Yield Response of Tomato under Different Combination of Manures and Fertilizers

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Abstract: An experiment was carried out on yield response of tomato (Lycopersicon esculentum Mill.) under different combination of manures and fertilizers at Hogladanga village under the Batiaghata upazila of Khulna district during November, 2013 to March, 2014. The experiment was set up in a Randomized Complete Block Design (RCBD) with three replications. The experiment consisted of seven treatments. The treatments were T1 = Recommended doses of NPK (Urea @ 350 kg ha\(^{-1}\), TSP @ 250 kg ha\(^{-1}\), MoP 300 kg ha\(^{-1}\), respectively), T2 = cowdung @ 10 t ha\(^{-1}\), T3 = vermicompost @ 10 t ha\(^{-1}\), T4 = Trichoderma compost @ 10 t ha\(^{-1}\), T5 = 50 % cowdung + 50 % recommended doses of fertilizer, T6 = 50 % vermicompost + 50 % recommended doses of fertilizer and T7 = 50 % Trichoderma compost + 50 % recommended doses of fertilizer. The response on growth and physiological characteristics, yield attributes, and yield of tomato were positively and significantly influenced by the application of vermicompost with recommended dose of NPK and also Trichoderma compost with the recommended dose of NPK. In most cases T5 (50 % vermicompost + 50 % recommended doses of fertilizer) treatment performed better. However, the maximum yield of tomato (78.02 t ha\(^{-1}\)) was obtained from the treatment receiving 50 % vermicompost + 50 % recommended doses of fertilizer and the lowest yield of tomato (42.36 t ha\(^{-1}\)) was obtained from treatment T2 (c cowarding @ 10 t ha\(^{-1}\)). The highest benefit cost ratio (BCR) of tomato (3.15) was obtained from application of 50 % vermicompost + 50 % recommended doses of fertilizer due to higher yield and market value. So, 50 % vermicompost + 50 % recommended doses of fertilizer treatment (T5) was proved more profitable and sustainable for cultivation of tomato obtaining better yield.

Key words: Morphological, Cowdung, Vermicompost, Trichoderma compost, Tomato

I. Introduction

Tomato (Lycopersicon esculentum Mill.), a member of the family Solanaceae, is the most popular vegetable in the world for its taste, colour and high nutritive value and also for its diversified use (Bose and Som, 1986). Tomato is one of the important vegetable crops grown throughout the world and ranks next to potato in terms of the area but ranks first as a processing crop (Mehdizadehet al., 2013). In Bangladesh tomato is mainly cultivated in winter season, although some recommended summer variety are cultivated during summer season. Popularity of tomato is increasing mainly cultivated in winter season, although some recommended summer variety are cultivated during summer season. Popularity of tomato is increasing...
Cowdung is the most cheap and available qualified manure. The use of available and cheap cowdung can ensure sustainability of production and balanced nutrition. The long term use of cow dung increased aggregate stability, macro pores and lowered bulk density (Olayinka et al., 2006). A great part of the benefit of animal manure lies in slow mineralization and the addition of organic matter to the soil which offers a definite advantage over inorganic fertilizers (Lakshmikathan, 1983).

Vermicompost is a finely divided manure peat like material with high porosity, aeration, drainage and water holding capacity and microbial activity and is stabilized by interaction between earthworms and microorganisms in a nonthermophilic process (Edwards and Burrows, 1988). Vermicompost contains a high proportion of humic substances (humic acids, fulvic acids and humin) which provide numerous sites for chemical reaction; microbial components known to enhance plant growth and disease suppression through the activities of bacteria (Bacillus), yeast (Sporobolomyces and Cryptococcus) and fungi (Trichoderma), as well as chemical antagonists such as phenols and amino acids (Theunissen et al., 2010). With the process of conversion of various organic wastes by earthworms, many of the nutrients are changed to their available forms in order to make them easily utilisable by plants.

Efficient use of Trichoderma-enriched biofertilizer may increase yield, reduce the uses of N fertilizers, reduce soil borne pathogens and improve soil health. Trichoderma compost is used to produce quality tomato seedlings, capable of withstanding adverse abiotic and biotic stresses after transplanting and improve mineral nutrient uptake, inspire producers to consider a combined pre sowing inoculation of seedling with Trichoderma harzianum.

The yield of tomato is not satisfactory in Bangladesh. Several factors such as deficiency of soil nutrients, cultural factors, spacing etc., are considered as the major constraints to successful tomato production. The farmer of our country use excess amount of inorganic fertilizer to gain better yield without considering adverse effect of it. High application of chemical fertilizers has negative effects on physical, chemical and biological properties of soil and may cause soil erosion (Davarinejad et al., 2004). Now-a-days there is more attention to replace chemical fertilizers with biological fertilizers (Kader et al., 2002). Excessive use of inorganic fertilizers creates environment related problems and situation can be improved through the use of biofertilizer (Saadatnia and Riahi, 2009). One of the possible options to reduce the use of chemical fertilizers could be recycling of organic wastes. Compost as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients. Organic waste have Positive effects on soil structure, aggregate stability and water-holding capacity (Odlare et al., 2008).

There are many problems in agriculture of Bangladesh among these degradation of soil health is one of the major problems. This problem creates due to higher use of agrochemicals such as fertilizers, pesticides, herbicides etc. in crops fields as well as for intensive cropping to produce more foods for the fast and vast growing populations without considering the negative impact of chemicals on soil. It is hypothesis that organic agricultural practices might be a potential alternative to mitigate the soil health degradation problem and may be gave higher yield and BCR. However, concept of organic farming is very preliminary in Bangladesh. This practice maintains crops yield at optimum level by assuring soil health.

From the above discussion it is revealed that cowdung, vermicompost and Trichoderma compost are highly beneficial with various properties influencing soil fertility, growth and yield of products. So this research was conducted with following objective:

- To assess the effect of different combination of manures and fertilizers on growth and yield of tomato

II. Materials and Methods

2.1 Plant material and growth condition

The field experiment was conducted at Hogladanga village under the Bataghatupamila of Khulna district during November, 2013 to March, 2014. Climate was sub-tropical which was characterized by heavy rainfall, high humidity, high temperature and relatively long day during the Kharif season (April to September) and scanty rainfall associated with moderately low temperature and short day period during the Rabi season (October to March). Plenty of sunshine and moderately low temperature is suitable for growing tomato, which prevails during Rabi season in Bangladesh.

The soil of experiment area was medium high in topography and clay loam to sandy loam in texture belonging to the Ganges Tidal Floodplain Tract under the Agro Ecological Zone-13 (FAO, 1988). The tomato cultivar used in the experiment was “Suraiksha”, which was a high yielding determinate and bacterial wilt resistant variety (“Namdharimalik Company”, India). Vermicompost was collected from Plant Breeding and Biotechnology laboratory under Agrotechnology discipline, Khulna University, Khulna. Trichoderma compost was collected from Grameen Krishok Sohayak Sangstha (GKSS), Gabtali, Bogra. Tomato seedlings were raised on one seedbed with special care (Hogladanga, Khulna). Twenty five days old healthy and uniform size seedlings were transplanted in the experimental plots on 6 December, 2013. In total, there were 21 unit plots in the experiment. The unit plot was 2.4 m × 1.6 m in size. Thus each unit plot arranged with 16 plants where plant to
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Plant and row to row distance were 40 cm and 60 cm, respectively. Furrow irrigation methods was followed for irrigation of tomato crops. Chemical analysis of soil sample was done after fertilization and after harvesting (SRDI, Daulatpur, Khulna). Different intercultural was done such as gap filling, staking, weeding, and crop protection (Malathion 57 EC @ 2 ml litre⁻¹, Dithane M-45@ 2g litre⁻¹, Furadan5G,Sundomil 72 WP was used) etc. Harvesting was started from 13th March and completed by 9th April. Fruits were harvested at four days interval during early ripe stage when they attained red color. During harvesting marketable and unmarketable fruits were divided.

2.2 Treatments and design

The single factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications which consisted of seven treatments such as T₁ = Recommended doses of NPK (Urea 350 kg ha⁻¹, TSP 250 kg ha⁻¹, MoP 300 kg ha⁻¹, respectively), T₂ = Cowdung @ 10 t ha⁻¹, T₃ = Vermicompost @ 10 t ha⁻¹, T₄ = Trichoderma compost @ 10 t ha⁻¹, T₅ = 50 % Cowdung + 50 % Recommended doses of fertilizer, T₆ = 50 % Vermicompost + 50 % Recommended doses of fertilizer, T₇ = 50 % Trichoderma compost + 50 % Recommended doses of fertilizer.

2.3 Data collection

Ten plants were selected randomly from each unit plot for data collection. Data were recorded from sample plants during the period of the experiment.

2.3.1 Plant height

Plant height was measured from the sample plants in centimeter from the ground level to the tip of the longest stem and mean value was calculated. Plant height was recorded from 10 days of planting up to 70 days to observe the growth rate of plants. Mean value of the ten selected plants were calculated for each unit plot as expressed in centimeter (cm).

2.3.2 Plant spread

Plant spread was measured from the sample plants in centimeter from the tip of the longest leaf one side to another and mean value was calculated. Plant spread was recorded from 10 days of planting up to 70 days to observe the spread rate of plants at 10, 20, 30, 40, 50, 60, 70 Days after Transplanting (DAT) and mean value was calculated for each unit plot and expressed in centimeter (cm).

2.3.3 Number of leaves plant⁻¹

The total number of leaves plant⁻¹ was counted from 10 sample plants from 20 days of planting up to 80 days to observe leaf no. of plants. Mean value of the ten selected plants were calculated for each unit plot as expressed in centimeter (cm).

2.3.4 Days to first flowering

Date of first flowering for each treatment was recorded during pre-flowering season and the number of days required for first flowering was calculated.

2.3.5 Number of flower clusters plant⁻¹

The number of flower clusters was counted from the sample plants periodically during flowering season, and average number of flower clusters plant⁻¹ was recorded.

2.3.6 Number of flowers cluster⁻¹

The number of flowers cluster⁻¹ was calculated as follows:

\[
\text{Number flowers cluster}^{-1} = \frac{\text{Total number of flowers from ten plants}}{\text{Total number of flower clusters from ten plants}}
\]

2.3.7 Number of fruit clusters plant⁻¹

The number of fruit clusters was recorded from the ten sample plants, and the average number of fruit clusters produced plant⁻¹ was recorded.

2.3.8 Number of fruits cluster⁻¹

The number of fruits cluster⁻¹ was calculated as follows:

\[
\text{Number of fruits cluster}^{-1} = \frac{\text{Total number of fruits from ten plants}}{\text{Total number of fruit clusters from ten plants}}
\]
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2.3.9 Number of fruits plant\(^{-1}\)

The number of fruits plant\(^{-1}\) was recorded from the ten sample plants and the average number of fruits produced per plant was recorded.

2.3.10 Fruit length

The length of fruit was measured with a slide calipers from the neck of the fruit to bottom of 30 selected marketable fruits from each plot and their average was calculated in centimeter (cm).

2.3.11 Fruit diameter

Diameter of fruit was measured at the middle portion of 30 selected marketable fruits from each plot with a slide calipers and their average was calculated in centimeter (cm).

2.3.12 Weight of individual fruit

The weight of fruit was measured with an electric weighing machine of 30 selected marketable fruits from each plot and their average was calculated in gram (g).

2.3.13 Weight of fruits plant\(^{-1}\)

It was recorded from the weight of fruits obtained from the selected plants and their average was calculated in kilogram (kg).

2.3.14 Fruit yield plot\(^{-1}\)

Total weight of fruits from five harvests of sample plants was measured. A pan scale balance was used to take the weight of fruits plot\(^{-1}\). It was measured by totaling of fruit yield from each unit plot separately during the period from first to final harvest and was recorded in kilogram (kg).

2.3.15 Fruit yield hectare\(^{-1}\)

It was measured by the following formula:

\[
\text{Fruit yield (t hectare}^{-1}) = \frac{\text{Fruit yield plot}^{-1}(\text{kg}) \times 10000}{\text{Area of plot in square meter} (m^2) \times 1000}
\]

2.4 Benefit cost ratio of tomato

To find out the BCR the following formula was used:

\[
\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return}}{\text{Total cost of production}}
\]

2.5 Statistical analysis

Recorded data were analyzed statistically with the help of computer package program MSTAT-C and the mean differences were adjusted with Duncan's New Multiple Range Test at 1% and 5% level of probability (Gomez and Gomez, 1984).

III. Results and Discussion

3.1 Plant height

Plant height was recorded at different days after transplanting (DAT). A marked variation in plant height was observed due to the influence of different organic manures and fertilizers. Statistically the result was highly significant at different DAT. The maximum height (88.40 cm) at 70 DAT was found in the plants grown under T\(_5\) treatment which was statistically identical with T\(_7\) (85.87 cm), T\(_3\) (83.13 cm) and T\(_1\) (83.53 cm) treatments, while the shortest plant (78.57 cm) was observed in the plants treated with T\(_4\) treatment which was statistically identical with T\(_2\) (78.87 cm) treatment (Table 1). Plant height is one of the important growth contributing characters for tomato highly related with yield condition. From the result it can be concluded that the combined treatment of inorganic fertilizer and organic manure gave better result than whole NPK or whole manure. But whole vermicompost @ 10 tha\(^{-1}\) also gave significant result. Najar and Khan (2013) found highest shoot length (76 cm) with application of vermicompost @ 6 tha\(^{-1}\). Abdul et al. (2013) observed the highest plant height with vermicompost: soil (1:1) ratio. Rodge and Yadlod (2009) and Senapatit et al. (2007) found significant plant height from the treatment combination (50% recommended dose of fertilizer + 50% vermicompost). Singh et al. (2010) recorded higher plant height of tomato from treatment combination T\(_4\) (50% NPK + 50% vermicompost) than control T\(_1\) (100% NPK) or T\(_4\) (100% vermicompost) treatment. Vermicompost had significant effect on plant height as reported by different authors. Vermicompost and inorganic fertilizer combination gave higher plant height. It is because vermicompost is a reservoir of many nutrients and it facilitates plant growth. It also creates good soil
environment and helps to grow plant vigorously. In case of whole manure treatment mineralization is slow process but in combined condition improved mineralization is found. It is because of rapid conversion of inorganic fertilizer into available form of nutrients to plants. As a result plant height increased day by day significantly at this treatment combination.

3.2 Plant spread

Plant spread was recorded at different days after transplanting (DAT). As significant variation in plant spread was observed due to influence of different combination of organic manures and fertilizer at different DAT. The maximum spread (106.8 cm) at 70 DAT was found in the plants grown under T4 treatment which was statistically identical with T1 (103.8) treatment, while the lowest plant spread (88.13 cm) was observed in the plants treated with T2 treatment which was statistically identical with T1 (90.53 cm), T3 (89.47 cm) and T3 (89.13 cm) treatments (Table 1). Plant spread increases due to progress of time. It is because vermicompost and recommended doses of fertilizers creates healthy and optimum condition on the soil. As a result, plant spread increased vigorously in the open air. According to Islam (2011) higher tomato plant spread was found from vermicompost and Trichoderma compost with NPK fertilizer than NPK.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Plant spread (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 DAT</td>
<td>20 DAT</td>
</tr>
<tr>
<td>T1</td>
<td>23.07</td>
<td>29.00</td>
</tr>
<tr>
<td>T2</td>
<td>24.32</td>
<td>29.40</td>
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<td>T3</td>
<td>24.13</td>
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<tr>
<td>T4</td>
<td>24.33</td>
<td>30.53</td>
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<tr>
<td>T5</td>
<td>23.67</td>
<td>28.87</td>
</tr>
<tr>
<td>T6</td>
<td>25.53</td>
<td>32.07</td>
</tr>
<tr>
<td>T7</td>
<td>24.17</td>
<td>29.07</td>
</tr>
</tbody>
</table>

Table 1. Effect of different combinations of manures and fertilizers on plant height and plant spread of tomato at different days after transplanting

T1 = Recommended doses of NPK (Urea @ 350 kg ha⁻¹, TSP @ 250 kg ha⁻¹, MoP @ 300 kg ha⁻¹)
T2 = Cowdung @ 10 t ha⁻¹
T3 = Vermicompost @ 10 t ha⁻¹
T4 = Trichoderma compost @ 10 t ha⁻¹
T5 = 50% Cowdung + 50% recommended doses of fertilizer
T6 = 50% Vermicompost + 50% recommended doses of fertilizer, T7 = 50% Trichoderma compost + 50% recommended doses of fertilizer

** Significant at 1% level of probability
* Significant at 5% level of probability
ns – Non significant, Different letters indicate significant variation among treatments ass per DMRT

3.3 Number of leaves plant⁻¹

Number of leaves plant⁻¹ was recorded at different days after transplanting (DAT). Up to 40 DAT, there was no significant variation, but at 60 DAT and 80 DAT noticeable variation had been observed. The maximum number of leaves plant⁻¹ (116.2) at 80 DAT was found in the plants grown under T4 treatment which was statistically identical to T7 (112.7) and T5 (110.12) treatments, while the lowest number of leaves plant⁻¹ (97.07) was observed in the plants treated with T2 treatment which was statistically identical to T1 and T2 treatments (Table 2). Organic manure mainly vermicompost creates good soil environment. It facilitated proper vegetative growth of tomato plants. On the other hand, plant absorbed more sunlight and produced more food for plant growth, that’s why the leaves plant⁻¹ increased day by day. Joshi and Vig (2010) found higher no. of leaves from 30% vermicompost and soil mixture.

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3.4 Days to 1st flowering

Days required to 1st flowering of tomato varied significantly due to the application of different levels of organic manures and fertilizers. Earlier flowering (28.67 days) was found in case of T3 treatment which was statistically similar to T4 (29.67) and T4 (30.33) treatments, on the other hand, T1 treatment produced flowers later than that all other treatments (32.33 days) though it was statistically similar to T5 (31.67) and T7 (31.00) treatments (Table 2). Vermicompost helps to initiate flowering earlier and was more effective than other treatments. This might be due to vermicompost undergoes mineralization and releases adequate quantities of N, P, K and smaller amount of micronutrients than other organic sources and helps to rigorous plant growth and flowering. Prodhanet al. (2014) and Nizamet al. (2014) both found earlier flowering with vermicompost @ 5 tha−1 and vermicompost @ 10 tha−1 with different spacing, respectively than other manure based treatments.

3.5 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. The highest number of flower cluster (14.40) was observed in T3 treatment which was statistically identical with T4 treatment (14.03) and the lowest number of flower cluster (12.27) was found from T4 treatment which was statistically identical with T5 treatment (12.57) and T7 treatment (12.53) (Table 2). Vermicompost increased the number of flower clusters plant−1 than other treatments. This might be occurred because of vermicompost acts as a nutritive organic fertilizer rich in NPK and micronutrients, beneficial soil microbes like nitrogen-fixing bacteria and mycorrhizal fungi which promotes the growth and flowering of plant. This result is in agreement with the findings of Nizamet al. (2014) and Prodhanet al. (2014) where they reported that vermicompost stimulates flowering, increasing the number and biomass of the flowers produced in tomato.

3.6 Number of flowers cluster−1

Number of flowers cluster−1 showed significant variation due to the application of different organic and inorganic sources of nutrients. Vermicompost increased the number of flowers cluster−1 than other treatments. The highest number of flowers cluster−1 (7.41) was observed from T5 treatment which was statistically identical to T7 treatment (7.34) and the lowest number of flowers cluster−1 (6.30) was found from T3 treatment which was statistically identical to T1 treatment (Table 2). Findings of Nizamet al. (2014) also obtained higher number of flowers cluster−1 with vermicompost and recommended doses of fertilizer. Number of flowers cluster−1 increased in vermicompost and recommended doses of fertilizers. It is due to vermicompost undergoes mineralization and return adequate quantities of macro and micro nutrients than other sources and helps to vigorous plant growth and increases flower number.

3.7 Number of fruit clusters plant−1

No significant variation was found in respect of numbers of fruits cluster−1 due to the application of different organic and inorganic source of nutrients. The highest number of fruits cluster−1 (9.73) was recorded from T4 treatment while the lowest number (8.40) derived from T2 treatment (Table 3). Vermicompost helps in vegetative growth and could be attributed to physiological changes within the plant and translocation of sugar at development of the flowering and fruiting stages. Nizamet al. (2014) reported that higher number of fruit cluster plant−1 was observed in vermicompost @ 10 t ha−1 treatment comparing with other organic sources (cowdung, leaf rottten compost).

3.8 Number of fruits cluster−1

The number of fruits cluster−1 of tomato was not significant due to the application of different organic manure and inorganic fertilizer. The highest number of fruits cluster−1 (4.06) was found in case of treatment T5 while the lowest number was obtained from T2 treatment (3.62) (Table 3). Vermicompost facilitated proper vegetative growth of tomato plant and could be attributed to physiological changes within the plant and helped to develop number of fruit cluster−1.

3.9 Number of fruits plant−1

Number of fruits plant−1 of tomato showed significant differences for the application of organic manure and inorganic fertilizers. The highest number of fruits plant−1 was recorded from T5 treatment (37.61) followed by T2 treatment (33.49) and T3 treatment (30.15), respectively. On the other hand, the lowest number (27.30) was observed from T4 treatment (Table 3). This result is in agreement with the findings of Nizamet al. 2014, Prodhanet al. 2014 where they reported that, vermicompost produces the higher number of fruits plant−1 than other manure. Chanda et al. (2010) suggested higher number of fruits plant−1 from vermicompost supplemented with NPK treated plots. Rodge and Yadlod (2009) found higher number of fruits plant−1 from the treatment combination 50% RDF (Recommended dose of fertilizer) and 50% vermicompost. Vermicompost and other...
recommended doses of fertilizers helps to proper growth of plants. It also supports to physiological changes within the plant. As a result, number of fruits plant⁻¹ increased in this combination. Trichoderma with NPK also gave good results. Here it should be concluded that higher number of fruit causes the fruit size in combined treatment was lower than whole organic treatment.

3.10 Weight of individual fruit

Significant variation was observed in respect of weight of individual fruit. The highest weight of individual fruit (75.14 g) was found from T₆ treatment followed by T₅ and T₁ (73.63 g and 73.43 g) treatments, respectively. The lowest weight (70.97 g) was observed in T₇ treatment (Table 3). Prodhant et al (2014) found higher individual fruit weight of tomato in case of vermicompost @ 5 tha⁻¹ (50.14 g) comparing with cowdung @ 10 tha⁻¹ (45.25 g) and leaf rotten compost @ 10 tha⁻¹ (46.23 g). Vermicompost and recommended dose of fertilizers creates healthy environment in soil. So plant grows vigorously in that environment. Finally, these vigorous plant produced larger fruit. As a result, individual fruit weight increases at that combinations.

3.11 Length of fruit

Application of different combination of organic manure and inorganic fertilizers showed significant variation on length of fruit. Tomato (4.84 cm) was recorded from T₆ treatment which was statistically identical with all other treatments except T₁ treatment having lowest weight of fruit (4.06 cm) (Table 3). Optimum doses of organic manure namely vermicompost and other NPK fertilizers facilitates proper growth of the fruit to plant and could be attributed to physiological changes within the plant and helps to increase fruit length. Higher length of fruit in case of T₆ treatment gave unique shape to attain consumer appeal.

3.12 Diameter of fruit

Diameter of tomato fruit varied significantly due to the application of different sources of organic and inorganic fertilizers. The highest diameter of fruit (5.33 cm) was recorded from T₆ treatment which was statistically identical to all other treatments except T₂ (4.29 cm) treatment (Table 3). In case of T₆ treatment there was comparatively lower no. of fruits that gave more space to grow up that's why fruit diameter was found higher. In case of T₆ treatment fruit number was highest which gave elongated shaped fruit with comparatively lower diameter than other treatments.

Table 2. Effect of different combinations of manures and fertilizers on leaves number and flower characters of tomato

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of leaves plant⁻¹</th>
<th>Flower characters</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>20 DAT</td>
<td>40 DAT</td>
</tr>
<tr>
<td>T₁</td>
<td>7.86</td>
<td>14.53</td>
</tr>
<tr>
<td>T₂</td>
<td>7.26</td>
<td>13.80</td>
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<tr>
<td>T₃</td>
<td>8.06</td>
<td>14.13</td>
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<tr>
<td>T₄</td>
<td>8.14</td>
<td>14.13</td>
</tr>
<tr>
<td>T₅</td>
<td>7.54</td>
<td>14.20</td>
</tr>
<tr>
<td>T₆</td>
<td>7.60</td>
<td>14.20</td>
</tr>
<tr>
<td>T₇</td>
<td>8.00</td>
<td>14.20</td>
</tr>
</tbody>
</table>

Level of significance | ns | ns | ** | *** | *** | ** | ** |
<table>
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<tbody>
<tr>
<td>CV (%)</td>
<td>7.51</td>
<td>3.73</td>
<td>4.39</td>
<td>3.04</td>
<td>5.67</td>
<td>5.55</td>
<td>6.24</td>
</tr>
</tbody>
</table>

T₁: Recommended doses of NPK (Urea @ 350 kg ha⁻¹, TSP @ 250 kg ha⁻¹, MoP @ 300 kg ha⁻¹)
T₂: Cowdung @ 10 t ha⁻¹, T₃: Vermicompost @ 10 t ha⁻¹
T₄=Trichoderma compost @ 10 t ha⁻¹, T₅= 50 % Cowdung + 50 % Recommended doses of fertilizer
T₆=50 % Vermicompost + 50 % Recommended doses of fertilizer, T₇=50 % Trichoderma compost + 50 %
Recommended doses of fertilizer
** Significant at 1 % level of probability
* Significant at 5 % level of probability
ns- Non significant. Different letters indicate significant variation among treatments as per DMRT

3.13 Fruit weight plant⁻¹

There was significant variation in weight of fruits plant⁻¹ in respect of different organic manures and fertilizers. The highest weight of fruit yield plant⁻¹ (2.55 kg) was observed from T₆ treatment which was statistically identical with T₇ (2.30 kg), T₅ (2.02 kg), T₄ (2.07 kg) treatments and the lowest fruit weight plant⁻¹ (1.20 kg) was found from T₂ treatment which was statistically identical with T₄ (1.20 kg) and T₃ (1.92 kg).
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treatments (Fig. 1). Vermicompost enriched treatment showed higher fruit weight plant\(^1\) although other combined treatment could have shown good result. This result is in agreement with the findings of Singh et al. 2010, Najar and Khan, 2013, where they confirmed that, the increased yield potential of vegetables achieved through application of vermicompost. Prodhan et al. (2014) found higher fruit weight plant\(^1\) with vermicompost. Vermicompost undergoes mineralization and release available plant nutrients which facilitated proper plant growth. As a result vigorous plant produced larger quantities of fruits.

Fig. 1. Fruit weight plant\(^1\) as influenced by cowdung, vermicompost, Trichoderma compost and NPK fertilizers.

\[ T_1 = \text{Recommended doses of NPK (Urea @ 350 kg ha}^{-1}, \text{TSP @ 250 kg ha}^{-1}, \text{MoP @ 300 kg ha}^{-1}) \]

\[ T_2 = \text{COWDUNG @ 10 t ha}^{-1}, T_3 = \text{Vermicompost @ 10 t ha}^{-1}, T_4 = \text{Trichoderma compost @ 10 t ha}^{-1} \]

\[ T_5 = 50 \% \text{ Cowdung + 50 }\% \text{ Recommended doses of fertilizer, T}_6 = 50 \% \text{ Vermicompost + 50 }\% \text{ Recommended doses of fertilizer, T}_7 = 50 \% \text{ Trichoderma compost + 50 }\% \text{ Recommended doses of fertilizer. Different letters indicate significant variation among treatments ass per DMRT} \]

3.14 Fruit yield plot\(^1\)

Organic manures and inorganic fertilizers combination exhibited significant effects on the yield of fruits plot\(^1\). The maximum yield plot\(^1\) (30.03 kg) was achieved by the application of 50% vermicompost + 50% of recommended dose of NPK (T\(_6\)) which was identical with T\(_7\) treatment (27.33 kg), while lowest yield plot\(^1\) (16.27) was found from T\(_2\) treatment (Fig. 2). Vermicompost and other recommended doses of fertilizer helps to create good soil environment and facilitates proper plant growth. Finally, plant produced higher number of fruits in each plot.

Fig. 2. Fruit yield plot\(^1\) as influenced by cowdung, vermicompost, Trichoderma compost and NPK fertilizers.

\[ T_1 = \text{Recommended doses of NPK (Urea @ 350 kg ha}^{-1}, \text{TSP @ 250 kg ha}^{-1}, \text{MoP @ 300 kg ha}^{-1}) \]

\[ T_2 = \text{COWDUNG @ 10 t ha}^{-1}, T_3 = \text{Vermicompost @ 10 t ha}^{-1}, T_4 = \text{Trichoderma compost @ 10 t ha}^{-1} \]

\[ T_5 = 50 \% \text{ Cowdung + 50 }\% \text{ Recommended doses of fertilizer, T}_6 = 50 \% \text{ Vermicompost + 50 }\% \text{ Recommended doses of fertilizer, T}_7 = 50 \% \text{ Trichoderma compost + 50 }\% \text{ Recommended doses of fertilizer. Different letters indicate significant variation among treatments ass per DMRT} \]
3.15 Fruit yield hectare^{-1}

Significant variation was recorded on yield hectare^{-1} due to the different levels of organic manures. The highest yield hectare^{-1} (78.20 t) was obtained from T₆ treatment which was followed by (71.18 t) with T₇ treatment, while the lowest yield (42.36 t) from T₂ treatment (Fig.3). Prodhan et al. (2014), found higher fruit yield hectare^{-1} (58.99 t) from vermicompost @ 5 tha^{-1} comparing with compost @ 10 tha^{-1} (53.94 ton). This results is also in agreement with the findings of Rodge and Yadlod, 2009, Singh et al. 2010, Theunissen et al. 2010, Najar and Khan 2013 and Nizam et al. 2014, where they confirmed that, the increased fruit yield per hectare achieved from vermicompost treatment. Organic manure mainly vermicompost goes mineralization and retain available nutrient for proper plant growth and attributed to physiological changes within the plant and helps to increase the number of fruits plot^{-1} and finally the total yield hectare^{-1} increased.

![Figure 3: Fruit yield per hectare as influenced by cowdung, vermicompost, Trichoderma compost and NPK fertilizers.](image)

T1 = Recommended doses of NPK (Urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1})

T2 = Cowdung @10 t ha^{-1}, T3 = Vermicompost @ 10 t ha^{-1}, T4 = Trichoderma compost @ 10 t ha^{-1}

T5 = 50 % Cowdung + 50 % Recommended doses of fertilizer, T6 = 50 % Vermicompost + 50 % Recommended doses of fertilizer, T7 = 50 % Trichoderma compost + 50 % Recommended doses of fertilizer. Different letters indicate significant variation among treatments ass per DMRT

3.16 Benefit cost ratio

The combination of organic manure and fertilizer for benefit cost ratio was different in all treatment combinations. The highest benefit cost ratio (3.15) was observed in T₆ treatment followed by T₇ treatment (2.80) and T₁ treatment (2.79). The lowest benefit cost ratio (1.13) was obtained from T₄ treatment (Fig. 4). Vermicompost with recommended doses of fertilizers (T₆) was focused as more profitable than any other treatment giving highest benefit cost ratio (3.15) which is not only for higher yield but also quality fruit. Unique shape, size and color carried higher market value than other treatments. Trichoderma with recommended doses of fertilizers (T₇) also gave better yield with quality fruit, but benefit cost ratio was lower due to high price of compost. So, it is proved that positive effect of vermicompost on growth and yield of tomato easily can compete with inorganic fertilizer having higher benefit cost ratio.
Yield Response of Tomato under Different Combination of Manures and Fertilizers

Fig. 4. Benefit cost ratio as influenced by cowdung, vermicompost, Trichoderma compost and NPK fertilizers.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of fruit clusters plant⁻¹</th>
<th>Number of fruit cluster⁻¹</th>
<th>Number of fruits plant⁻¹</th>
<th>Weight of individual fruit (g)</th>
<th>Length of fruit (cm)</th>
<th>Diameter of fruit (cm)</th>
</tr>
</thead>
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<tr>
<td>T₁</td>
<td>8.93</td>
<td>3.76</td>
<td>28.32 bc</td>
<td>73.43 ab</td>
<td>4.061 ab</td>
<td>5.050 a</td>
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<td>T₂</td>
<td>8.40</td>
<td>3.62</td>
<td>27.55 c</td>
<td>72.63 b</td>
<td>4.613 ab</td>
<td>5.054 a</td>
</tr>
<tr>
<td>T₃</td>
<td>8.93</td>
<td>3.75</td>
<td>29.00 bc</td>
<td>73.18 ab</td>
<td>4.629 ab</td>
<td>5.074 a</td>
</tr>
<tr>
<td>T₄</td>
<td>8.64</td>
<td>3.72</td>
<td>27.30 c</td>
<td>72.40 b</td>
<td>4.521 ab</td>
<td>4.987 a</td>
</tr>
<tr>
<td>T₅</td>
<td>9.34</td>
<td>3.76</td>
<td>30.50 bc</td>
<td>73.63 ab</td>
<td>4.604 ab</td>
<td>5.332 a</td>
</tr>
<tr>
<td>T₆</td>
<td>9.73</td>
<td>4.09</td>
<td>37.61 a</td>
<td>74.62 a</td>
<td>4.845 a</td>
<td>4.295 b</td>
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<tr>
<td>T₇</td>
<td>9.66</td>
<td>3.96</td>
<td>33.49 ab</td>
<td>70.97 c</td>
<td>4.393 ab</td>
<td>5.152 a</td>
</tr>
</tbody>
</table>

Level of significance: ns - Non significant, Different letters indicate significant variation among treatments ass per DMRT

** Significant at 1 % level of probability
* Significant at 5 % level of probability

T₁ = Recommended doses of NPK (Urea @ 350 kg ha⁻¹, TSP @ 250 kg ha⁻¹, MoP @ 300 kg ha⁻¹)
T₂ = Cowdung @ 10 t ha⁻¹
T₃ = Vermicompost @ 10 t ha⁻¹
T₄ = Trichoderma compost @ 10 t ha⁻¹
T₅ = 50 % Cowdung + 50 % Recommended doses of fertilizer
T₆ = 50 % Vermicompost + 50 % Recommended doses of fertilizer
T₇ = 50 % Trichoderma compost + 50 % Recommended doses of fertilizer

Table 3. Effect of different combinations of manures and fertilizers on fruit characters of tomato

IV. Conclusion

The present study revealed that vermicompost combined with NPK fertilizers increased the tomato growth and yield. Based on the findings of the experiment, treatment T₆ (50% Vermicompost + 50% Recommended dose of NPK) was most profitable than rest of the treatment combinations. So vermicompost can be suggested as organic source to minimize inorganic fertilizer obtaining higher yield of tomato (Suraksha variety). However, the present research work was carried out at Hogladanga village under the Batiaghata upazila of Khulna district under the Agrotechnology Discipline of Khulna University in one season only. Further trial of this research work in different locations of the country is needed before final recommendation in applied level.
Yield Response of Tomato under Different Combination of Manures and Fertilizers

References


