefully and excavated from each plot to minimize root damage. The roots were thoroughly washed with distilled water to remove adhering soil particles and subsequently evaluated for root length, root volume and fresh and dry root weight. Standard agronomic procedures were strictly followed to ensure the accuracy and consistency of data collection.

2.7 Statistical Analysis

Data were analyzed using analysis of variance (ANOVA) appropriate for the RCBD design. The Least Significant Difference (LSD) at a 5 percent probability level was used to compare treatment means. The coefficient of variation (CV) was calculated to assess data variability.

3. Result and Discussion

The baseline soil test of the experimental field revealed poor fertility conditions. Organic matter and total nitrogen were found to be very low, suggesting limited soil productivity. Phosphorus and copper were not detected, indicating severe nutrient deficiencies. In contrast, the level of available potassium was extremely high pointing to an imbalance in nutrient availability. The soil pH was slightly acidic (6.12 pH) which is generally favorable for cabbage cultivation. However, micronutrients such as zinc, iron and manganese were also found to be in very low amounts. These findings emphasize the necessity of incorporating organic amendments to improve soil health and enhance agricultural productivity in the study sites.

Table 3: Soil Nutrient Status and Fertility Rating of the Experimental Field

Parameter	Status	Remarks
Organic Matter (%)	0.52	Very low
Total Nitrogen (%)	0.03	Very low
Available Phosphorous (kg/ha)	ND	Not detected
Available Potash (kg/ha)	822.7	Very high
pH	6.12	Slightly acidic
Zn (ppm)	0.107	Very low
Cu (ppm)	ND	Not detected
Fe (ppm)	0.141	Very low
Mn (ppm)	0.237	Very low

3.1 Plant Height

The application of various organic treatments influenced the height of cabbage plants measured at 30, 45, and 60 days after transplanting. Most treatments (T_1 to T_4) showed similar results, with plant height steadily increasing about 9 centimeters at 30 days to nearly 37 to 38 centimeters at 60 days. In contrast, treatment T_5 resulted in noticeably shorter plants, reaching only around 32 centimeters by 60 days. These findings suggest that the majority of the organic manures tested were effective in promoting cabbage growth compared to T_5.

Table 4: Effect of Different Organic Manures on Plant Height of Cabbage

Treatment	30 DAT	45 DAT	60 DAT
T_1	9.66a	22.28a	37.34a
T_2	9.93a	23.56a	38.66a
T_3	9.98a	23.15a	38.61a
T_4	9.27a	22.39a	37.49a
T_5	7.67b	19.72b	32.12b
LSD (0.05)	**1.54**	**3.36**	**5.34**
CV (%)	**6.86**	**7.2**	**8.37**

3.2 Number of Leaves

At 30 days, Treatment 3 (T_3) exhibited the highest number of leaves 7.9, indicating the most pronounced initial response among all treatments. Similarly, Treatment 5 (T_5) recorded the lowest value at this stage, measuring a value of 5.3. By 45 DAT, all treatments showed further improvement, with T_3 continuing to lead. Treatments 2 (T_2) and 1 (T_1) followed closely the numbers of 12.1 and 11.4 respectively. Although Treatment 5 remained the lowest value (8.8). At 60 DAT, differences between treatments became more distinct. Treatment 3 sustained its superior performance, reaching a value of 17.0. Treatments 2 and 1 followed with values of 15.8 and 14.6, while Treatments 4 (T_4) and 5 (T_5) stayed comparatively lower at values of 12.5 and 11.2 respectively. The data indicate a steady increase in the measured parameter across all treatments, with T_3 consistently outperforming the others throughout the study period.

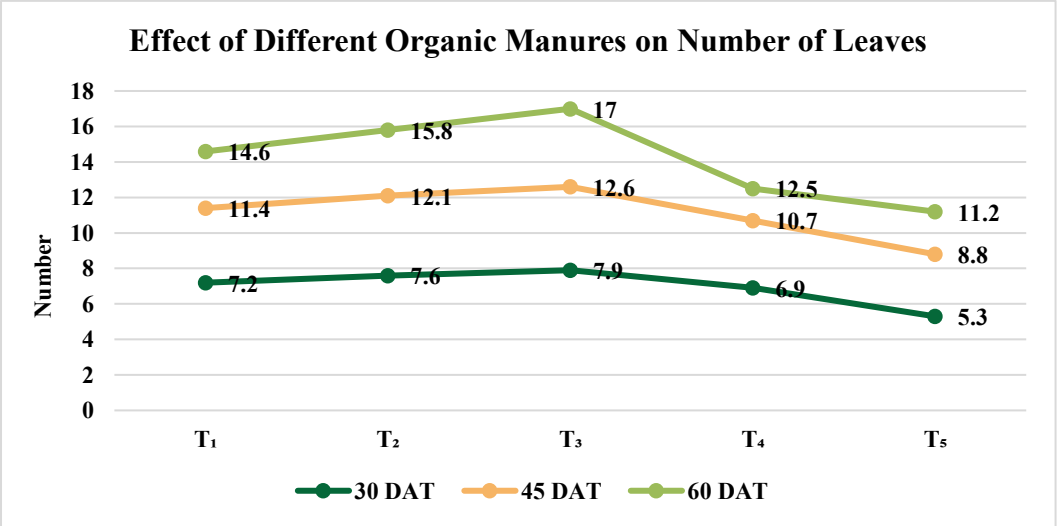

Figure 2: Effect of Different Organic Manures on Number of Leaves

3.3. Leaf Length and Breadth

At 30 DAT, Treatment 3 (T_3) exhibited the highest initial value of 12.7, closely followed by T_2 at 12.5 and T_1 at 12.1. Treatment 5 (T_5) with a value of 9.7, showed the lowest performance at this stage. By 45 DAT, a notable improvement was observed in all treatments. T_3 maintained its leading position with a value of 26.8, followed by T_2 and T_1 at 26.0 and 24.7cm respectively. T_4 also showed considerable progress, reaching 23.5 cm while treatments T_5 were lowest (18.6cm). At 60 DAT, treatment 3 achieved the highest value of 34.2cm. It was followed by T_2 (33.5cm) and T_1 (31.3cm). T_4 reached 29.7 cm whereas T_5 despite consistent growth remained at the lowest value of 23.3 cm.

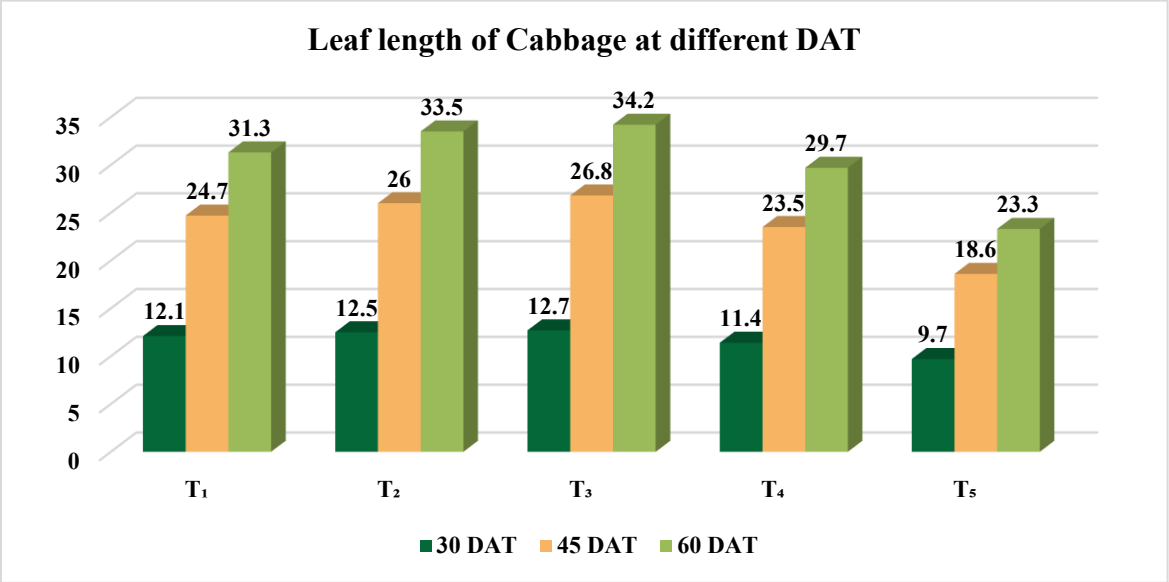

Figure 3: Effect of Different Organic Manures on Leaf Length (Cm)

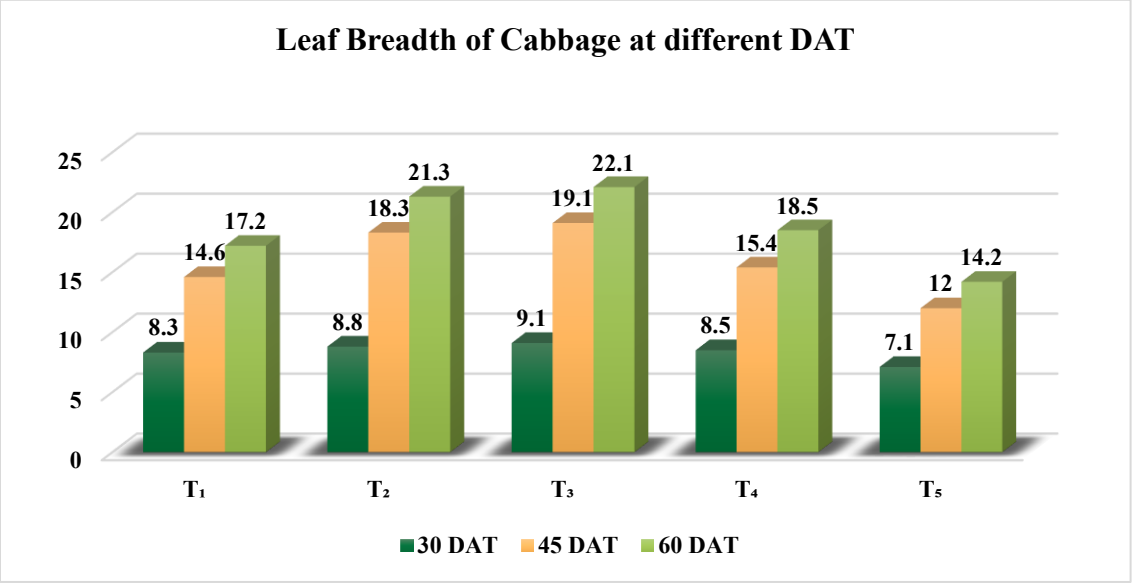

Figure 4: Effect of Different Organic Manures on Leaf Breadth (Cm)

At 30 DAT, Treatment 3 (T_3) recorded the highest value of 9.1 cm indicating the strongest initial response, while Treatment 5 (T_5) showed the lowest value of 7.1 cm. By 45 DAT, all treatments exhibited significant growth, with T_3 again leading at the value of 19.1cm. Treatment 2 (T_2) followed closely behind (18.3cm) and Treatments 1 (T_1) and 4 (T_4) recorded 14.6 and 15.4cm respectively. At 60 DAT, the differences among treatments became more distinct. Treatment 3 maintained the highest value of 22.1cm, followed by T_2 (21.3cm) and T_1 (17.2cm) respectively.

3.4 Yield and Yield Attributes

Table 5: Effect of Different Organic Manures on Head Diameter, Head Weight and Yield

Treatment	Head Diameter (cm)	Head Weight (kg)	Yield (ton/ha)
T_1	13.16 ± 0.5a	1.63 ± 0.03a	34.56 ± 0.6a
T_2	14.34 ± 0.4a	1.78 ± 0.05a	36.54 ± 0.8a
T_3	15.61 ± 0.6a	1.89 ± 0.06a	38.25 ± 0.7a
T_4	12.08 ± 0.5a	1.52 ± 0.04a	32.43 ± 0.5a
T_5	10.22 ± 0.4b	1.12 ± 0.03b	25.14 ± 0.4b
LSD (0.05)	**1.36**	**0.11**	**1.92**
CV (%)	**6.21**	**4.24**	**5.68**

3.5 Root length, Number of Fibrous Roots, Fresh Weight and Dry Weight of Roots

The maximum root length (23.1 cm) was recorded in treatment T_2, which was significantly superior among treatments, followed by T_3 (21.5 cm) and

T_1 (18.5 cm). The shortest length (14.2 cm) was observed in treatment T_5. Similarly, the number of fibrous roots was highest in T_2 (32cm), closely followed by T_3 (31cm), while the lowest number (21cm) was observed in T_5. Treatments T_2 and T_3 were significantly different from T_4 and T_5. In terms of the fresh weight of roots, treatment T_2 exhibited the highest value (22.02 g) indicating better root biomass accumulation. This was followed by T_3 (19.15 g) and T_1 (18.34 g). The minimum fresh root weight (12.08 g) was found in T_5. The trend was similar for dry root weight, where T_2 resulted in the highest dry biomass (5.78 g) which was significantly different among treatments. The lowest dry root weight was recorded in T_5 (3.32 g) indicating poor root development. The treatment T_2 consistently outperformed the other treatments across all root parameters, suggesting its effectiveness in promoting better root growth and development.

Table 6: Effect on Root Length, Number of Fibrous Roots, Fresh Weight and Dry Weight of Roots

Treatment	Root Length (cm)	Number of Fibrous Roots	Fresh Weight of Roots (g)	Dry Weight of Roots (g)
T_1	18.5	28	18.34	4.45
T_2	23.1	32	22.02	5.78
T_3	21.5	31	19.15	4.01
T_4	16.3	25	15.89	3.97
T_5	14.2	21	12.08	3.32
LSD (0.05)	**2.35**	**3.11**	**3.02**	**1.01**
CV (%)	**14.32**	**10.46**	**16.32**	**15.59**

4. Conclusion

This study revealed that organic amendments significantly enhanced soil fertility and cabbage yield in the Bheriganga Municipality of Surkhet District. The baseline soil analysis indicated deficiencies in organic matter, nitrogen and essential micronutrients. The application of organic manures, particularly poultry manure and Vermicompost, substantially improved the soil's nutrient status and promoted vigorous cabbage growth and productivity. Among the treatments, poultry manure demonstrated the highest effectiveness, resulting in increased plant height, greater leaf number and maximum head weight. Vermicompost also performed commendably, showing outcomes comparable to poultry manure. All organic amendments exhibited clear advantages over the control, underscoring their potential to rejuvenate soil health and improve crop yield under organic production systems. These findings underscore the value of incorporating locally available organic inputs as viable alternatives to chemical fertilizers. Promoting the use of such amendments can contribute significantly to sustainable soil management, organic agriculture, and food security in Karnali Province. This research provides compelling evidence to support policies and farming practices aimed at enhancing soil fertility and promoting environmentally sound agricultural development.

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