

# GROWTH AND YIELD RESPONSE OF SWEET PEPPER TO DIFFERENT TYPES OF ORGANIC MANURE

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## Abstract

Having the role of organic amendments in improving soil structure, nutrient retention, and plant growth, it is important to evaluate their combined application with fertilizers to enhance productivity of sweet pepper. With this idea, a field experiment was conducted from November 2023 to April 2024 in a randomized complete block design (RCBD) with three replications to evaluate the impact of different organic manure with fertilizers on the growth and yield of sweet pepper. The treatments were T<sub>1</sub>: control, T<sub>2</sub>: Recommended dose of fertilizers (RDF), T<sub>3</sub>: Vermicompost (VC) @ 5 t ha<sup>-1</sup> + RDF, T<sub>4</sub>: Poultry manure (PM) @ 5 t ha<sup>-1</sup> + RDF, T<sub>5</sub>: Rice straw (RS) @ 5 t ha<sup>-1</sup> +RDF, T<sub>6</sub>: Oilcake (OC) @ 5 t ha<sup>-1</sup> +RDF. The results indicate that application of VC along with fertilizer (T<sub>3</sub>) produced significantly the highest number of branches (18.2), number of fruits per plant (16), individual fruit weight (63.1 g), and fruit yield (9.1 t ha<sup>-1</sup>) of sweet pepper. T<sub>3</sub> treatment also required least number of days to initiate flowers (25 days) and fruits (55 days) compared to the others. Hence, application of vermicompost and chemical fertilizers together performed well in enhancing the growth and yield of sweet pepper.

**Keywords:** Fertilizers, Oilcake, Poultry manure, rice straw, Sweet pepper, Vermicompost

## 1. Introduction

Sweet pepper (*Capsicum annum* L.) has emerged as one of the most prospective profitable non-traditional crops in Bangladesh. It is a vegetable from the Solanaceae family and valued globally for its rich nutritional content and economic importance. Sweet peppers are different from regular hot peppers in terms of fruit size and shape, capsaicin concentration, and utilization (Adhikari *et al.*, 2016). It is relatively non pungent or less pungent in taste. Its charming appearance with diversified color (red, green, yellow) attracts both producers and consumers. Sweet Pepper fruits are rich in calories (100 g provide about 30 calories), fat, vitamin C, polyphenols, chlorophylls, carotenoids, sugars, as well as flavonoids (lutein, zeaxanthin, and cryptoxanthin) and potent antioxidants (Younes and Mustafa, 2024). In our country, it is popularly known as capsicum and widely used in a variety of dishes, including salads, noodles, and soups (Kumari and Kaushal, 2014). Its cultivation was formerly restricted to upscale restaurants and commercial markets, but it is now widespread across the nation due to expanding urbanization, high price, growing health consciousness,

and the emergence of continental and multicultural cuisines (Ahmed *et al.*, 2022). Under ideal conditions, the yield sweet pepper ranged from 25 to 35 t ha<sup>-1</sup> which generates a net return far more than that of country's typical vegetables (Daily Sun, 2022). Due to its high market values, sweet pepper cultivation is becoming a lucrative venture for commercial producers and an integral component of Bangladesh's agricultural diversification and export potential (The Business Standard, 2025).

Plant growth, development, and fruit production significantly relied on the choice of nutrient sources and their balanced application (Satyanarayana *et al.*, 2002; Alam *et al.*, 2023). Chemical fertilizers are thought to be a key source of plant nutrients. But their overuses lead to significant crop production expenses as well as degradation of soil fertility and contamination of agro-eco system (Singh and Ryan, 2015; Rahman *et al.*, 2024). Sustainable soil health is a prerequisite for ensuring higher yields and quality production (Khanam *et al.*, 2024). The addition of organic materials such as crop residues, animal manures, green manures to soils not only improves the physical properties but also promotes the release of nutrients. According to Myint *et al.*, (2010), Organic manures have been proven to improve the soil fertility and health with the reduction of the demand for chemical fertilizers as they can supply the plant with essential nutrients upon decomposition (Binte *et al.*, 2021; Rahman *et al.*, 2020). The yield and quality can be raised with the application of organic and inorganic fertilizers in a balanced manner (Alkharpotly, 2018). It was hypothesized that integrated application of organic manures with chemical fertilizers will improve soil health, enhance nutrient availability, and increase the growth, yield, and quality of sweet pepper compared to sole application of chemical fertilizers. Therefore, the field study was designed to explore the effect of organic manures integrated with chemical fertilizers on growth and yield of sweet pepper. It is expected that integrated fertilizer management increased sweet pepper growth, yield, and fruit quality through balanced nutrient supply.

## 2. Materials and Methods

### 2.1 Experiment description

A field experiment was conducted during growing season of 2023-2024 at Gazipur Agricultural university, Gazipur to explore the effect of various organic manures on growth and yield of sweet pepper. The soil was shallow red brown terrace soil under the agroecological zone Madhupur Tract (AEZ 28). The soil texture was silty loam having pH 5.65, organic carbon 0.77%, total nitrogen (TN) 0.098%, phosphorus (P) 7.56 mg kg<sup>-1</sup> and sulfur (S) 26.32 mg kg<sup>-1</sup>. Soil basic cations calcium (Ca), magnesium (Mg) and potassium (K) contents were 1.42, 1.67 and 0.13 cmol(+)kg<sup>-1</sup>, respectively. The 'BARI Capsicum I' was used as the test crop in this experiment. Seeds were sown in the well-drained seedbeds at 1-2 cm distance. Before sowing, the seeds were soaked in water for 12 hours. Seven to ten days after sowing, seedlings having 3-4 leaves were transferred in the separate poly bags. The experimental field was divided into 2 m × 1.5 m plots maintaining a distance of 1 m from one plot to another. To

stop irrigation water from running off laterally, each plot was creating a ridge that was 20 cm high. Healthy and uniform sized 35 days old seedlings were transplanted in the experimental plot on 18th December, 2023 at a spacing of 45 cm × 45 cm. Each plot had three rows with four plants in each row. All the intercultural operations were performed as per standard methods and procedures. Harvesting was done by following standard procedure.

## 1.2 Experimental design and treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three (03) replications. The treatments of the experiment were as follows:  $T_1$ : Control;  $T_2$ : Recommended dose of chemical fertilizers (RDF);  $T_3$ : Vermicompost (VC) @ 5 t ha<sup>-1</sup> + RDF;  $T_4$ : Poultry manure (PM) @ 5 t ha<sup>-1</sup> + RDF;  $T_5$ : Rice straw (RS) @ 5 t ha<sup>-1</sup> + RDF;  $T_6$ : Oil cake (OC) @ 5 t ha<sup>-1</sup> + RDF. Vermicompost was collected from Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh. On the other hand, poultry manure, rice straw and oil cake were collected from the farmer's farm nearby GAU. Decomposed organic manures were applied in the field 7 days before transplanting. The required amount of urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum and Zinc Oxide as the source of N, P, K, S, and Zn were applied at the rates of 140, 78, 148, 25 and 1 kg ha<sup>-1</sup>, respectively as prescribed by Horticulture Research Center of Bangladesh Agricultural Research Institute (BARI, 2014). The whole amount of P, K, S, Zn and one third of N were broadcast and thoroughly incorporated into the soil at the time of final land preparation and the remaining two third of N was top dressed in two equal installations at 15 and 35 days after transplanting.

## 2.3 Data collection and statistical analysis

The data pertaining to the following characters were recorded from randomly selected 5 capsicum plants. The collected data were plant height (cm), number of branches per plant, SPAD value, days to first flowering, days to first fruit set, days to first harvest, fruit length (cm), fruit weight (g), fruit diameter (cm), fruit yield (t ha<sup>-1</sup>). Data were analyzed statistically with the help of computer package R software (version 4.0.3) in R Studio (version 1.3.1093). The mean differences of the treatments were observed by Tukey's honest significant difference (HSD) test at 5% level of probability for the interpretation of results.

## 3. Results and Discussion

### 3.1 Effect of organic manure on the growth of sweet pepper

The plant height, number of branches per plant and SPAD of leaves (Soil Plant Analysis Development) of sweet pepper was significantly influenced ( $p < 0.05$ ) by the application of organic manures in combination with inorganic fertilizers (Table 1). The longest plant of 43.6 cm was recorded in treatment  $T_5$  (Rice straw @ 5 t ha<sup>-1</sup> + RDF), which was statistically equivalent to treatments  $T_4$  (40.06 cm) and  $T_3$  (39.06 cm). In contrast, the shortest plants, with an average height of 28.2 cm, were observed in the control treatment ( $T_1$ ), which received no

organic manure and fertilizer, followed by treatment  $T_2$ , which get only RDF (recommended dose of fertilizers). Rice straw is known to contain essential nutrients such as nitrogen, phosphorus, and potassium, which play a critical role in promoting plant growth and development (Gaihre *et al.*, 2016). These nutrients likely released continuously throughout the crop's growth cycle upon decomposition and contributed to the enhanced plant height. Similarly, Rahman *et al.*, (2024) reported that the growth performance of Boro rice was significantly improved when poultry manure was applied in combination with inorganic fertilizers compared to the use of inorganic fertilizers alone. A significant variation ( $p < 0.05$ ) was also observed in the number of branches per plant following the application of organic manures combined with synthetic chemical fertilizers (Table 1). The treatment  $T_3$  (Vermicompost @ 5 t ha<sup>-1</sup> + RDF) resulted in profuse number of branches (17.73) subsequent to the treatment  $T_5$  (16.27),  $T_4$  (15.73) and  $T_6$  (15.40), respectively and the minimal number of branches (10.33) was noticed in the control treatment ( $T_1$ ), which was statistically similar to the RDF treatment ( $T_2$ ). The use of vermicompost has been shown to increase branching because of its rich nutrient profile, natural plant growth hormones like cytokinin and auxins that promote cell elongation and division required for vigorous plant growth. These findings align with those of Jamir *et al.*, (2017), who reported that *Capsicum annuum* L. plants treated with vermicompost exhibited a significantly higher number of branches than plants grown without any fertilizers. The application of organic amendments combined with inorganic fertilizers exerted positive effect on the SPAD values of sweet pepper leaves. The highest SPAD value (55.89) was generated in treatment  $T_3$  (Vermicompost @ 5 t ha<sup>-1</sup> + RDF), statistically at par with  $T_4$  (54.64) and  $T_5$  (54.48) treatments. Conversely, the lowest SPAD value of 47.66 was recorded in the control treatment ( $T_1$ ), which did not receive any organic manure and mineral fertilizers. The SPAD value is an index that measure the amount of leaf chlorophyll content. The consistent release of nitrogen and other vital nutrients from organic sources promoted prolonged chlorophyll production which is responsible for the higher SPAD values in treatments receiving organic manures in addition to inorganic fertilizers. These findings are consistent with the results reported by (Binte *et al.*, 2021) who found that organic amendments such as cow dung and dairy manure substantially enhanced SPAD values. The addition of various organic manures with mineral fertilizers had a considerable influence on the flowering, fruit setting and harvesting of sweet pepper fruits. In case of initiation of flowering, the prolonged duration was observed in the control treatment ( $T_1$ ), which took 41 days to exhibit its first flower while the  $T_3$  (vermicompost @ 5 t ha<sup>-1</sup> + RDF) treatment required only 25 days. Likewise, the control treatment ( $T_1$ ) needed more days (76 days) to start fruiting, indicating a delayed reproductive response in the absence of nutrient supplementation. On the other hand, rice straw @ 5 t ha<sup>-1</sup> + RDF ( $T_5$ ) initiated fruits within 52.67 days undermining same statistical category with the treatments  $T_4$  (54 days),  $T_3$  (55 days), and  $T_6$  (56 days). The treatments that received organic manures along with inorganic fertilizers specifically  $T_3$ ,  $T_4$ ,  $T_5$ , and  $T_6$  attained mature fruits ready for harvesting earlier than the control ( $T_1$ ), and inorganically fertilized treatments ( $T_2$ ) which required 95 and 91 days respectively. These results indicated that organic amendments significantly accelerated the onset of flowering,

fruiting and harvesting in comparison with the control and solely inorganic fertilized treatments. This improved reproductive performance of sweet pepper was explained by the synergistic benefits from readily available nutrients from chemical fertilizers and the gradual nutrient release, improved soil structure, enhanced microbial activity and plant growth-promoting substances driven by organic manures. The balanced and sustained supply of essential nutrients throughout the growing period making integrated nutrient management more effective than using either fertilizer alone.

**Table 1.** The growth characters of sweet pepper plant as influenced by different manure

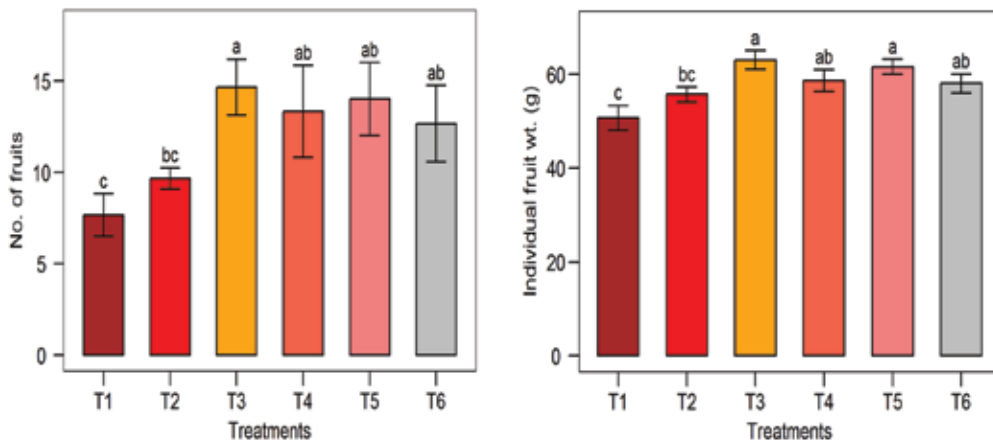
Treatments	Plant height (cm)	No. of branches	SPAD value	Days to first flowering	Days to first fruit set	Days to first harvest
T <sub>1</sub>	29.73 d	10.33 d	47.66 c	41.33 a	76.00 a	95.00 a
T <sub>2</sub>	33.87 c	12.53 c	51.15 b	37.00 b	65.67 b	91.00 b
T <sub>3</sub>	39.06 ab	17.73 a	54.89 a	25.33 d	55.00 c	84.00 c
T <sub>4</sub>	40.06 ab	15.73 b	54.64 a	28.67 c	55.33 c	84.00 c
T <sub>5</sub>	42.06 a	16.27 b	54.48 a	29.33 c	52.67 c	84.00 c
T <sub>6</sub>	37.47 bc	15.40 b	53.43 ab	30.67 c	56.00 c	84.00 c
<i>S.E.</i> (±)	1.63	0.49	1.19	1.23	1.60	1.41
CV%	5.38	4.14	2.77	4.69	3.27	1.98

Means followed by similar letter are not significantly different at 5% level of probability by Tukey HSD. **T<sub>1</sub>**: Control, **T<sub>2</sub>**: 100% recommended dose of fertilizers (RDF), **T<sub>3</sub>**: Vermicompost (5 t ha<sup>-1</sup>) + RDF, **T<sub>4</sub>**: Poultry Manure (5 t ha<sup>-1</sup>) + RDF, **T<sub>5</sub>**: Rice straw (5 t ha<sup>-1</sup>) + RDF, **T<sub>6</sub>**: Oil cake (5 t ha<sup>-1</sup>) + RDF.

### 3.2 The yield attributes of sweet pepper as influenced by different manure

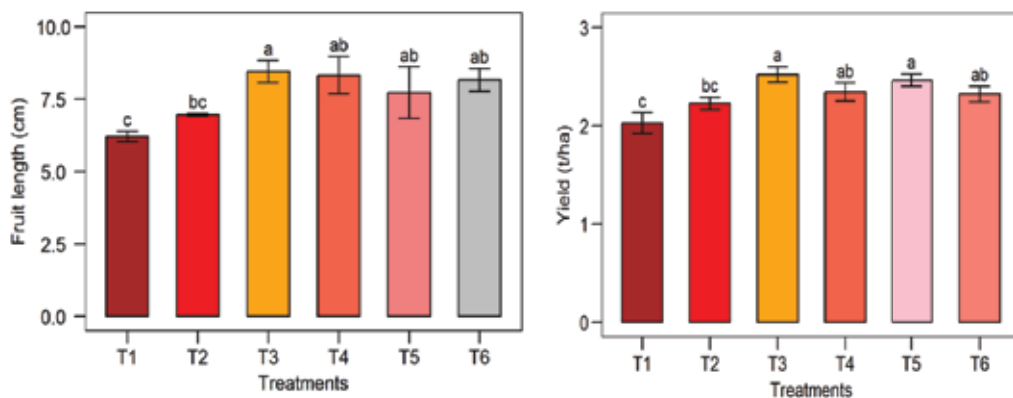
The yield traits of sweet pepper were estimated as number of fruits per plant, fruit weight (g), fruit length (cm) and fruit yield (t ha<sup>-1</sup>) shown by Fig. 1. The number of fruits per plant was markedly influenced by the dual application of organic manures along with recommended dose of chemical fertilizers (Fig. 1a). The maximum number of fruits (15) was yielded from treatment T<sub>3</sub> (vermicompost @ 5 t ha<sup>-1</sup> + RDF), keeping statistically equivalency with T<sub>5</sub> (14), T<sub>4</sub> (13), and T<sub>6</sub> (12) treatments

while the control treatment ( $T_1$ ), produced the minimum number of fruits per plant (7). Similarly, Fig. 1b. clearly showed that fruit weight of sweet pepper was significantly affected by the different nutrient treatments ( $p < 0.05$ ).  $T_3$  (vermicompost @ 5 t ha<sup>-1</sup> + RDF) treatment was resulted in the heaviest fruit (63.08 g) compared to others maintaining in the same statistical group with  $T_5$  (61.62g),  $T_4$  (58.63g) and  $T_6$  (58.07g) treatments and the lightest fruits (50.7 g) were collected from the control plot ( $T_1$ ), which received no organic and inorganic sources. The simultaneous application of organic manures with mineral fertilizers significantly enhanced the fruit length of sweet pepper as illustrated by Fig. 1c. Among the various treatments,  $T_3$  (vermicompost @ 5 t ha<sup>-1</sup> + RDF) had the largest fruits, approximately 8.46 cm in length, which was statistically alike to  $T_4$  (8.33 cm),  $T_6$  (8.16 cm) and  $T_5$  (7.73 cm) treatments. However, the control treatment ( $T_1$ ), which was free from any organic and inorganic fertilization, produced the shortest fruits (6.21 cm). The highest number of fruits per plant, fruit weight (g) and fruit length (cm) contributed to the significantly greatest fruit yield (2.52 t ha<sup>-1</sup>) in vermicompost added plots with recommended dose of chemical fertilizers ( $T_3$ ) followed by others organically treated plots viz.  $T_5$  (2.46 t ha<sup>-1</sup>),  $T_4$  (2.34 t ha<sup>-1</sup>) and  $T_6$  (2.32 t ha<sup>-1</sup>) which were remaining in the same statistical classification (Fig. 1d). Similarly, the control treatment (2.03 t ha<sup>-1</sup>), then only inorganically fertilized treatment (2.15 t ha<sup>-1</sup>) yielded lowest, due to the absence of organic sources. These findings suggested that plant yield benefited positively from all sources of applied organic amendments. In particular, vermicompost is essential for enhancing the nutrient dynamics, structure, and biological activity of soil. When it is applied, it improves microbial proliferation, root development, and uptake of nutrients by plants. These enhancements directly lead to higher total output including greater fruit size, higher fruit set, and increased vegetative development. Additionally, organic manures enhance aeration, moisture retention, and porosity of the soil which might boost the physiological performance and production of the plant. These findings are in agreement with Hameeda *et al.*, (2007), who emphasized the role of organic fertilization in enhancing nutrient availability and crop yield. Likewise, Sharma *et al.*, (2022) reported significantly higher fruit yields in kiwi when organic manures were incorporated, underlining the broad applicability and effectiveness of integrated nutrient management strategies across diverse horticultural crops.



(a) Number of fruits per plant

(b) Weight of individual fruit (g)



(c) Fruit length (cm)

(d) Fruit yield (t ha<sup>-1</sup>)

**Fig. 1** Yield attributes of sweet pepper as influenced by different manure in combination with c fertilizers. Means followed by similar letter are not significantly different at 5% level of probability by Tukey HSD. **T<sub>1</sub>**: Control, **T<sub>2</sub>**: 100% recommended dose of fertilizers (RDF), **T<sub>3</sub>**: Vermicompost (5 t ha<sup>-1</sup>) + RDF, **T<sub>4</sub>**: Poultry Manure (5 t ha<sup>-1</sup>) + RDF, **T<sub>5</sub>**: Rice straw (5 t ha<sup>-1</sup>) + RDF, **T<sub>6</sub>**: Oil cake (5 t ha<sup>-1</sup>) + RDF. Error bar indicates (± S.E.)

## 4. Conclusions

Combined application of organic amendments with chemical fertilizers had a significant positive impact on the production of sweet pepper. Application of vermicompost @ 5 t ha<sup>-1</sup> with chemical fertilizers showed better performance on the improvement of growth and yield of capsicum. The study demonstrates that integrating vermicompost with recommended chemical fertilizers significantly improves growth, accelerates flowering and fruiting, and maximizes sweet pepper yield, offering an effective and sustainable nutrient management strategy for vegetable production.

## Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this paper.

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