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Effects of different manures and fertilizers on growth and yield of tomato

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ABSTRACT

An investigation was carried out at the Horticulture Farm, Bangladesh Agricultural University (BAU), Mymensingh from November 2017 to April 2018 to investigate the effects of different manures on growth and yield of tomatoes. The experiment was laid out in RCBD with three replications. The experiment comprised six treatments such as T_0 (control), T_1 (Urea @ 300 kgha^{-1} + TSP @ 250 kgha^{-1} + MoP @ 200 kgha^{-1}), T_2 (Cowdung @ 10 tha^{-1}), T_3 (Cow dung @ 8 tha^{-1} + compost @ 5 tha^{-1}), T_4 (Cowdung @ 5 tha^{-1} + compost @ 8 tha^{-1} + mustard oil cake @ 0.3 tha^{-1}) and T_5 (Cowdung @ 5 tha^{-1} + compost @ 5 tha^{-1} + poultry manures @ 2 tha^{-1} + mustard oil cake @ 0.2 tha^{-1}). Organic manures exerted significant effects on the growth and yield components of tomatoes. The highest marketable yield of tomato (17.24 tha^{-1}) was obtained from the application of T_5 (Cowdung @ 5 tha^{-1} + compost @ 5 tha^{-1} + poultry manure @ 5 tha^{-1} + mustard oil cake @ 0.2 tha^{-1}). The highest plant height, number of flower clusters plant^{-1}, number of flowers cluster^{-1} and number of fruits plant^{-1} were obtained from the T_5 (Cowdung @ 5 tha^{-1} + compost @ 5 tha^{-1} + poultry manure @ 5 tha^{-1} + mustard oil cake @ 0.2 tha^{-1}) treatment combination. The second highest yield (13.50tha^{-1}) of tomato was obtained from the treatment combination of T_3 (Cowdung @ 8 tha^{-1}+ compost @ 5 t ha^{-1}). The lowest marketable yield of tomato (6.24tha^{-1}) was obtained from the treatment T_0 (Control). Considering above findings, the application of Cowdung @ 5 t ha^{-1} + compost @ 5 tha^{-1} + poultry manure @ 5 tha^{-1} + mustard oil cake @ 0.2 tha^{-1} showed the best performance for higher production at the Horticulture Farm condition of BAU, Mymensingh.

Key Words: *Organic manures, Cowdung, Compost, Yield and Tomato.*

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I. Introduction

Tomatoes are a popular and widely cultivated vegetable crop essential for human consumption due to their high nutritional value. Because of its adaptability to a wide range of soil and temperature conditions, it was grown in practically all home gardens as well as in the field (Ahmed, 1986). In Bangladesh, the cultivated area under tomato in 2020-21 was 72878.64 acres, with a total production of 447815.43 metric tons. (BBS, 2022). It has a high food value due to its high vitamin content (Bose and Som, 1990). Tomatoes are a good source of vitamins A, B and C. People in Bangladesh have long suffered from vitamin deficiency, though consumption of tomatoes can significantly increase the levels of vitamin C (Hossain et al., 2013) and vitamin A (Kibria et al., 2015). When compared to 39 significant fruits and vegetables, tomatoes score #1 in terms of "relative contribution to human nutrition" (Bourne, 1977). One medium tomato contains around 35 calories and contains 40% of the RDA of vitamin C (ascorbic acid), 20% of the RDA of vitamin A, significant amounts of potassium, dietary fiber, calcium, and minor amounts of iron, magnesium, thiamine, riboflavin, and niacin (FAO/UNEP, 1979).

Various factors, including manures and fertilizers, can influence the growth and yield of tomato plants. Manures and fertilizers are essential for providing nutrients to the soil, affecting the growth, development, and yield of tomato plants. The type and amount of manure or fertilizer used can significantly impact the growth and yield of tomato plants. Organic manures, such as poultry manure and compost, can improve soil fertility and enhance the growth and yield of tomato plants. Using organic manures can significantly improve the growth and yield of tomato plants compared to using inorganic fertilizers (Wang et al., 2015). Inorganic fertilizers, such as nitrogen and phosphorus, are also crucial for the growth and yield of tomato plants. These fertilizers provide essential nutrients to the soil and can improve the growth and development of tomato plants. Singh et al. (2017) reported that using inorganic fertilizers can improve the growth and yield of tomato plants, leading to a higher production of high-quality tomatoes.

The primary means of boosting crop production are improved production technologies and soil conditions. Maintaining soil fertility with organic manures and fertilizer management strategies may help. The organic matter content of Bangladesh soil is less than 1% in approximately 60% of cultivable land (BARC, 2005). Organic manure is a food supply for many microorganisms and critters, such as earthworms, which break it down into micronutrients that plants may easily absorb. Organic manure directly impacts plant growth by providing all necessary macro and micronutrients in usable forms during mineralization, hence increasing the physical and physiological qualities of the soil. Organic manures such as cowdung, poultry manure, and vermicompost promote soil structure, aeration, and slow release nutrients that encourage root development, increasing tomato plant growth and yield. Tomato cultivation requires calcium as well as the micronutrients boron, manganese, molybdenum, and iron. These nutrients are frequently abundant in biologically active soils with appropriate organic matter. Considering the foregoing, the current study was designed to determine the best quantities of NPK, cowdung, and organic manures (compost + poultry manure + mustard oil cake) for maximum tomato yield under BAU farm settings.

II. Materials and Methods

Location

The experimental was conducted in (Horticulture Farm at Bangladesh Agricultural University, Mymensingh) from November 2017 to April 2018 in the Sonatola Soil Series of the historic Brahmaputra Flood Plain Alluvial Tract in Agro Ecological Zone 9 (AEZ-9) on medium-high terrain with long days, high temperatures, plenty of rain, and high humidity from April to September.

Experimental design

The tomato cultivar used in the experiment was "Roma VF", a high yielding determinate variety. The experiment was laid out in the Randomized complete block design (RCBD) with three replications. The unit plots were (2.4 m × 2 m) in size with a 1 m distance between the blocks and 50 cm between the unit plots. This single factor experiment consisted of 6 treatments, *i.e.*

T_0 = Control
T_1= Recommended doses of Urea @ 300 kgha^{-1} + TSP @ 250 kgha^{-1} + MoP @ 200 kgha^{-1})
T_2 = Cowdung @ 10 tha^{-1}
T_3 = Cowdung @ 8 tha^{-1} + Compost @ 5 tha^{-1}
T_4 = Cowdung @ 5 tha^{-1} + Compost @ 8 tha^{-1} + Mustard Oil Cake @ 0.3 tha^{-1}
T_5= Cowdung @ 5 tha^{-1} + Compost @ 5 tha^{-1} + Poultry Manure @ 2 tha^{-1} + Mustard Oil Cake @ 0.2 tha^{-1}

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Intercultural operation

Basic manures and fertilizers were applied to the ground, preparing it for cultivation. The plots' irrigation channels were set up four days before planting the seedlings. As directed by the protocol, urea was used to supply nitrogen to the soil. The treatment plots received the same amount of cowdung and other fertilizers. The entire quantity of well-rotted cow manure was spread across the first few hours after clearing the ground. During final land preparation, TSP was administered as a basal dosage, along with compost and chicken manure. After 14 days of transplantation, the MOC was ringed on. Two equal applications of Urea and MoP were made using the ring technique. After 21 days from the transplant, the first ring was placed, and the other rings were placed 14 days later. In the Horticulture Farm of the Bangladesh Agricultural University in Mymensingh, one seedbed measuring 3m by 1m was used to cultivate tomato seedlings. On November 17, 2017, healthy seedlings were dug out from the seedbeds and transplanted into the experimental plots, with a 60 cm row spacing and a 40 cm plant spacing. This meant that each allotment could hold 20 plants. The seedlings were watered as soon as they were planted. Additionally, seedlings were planted all around the perimeter of the experimental area to fill in any gaps and assess the boundary impact. Intercultural activities, including gap filling, weeding, staking, irrigations, insect pest and disease control, were carried out after seedlings were transplanted to promote healthy plant growth and development.

Data collection

Five plants were randomly chosen from each unit plot to collect data on the growth and yield-contributing traits to avoid the border effect as precisely as possible. To monitor the growth rate of the sample plants, plant height and spread were measured in centimeters from the ground level to the tip of the tallest stem, with the mean value being recorded from 15 days after planting up to 75 days at intervals of 15 days. The plant height at the time of the last harvest was then measured. The date of the first blooming was noted, and the time needed for the first flowering to occur was computed. From the sample plants, the number of flower clusters, total flowers, and fruits per plant were periodically tallied, and an average was kept. A ruler and sliding calipers were used to measure the length and diameter of the fruit. The first and last harvests of the seven commercial fruit harvests from first to last were left out, and the other five were utilized to calculate the weight of each fruit (g). Fruits were picked four days apart at an early stage of ripeness when they turned red. Fruit yield was recorded individually for each unit plot from the first to the last harvest and was expressed in kilograms (kg), then translated to fruit yield per hectare.

Data analysis

The data obtained from different yield components and yields were statistically analyzed with the statistical software package MStat-C program to determine the significance of the difference among the treatments. The analysis was performed by F- variance test, and the significance of the difference between pairs of treatment means was evaluated by the Least Significant Difference (LSD) test at 5% and 1% probability levels (Gomez and Gomez, 1984).

III. Results and Discussion

Plant height

Due to the impact of various organic manures, there was a noticeable difference in plant height reported on numerous days after transplanting (DAT), and statistically, it was highly significant at various DAT and harvest. The plants cultivated in the T5 combination had the highest height at harvest (63.74 cm), whereas the plants treated with T4 had the lowest height at harvest (58.89 cm) (Figure 01). This outcome may result from applying various organic manure mixtures and quick performance on growth characteristics. Higher plant height was produced by combining several organic manures. This allows plants to grow more efficiently and manures to act as nutrient reservoirs.

Additionally, it improves soil quality and promotes plant growth. The tallest plant was the result of combining organic manures, demonstrating optimal vegetative development. According to Youseef et al. (2001), treatments that included 100% organic manure alone or in conjunction with ammonium nitrate produced taller plants than those that did not.

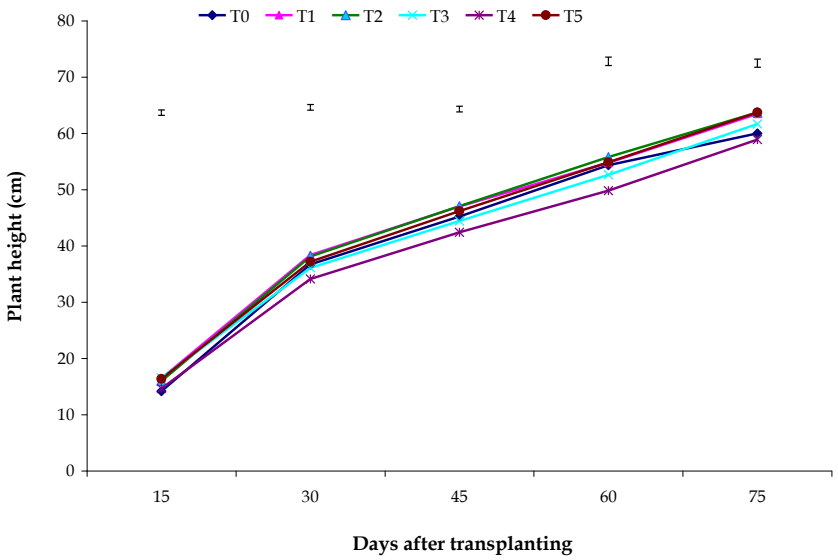

Figure 01. Effects of different organic manures on plant height.
Vertical bars represent LSD at 1% level of significance
(T_0 = control, T_1 = recommended dose of NPK, T_2 = cowdung @ 10 tha^{-1}, T_3 = cowdung @ 8 tha^{-1} + compost @ 5 tha^{-1}, T_4 = cowdung @ 5 tha^{-1} + compost @ 8 tha^{-1} + mustard oil cake @ 0.3 tha^{-1}, T_5 = cowdung @ 5 tha^{-1} + compost @ 5 tha^{-1} + poultry manure @ 2 tha^{-1} + mustard oil cake @ 0.2 tha^{-1}).

Plant spread

Plant spread is another crucial parameter positively correlated with tomatoes' yield. Judicial application of different organic manures combination affects the plant spread. The highest trends of plant spread at different DAT have been shown (Figure 02). It was found that the treatment T_5 enhanced the spreading of plant most (69.24 cm), and in T_0, the spread was minimum (56.57 cm). Plant spread was maximum at T_5 due to the judicial application of different organic manure combinations. Plant spread increases due to progress over time. It is because the organic manures and creates healthy and optimum soil conditions. As a result, plant spread raised vigorously in the open air.

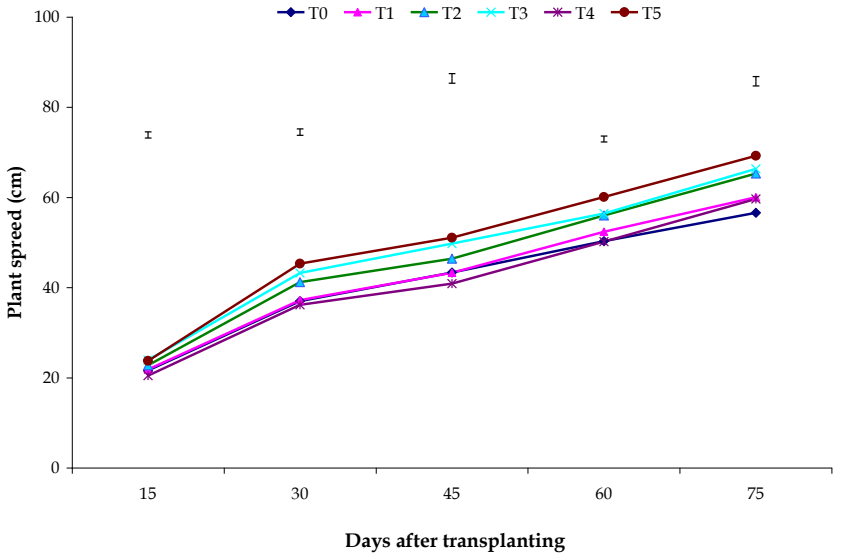

Figure 02. Effects of different organic manures on plant spread.
Vertical bars represent LSD at 1% level of significance

Days to first flowering

A remarkable variation in **days to first flowering** was observed due to the influence of different organic manures. The bar diagram (Figure 03) showed that the treatment T_0 and T_1 accelerated early flowering (after 38 days of transplanting) in plants. However, treatment T_4 showed that the days to early flowering were lower than treatment T_0 and T_1 about 42 days after transplanting. Inorganic fertilizer initiate flowering earlier due rapid release of nutrients. A combination of organic manures application initiates flowering earlier than other manure applications. This might be due to the combination of organic manures that undergoes mineralization and releases adequate quantities of N,

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P, K and smaller micronutrients than other organic sources, helping to vigorous plant growth and flowering. Bal et al. (2006) carried out an experiment where they found the early flowering of tomato plants with the application of organic manure (*Trichoderma harzianum*) @ 24 gm^{-1}.

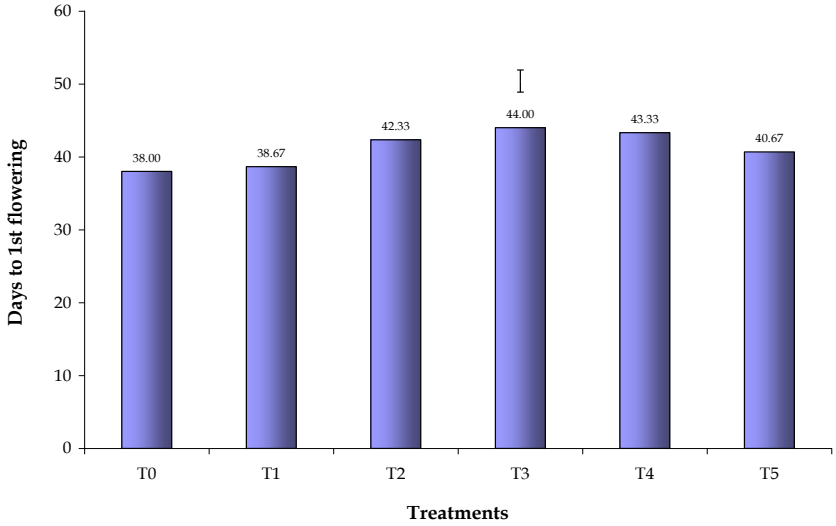

Figure 03. Effects of organic manures on days to first flowering.
Vertical bar represents LSD at 1% level of significance

Number of flower clusters plant^{-1}

Number of flower clusters plant^{-1} showed significant variation due to the application of different organic sources of nutrients (Table 01). The maximum number of flower clusters plant^{-1} (14.75) was found at treatment T_5 and the minimum (9.05) at treatment T_0. This might be because application of different organic manures combination as a nutritive due to being rich in NPK, micronutrients, and beneficial soil microbes like N-fixing bacteria and mycorrhizal fungi promotes the growth and flowering of the plant. Grimme (2006) found the maximum number of tomato flowers cluster plant^{-1} with the application of 100% well decomposed cowdung and vermicompost.

Number of flowers cluster^{-1}

The number of flowers in cluster^{-1} showed significant variation due to the application of different organic sources of nutrients (Table 01). Applications of different organic manure combinations increased the number of flowers cluster^{-1} than other treatments. The maximum number of flowers cluster^{-1} (4.58) was found at T_5 and the minimum (2.78) at T_4. The maximum number of flowers cluster^{-1} was found at treatment T_5 because organic manures undergo mineralization and return adequate quantities of macro and micro-nutrients than other sources which helps to vigorous plant growth and increase flower number. Rahman (1993) also supported the result of present findings.

Table 01. Effects of different organic manures on growth and yield of tomato

Treatments	No. of flower clusters plant^{-1}	No. of flowers cluster^{-1}	Length of fruit (cm)	Diameter of fruit (cm)	Yield plot^{-1} (kg)
T_0	9.05	2.80	6.63	5.40	3.00
T_1	9.33	3.00	6.97	5.77	6.19
T_2	9.17	2.92	6.80	5.63	4.85
T_3	10.58	3.50	7.00	5.53	6.48
T_4	9.60	2.78	6.40	5.07	5.02
T_5	14.75	4.58	7.40	5.90	8.27
LSD(0.05)	0.85	0.57	0.32	0.33	1.84
LSD (0.01)	1.20	0.81	0.45	0.48	2.61
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability

(T_0 = control, T_1 = recommended dose of NPK, T_2 = cowdung @ 10 tha^{-1}, T_3 = cowdung @ 8 tha^{-1} + compost @ 5 tha^{-1}, T_4 = cowdung @ 5 tha^{-1} + compost @ 8 tha^{-1} + mustard oil cake @ 0.3 tha^{-1}, T_5 = cowdung @ 5 tha^{-1} + compost @ 5 tha^{-1} + poultry manure @ 2 tha^{-1} + mustard oil cake @ 0.2 tha^{-1}).

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Number of flowers plant^{-1}

The maximum number of flowers plant^{-1} (62.63) was found at treatment T_5 and the minimum number of flowers plant^{-1} was (28.00) at treatment T_2 (Figure 04). The better result in the highest combination of organic manure applications was possibly due to higher available nitrogen, which might have resulted in increased number of flower plant^{-1}. An almost similar opinion was forwarded by Grela et al. (1988).

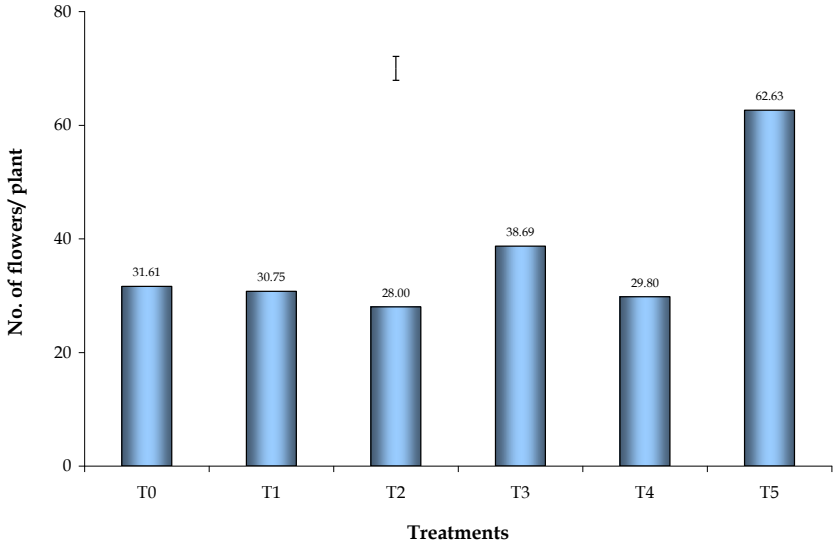

Figure 04. Effects of organic manures on number of flowers plant^{-1}.
Vertical bar represents LSD at 1% level of significance

Number of fruits plant^{-1}

The different treatments showed significant variation in the number of fruits plant^{-1}. The highest number of fruits per plant (31.23) was obtained in the treatment T_5 and the lowest number of fruits plant^{-1} (20.80) was obtained in the treatment T_4 (Figure 05). This was possibly due to nutrients and supported the plant's physiological changes. Hallorans et al. (1993) reported that poultry manure increases the number of fruits.

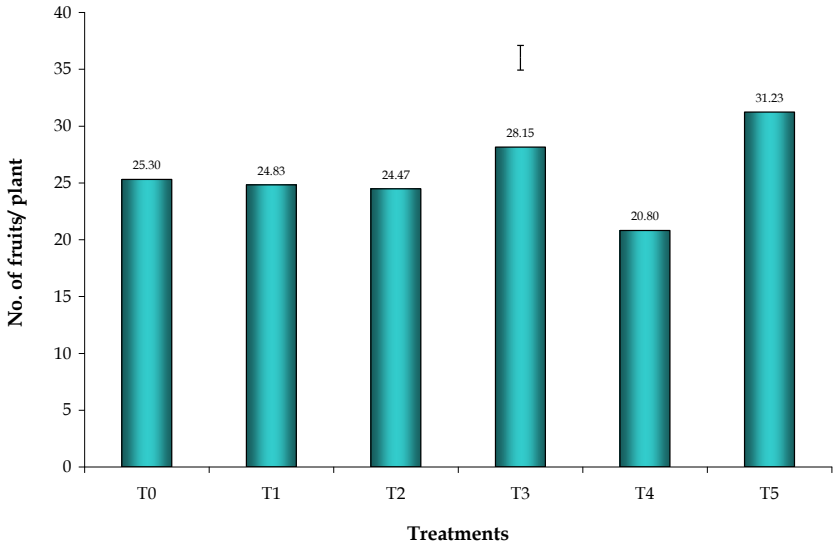

Figure 05. Effects of organic manures on number of fruits plant^{-1}.
Vertical bar represents LSD at 1% level of significance

Length of fruits

Application of a different combination of organic manures showed a significant variation in the length of the fruit of the tomato. The largest fruit (7.40 cm) was found in T_5. The lowest fruit length (6.63 cm) was found in T_0. In other treatments, the fruit length was different and statistically similar to T_0 (Table 01). Applying optimum doses of organic manures facilitates proper growth of the fruit to plant and could be attributed to physiological changes within the plant and helps increase fruit length. Nasreen (1990) had similar findings which support the present results. Prezotti et al. (1988) stated that the

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application of poultry manure increased the total productivity by about 48% and improved the proportion of large fruits in the total yield.

Diameter of fruits

Marked variation in the diameter of fruits was observed due to the influence of different organic manures (Table 01). The maximum fruit diameter (5.90 cm) was found in treatment T_5. The minimum fruit diameter (5.07 cm) was found in treatment T_4. The difference of fruit diameter was not high between T_5 and T_4 (Table 01). This happened because the number of fruits per plant was lower in treatment T_4. So, the fruits of T_4 took more space to grow, that's why the fruit diameter between both treatments is not too high. Poultry manures and cow dung were separated from all other organic residues regarding tomato growth, vigor and yield (Babafoly, 1989).

Weight of individual fruits (g)

Weight of individual fruits is one of the most critical parameters, which is positively correlated with the yield of tomatoes. The T5 caused the maximum weight of individual fruit (113.33 g), while the minimum (86.33 g) was found from the T_4 (Figure 06). This happened due to the combined application of organic manures. Reddy et al. (2002) conducted a study where they found the maximum weight of individual tomato fruit (66.7g) with the application of 50% N through FYM + 50% N through urea.

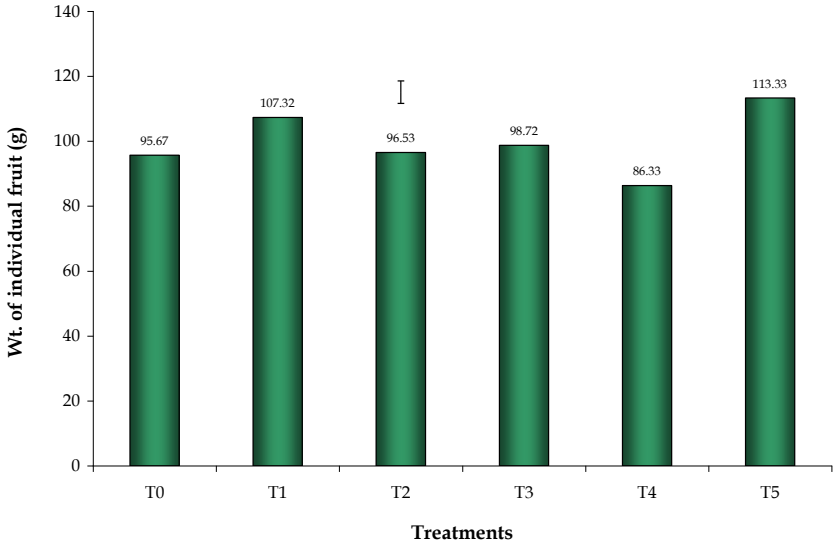

Figure 06. Effects of organic manures on weight of individual fruits.
Vertical bar represents LSD at 1% level of significance

Fruit yield plot^{-1}

Different organic manure combinations significantly affected the yield of fruits per plot. The maximum yield per plot (8.27 kg) was achieved by applying T_5. The lowest was found in T_0 (control) and it was (3.00 kg) (Table 01). Applying a different combination of organic manures helps create a good soil environment and facilitates proper plant growth. Finally, the plant produced a higher number of fruits in each plot. Akanbi et al., 2005 also supported the result of present findings.

Fruit yield hectare^{-1}

Due to varying quantities of organic manures, there was a significant variance in yield per hectare. T5 had the highest yield per acre (17.24 tons). The treatment T3 had the second-highest yield (13.50 tha-1) after that. The lowest yield (6.24 tha-1) was found in treatment T0 (control) (Figure 07). Different organic manures go through mineralization and retain nutrients necessary for healthy plant growth. This is related to physiological changes inside the plant and contributes to an increase in the number of fruits on plot-1 and, ultimately, the overall yield (tha^{-1}). According to Dumitrescu's (1965) study on cow dung as organic manures with high fertilizing potential, applying FYM at a rate of 20 tha-1 increased tomato output overall.

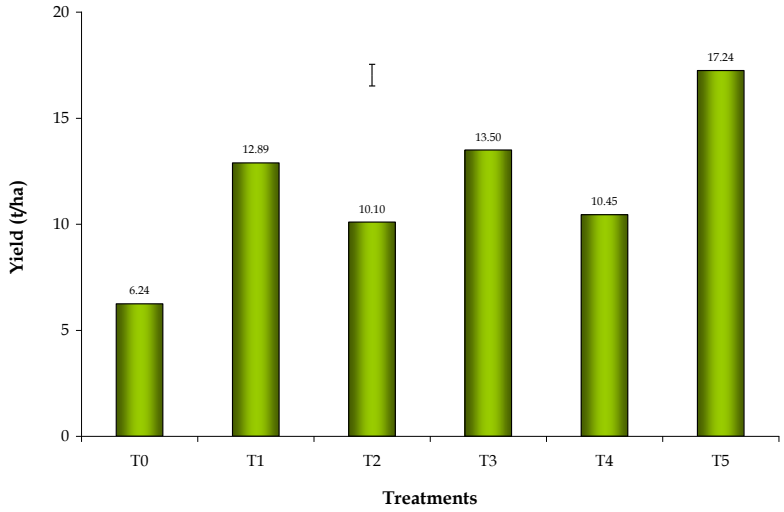

Figure 07. Effects of different organic manures on fruit yields (tha^{-1}).
Vertical bar represents LSD at 1% level of probability

V. Conclusion

All the parameters studied were significantly influenced by applying different combinations of organic manure and the recommended dose of NPK. T_5 (Cow dung @ 5 tha^{-1} + compost @ 5 tha^{-1} + poultry manure @ 2 tha^{-1} + mustard oil cake @ 0.2 tha^{-1}) significantly influenced the growth and yield of tomato. Application of T_5 produced the highest plant height (63.74 cm), plant spread (69.24 cm), number of flower clusters plant^{-1} (14.70), number flowers cluster^{-1} (4.58), number of flowers plant^{-1} (62.63), number of fruits plant^{-1} (31.23), length of fruits (7.40 cm), diameter of fruits (5.90 cm), the weight of individual fruit (113.33 g), fruit yield plot^{-1} (8.27 kg) and fruit yield(17.24 tha^{-1}) was obtained from the application of different doses. The second and third best results of 6.48 kg and 6.19 kg plot^{-1}, 13.50 tha^{-1} and 12.89 tha^{-1} were respectively produced in plants treated with T_3 (Cowdung @ 8 tha^{-1} + compost @ 5 tha^{-1}) and T_1 (Recommended doses of Urea @ 300 kgha^{-1} + TSP @ 250 kgha^{-1} + MoP @ 200 kgha^{-1}). The experiment results summarized that treatment T_5 (Cow dung @ 5 tha^{-1} + compost @ 5 tha^{-1} + poultry manure @ 2 tha^{-1} + mustard oil cake @ 0.2 tha^{-1}) significantly influenced all the parameters contributing growth and yield of tomato.

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