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GROWTH AND YIELD PERFORMANCE OF TOMATO (*SOLANUM LYCOPERSICUM* L.) SWAYED BY MULCHING AND ORGANIC FERTILIZERS

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Keywords: growth and yields of tomato, mulching, mustard oil cake, poultry manure, vermicompost

Abstract

The utilization of organic fertilizers is currently on the rise to sustain higher food quality while minimizing environmental pollution. Mulching with organic materials maintains soil physical conditions, crucial for realizing a crop's genetic yield potential even when all other requirements are met. Hence, a field experiment was conducted to investigate the effects of mustard oil cake (MOC), poultry manure (PM) and vermicompost (V) alone and in combination with mulching (Mu) on growth and yield parameters of Tomato. Significant increases were ($p \leq 0.05$) observed in plant height, leaf number, leaf area, stem girth, root length and root girth of tomato plants compared to the control (T_1), where no fertilizers were applied. At 90 days after transplantation (DAT), the T_9 (V_8Mu_0) treatment resulted in the highest plant height (142 cm) and the longest root length (25 cm) while the maximum quantity of fresh weight (154.63 g plant^{-1}) for tomato plant was obtained from the treatment T_6, which received vermicompost at 4 t ha^{-1} with mulching. Application of poultry manure at the rate of 8 t ha^{-1} without mulching (T_8) resulted in a significant higher number (14 fruits plant-1) of green tomatoes. Fresh weight of green tomatoes were varied significantly ($p \leq 0.05$) among the treatments with the maximum fresh weight obtained from the T_9 (128.97 g plant^{-1}) and the minimum from T_1 (12.73 g plant^{-1}) treatments. Nitrogen, P, K, Ca, Mg and S of green tomatoes varied significantly among the treatments. The utmost P, K, S, Ca and Mg contents (0.72, 6.26, 0.23, 0.54 and 0.31 g kg^{-1}, respectively) of green tomatoes were recorded in the treatment T_6 (V_4Mu). Hence, the utilization of organic fertilizers, either alone or in conjunction with mulching, markedly enhanced the growth and yield of the tested vegetable, offering viable strategies for enhancing the yield potential.

Introduction

The cultivated Tomato (*Solanum lycopersicum* L.), belongs to the diverse family Solanaceae, which includes more than 3000 species, occupying a wide variety of habitats. The Solanaceae contain many species of economic use, such as food (tomatoes, potatoes, peppers

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and eggplants), medicines (deadly nightshade, henbane, and datura) and ornamental purposes (petunias). These species are all endemic to South America, but the cultivated tomato itself has achieved worldwide distribution with the help of human populations[1]. The fruit is an edible, brightly colored (usually red, from the pigment lycopene) berry, 1-2 cm diameter in wild plants, commonly much larger in cultivated forms. It is botanically a berry, a subset of fruit. Tomatoes are believed to benefit the heart among other things, as it contains lycopene, one of the most powerful natural antioxidants which, especially when cooked, have been found to help prevent prostate, lung, stomach, pancreatic, colorectal, esophageal, oral, breast and cervical cancers.

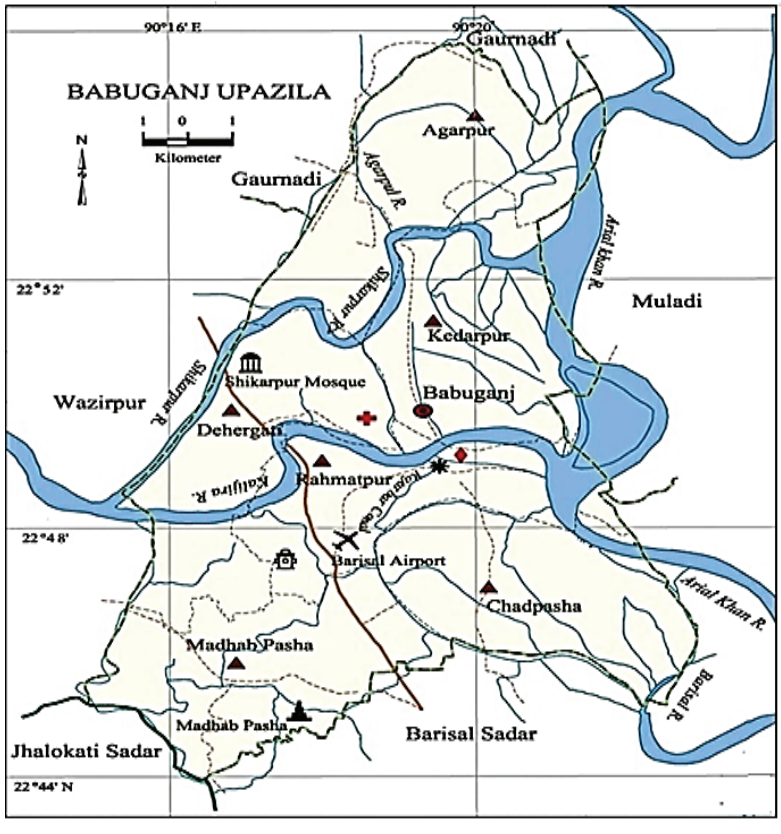
Bangladesh is a developing country with high population density where 26.2% of its total population lives under poverty and a huge proportion (roughly 66%) of its total population derive their livelihoods from farms and forests i.e., agriculture[2]. Climate change in Bangladesh is an especially serious concern because agriculture is an important sector in the country. It contributes roughly 16% to gross domestic product (GDP), with crops representing 9.1%, livestock 1.8 %, fisheries 3.7%, and forestry 1.7 %[3]. Furthermore, the sector provides employment and income to some of the poorest and most vulnerable members of society. Climate change will alter temperature and rainfall patterns. Since agriculture is dependent on weather and crops are known to suffer yield losses due to high temperatures, there is concern that warming caused by climate change will lower crop yields as well as threaten the food security in many parts of the world[4]. As soil temperature increase, the decomposition rate of organic matter will increase, and then nutrient mineralization and availability for plants uptake become increased in presence of sufficient water if other conditions are unchanged. Intensive agricultural production using inorganic fertilizers has led to increased yield, albeit at the expense of poor product quality, particularly under protected cultivation. The use of organic fertilizers as nutrient inputs to the soil is currently increasing and used to sustain economic vegetable production with minimal environmental pollution and higher food quality. Mulching with organic materials increases the soil nutrients, protects the soil from erosion, reduces compaction from the impact of heavy rains, prevents weed germination and growth, maintains more even soil temperature, and protects plant roots from extreme summer and winter temperatures[5]**.** Unless the soil physical environment is maintained at its optimum level, the genetic yield potential of a crop cannot be realized even when all the other requirements are fulfilled.

Application of organic manure (mustard oil cake, poultry manure and vermicompost) and mulch practicing can promote growth of vegetables. According to Das *et al*.[6] different mulching materials and organic manures significantly influenced the morphological performance of French bean. Plastic mulch is considered useful for weed control, temperature control, reduced salinity which reduces water loss from the soil due to increased water resistance[7]. In agricultural practices, mulching showed a good impact on good crop growth and yield[8]. It is also reported that grafted brinjal plastic mulch also gives a higher yield[9]. To produce quality vegetables and also for earliness with better yield use of plastic mulch is a good option[10,11]. Mulching with crop residue like organic mulching is reported to be one of the best options for more yields in crop production likes groundnut

and cassava[12,13]. Common organic mulches are leaf stubble, maize stalk, paddy straw, husk and water hyacinth, etc. are used in agriculture on large scale[14] to improve soil properties and organic matter to the soil. Therefore, the purpose of this study is to investigate the effects of organic amendments and mulching on the growth, yield, and yield parameters of tomato under field condition.

Materials and Methods

Experimental Setup: A field experiment was conducted at the net house premises of the Department of Soil, Water, and Environment, University of Dhaka, Dhaka-1000, to assess the impact of mulching and organic fertilizers on the growth and yield of tomato vegetables. Surface soil samples were collected from a medium-high land agricultural field in Rahmatpur Union, Babuganj Upazila, Barishal district (Map 1), located between N 22°42′ and E 90°23′, within AEZ-13 known as the Ganges Tidal Floodplain. The collected soil samples were placed onto the designated plots as illustrated in Figure 1. The plots were prepared by plowing and cross-plowing and subdivided into 9 sub-plots measuring 50 × 30 cm each. The experiment was designed in a completely randomized manner, with three replications within the sub-plots.



Map 1. Map of sampling site at Babuganj upazila of Barishal district[15]

Two different doses of mustard oil cake (MOC), poultry manure (PM), and vermicompost (V) were applied, both individually and in combination with mulching (Mu). The treatments and their denotations for the field experiment are presented in Table 1.

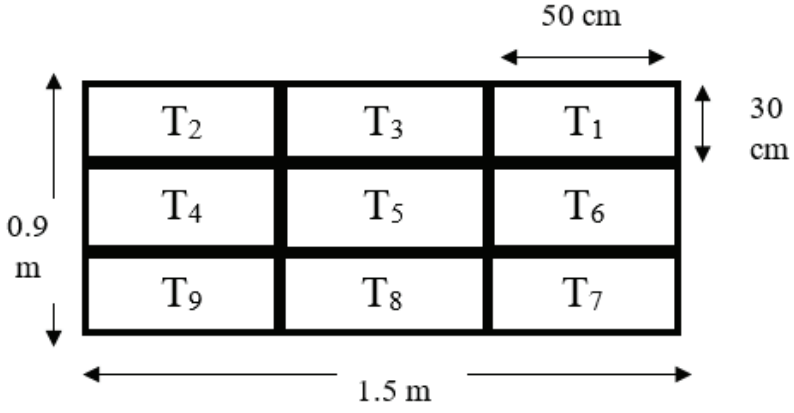


Fig. 1. Layout of the field experiment

Table 1. Treatment number and denotations used for the experiment

Treatment		Description
No.	Denotation	
T_1	Absolute C	Absolute Control
T_2	C	Control
T_3	Mu	Mulching
T_4	MOC_4Mu	Mustard oil cake @ 4 t ha^{-1} with Mulching
T_5	PM_4Mu	Poultry manure @ 4 t $ha^{-1}$with Mulching
T_6	V_4Mu	Vermicompost @ 4 t ha^{-1} with Mulching
T_7	MOC_8Mu_0	Mustard oil cake @ 8 t ha^{-1} without Mulching
T_8	PM_8Mu_0	Poultry manure @ 8 t ha^{-1} without Mulching
T_9	V_8Mu_0	Vermicompost @ 8 t ha^{-1} without Mulching

Transplantation Protocol: Basal doses of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) from Urea, TSP, and MoP fertilizers were applied at the rates of 80, 24, and 50 kg ha^{-1} considering soil amendments and initial nutrient contents. All organic fertilizers, phosphorus, potassium and half of nitrogen fertilizers were incorporated during final land preparation. The remaining nitrogen fertilizer were applied in two equal splits at 15 and 35 days after transplantation followed by irrigation as per the Fertilizer Recommendation Guide[16].

Four-weeks-old healthy tomato seedlings, measuring 15-20 cm tall with 3-5 true leaves, were transplanted into the field. Rice straw mulch, applied two weeks after planting,

involved uniformly spreading 2 t ha^{-1} (300 g/subplot) of rice straw manually as soil surface cover with a thickness of approximately 3-4 cm. Calculated amounts of water were applied daily, and intercultural operations were performed as necessary. Weeds were manually removed when required.

Data Collection and Statistical Analyses: Plant height, leaf number, leaf area, stem girth at different stages of growth, the number of fruits, as well as the fresh weight and oven-dry weight of tomato plant at harvesting stage were recorded. Additionally, root length and root girth were noted after harvest. Data were analyzed using Analysis of Variance (ANOVA) and least significant differences (LSD) at a 5% significance level, steered using Microsoft Excel and Stata-14.

Results and Discussion

Plant Height: Significant differences due to different treatments were observed on the plant height of tomato plants at various growth stages (Fig. 2). Significant differences were observed in the plant height of tomato plants at different days after transplantation owing to the application of different doses of organic amendments in combination with or without mulching (Fig. 2). After 30 days of transplanting, the highest height was found in treatment T9 (24 cm), followed by T8 (22.5 cm), while the least value (14 cm) was recorded in T_1 treatment. However, at 60 days after transplantation, the maximum average plant height (78 cm) was exhibited by treatment T_7 (MOC_8Mu_0), whereas at 90 DAT, the highest plant height (142 cm) was recorded in treatment T_9 (V_8Mu_0). Treatment T_6 (V_4Mu) = T_7 (MOC_8Mu_0) exhibited the second-best height (116 cm) at this stage.

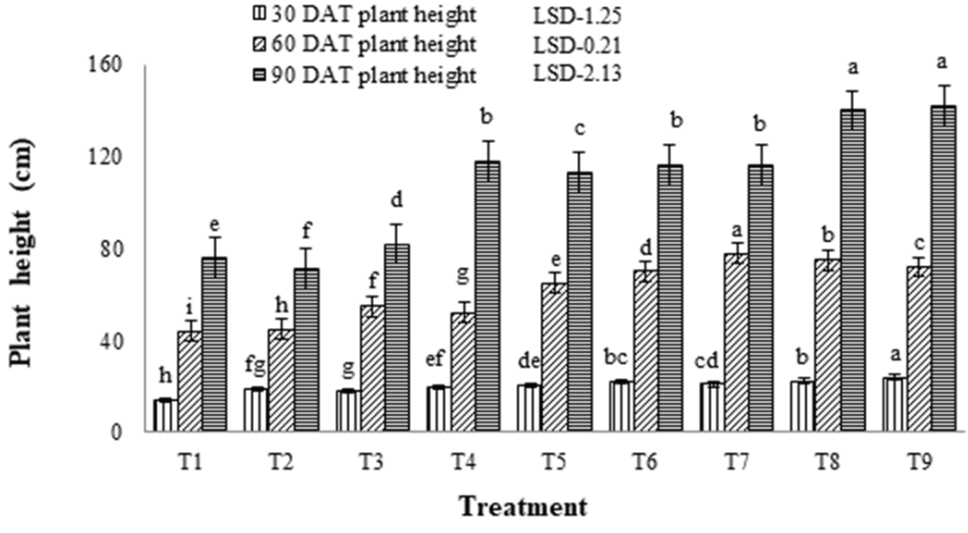


Fig. 2. Effects of organic fertilizer and mulching on plant height of tomato at different stages of growth. In a bar, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test.

Number of Leaves per Plant: Significant positive effects of the treatments on the leaf numbers of tomato plants were observed. At 30 DAT, the maximum number of leaves (40 leaves per plant) was found in T_4 (MOC_4Mu) treatment, followed by the T_6 and T_9 treatments (Table 2). The number of leaves per plant varied significantly among treatments at 60 days after transplanting, with the application of vermicompost at 8 t ha^{-1} without mulching (T_9) providing the highest number of leaves (91 leaves per plant). The lowest value was observed in T_4 (MOC_4Mu) and T_7 (MOC_8Mu_0) treatments. After 90 days of transplantation, the number of leaves per Tomato plant increased significantly over control. Treatment T_9 (V_8Mu_0) exhibited the maximum number of leaves (189 leaves per plant), followed by T_6 (V_4Mu), T_8 (PM_8Mu_0), and T_5 (PM_4Mu) treatments. Vermicompost showed the best performance in increasing leaf number, supported by the findings of Wang *et al.*[17], who found that vermicompost and chicken manure compost more effectively promoted plant growth, including stem diameter and plant height of tomato plants, compared with other fertilizer treatments. The minimum number of leaves (74 leaves per plant) was recorded in T3 (Mulching) treatment at the final stage of its growth.

Leaf Area: The highest leaf area (69.90 cm^2) for tomato plants was observed in treatment T_7, followed by treatment T_5 (62.17 cm^2). The lowest leaf area was recorded in the absolute control treatment. Significant differences were also observed among the treatments at 60 and 90 days after transplantation, with the treatments T_9 and T_7, which showed the highest leaf areas.

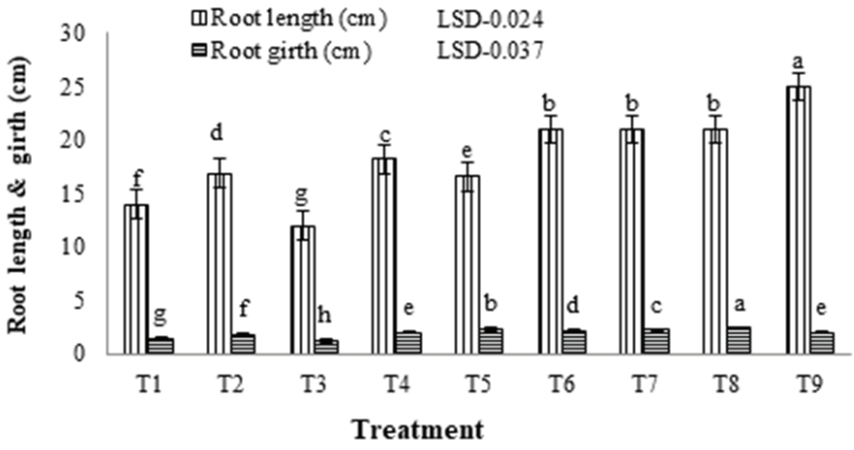
Stem Girth: The application of organic amendments increased stem girth of tomato plants significantly. The treatment T_6 exhibited the highest stem girth (1.9 cm) at 30 days after transplantation, while treatment T_9 resulted in the highest stem girth (2.6 cm) at 60 days after transplantation. The treatment T_9 also produced the maximum stem girth (3.2 cm) at 90 days after transplanting. The second highest value (3.0 cm) was observed in T_7 treatment, which received mustard oil cake @ 8 t ha^{-1} without mulching (Table 2).

*Root Length and Root Girth: S*tatistically significant variation was found among the treatments for root length and root girth of the tested vegetable (Fig. 3). Maximum root length and girth were observed in treatments with vermicompost, while minimum values were observed in the control treatment. The highest root length (25 cm) was found from the treatment T_9, which was statistically identical with T_6, T_7 and T_8 (21 cm) while minimum (14 cm) from the T_1 treatment. The highest root girth (2.4 cm) was recorded in T_8 treatment whereas the lowest value of root girth (1.2 cm) was recorded in treatment T_3 (Fig. 3).

Table 2. Effects of organic fertilizer and mulching on some selected growth parameters of tomato plant at different stages of growth

Treatment		30 days after transplant (DAT)			60 DAT			90 DAT		
No.	**Denotation**	**Leaf number**	**Leaf area (cm^2)**	**Stem girth (cm)**	**Leaf number**	**Leaf area (cm^2)**	**Stem girth (cm)**	**Leaf number**	**Leaf area (cm^2)**	**Stem girth (cm)**
T_1	Absolute C*	20 **e**	40.66 **h**	1.2 **d**	70 **c**	50.26 **i**	1.5 **c**	120 **e**	85.25 **h**	2.5 **bcd**
T_2	Control (C)	30 **c**	46.20 **f**	1.5 **bcd**	40 **h**	55.50 **h**	1.6 **c**	84 **h**	91.75 **f**	2.8 **abc**
T_3	Mu	25 **d**	42.06 **g**	1.5 **bcd**	42 **g**	60.00 **g**	2.2 **b**	54 **i**	79.40 **i**	2.2 **d**
T_4	MOC_4Mu	40 **a**	53.39 **d**	1.9 **a**	60 **e**	66.33 **e**	2.0 **b**	105 **g**	88.50 **g**	2.4 **cd**
T_5	PM_4Mu	25 **d**	62.17 **b**	1.7 **abc**	50 **f**	65.00 **f**	2.0 **b**	126 **d**	97.75 **e**	2.2 **d**
T_6	V_4Mu	35 **b**	50.30 **e**	1.9 **a**	66 **d**	81.00 **d**	2.2 **b**	162 **b**	123.8 **c**	2.2 **d**
T_7	MOC_8Mu_0	30 **c**	69.90 **a**	1.4 **cd**	60 **e**	90.00 **b**	2.2 **b**	117 **f**	137.70 **a**	3.0 **ab**
T_8	PM_8Mu_0	25 **d**	59.00 **c**	1.4 **cd**	77 **b**	87.00 **c**	2.2 **b**	140 **c**	119.70 **d**	2.5 **bcd**
T_9	V_8Mu_0	35 **b**	59.75 **c**	1.8 **ab**	91 **a**	90.52 **a**	2.6 **a**	189 **a**	125.00 **b**	3.2 **a**
LSD (5%)		**3.39**	**1.13**	**0.31**	**1.78**	**0.48**	**0.24**	**1.79**	**0.95**	**0.48**

In a column, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test. *C = control, Mu = Mulching, MOC_4Mu = mustard oil cake @ 4 t ha^{-1} with mulching, PM_4Mu = poultry manure @ 4 t ha^{-1} with mulching, V_4Mu = vermicompost @ 4 t ha^{-1} with mulching, MOC_8Mu_0 = mustard oil cake @ 8 t ha^{-1} without mulching, PM_8Mu_0 = poultry manure @ 8 t ha^{-1} without mulching, V_8Mu_0 = vermicompost @ 8 t ha^{-1} without mulching.



In a bar, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test.

Fig. 3. Effects of organic fertilizers and mulching on root length and root girth of tomato plants

Fresh weight: The ANOVA and Duncan's Method (DMRT) showed that the fresh weight of leaf, stem and root of tomato plants significantly increased (5% level) due to application of different organic fertilizers and mulching (Table 3). Total fresh weight was calculated from the summation of fresh weight of leaf, stem and root (Fig. 4).

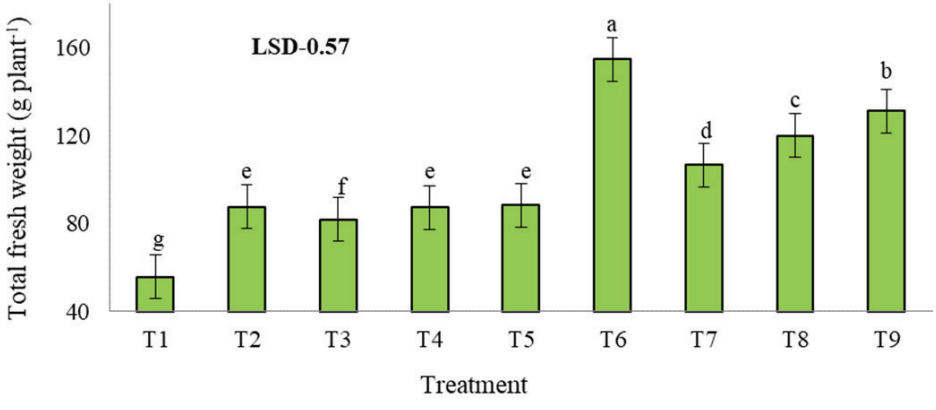
The maximum quantity of fresh weight (154.63 g plant-^{1}) for tomato plant was obtained from the treatment T6, which received vermicompost @ 4t ha-^{1} with mulching. According to Ramakrishna *et al*.(18), groundnut plants in straw mulched plots were generally tall, more vigorous and reached 50% flowering 4-6 days earlier than in the unmulched plots. The second-best result (131.33 g plant-^{1}) was gained for the treatment T_9 (V_8Mu_0). The treatment T_1 produced the minimum fresh weight (55.84 g plant-^{1}) of tomato plant (Fig. 4 and Table 3).

Dry weight: Statistically significant variation was found among the treatments for plants dry weight. The results of the analyses of total dry weight of plant are depicted in the Table 4. The maximum dry weight (29.03 g plant^{-1}) was recorded from the T_9 treatment, which was statistically identical (24.63g plant^{-1}) with T_6 and the minimum (7.6 g plant^{-1}) was recorded from T_1 (Table 4) treatments. Vermicompost ensured maximum plant nutrients which helped proper growth of plant and the results were the highest dry weight in the plant. Islam *et al*.[19] reported almost similar trend of results from their experiment. They examined that fertilizer application, especially for chemical fertilizer and organic manure applied to tomato field, can be highly profitable with sustainable production.

Table 3. Effects of organic fertilizers and mulching on fresh weight (g plant-1) of tomato plants

Treatment No.	Denotation	Leaf fresh weight	Stem fresh weight	Root fresh weight	root-shoot ratio
T_1	Absolute C*	25.04h	22.49g	8.31d	0.175
T_2	Control (C)	36.71f	38.86e	12.01b	0.159
T_3	Mu	35.03g	38.70e	8.10d	0.110
T_4	MOC_4Mu	37.42f	41.50d	8.54d	0.108
T_5	PM_4Mu	43.95e	32.69f	11.71b	0.153
T_6	V_4Mu	75.15b	65.30a	14.18a	0.101
T_7	MOC_8Mu_0	47.73d	48.32c	10.58c	0.110
T_8	PM_8Mu_0	50.65c	58.78b	10.7c	0.098
T_9	V_8Mu_0	77.51a	41.50d	12.32b	0.104
LSD (5%)		**0.63**	**0.63**	**0.38**	**-**

In a column, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test. *C = control, Mu = Mulching, MOC_4Mu = mustard oil cake @ 4 t ha^{-1} with mulching, PM_4Mu = poultry manure @ 4 t ha^{-1} with mulching, V_4Mu = vermicompost @ 4 t ha^{-1} with mulching, MOC_8Mu_0 = mustard oil cake @ 8 t ha^{-1} without mulching, PM_8Mu_0 = poultry manure @ 8 t ha^{-1} without mulching, V_8Mu_0 = vermicompost @ 8 t ha^{-1} without mulching.



In a bar, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test.

Fig. 4. Effects of organic fertilizers and mulching on total fresh weight of tomato plants

Fruits: Tomato plants under the treatment T_1 (absolute control), T_5 (PM4Mu), T_6 (V_4Mu), T_7 (MOC_8Mu_0), T_8 (PM_8Mu_0) and T_9 (V_8Mu_0) produced green fruits. At 90 days after transplanting harvest was done and the parameters like number of fruits, fresh

weight of fruits, nutrient contents (nitrogen, phosphorus, potassium, sulfur, calcium and magnesium) were analyzed and are presented in Table 5. Application of poultry manure @ 8 t ha^{-1} without mulching (T_8) resulted in significant higher amounts (14 fruits $plant^{-1}$) of green tomato.

Table 4. Effects of organic fertilizer and mulching on dry weight (g plant-1) of tomato plants

Treatment No.	Denotation	Leaf dry weight	Stem dry weight	Root dry weight	Total dry weight
T_1	Absolute C*	1.83 g	4.35 g	1.42 bc	7.6h
T_2	Control (C)	5.76 e	6.80 cde	3.44 a	16d
T_3	Mu	5.28 ef	4.99 fg	0.94 c	11.21g
T_4	MOC_4Mu	5.21 f	6.23 efg	0.82 c	12.26f
T_5	PM_4Mu	7.39 c	4.19 g	1.76 abc	13.34e
T_6	V_4Mu	11.92 b	9.40 b	3.29 ab	24.63b
T_7	MOC_8Mu_0	7.67 c	8.17 bcd	3.09 ab	18.93c
T_8	PM_8Mu_0	6.81 d	8.94 bc	2.67 abc	18.42c
T_9	V_8Mu_0	14.82 a	11.75 a	2.45 abc	29.03a
	LSD (5%)	**0.33**	**1.37**	**1.13**	**0.42**

In a column, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test. *C = control, Mu = Mulching, MOC_4Mu = mustard oil cake @ 4 t ha^{-1} with mulching, PM_4Mu = poultry manure @ 4 t ha^{-1} with mulching, V_4Mu = vermicompost @ 4 t ha^{-1} with mulching, MOC_8Mu_0 = mustard oil cake @ 8 t ha^{-1} without mulching, PM_8Mu_0 = poultry manure @ 8 t ha^{-1} without mulching, V_8Mu_0 = vermicompost @ 8 t ha^{-1} without mulching.

Fresh weight of green tomato was varied significantly (5%) among the different treatments. However, maximum yield was obtained from the T_9 (128.97 g $plant^{-1}$) while minimum from the T_1 (12.73 g $plant^{-1}$) treatments. Ali et al.[20] examined that, maximum number of fruit and yield of Tomato were found from the foliar application of leachate from vermicompost which was followed by mustard oil cake whereas minimum from the control.

The data on nutrient contents (nitrogen, phosphorus, potassium, calcium, magnesium and sulfur) of green Tomatoes revealed that there was statistically significant difference among the treatments (Table 5). The maximum P, K, S, Ca and Mg contents (0.72, 6.26, 0.23, 0.54 and 0.31 g kg^{-1}, respectively) of green Tomatoes were recorded in the treatment T_6 (V_4Mu) and it was the superior to all other treatments. Arancon et al.[21] indicated the improvements in crop growth and increase in fruit yields (tomatoes, peppers and strawberries) could also be due to partially to large increase in soil microbial biomass after application of vermicompost, leading to the more hormones or humate content in the vermicompost treatment. Groundnut plants in polythene and straw mulched plots were generally tall, vigorous and reached early flowering. Use of straw as mulch provides an

attractive and an environment friendly option in Vietnam and rice straw mulch recycles plant nutrients effectively[18].

Table 5. Effects of organic manure and mulching on selected properties of green tomatoes

Treatment		No. of fruits plant^{-1}	Fresh weight (g plant^{-1})	Nutrient contents (g kg^{-1})					
No.	Denotation			N	P	K	S	Ca	Mg
T_1	Absolute C	1 **e**	12.73 **f**	9.1 **e**	0.12 **e**	1.50 **e**	0.12 **b**	0.13 **e**	0.09 **d**
T_5	PM_4Mu	2 **de**	20.57 **e**	14.8 **b**	0.45 **c**	5.83 **b**	0.28 **a**	0.42 **c**	0.30 **a**
T_6	V_4Mu	6 **cd**	76.53 **d**	13.6 **c**	0.72 **a**	6.26 **a**	0.23 **a**	0.54 **a**	0.31 **a**
T_7	MOC_8Mu_0	13 **ab**	100.21 **b**	17.6 **a**	0.36 **d**	5.43 **c**	0.27 **a**	0.49 **b**	0.27 **b**
T_8	PM_8Mu_0	14 **a**	97.98 **c**	12.7 **d**	0.11 **e**	2.99 **d**	0.10 **b**	0.21 **d**	0.10 **d**
T_9	V_8Mu_0	9 **bc**	128.97 **a**	13.8 **bc**	0.67 **b**	5.41 **c**	0.09 **b**	0.45 **bc**	0.23 **c**
LSD (%)		**4.08**	**2.11**	**1.46**	**0.039**	**0.13**	**0.051**	**0.051**	**0.041**

In a column, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test. T_1 = (absolute control), T_5 = PM4Mu (poultry manure @ 4 t ha^{-1} with mulching), T_6 = V_4Mu (vermicompost @ 4 t ha^{-1} with mulching), T_7 = MOC_8Mu_0 = (mustard oil cake @ 8 t ha^{-1} without mulching), T_8 = PM_8Mu_0 (poultry manure @ 8 t ha^{-1} without mulching), T_9 = V_8Mu_0 (vermicompost @ 8 t ha^{-1} without mulching).

Conclusion

Mulching is a valuable process that can significantly contribute to the production of high-quality food in large quantities. In the days ahead, farmers are likely to increasingly adopt this technique, which aids in moisture conservation, reduces greenhouse gas emissions, suppresses weed growth, and greatly improves soil health while enhancing productivity. This will play a crucial role in achieving global food security sustainably.

Poultry manure and mustard oil cake represent distinct forms of organic waste and can lead to environmental pollution if not managed effectively. Utilizing kitchen waste, cow dung, and other organic materials in vermicomposting offers a sustainable solution. By carefully managing poultry manure, mustard oil cake, and vermicompost as fertilizers, we can reduce waste production and risk of pollution.

In this study, the trialed variety of vegetable, exhibited enhanced growth responses under varying applications of mustard oil cake, poultry manure, vermicompost, and mulching. Particularly, treatments involving rice straw mulch combined with different levels of organic fertilizers demonstrated superior growth and yield performance compared to plots without mulch. Hence, employing organic fertilizers in conjunction with mulching, irrespective of their dosages, presents a promising approach for increasing vegetable yields to meet current demand levels.

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References

1. Knapp S and IE Peralta 2016. The Tomato (*Solanum lycopersicum* L., Solanaceae) and Its Botanical Relatives. *In*: Causse M, L Giovannoni, M Bouzayen and M Zouine (eds), The Tomato Genome, Compendium of Plant Genomes. Springer, Berlin, Heidelberg, pp. 7-21.
2. BBS (Bangladesh Bureau of Statistics) 2017. Data Collected from Statistics and Informatics Division (SID), Ministry of Planning, Government of Bangladesh, Dhaka, Bangladesh, pp. 23-25.
3. Bangladesh Bank 2014. Annual Report 2013-14. Dhaka, Bangladesh, pp. 79-87.
4. Chowdhury IUA and MAE Khan 2015. The impact of climate change on rice yield in Bangladesh: a time series analysis. Russian Journal of Agricultural and Socio-Economic Sciences **4**(40): 12-28.
5. Ranjan P, GT Patle, M Prem and KR Solanke 2017. Organic Mulching- A water saving technique to increase the production of fruits and vegetables. Current Agricultural Research Journal **5** (3): 371-380.
6. Das BC, K Khatun, AFMJ Uddin, MJ Hasan, MKA Nadim, M Rahman, S Adhikary and SE Akter 2023. Influence of Mulching and Organic Manure on the Growth and Pod Yield of French Bean (*Phaseolus vulgaris* L.). Asian J. Agric. Hortic. Res. **4**: 303-309.
7. Kumar P, S Kumar, M Kumari and V Kumar 2019. Effect of Mulching on Brinjal Cultivation. International Journal of Science, Environment and Technology **8**: 624-629.
8. Ashworth S and H Harrison 1983. Evaluation of Mulches for Use in the Home Garden. Hort. Science **18**: 180-182.
9. Rajasekar M, V Udhayani, N Swaminathan and K Balakrishnan 2017. Impact of Mulching and Fertigation on Growth and Yield of Grafted Brinjal (*Solanum melongena* L.) under Drip Irrigation System. International Journal of Chemical Studies **5**: 163-166.
10. Raina JN, BC Thakur, and ML Verma 1999. Effect of Drip Irrigation and Polythene Mulch on Yield, Quality and Water Use Efficiency of Tomato (*Solanum lycopersicon* L.). Indian Journal of Agricultural Research **69**: 430-433.
11. Bharadwaj RL 2013. Effect of Mulching on Crop Production under Rainfed Condition: A Review. Agricultural Reviews **34**: 188-197. https://doi.org/10.5958/j.0976-0741.34.3.003

12. Chakraborty D, S Nagarajan, P Aggarwal, VK Gupta, RK Tomar, RN Garg, RN Sahoo, UK Chopra and N Kalra 2008. Effect of Mulching on Soil and Plant Water Status, and the Growth and Yield of Wheat (*Triticum aestivum* L.) in a Semiarid Environment. Agricultural Water Management, **95**: 1323-1334. https://doi.org/10.1016/j.agwat.2008.06. 001

13. Ghosh PK, D Dayal, KK Bandyopadhyay and M Mohanty 2006. Evaluation of Straw and Polythene Mulch for Enhancing Productivity of Irrigated Summer Groundnut. Field Crops Research **99**: 76-86. https://doi.org/10.1016/j.fcr.2006.03.004

14. Memon MS, J Zhou, J Guo, F Ullah, M Hassan, A Ara, CY Ji et al. 2017. Comprehensive Review for the Effects of Ridge Furrow Plastic Mulching on Crop Yield and Water Use Efficiency under Different Crops. International Agricultural Engineering Journal **26**: 58-66.

15. Web-1: http://encrypted-tbn1.gstatic.com/images?q=tbn: And9G5UEefJLgsii6CqyZ

16. FRG (Fertilizer Recommendation Guide) 2018. Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh.

17. Wang W, J Sardans, C Wang, T Pan, C Zeng, D Lai, M Bartrons and J Peñuelas 2017. Straw Application Strategy to Optimize Nutrient Release in a Southeastern China Rice Cropland. Agronomy **7**.

18. Ramakrishna A, HM Tam, SP Wani and TD Long 2005. Effects of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam. Field Crops Research **95**: 115–125.

19. Islam MK, MUS Khatun, MA Alam, UK Laily and MM Rahman 2018. Performance of organic fertilizer on yield and yield attributes on tomato. International Journal of Applied Research **4**: 30-33.

20. Ali MR, H Mehraj and AFMJ Uddin 2014. Foliar application of the leachate from vermicompost and mustard oil cake on the growth and yield of summer tomato. Middle-East Journal of Scientific Research **22(**8): 1233-1237.

21. Arancon NQ, CA Edwards, P Bierman, JD Metzger, S Lee and C Welch 2003. Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries: the 7th international symposium on earthworm ecology Cardiff Wales. Pedobiologia **47**: 731–735.

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