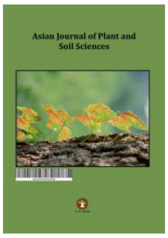

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Effects of Different Sources of Organic Manure on Growth and Yield Performance of Sweet Pepper (*Capsicum annuum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The indiscriminate use of chemical fertilizers has raised concerns about soil health and environmental sustainability. Organic manures are emerging as viable alternatives to improve soil fertility and crop productivity. This study was conducted at the Institute of Agriculture and Animal Science (IAAS), Lamjung Campus, Nepal, to evaluate the effects of different organic manures on the growth and yield of sweet pepper (*Capsicum annuum* L., variety Ganga). The experiment was

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laid out in a Complete Randomized Design (CRD) with eight treatments replicated thrice: control, vermicompost, goat manure, farmyard manure (FYM), poultry manure, bokashi compost, poultry manure + goat manure, and poultry manure + FYM. Parameters including plant height, leaf number, branch number, flowers, fruits, fruit diameter, fruit length, average fruit weight, and yield per plant were recorded. Results indicated that poultry manure significantly outperformed other treatments, recording the highest plant height (37.15 cm), leaf number (31), branch number (14), flowers (10), fruits (5.28), fruit length (8.37 cm), fruit diameter (5.8 cm), and yield (120.6 g/plant). Vermicompost and bokashi compost followed closely, while control plants showed the lowest performance. The study concludes that poultry manure is the most effective organic manure for enhancing sweet pepper growth and yield under Lamjung conditions, with vermicompost and bokashi as promising alternatives.

Keywords: Capsicum annuum; organic manure; poultry manure; vermicompost; bokashi compost; yield performance.

1. INTRODUCTION

"Sweet pepper (*Capsicum annuum* L.), a member of the *Solanaceae* family, is an important vegetable crop valued for its nutritional and economic significance. Originating from Central and South America, it spread worldwide after its introduction to Europe in the late 15th century. Unlike hot peppers, sweet peppers are non-pungent and are consumed fresh or cooked due to their rich content of vitamin C, antioxidants, and essential minerals" (Hazra et al., 2011). In Nepal, sweet pepper is increasingly cultivated under open-field and protected conditions, particularly in the mid-hills, where favorable climatic conditions support its productivity (Kunwar et al., 2024).

"Nutrient management plays a critical role in sustaining crop productivity" (Abid et al., 2010). Although chemical fertilizers boost yields, their long-term use often leads to soil degradation and environmental pollution. In contrast, organic manures such as farmyard manure (FYM), goat manure, poultry manure, vermicompost, and bokashi improve soil fertility, microbial activity, and water retention while enhancing crop yield and quality" (Tadesse et al., 2013; Seenan et al., 2018). "Studies in Nepal have shown that integrated use of organic inputs can significantly improve the growth, yield, and nutrient use efficiency of sweet pepper under polyhouse and open-field conditions" (Timilsina & Khanal, 2024; Lohani et al., 2023). However, sole reliance on organic manures may not fully meet the crop's nutrient demand, often resulting in nutrient deficiencies (Adhikari et al., 2016; Hameedi et al., 2018; Khaitov et al., 2019).

Given the growing emphasis on sustainable agriculture, research on organic nutrient sources is particularly relevant for Nepal, where resource availability and soil health vary across regions. This study was conducted to evaluate the effects of different organic manures on the growth and yield of sweet pepper, with the aim of identifying sustainable nutrient management practices suitable for Nepalese farming systems.

2. MATERIALS AND METHODS

2.1 Research Site and Conditions

The experiment was conducted during 2023 at IAAS, Lamjung Campus, Nepal (625 masl), under subtropical climatic conditions. The region experiences a monsoon season (May–October), winter (November–February), and a hot pre-monsoon period (March–April). Average temperatures range from 6–10 °C in winter to 25–35 °C in summer, with annual rainfall concentrated from June to September.

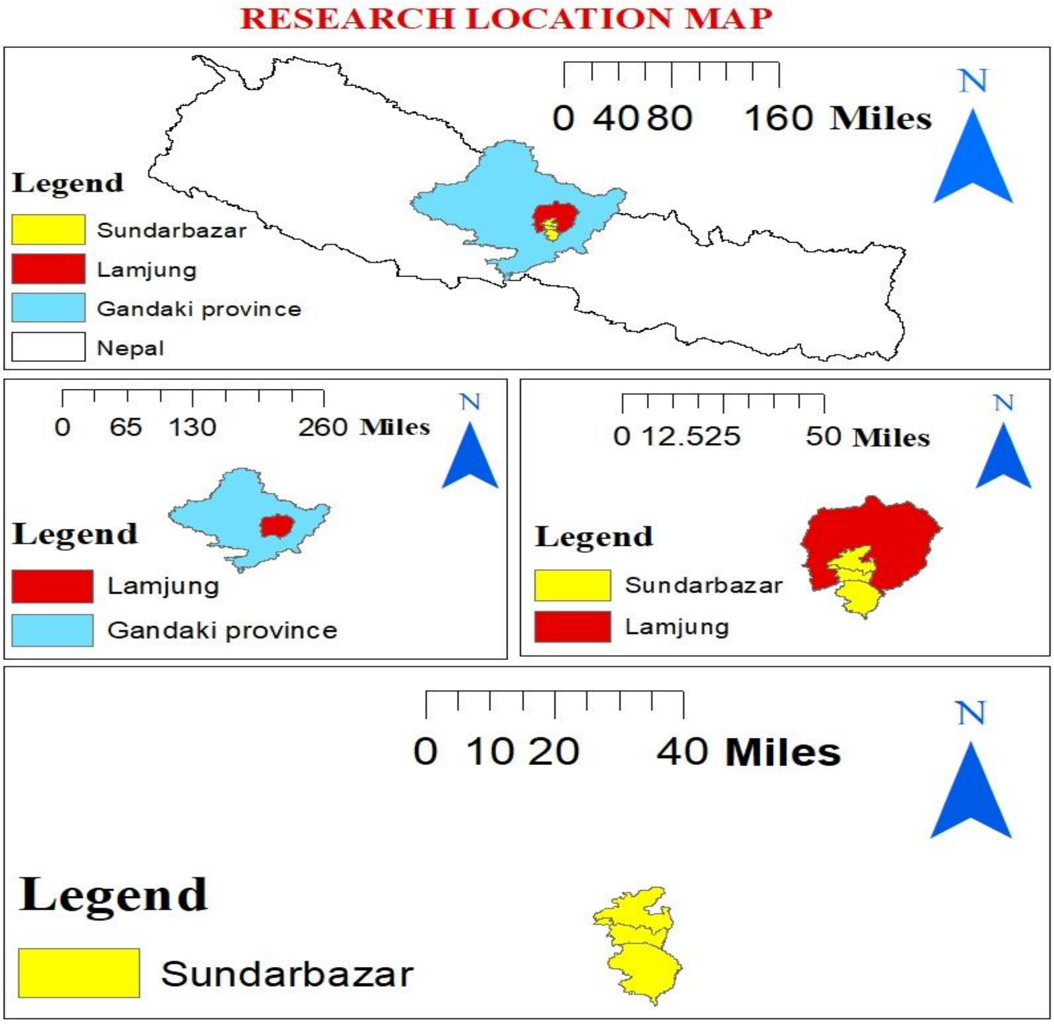
The location of experiment site is shown in Fig. 1.

2.2 Variety and Seedlings Selection

The F1 hybrid Ganga sweet pepper variety was selected for current experiment which was grown in horticulture nursery of IAAS, Lamjung campus. The robust and vigorous seedlings at 5-6 true leaf stage were selected for transplanting into the research pots.

2.3 Design of Experiment

The experiment was carried out in Complete Randomized Design (CRD) with 8 treatments replicated thrice. The treatments consisted different sources of organic manure compared to that of untreated control and chemical fertilizer.



Map. 1. Research location Map of Nepal

Source: National geoportal Nepal

2.4 Pot Filling

Soil was gathered for the experiment from the Lamjung campus's surrounding forest property. In order to make the soil fine, it was destroyed and distributed above the earth. Poultry manure, vermicompost, goat manure, farm yard manure, bokashi compost, fym + pm, and pm + gm were measured out and combined individually in the needed amounts. The plastic pot had a drainage hole in the bottom. And 24 plastic pots were filled with the prescribed amount of soil and the calculated amount of treatment.

These treatments were made during soil preparation and pot filling, then mixed with different sources of organic manure as to maintain different treatments.

Table 1. Treatment details

Treatment	Treatment details
T1	Control
T2	Vermicompost (VC)800g/pot
T3	Goat manure (GM)900g/pot
T4	Farm yard manure (FYM) 950g/pot
T5	Poultry manure (PM)900g/pot
T6	Poultry manure + Goat manure(50%PM+50%GM)
T7	Goat manure + Farm yard manure(50%GM+50%FYM)
T8	Bokashi compost (BC) 1kg/pot

T_2	T_5	T_6
T_1	T_8	T_5
T_4	T_2	T_6
T_7	T_7	T_5
T_6	T_3	T_3
T_3	T_1	T_4
T_7	T_2	T_1
T_4	T_8	T_8

Fig. 1. Layout and Randomization of CRD for 8 Treatments and 3 Replications

2.5 Cultivation Practices

2.5.1 Soil preparation and manure addition

The experiment was conducted in pots, with one plant treated in each pot for the duration of the experiment. Unneeded stubbles and plant materials were removed before taking upland soil from the orchard. Then, in order to preserve varied, soil was mixed with various sources of organic manures.

2.5.2 Weed control and plant protection

Each container was manually weeded by hand to prevent any competition from unwelcome plants. Regardless of the number of days till transplanting, weeding was done. During the establishment and expansion of the crop, little significant threats from insects or illnesses were seen. Aphid and fruit borer damage was seen during fruit production, however the impact was minimal. was negligible

2.5.3 Harvesting

First harvest was obtained from poultry manure exactly 62 days after transplanting. Fruits were harvested manually after they obtained proper size, texture and color. Then fresh weight for individual fruit was taken.

2.6 Observations

2.6.1 Plant height (cm)

Plant height was measured from plants of each pot. It was measured with the help of measuring scale from the ground level to the tip of the main shoot. It was measured at 20 DAT,40DAT and 60 DAT.

2.6.2 Days to first flowering

It is the numbers of days to first flowering of the plants within a sample plant from the date of transplanting. It was taken from day to day supervision of pots. The first flowering was seen in poultry manure within the 45 days after transplanting followed by vermicompost.

2.6.3 Days to first harvest

Numbers of days for first harvest in each plant after transplanting was observed**.**

2.6.4 Number of leaves

At 20, 40, and 60 days following transplanting, we manually counted the total number of leaves from each plant.

2.6.5 Number of branches

It is the total numbers of branches present on the each pot of panditas taken by counting the total numbers of branches of a plant. The result showed that maximum number of branches were seen in poultry manures.

2.6.6 Number of flowers

It is the number of flowers present on each plant which was observed by counting the total number of flowers from each plant at 20,40 and 60 days after transplanting.

2.6.7 Fruit length(cm)

During harvest, the mature fruits were removed from each pot and measured for length. Fruits were measured without the peduncle, from the base to the tip. Fruit length was measured by rope, which was then measured using a scale. Average fruit length was then calculated for each treatment pot.

2.6.8 Fruit diameter

The same fruit taken length. Fruits for measuring fruit length were used for calculating diameter of fruits from each treatment pot. Diameter were measured in the places of fruits at one base, mid and near tip of the fruits and averaged to get average diameter.

2.6.9 Average fruit weight

Fruits were weighed after harvest to determine their fresh weight. After harvesting, the weights were taken immediately. The typical fruit weight for each treatment was then determined for each plant.

2.6.10 Yield per plant

For the purpose of calculating the yield per plant, the total quantity of fruits produced by each plant at various harvest dates were added.

2.7 Statistical analysis

Analysis of variance (ANOVA) was performed to determine the effects of organic manures on the growth and yield of sweet pepper. Data entry was carried out in Microsoft Excel, and statistical analyses were conducted using R software (version 4.0.2). The significance of treatment effects was tested using the F-test. Mean separation was performed using the Least Significant Difference (LSD) test at a 5% level of significance. The R package “agricolae” was used for mean separation, “pastecs” for Levene’s test to check homogeneity of variance, Shapiro–Wilk test for normality assessment, and “plotrix” for calculating the standard error of the mean (SEM).

3. RESULTS

3.1 Plant Growth

Poultry manure treatment (T5) consistently produced the tallest plants across all sampling dates, reaching 37.15 cm at 60 DAT, followed by vermicompost (36.30 cm) and bokashi compost (33.11 cm). Control plants recorded the lowest height (19.95 cm).

Final plant height was different in accordance with various manures and fertilizers used.

It was found that the effect of several doses of organic manure on plant height was quite remarkable.

At 20 DAT, the most dramatic rise in plant height was obtained by applying poultry manure (12.3 cm), vermicompost (11.97 cm). The next-highest plant height came from Bokashi manure, and where there was no temperature control, raising the lowest plant heights (6.20 cm). On the trailing end of this spectrum were goat manure, farmyard manure, poultry manure + goat manure, and poultry manure + farmyard manure.

At 40 DAT with the Latvian Agricultural Academy, the same poultry manure had the highest plant height (24.55 cm) followed by vermicompost (23.99 cm). The second-best figure for plant height was Bokashi manure (22.38 cm), while control reversing then returned the lowest plant height (13.18 cm), followed by poultry manure + goat manure, goat manure, poultry manure + farmyard manure, and farmyard manure.

At 60 DAT, similar to the earlier two periods, poultry manure produced the biggest plant height (37.15 cm), followed by vermicompost (36.30 cm), Bokashi manure (33.11 cm), and control producing the lowest plant height, lastly goat manure, poultry manure + farmyard manure, farmyard manure, and poultry manure + goat manure.

The rapid release of nutrients—particularly nitrogen, the essential building block for proteins, cell division, and growth—helps explain why poultry manure and vermicompost often produce the greatest plant height among organic manures (Murugan & Swarnam, 2014; “Exploring the fertilizer value …,” 2025).

Table 2. Effect of different sources of treatments used on plant height of sweet pepper at Sundarbazar Lamjung, Nepal

Treatments	Plant height at 20 DAT (cm)	Plant height at 40 DAT (cm)	Plant height at 60 DAT (cm)
Control	6.20^{f}	13.18^{f}	19.95^{e}
Farm yard manure	8.13^{de}	16.60^{d}	25.11^{d}
Vermicompost	11.97^{a}	23.99^{a}	36.30^{a}
Poultry manure	12.3^{ab}	24.55^{a}	37.15^{a}
Goat manure	7.47^{e}	14.12^{e}	21.38^{e}

Treatments	Plant height at 20 DAT (cm)	Plant height at 40 DAT (cm)	Plant height at 60 DAT (cm)
Poultry manure + Farm yard manure	8.60^{cd}	16.21^{d}	24.55^{d}
Poultry manure + Goat manure	9.38^{c}	14.12^{c}	28.18^{c}
Bokasi Compost	11.23^{b}	22.38^{b}	33.11^{b}
F-test	***	***	***
$LSD_{(0.05)}$	1.00	0.02	0.03
Sem	0.33	1.00	1.00
CV%	2.12	1.10	1.18
Grand Mean	9.41	18.62	27.58

*The mean were separated by using Least Significant Difference (LSD) at 5% level of significance *** means highly significant and DAT means days after transplanting*

Table 3. Effect of different sources of organic manure used on leaf numbers of sweet pepper at Sundarbazar Lamjung, Nepal

Treatments	Leaf numbers at 20 DAT	Leaf number at 40 DAT	Leaf number at 60 DAT
Control	7.41^{de}	12.5^{e}	17^{g}
Farm yard manure	7.94^{de}	14.0^{de}	20^{f}
Vermicompost	13.80^{b}	21.5^{b}	29^{b}
Poultry manure	19.95^{a}	25.5^{a}	31^{a}
Goat manure	6.91^{e}	13.0^{e}	19^{f}
Poultry manure +Farm yard manure	9.77^{cd}	17.0^{c}	24^{d}
Poultry manure Goat manure	8.91^{cde}	15.5^{cd}	22^{e}
Bokasi Compost	11.77^{bc}	19.5^{b}	27^{c}
F-test	***	***	***
$LSD_{(0.05)}$	0.14	2.12	1.73
Sem	1.01	1.50	1.00
CV%	7.98	7.07	4.23
Grand Mean	10.23	17.31	23.63

*mean were separated by using Least Significant Difference(LSD) at 5% level of significance. *** means highly significant and DAT means days after transplanting.*

Information on how many leaves each plant produced in capsicum is detailed in Table 2. The table reveals that the number of leaves produced is significantly affected by the application of different organic manures.

Goat manures, without manure, the lowest number of leaves produced happened to be found in the control capsicum plant. On the other hand, poultry manure treatment produced the highest number of leaves, followed by vermicompost and bokashi. It is possible that the nitrogen of poultry manure used in this treatment provided necessary nutrients for the capsicum plant, increasing chlorophyll content.

This is also reflected in the fact that nitrogen is a constituent of the chlorophyll molecule; on one hand, it is essential for starch in leaves and amino synthesis on the other (Amalitos, 2018). The results are concordant with figures from (Atta et al., 2020).

With reference to capsicum, Bolan *et al*; (2010) found that plant performance was positively correlated with manure. As nitrogen is a component of chlorophyll, it plays a pressing role in protein and amino synthesis, which contributes to the perfect atmosphere and nutrient conditions owing to increased numbers of leaves.

Based on the results, the results are remarkably similar to those reported by (Deore et al., 2010). Ascending levels of liquid organic nitrogen increased the number of leaves per plant.

Table 4 demonstrates that there was a substantial variation in the number of branches seen under various applications of organic fertiliser. After 20 days of transplanting, no branches had appeared since The sweet pepper's branching process takes 3–4 weeks.

Table 4. Effect of different sources of organic manure on branch number of sweet pepper at Sundarbazar Lamjung, Nepal

Treatments	BN at20 DAT	BN at40 DAT	BN at60 DAT
Control	-	2^{g}	6^{f}
Farm yard manure	-	4^{ef}	8^{de}
Vermicompost	-	8^{ab}	13^{ab}
Poultry manure	-	9^{a}	14^{a}
Goat manure	-	3^{fg}	7^{ef}
Poultry manure +Farm yard manure	-	6^{cd}	10^{c}
Poultry manure Goat manure	-	5^{de}	9^{cd}
Bokasi Compost	-	7^{bc}	12^{b}
F-test	-	***	***
$LSD_{(0.05)}$	-	1.73	1.73

*Mean were separated by using Least Significant Difference(LSD) at 5% level of significance.*** means highly significant and DAT means days after transplanting*

The control capsicum plant has the fewest branches (2, 6) at 40 and 60 days after transplanting per plant respectively. On the other hand, treatment of chicken manure resulted in the greatest number of branches (9,14) followed by vermicompost (8,13) and bokashi manure (7 ,12) at 40 and 60 days after transplanting per plant respectively.

The majority of macro- and micronutrients are present in the applied poultry manure, and the recommended NPK dose gives the plant nutrients and has a large impact on the number of branches per plant.

Because it stimulates vegetative development, the nitrogen provided by poultry manure had a considerable impact on the number of branches per plant. Tumbare and Bhoite (2002) reported a comparable outcome (Khandaker & Rohani, 2017).

3.2 Reproductive Traits

Poultry manure also led to the highest reproductive performance, producing the maximum flowers (10/plant) and fruits (5.28/plant), followed by vermicompost (9 flowers, 4.3 fruits) and bokashi compost (8 flowers, 3.83 fruits). Control treatment had the lowest reproductive traits.

As shown in Table 5, It looks like the number of flowers was highest in the poultry manure (10) treatment plant, then followed by vermicompost (9) and bokashi (8) treatment plants, while control produced the fewest flowers (3), together with pm + fym (6) and pm + gm (7) (see Table 5). The increased number of flowers per plant may be traced back to the translocation of plant nutrients from roots to aerial parts by PM application to a certain extent. After an adequate supply of nutrients is provided, this increased blossoming could also be seen as a result of large amounts of calcium (Ca), magnesium (Mg), zinc (Zn), and manganese (Mn) in poultry manure, which can lead to more branches with flowers per capsicum plant (more branching leads to shorter fruit-set days). By adding poultry manure, the plant nutrients are further dissolved, thus maximizing the uptake rates of nitrogen, phosphorus, and potassium, resulting in the highest number of flowers per plant (Atta et al., 2020). The results have been corroborated by the study of Atta et al. (2020).

The maximum fresh weight yield of 120.60g per plant was recorded in the treatment poultry manure (T4) followed by vermicompost (115.53g). Fresh weight yield obtained from the application of treatment (pm +fym) and (pm +gm) were similar and the lowest fresh weight yield of 82.55g per plant was recorded in treatment control(T1).

Table 5. Effect of different sources of organic manures on numbers of flowers and fruits of sweet pepper at Sundarbazar Lamjung, Nepal

Treatments	FLN	FRN
Control	3^{g}	1.21^{g}
Farm yard manure	5^{ef}	1.95^{f}
Vermicompost	9^{ab}	4.3^{b}

Treatments	FLN	FRN
Poultry manure	10[a]	5.28[a]
Goat manure	4[fg]	1.72[f]
Poultry manure +Farm yard manure	6[de]	2.39[e]
Poultry manure + Goat manure	7[cd]	2.70[d]
Bokasi Compost	8[bc]	3.83[c]
F-test	***	***
$LSD_{(0.05)}$	1.73	0.30
Sem	1.00	0.03
CV%	15.38	6.01
Grand Mean	6.50	2.88

*mean were separated by using Least Significant Difference(LSD) at 5% level of significance .*** means highly significant and DAT means days after transplanting: number of flowers, FRN: number of fruits .*

Table 6. Effect of different sources of organic manures on fruit yield per treatment of sweet pepper at Sundarbazar Lamjung, Nepal

Treatments	FY
Control	82.55[e]
Farm yard manure	105.37[cd]
Vermicompost	115.53[ab]
Poultry manure	120.60[a]
Goat manure	97.12[d]
Poultry manure +Farm yard manure	110.53[bc]
Poultry manure + Goat manure	108.50[bc]
Bokasi Compost	113.67[abc]
F-test	***
$LSD_{(0.05)}$	8.92
Sem	1.39
CV%	4.83
Grand Mean	106.73

*mean were separated by using Least Significant Difference(LSD) at 5% level of significance .*** means highly significant and DAT means days after transplanting, FY:Fruit yield.*

Table 7. Effect of different sources of organic manure on fruit diameter and length of sweet pepper at Sundarbazar Lamjung, Nepal

Treatments	Fruit diameter	Fruit length
Control	3.2[h]	5.77[h]
FYM	3.7[f]	6.47[f]
Vermicompost	5.6[b]	8.06[b]
Poultry manure	5.8[a]	8.37[a]
Goat manure	3.5[g]	6.17[g]
Poultry manure +Farm yard manure	4.6[e]	6.97[e]
Poultry manure + Goat manure	5.0[d]	7.4[d]
Bokasi Compost	5.3[c]	7.80[c]
F-test	***	***
$LSD_{(0.05)}$	0.17	0.24
Sem	0.01	0.02
CV%	2.18	1.98
Grand Mean	4.59	17.12

*mean were separated by using Least Significant Difference(LSD) at 5% level of significance .*** means highly significant and DAT means days after transplanting.*

The production yields would be different for different treatments. In this sense, the treatments receiving poultry manure produce a higher number of fruits (5.2), followed by vermicompost (4.3) or mimicking nature through Bokashi (3.83); those plants with no supplementary treatment produce fewer on average (1.21) (from Table 5).

The highest number of fruits per plant (Khan et al., 2014) noted the highest fruit production is probably due to the vigor of the plant and more number of leaves per plant. Higher fruit production is closely related to high flower production, high fruit set rates, and less flower and fruit shedding than low-yielding plants. In addition, the increased C/N ratio and higher plant metabolism may be responsible for this.

Fruit diameter: Application of poultry manure recorded highest fruit diameter of 5.8cm followed by vermicompost (5.6cm) and bokashi(5.3cm) while control recorded least fruit diameter (3.2cm).

According to the Khandaker & Rohani, (2017), vermicompost gave the higher fruit diameter due to an improvement in fruit size with increasing nitrogen contents in organic manure

Fruit length: The maximum fruit length of 8.37 cm was recorded in the treatment poultry manure which was followed by vermicompost 8.06 cm both are statistically at par with each other. Fym, pm +fym and goat manure are statistically par with each other. The least fruit length of 5.77cm was recorded in the treatment control. According to (Ghimire et al., 2013) Fruit length was the highest (8.92 cm) with FYM 50% + urea 50% followed by vermicompost 100% (8.65cm) and vermicompost 50% + urea 50% (8.5 cm) due to improved N availability during early stage of growth increased pepper fruit size and length.

4. DISCUSSION

“The present findings confirm that at Tibetan middle and low altitudes, poultry manure proved more effective than other organic manures in enhancing the growth and productivity of sweet pepper. Its superiority can be attributed to its high nitrogen content, which is essential for protein synthesis, cell division, and chlorophyll formation. Nitrogen availability directly supports vigorous vegetative growth, enhanced leaf area development, and reproductive structural changes that ultimately contribute to higher yields. Similar results have been reported in Nepal and elsewhere, where poultry manure supplied readily available nutrients that stimulated rapid plant growth and yield improvement” (Timilsina & Khanal, 2024; Murugan & Swarnam, 2014; Shehu, 2019).
“Vermicompost also demonstrated a significant positive effect on crop performance. This can be linked to its high organic matter content and the presence of humic substances, which improve soil aggregation, water retention, and nutrient uptake efficiency” (Seenan et al., 2018; Ahmadi & Akbari, 2021). Vermicompost additionally contains plant growth-promoting hormones and microbial metabolites, which enhance root development, photosynthetic activity, and fruit set, resulting in improved fruit quality and antioxidant activity (Aminifard & Bayat, 2017; Rikza, 2021).

Bokashi compost, while slower in immediate nutrient release compared with poultry manure, contributed to improved yield attributes by enhancing soil microbial biomass and nutrient cycling processes. Its fermentation-based preparation enriches beneficial microorganisms, increases nutrient availability, and enhances soil porosity, thereby supporting long-term soil fertility (Álvarez-Solís & Jones, 2016; Utami et al., 2021). Although its fertilizer properties are less potent than poultry manure, the balanced nutrient release pattern and stimulation of microbial activity make bokashi a valuable amendment for sustainable production systems.

In contrast, goat manure and farmyard manure (FYM) showed comparatively limited effects in pot culture conditions. This may be attributed to their slower mineralization rates, which result in delayed nutrient availability to the crop during critical growth stages (Khanal, 2018; Awodun, 2007). While these manures improve soil structure and organic matter over the long term, their nutrient release dynamics may not align with the immediate nutrient demands of high-value crops like sweet pepper (Subbiah et al., 1982; Tadesse et al., 2013; Jamir et al., 2017; Muradi & Singh, 2023).

Overall, the results emphasize that nutrient release dynamics strongly influence crop response to organic manures. Poultry manure and vermicompost appear more effective in meeting short-term nutrient requirements and promoting yield, while bokashi supports soil health and long-term sustainability. The integration of these organic sources, potentially in combination with limited inorganic fertilizers, could optimize nutrient use efficiency, sustain soil fertility, and ensure high productivity in sweet pepper cultivation under Nepalese conditions.

5. CONCLUSION

This study demonstrated that sweet pepper production can be significantly enhanced through the application of organic manures, particularly chicken manure and bokashi compost. Among the treatments, poultry manure contributed the most to plant growth, fruit quality, and overall yield, owing to its higher nutrient availability and faster mineralization rate. Bokashi compost and vermicompost also played important roles by improving soil health, microbial activity, and sustaining nutrient supply.

For Nepal's mid-hill regions, where sweet pepper is an emerging high-value crop, chicken manure appears to be the most effective and practical source of organic nutrients. However, integrating it with other farm-produced resources such as bokashi and vermicompost could further enhance soil fertility and long-term productivity. Utilizing these locally available organic inputs offers a low-cost, eco-friendly alternative to chemical fertilizers, reduces dependence on external inputs, and lays a strong foundation for sustainable and resilient cropping systems in Nepal.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of this manuscript. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

Details of the AI usage are given below:

1. When writing a manuscript, ChatGPT is used to search a new publications and make the language clear and comprehensible.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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