



## Growth and yield of tomato as affected by organic and inorganic fertilizers

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### ABSTRACT

Unscrupulous use of synthetic fertilizers are not only increasing cost of tomato production but also decreasing tomato yield and quality, deteriorating soil health and environment. Organic manures can produce quality product as well as maintain soil health. Considering this verity an experiment was carried out at the Dr. Purnendu Gain Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna to evaluate the performance of tomato crop under application of different organic and inorganic fertilizers. The experiment was designed in RCBD using two varieties (BARI Tomato-14 and BARI Tomato-15) and eight treatments [i) 100% Recommended fertilizer dose (RFD) for N, P and K; ii) 100% cowdung (CD); iii) 100% poultry manure (PM); iv) 100% vermi-compost (VC); v) 100% Mustard oil cake (MOC); vi) 100% organic manures (25% of each of CD, PM, VC and MOC); vii) 80% organic manure (20% of each of CD, PM, VC and MOC) + 20% RFD; viii) 60% organic manure (15% of each of CD, PM, VC and MOC) + 40% RFD]. The tallest plant (77.5 cm) with maximum fruit length (5.98 cm), maximum number of flower clusters plant<sup>-1</sup> (16.24), number of flowers cluster<sup>-1</sup> (13.07), number of fruit clusters plant<sup>-1</sup> (8.20) and number of fruits cluster<sup>-1</sup> (6.97) were observed from combined effect of 60% organic manures with 40% RFD in BARI Tomato-15. On the contrary, this treatment produced maximum fruit diameter (6.29cm), maximum weight of individual fruit (91.43g) and the highest yield (87.17 t/ha) in BARI tomato-14. From economic point of view, maximum net return (Tk. 841345) as well as benefit cost ratio (5.11) was also observed from 60% organic manure + 40% RFD. Thus, BARI tomato-14 with combination of organic manures (60%) and inorganic fertilizers (40%) provided better performance concerning growth, yield and economic aspects.

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### Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetables in the world and in terms of area, it ranks next to potato and sweet potato but ranks first as the processing crop (FAO, 2010). It can be consumed either as raw, or as soup, sliced, dried and juice (Musa *et al.*, 2007). In Bangladesh, the area under tomato cultivation is 27518.62 hectare with a total production of 3, 89,000 metric tons having an average yield of 14.05 t/ha (BBS, 2018) whereas, the world tomato production is 200.95 million tons from the area of 4.8 million hectare with an average yield of 41.45 t/ha (FAOSTAT, 2018). Unfortunately, the average yield of tomato in Bangladesh is very low compared to that of neighboring countries like China (56.2 t/ha) and India (24.2 t/ha) (Halder *et al.*, 2003).

This low yield of tomato in Bangladesh is not a sign of low potentiality of the crop, but it may be due to a number of causes, for example, unavailability of good quality seeds of superior varieties and improper fertilization, irrigation and disease control measures, etc. As varietal difference, balanced fertilization and other

inputs are the key indicators of increasing yield as well as quality of tomato. It is essential to find out the best productive variety with optimum fertilizer dose for maximum production (Latha *et al.*, 2002). In this regard, synthetic fertilizers are the best way of crop production, but continuous application of chemical fertilizer increases organic matter depletion and damages the chemical and physical properties of soil. Moreover, those fertilizers are expensive and sometimes they are not readily available in the market. Considering these facts, the society is being increasingly concerned about environmental hazard especially with respect to health hazards which are created by the indiscriminate use of agrochemicals (Van der Berge *et al.*, 2000). As a consequence, many countries are considering organic agriculture as the well-established and certified forms of cropping systems among all the alternative cropping patterns (Adediran *et al.*, 2003).

On the contrary, organic manures are easily available to the growers and their price is lower than that of chemical fertilizers (Alam *et al.*, 2007). In addition, organic fertilizers improve higher growth, yield and quality of crops. They also contain essential macro and micro

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nutrients, many vitamins, growth promoters and some beneficial microorganisms (Natarjan, 2007; Sreenivasa et al., 2010). Farmers apply various types of organic manures such as cowdung, poultry manure, goat manure, farmyard manure, compost, vermicompost, mustard oil cake, etc. for tomato production. Among these organic manures, cowdung @ 15 t/ha can play a key role in increasing growth and yield of tomato when it is applied in combination with chemical fertilizers (Rahman et al., 1996). Poultry manure also enriches the soils by enhancing the nutrient status and improving the structure of the soil (Odiete and Ogunmoye, 2005). Shaheed (1997) described mustard oil cake (150 g/plot) as an alternative of poultry dropping and cowdung which may contribute to improve the yield of grafted tomato.

Although organic manure is eco-friendly, it renders lower yield in comparison to inorganic fertilizers. In this regard, by applying organic manure in combination with inorganic fertilizer we can increase production as well as improve soil health. In addition, this combined application maximizes the use of available organic resources and minimizes the use of expensive inorganic fertilizers (Manral and Saxena, 2003; Ghosh et al., 2004). We hypothesized that incorporation of organic and inorganic fertilizers may provide better yield and quality of crop with improvement in soil health. Therefore, the present study was conducted to evaluate the performance of two tomato varieties with different combinations of organic and inorganic fertilizers.

## Materials and Methods

### Experimental site and soil

The experiment was conducted at the Dr. Purnendu Gain Field Laboratory of Agrotechnology Discipline (AEZ-13, i.e. Ganges Tidal Floodplain) of Khulna University in Khulna, Bangladesh during the period from October 2014 to March 2015. Soil samples of the experimental plots were collected from a depth of 0 to 15 cm before conducting the experiment and analyzed in SRDI laboratory at Daulatpur, Khulna. The soil was clay loam in texture having pH 7.8, organic matter content 2.03%, total nitrogen 0.125%, available phosphorus 10.20 ppm, available potassium 5.2 ppm, zinc 1.57 ppm and boron 0.75 ppm.

### Treatments and design of the experiment:

Two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experiment consisted of 8 treatments (T) and 2 varieties (V).

Factor A: Manure and fertilizer treatments as presented in Table 1.

Factor B: Variety  
V<sub>1</sub>= BARI Tomato-14  
V<sub>2</sub>= BARI Tomato-15

Table 1. Manure and fertilizer doses per hectare as applied in different treatments

| Treatment  | Manure and fertilizer doses per hectare |        |        |       |               |       |      |
|--|---|--------|--------|-------|---------------|-------|------|
|  | Fertilizer kg/ha                        |        |        |       | Manure ton/ha |       |      |
|  | Urea                                    | TSP    | MoP    | CD    | PM            | VC    | MOC  |
| T <sub>1</sub> = 100% RFD for N, P, and K  | 350.00                                  | 200.00 | 220.00 | -     | -             | -     | -    |
| T <sub>2</sub> = 100% cowdung (CD)   | -                                       | -      | -      | 16.00 | -             | -     | -    |
| T <sub>3</sub> = 100% poultry Manure(PM)   | -                                       | -      | -      | -     | 10.75         | -     | -    |
| T <sub>4</sub> = 100% vermi-compost (VC)   | -                                       | -      | -      | -     | -             | 16.00 | -    |
| T <sub>5</sub> = 100% mustard oil cake (MOC)                                       | -                                       | -      | -      | -     | -             | -     | 3.25 |
| T <sub>6</sub> = 100% organic manures (25% of each of CD, PM, VC and MOC)          | -                                       | -      | -      | 4.00  | 2.68          | 4.00  | 0.80 |
| T <sub>7</sub> = 80% organic manures (20% of each of CD, PM, VC and MOC) + 20% RFD | 70.00                                   | 40.00  | 44.00  | 3.20  | 2.15          | 3.20  | 0.65 |
| T <sub>8</sub> = 60% organic manure (15% of each of CD, PM, VC and MOC) + 40% RFD  | 140.00                                  | 80.00  | 88.00  | 2.40  | 1.60          | 2.40  | 0.48 |

Treatments of organic manures are based on nitrogen (N %) content

### Application of manures and fertilizers

The entire amount of well decomposed cowdung, poultry manure, mustard oil cake and vermicompost were applied immediately after opening the land and the total amount of TSP was applied as basal dose during final land preparation. The urea and MoP were applied in two equal installments [21 and 35 days after transplanting (DAT)] by using ring method.

### Seed sowing and intercultural operations

Five grams of seeds were sown in each seedbed (3m × 1m). Heptachlor 40 WP was applied @ 4 kg ha<sup>-1</sup> in each seedbed as precautionary measure against ants and worms. Weeding, mulching and irrigation were done as and when necessary. The emergence of seedlings took place within 5 to 6 days after sowing. Healthy seedlings were uprooted from the seedbeds and transplanted in the plots (spacing 60 cm × 40 cm, 12 plants per plot) followed by watering. Various intercultural operations

## Effect of fertilizers on tomato

such as weeding, gap filling, staking and irrigation practices were conducted as required. Malathion 57EC was applied @ 2 mL L<sup>-1</sup> as preventive measure against insect pests like cut worms, leaf hoppers and fruit borers. Dithane M-45 @ 2 g L<sup>-1</sup> was applied fortnightly during the early vegetative stages against diseases.

### Collection of experimental data

Plant height (cm) at 15, 30, 45, 60 and 75 DAT was recorded from the ground to the tip of stem. Then the number of fruits and flowers per cluster and number of fruit and flower clusters per plant were also recorded. Fruits were harvested at 4 days interval starting from the early ripening stage to attaining red color. After that, length (cm) and diameter (cm) of twenty fruits per plot were measured by slide calipers. Weight of individual fruit and total fruits per plant (g) was eventually recorded from the selected plants by an electric balance.

### Economic analysis

Total material input costs, non-material input costs, interests on fixed capital of land and miscellaneous costs were considered for calculation of total cost of production. Interest was calculated @ 12% for six months and miscellaneous cost was considered as 5% of the total input cost.

Gross income was calculated based on the sale price (Tk kg<sup>-1</sup>) of marketable fruit and net return was calculated by deducting the total production cost from the gross return for each treatment combination. Benefit cost ratio (BCR) was calculated using following formula (Reddy and Ram, 1996):

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross income}}{\text{Total cost of production}}$$

### Analysis of data

The data were statistically analyzed by using the MSTAT-C statistical package. The analysis of variance (ANOVA) was performed by F- test, and the treatment means were separated by the Duncan's New Multiple's Range test (DMRT).

Table 2. Effect of manures and fertilizer treatment on plant height

| Treatment             | Plant height (cm) |                     |                    |                    |                     |
|-----------------------|-------------------|---------------------|--------------------|--------------------|---------------------|
|                       | 15DAT             | 30DAT               | 45DAT              | 60DAT              | 75DAT               |
| T <sub>1</sub>        | 20.05             | 40.43 <sup>a</sup>  | 52.87 <sup>a</sup> | 64.22 <sup>a</sup> | 78.63 <sup>a</sup>  |
| T <sub>2</sub>        | 19.12             | 36.87 <sup>c</sup>  | 47.69 <sup>c</sup> | 57.58 <sup>c</sup> | 67.13 <sup>c</sup>  |
| T <sub>3</sub>        | 19.55             | 39.40 <sup>ab</sup> | 51.27 <sup>b</sup> | 61.72 <sup>b</sup> | 77.02 <sup>ab</sup> |
| T <sub>4</sub>        | 19.58             | 36.37 <sup>c</sup>  | 47.73 <sup>c</sup> | 57.52 <sup>c</sup> | 68.80 <sup>cd</sup> |
| T <sub>5</sub>        | 19.10             | 36.00 <sup>cd</sup> | 47.67 <sup>c</sup> | 57.05 <sup>d</sup> | 68.90 <sup>cd</sup> |
| T <sub>6</sub>        | 19.12             | 36.87 <sup>c</sup>  | 47.69 <sup>c</sup> | 57.58 <sup>c</sup> | 67.93 <sup>c</sup>  |
| T <sub>7</sub>        | 19.72             | 39.69 <sup>a</sup>  | 52.27 <sup>a</sup> | 64.17 <sup>a</sup> | 78.12 <sup>ab</sup> |
| T <sub>8</sub>        | 19.45             | 40.18 <sup>a</sup>  | 53.00 <sup>a</sup> | 65.20 <sup>a</sup> | 79.63 <sup>a</sup>  |
| Level of Significance | NS                | 0.01                | 0.01               | 0.01               | 0.01                |
| CV (%)                | 12.25             | 9.54                | 9.20               | 10.10              | 10.33               |

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. NS= Not significant, CV= Coefficient of variation

## Results

### Effect of variety on plant height

The significant differences in plant height at different DAT except 15 DAT were observed for selected tomato varieties. BARI Tomato-15 was significantly taller variety starting from initial stage to maturity of plant in this experiment (Figure 1).

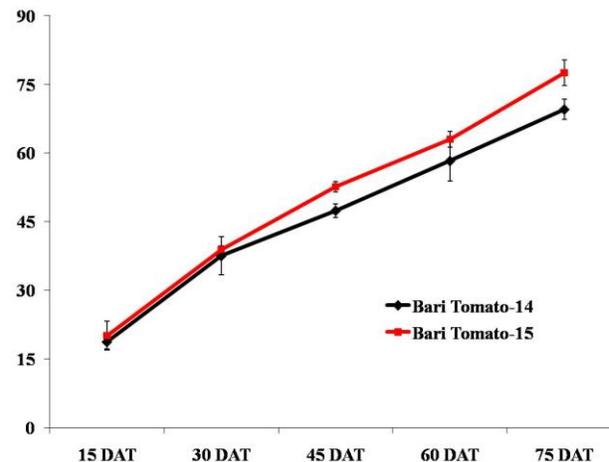


Fig. 1 Effect of variety on plant height of tomato at different growth stages

### Effect of manures and fertilizer treatment on plant height

Significance difference among the plant heights were observed (P=0.01) in all the days of data collection except 15 days after transplanting. The height of the plant increased significantly with advancement of time in case of different manure and fertilizer treatments. At 75 DAT, the tallest plants (79.63 cm) were observed from the treatment T<sub>8</sub> (60% Organic manure + 40% RFD) which was statistically similar (78.63 cm) to T<sub>1</sub> (N, P, K RFD) and the shortest (67.13 cm) was from T<sub>2</sub> (100% cow dung) which was statistically similar (67.93 cm) to T<sub>6</sub> (100% organic manures) (Table 2).

### Effect of treatments and variety on plant height

The combined effect of tomato variety and fertilizer treatments on plant height at different DAT except 15 DAT were found statistically significant (Table 2). The height of the plant increased significantly with advancement of time in case of both the varieties. Both BARI Tomato-14 and BARI Tomato-15 revealed the maximum plant height (76.07cm and 84.93cm, respectively) when they were treated with 60% organic manures (15% of each of CD, PM, VC and MOC) plus 40% RFD (T<sub>8</sub>) at 75 DAT (Table 3). In BARI Tomato-15, the second highest plant height (82.20 cm) was found in T<sub>7</sub> treatment [80% organic manures (20% of each of CD, PM, VC and MOC) + 20% RFD] which was statistically identical with the maximum height (84.93 cm) as recorded in T<sub>8</sub>.

Table 3. Combined effect of manures and variety on plant height at different days after transplanting (DAT)

| Variety x Treatment           | Plant height(cm) |                     |                     |                     |                     |
|-------------------------------|------------------|---------------------|---------------------|---------------------|---------------------|
|                               | 15DAT            | 30DAT               | 45DAT               | 60DAT               | 75DAT               |
| T <sub>1</sub> V <sub>1</sub> | 19.03            | 40.13 <sup>b</sup>  | 48.07 <sup>f</sup>  | 61.10 <sup>ef</sup> | 72.63 <sup>gh</sup> |
| T <sub>2</sub> V <sub>1</sub> | 18.30            | 36.03 <sup>ef</sup> | 45.87 <sup>gh</sup> | 55.57 <sup>hi</sup> | 64.53 <sup>kl</sup> |
| T <sub>3</sub> V <sub>1</sub> | 19.80            | 38.70 <sup>cd</sup> | 47.97 <sup>f</sup>  | 59.13 <sup>fg</sup> | 72.77 <sup>g</sup>  |
| T <sub>4</sub> V <sub>1</sub> | 18.60            | 35.67 <sup>f</sup>  | 46.10 <sup>g</sup>  | 55.73 <sup>hi</sup> | 65.23 <sup>k</sup>  |
| T <sub>5</sub> V <sub>1</sub> | 18.80            | 36.07 <sup>ef</sup> | 45.83 <sup>gh</sup> | 55.73 <sup>hi</sup> | 65.83 <sup>k</sup>  |
| T <sub>6</sub> V <sub>1</sub> | 18.35            | 36.03 <sup>ef</sup> | 45.87 <sup>gh</sup> | 55.63 <sup>hi</sup> | 64.60 <sup>kl</sup> |
| T <sub>7</sub> V <sub>1</sub> | 18.63            | 38.67 <sup>c</sup>  | 48.77 <sup>ef</sup> | 60.57 <sup>f</sup>  | 74.33 <sup>f</sup>  |
| T <sub>8</sub> V <sub>1</sub> | 18.77            | 38.87 <sup>c</sup>  | 50.77 <sup>d</sup>  | 62.63 <sup>e</sup>  | 76.07 <sup>e</sup>  |
| T <sub>1</sub> V <sub>2</sub> | 20.57            | 41.60 <sup>a</sup>  | 56.47 <sup>a</sup>  | 67.23 <sup>b</sup>  | 83.60 <sup>a</sup>  |
| T <sub>2</sub> V <sub>2</sub> | 19.93            | 37.70 <sup>d</sup>  | 49.50 <sup>e</sup>  | 59.60 <sup>fg</sup> | 71.33 <sup>h</sup>  |
| T <sub>3</sub> V <sub>2</sub> | 20.30            | 40.10 <sup>b</sup>  | 54.57 <sup>bc</sup> | 64.30 <sup>d</sup>  | 81.27 <sup>bc</sup> |
| T <sub>4</sub> V <sub>2</sub> | 20.33            | 37.07 <sup>de</sup> | 49.37 <sup>e</sup>  | 59.30 <sup>fg</sup> | 72.37 <sup>gh</sup> |
| T <sub>5</sub> V <sub>2</sub> | 19.40            | 35.93 <sup>ef</sup> | 49.50 <sup>e</sup>  | 58.37 <sup>g</sup>  | 71.97 <sup>gh</sup> |
| T <sub>6</sub> V <sub>2</sub> | 19.93            | 37.70 <sup>d</sup>  | 49.50 <sup>e</sup>  | 59.60 <sup>fg</sup> | 71.33 <sup>h</sup>  |
| T <sub>7</sub> V <sub>2</sub> | 20.27            | 40.50 <sup>ab</sup> | 54.97 <sup>bc</sup> | 65.80 <sup>c</sup>  | 82.20 <sup>ab</sup> |
| T <sub>8</sub> V <sub>2</sub> | 20.40            | 40.73 <sup>ab</sup> | 57.23 <sup>a</sup>  | 69.83 <sup>a</sup>  | 84.93 <sup>a</sup>  |
| Sg. level                     | NS               | 0.05                | 0.01                | 0.05                | 0.05                |
| CV (%)                        | 12.25            | 9.54                | 9.20                | 10.10               | 10.33               |

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. NS= Not significant, CV= Coefficient of variation

### Effect of manuring and variety on yield and yield contributing characteristics

Two tomato varieties differed significantly on yield and yield contributing characteristics (Table 3). Though BARI Tomato-15 generated higher number of flower

clustersplant<sup>-1</sup> (14.23), number of flowers cluster<sup>-1</sup> (12.07), number of fruit clustersplant<sup>-1</sup> (6.90), number of fruits cluster<sup>-1</sup> (5.68) and fruit length (5.54) while BARI Tomato-14 produced higher fruit diameter (5.46 cm), weight of individual fruit (80.74 g) and yield (59.68 t ha<sup>-1</sup>). The higher fruit diameter (5.46 cm) and individual fruit weight (80.74g) may result higher fruit yield (59.68 tha<sup>-1</sup>) for BARI Tomato-14.

Yield and yield contributing characteristics of tomato also differed significantly in respect of different treatments (Table 4). Among eight treatments, T<sub>8</sub> (60% organic manures plus 40% RFD) produced the maximum number of flower cluster plant<sup>-1</sup> (14.3), number of flowers cluster<sup>-1</sup> (7.25), number of fruit cluster plant<sup>-1</sup> (11.72), number of fruits cluster<sup>-1</sup> (6.55), fruit length (5.55cm), fruit diameter (5.40cm), individual fruit weight (82.53 g) and highest tomato yield (82.13 t ha<sup>-1</sup>).

In case of combined effect of treatment and variety, two tomato varieties with different treatments differed significantly on yield and yield contributing characteristics (Table 5) of tomato. BARI Tomato-15 showed significantly better performance while they were treated with 60% organic manures plus 40% RFD. However, fruit diameter, individual fruit weight and yield were significantly higher in BARI Tomato-14 while they were treated with 60% organic manures plus 40% RFD. Specifically, maximum flower cluster plant<sup>-1</sup> (16.24), number of flower cluster<sup>-1</sup> (13.07), fruit cluster (8.20), fruit cluster<sup>-1</sup> (6.97), maximum fruit length (5.98 cm) were observed in tomato variety of BARI Tomato-15 when treated with 60% organic manures plus 40% RFD. However, BARI Tomato-15 did not differ significantly in respect of number of flowers clusters plant<sup>-1</sup> and number of flowers cluster<sup>-1</sup> while they were treated with 100% organic manures and 80% organic manures.

BARI Tomato-15 showed statistically similar fruit length irrespective of the treatments. On the other hand, statistically higher yield (87.17 tha<sup>-1</sup>), maximum fruit diameter (6.29 cm) and higher fruit weight (91.43 g) were recorded from BARI Tomato-14 when it was treated with 60% organic manures plus 40% RFD (Table 5).

Table 4. Effect of variety on yield and yield contributing characteristics of tomato

| Variety            | No. of flower cluster/plant | No. of flowers Cluster <sup>-1</sup> | No. of fruit clusters plant <sup>-1</sup> | No. of fruit Cluster <sup>-1</sup> | Fruit length (cm) | Fruit diameter (cm) | Weight of individual fruit (g) | Yield (t ha <sup>-1</sup> ) |
|--------------------|-----------------------------|--------------------------------------|---|------------------------------------|-------------------|---------------------|--------------------------------|-----------------------------|
| BARI Tomato-14     | 10.24                       | 8.68                                 | 5.51                                      | 4.68                               | 4.33              | 5.46                | 80.74                          | 59.68                       |
| BARI Tomato-15     | 14.23                       | 12.07                                | 6.90                                      | 5.68                               | 5.54              | 4.09                | 67.33                          | 52.34                       |
| Significance level | 0.01                        | 0.01                                 | 0.01                                      | 0.01                               | 0.01              | 0.01                | 0.01                           | 0.05                        |
| LSD                | 1.34                        | 3.33                                 | 0.60                                      | 0.54                               | 0.63              | 0.57                | 7.78                           | 6.57                        |

Table 5. Effect of treatment on yield and yield contributing characteristics of tomato

| Treatment      | No. of flower cluster Plant <sup>-1</sup> | No. of flower cluster <sup>-1</sup> | No. of fruit clusters plant <sup>-1</sup> | No. of fruits cluster <sup>-1</sup> | Fruit Length (cm) | Fruit diameter (cm) | Weight of individual fruit (g) | Yield (t ha <sup>-1</sup> ) |
|----------------|---|-------------------------------------|---|-------------------------------------|-------------------|---------------------|--------------------------------|-----------------------------|
| T <sub>1</sub> | 12.63ab                                   | 6.72 ab                             | 10.57ab                                   | 5.38bc                              | 5.23ab            | 5.17ab              | 79.43ab                        | 69.75b                      |
| T <sub>2</sub> | 10.90cd                                   | 5.583cd                             | 9.95 bc                                   | 4.61de                              | 4.56bc            | 4.57 bc             | 69.82cd                        | 41.78d                      |
| T <sub>3</sub> | 12.54ab                                   | 6.71ab                              | 10.87ab                                   | 5.23cd                              | 5.34ab            | 5.07ab              | 76.10ab                        | 57.85bc                     |
| T <sub>4</sub> | 11.60bc                                   | 5.45 d                              | 9.27cd                                    | 4.43ef                              | 4.64 bc           | 4.34cd              | 66.30d                         | 43.30d                      |
| T <sub>5</sub> | 9.33d                                     | 4.78d                               | 8.66d                                     | 4.17f                               | 4.20c             | 3.97d               | 65.4d                          | 35.33de                     |
| T <sub>6</sub> | 13.07ab                                   | 6.27bc                              | 10.80ab                                   | 5.03cd                              | 4.74ab            | 4.55bc              | 71.07bc                        | 51.13c                      |
| T <sub>7</sub> | 13.48a                                    | 6.87ab                              | 11.17ab                                   | 6.03ab                              | 5.24ab            | 5.17ab              | 81.55ab                        | 66.57b                      |
| T <sub>8</sub> | 14.3 a                                    | 7.25a                               | 11.72a                                    | 6.55a                               | 5.55a             | 5.40a               | 82.53a                         | 82.13a                      |
| Sig. level     | 0.01                                      | 0.01                                | 0.01                                      | 0.01                                | 0.01              | 0.01                | 0.01                           | 0.01                        |
| CV (%)         | 9.89                                      | 9.37                                | 9.36                                      | 9.59                                | 10.71             | 11.32               | 10.68                          | 11.39                       |

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. CV= Coefficient of variation

Table 6. Effect of treatment and variety on yield and yield contributing characteristics of tomato

| Variety x Treatment           | No. of flower clusters plant <sup>-1</sup> | No. of flowers cluster <sup>-1</sup> | No. of fruit clusters plant <sup>-1</sup> | No. of fruits cluster <sup>-1</sup> | Fruit length (cm)  | Fruit diameter (cm) | Weight of individual fruit (g) | Yield (t ha <sup>-1</sup> ) |
|-------------------------------|--|--------------------------------------|---|-------------------------------------|--------------------|---------------------|--------------------------------|-----------------------------|
| T <sub>1</sub> V <sub>1</sub> | 10.83 <sup>de</sup>                        | 8.67 <sup>gh</sup>                   | 6.13 <sup>d</sup>                         | 5.10 <sup>de</sup>                  | 4.70 <sup>cd</sup> | 5.92 <sup>a</sup>   | 88.53 <sup>ab</sup>            | 73.04 <sup>b</sup>          |
| T <sub>2</sub> V <sub>1</sub> | 9.27 <sup>f</sup>                          | 8.07 <sup>hi</sup>                   | 4.90 <sup>ef</sup>                        | 4.10 <sup>gh</sup>                  | 3.93 <sup>ef</sup> | 5.13 <sup>b</sup>   | 75.50 <sup>c</sup>             | 45.90 <sup>d</sup>          |
| T <sub>3</sub> V <sub>1</sub> | 10.61 <sup>de</sup>                        | 9.17 <sup>fg</sup>                   | 5.93 <sup>d</sup>                         | 4.53 <sup>fg</sup>                  | 4.97 <sup>bc</sup> | 5.86 <sup>a</sup>   | 83.10 <sup>b</sup>             | 60.67 <sup>c</sup>          |
| T <sub>4</sub> V <sub>1</sub> | 9.67 <sup>ef</sup>                         | 7.33 <sup>ij</sup>                   | 4.60 <sup>f</sup>                         | 4.00 <sup>hi</sup>                  | 3.97 <sup>ef</sup> | 4.80 <sup>bc</sup>  | 71.20 <sup>cd</sup>            | 46.03 <sup>d</sup>          |
| T <sub>5</sub> V <sub>1</sub> | 7.70 <sup>g</sup>                          | 6.83 <sup>j</sup>                    | 4.37 <sup>f</sup>                         | 3.8 <sup>ii</sup>                   | 3.23 <sup>f</sup>  | 4.75 <sup>bc</sup>  | 71.00 <sup>cd</sup>            | 39.33 <sup>de</sup>         |
| T <sub>6</sub> V <sub>1</sub> | 10.34 <sup>ef</sup>                        | 9.33 <sup>fg</sup>                   | 5.77 <sup>d</sup>                         | 4.33 <sup>gh</sup>                  | 4.14 <sup>de</sup> | 5.03 <sup>bc</sup>  | 74.27 <sup>cd</sup>            | 53.73 <sup>cd</sup>         |
| T <sub>7</sub> V <sub>1</sub> | 11.09 <sup>d</sup>                         | 9.67 <sup>ef</sup>                   | 6.10 <sup>d</sup>                         | 5.43 <sup>cd</sup>                  | 4.60 <sup>cd</sup> | 5.96 <sup>a</sup>   | 90.90 <sup>a</sup>             | 70.60 <sup>b</sup>          |
| T <sub>8</sub> V <sub>1</sub> | 12.37 <sup>c</sup>                         | 10.37 <sup>de</sup>                  | 6.30 <sup>cd</sup>                        | 6.13 <sup>b</sup>                   | 5.13 <sup>ab</sup> | 6.29 <sup>a</sup>   | 91.43 <sup>a</sup>             | 87.17 <sup>a</sup>          |
| T <sub>1</sub> V <sub>2</sub> | 14.43 <sup>b</sup>                         | 12.47 <sup>ab</sup>                  | 7.30 <sup>b</sup>                         | 5.67 <sup>bc</sup>                  | 5.75 <sup>ab</sup> | 4.413 <sup>bc</sup> | 70.33 <sup>cd</sup>            | 66.01 <sup>bc</sup>         |
| T <sub>2</sub> V <sub>2</sub> | 12.57 <sup>c</sup>                         | 11.83 <sup>bc</sup>                  | 6.27 <sup>cd</sup>                        | 5.13 <sup>de</sup>                  | 5.18 <sup>ab</sup> | 4.01 <sup>de</sup>  | 64.13 <sup>ef</sup>            | 37.66 <sup>de</sup>         |
| T <sub>3</sub> V <sub>2</sub> | 14.47 <sup>b</sup>                         | 12.57 <sup>ab</sup>                  | 7.50 <sup>b</sup>                         | 5.93 <sup>b</sup>                   | 5.72 <sup>ab</sup> | 4.28 <sup>cd</sup>  | 69.10 <sup>cd</sup>            | 55.03 <sup>cd</sup>         |
| T <sub>4</sub> V <sub>2</sub> | 13.53 <sup>bc</sup>                        | 11.20 <sup>cd</sup>                  | 6.30 <sup>cd</sup>                        | 4.87 <sup>ef</sup>                  | 5.32 <sup>ab</sup> | 3.88 <sup>ef</sup>  | 61.40 <sup>fg</sup>            | 40.56 <sup>de</sup>         |
| T <sub>5</sub> V <sub>2</sub> | 10.96 <sup>d</sup>                         | 10.50 <sup>de</sup>                  | 5.20 <sup>e</sup>                         | 4.53 <sup>fg</sup>                  | 5.17 <sup>ab</sup> | 3.18 <sup>f</sup>   | 59.97 <sup>g</sup>             | 31.33 <sup>e</sup>          |
| T <sub>6</sub> V <sub>2</sub> | 15.80 <sup>a</sup>                         | 12.27 <sup>ab</sup>                  | 6.77 <sup>c</sup>                         | 5.73 <sup>bc</sup>                  | 5.33 <sup>ab</sup> | 4.08 <sup>d</sup>   | 67.87 <sup>de</sup>            | 48.53 <sup>d</sup>          |
| T <sub>7</sub> V <sub>2</sub> | 15.87 <sup>a</sup>                         | 12.67 <sup>ab</sup>                  | 7.63 <sup>b</sup>                         | 6.63 <sup>a</sup>                   | 5.88 <sup>a</sup>  | 4.38 <sup>bc</sup>  | 72.20 <sup>cd</sup>            | 62.53 <sup>c</sup>          |
| T <sub>8</sub> V <sub>2</sub> | 16.24 <sup>a</sup>                         | 13.07 <sup>a</sup>                   | 8.20 <sup>a</sup>                         | 6.97 <sup>a</sup>                   | 5.98 <sup>a</sup>  | 4.51 <sup>bc</sup>  | 73.63 <sup>cd</sup>            | 77.09 <sup>ab</sup>         |
| Sig. level                    | 0.05                                       | 0.05                                 | 0.05                                      | 0.05                                | 0.05               | 0.05                | 0.05                           | 0.01                        |
| CV (%)                        | 9.89                                       | 9.37                                 | 9.36                                      | 9.59                                | 10.71              | 11.32               | 10.68                          | 11.39                       |

Mean values in a column having the same letter(s) do not differ significantly whereas mean values having different letter(s) differ significantly as per DMRT. CV= Coefficient of variation

Table 7. Cost and return of tomato from application of different fertilizers

| Variety X Treatment           | Total cost of production (Tk./ha) | Gross Return (Tk./ha) | Net return (Tk./ha) | BCR  |
|-------------------------------|-----------------------------------|-----------------------|---------------------|------|
| T <sub>1</sub> V <sub>1</sub> | 179656                            | 876480                | 696824              | 4.87 |
| T <sub>2</sub> V <sub>1</sub> | 187440                            | 550800                | 363360              | 2.93 |
| T <sub>3</sub> V <sub>1</sub> | 187732                            | 728080                | 540348              | 3.87 |
| T <sub>4</sub> V <sub>1</sub> | 318480                            | 552360                | 233880              | 1.73 |
| T <sub>5</sub> V <sub>1</sub> | 218445                            | 471960                | 253515              | 2.16 |
| T <sub>6</sub> V <sub>1</sub> | 228024                            | 644760                | 416736              | 2.82 |
| T <sub>7</sub> V <sub>1</sub> | 216360                            | 847200                | 630840              | 3.91 |
| T <sub>8</sub> V <sub>1</sub> | 204695                            | 1046040               | 841345              | 5.11 |
| T <sub>1</sub> V <sub>2</sub> | 179656                            | 660100                | 480444              | 3.67 |
| T <sub>2</sub> V <sub>2</sub> | 187440                            | 376600                | 189160              | 2.01 |
| T <sub>3</sub> V <sub>2</sub> | 187732                            | 550300                | 362568              | 2.93 |
| T <sub>4</sub> V <sub>2</sub> | 318480                            | 405600                | 87120               | 1.27 |
| T <sub>5</sub> V <sub>2</sub> | 218445                            | 313300                | 94855               | 1.43 |
| T <sub>6</sub> V <sub>2</sub> | 228024                            | 485300                | 257276              | 2.12 |
| T <sub>7</sub> V <sub>2</sub> | 216360                            | 625300                | 408940              | 2.89 |
| T <sub>8</sub> V <sub>2</sub> | 204695                            | 770090                | 565395              | 3.76 |

## Discussion

In this experiment, BARI Tomato-15 produced taller plant than BARI Tomato-14. In case of interaction effect, both of these varieties revealed the tallest plant when they were treated with 60% Organic manure and 40% RFD at 75 DAT. Similar result was obtained from Rodge and Yadlod (2009), where they found the highest tomato plant height with application of 50% Recommended dose of fertilizer and 50% Farm yard manure. Reddy et al. (2002) also found maximum plant height through the application of combination of organic and inorganic fertilizer. Similarly, Patil et al. (2004) reported the highest plant height by application of organic manure in combination with inorganic fertilizer. Islam et al. (2017) obtained the highest Plant height from mixed fertilizers (organic<sup>2/3</sup>+inorganic<sup>1/3</sup>) or IPNS (integrated plant nutrient system) in Roma VF.

In respect of varietal effect on yield contributing parameters BARI Tomato-15 resulted higher number of flower clusterplant<sup>-1</sup>, number of flower cluster<sup>-1</sup>, number of fruit clusterplant<sup>-1</sup>, number of fruit cluster<sup>-1</sup> and fruit length while BARI Tomato-14 produced higher fruit diameter, weight of individual fruit and yield. On the other hand, Islam et al. (2017) found that Roma VF produced significantly higher yield (12.8 t/ha) than BARI tomato 15 (10.1 t/ha).

Considering the effect of treatments on yield and yield contributing characters, T<sub>8</sub> (60% organic manures plus 40% RFD) resulted the best performance among eight treatments. Similar result obtained from Patil et al. (2004); Rodge and Yadlod (2009). Adekiya and Agbede (2009) stated combined use of NPK 15-15-15 fertilizer and poultry manure increased tomato yield compared to the application of NPK 15-15-15 fertilizer or poultry manure alone. Agele (2001) also found that poultry manure litters resulted in better growth and yield of tomato than NPK fertilizer alone. Qian and Schoenau (2002), and Okwugwu and Alleh (2003) reported that high and sustained crop yield could be achieved with a judicious and balanced NPK fertilizer treatment combined with organic matter amendments. The combined application of pig manure and NPK fertilizer also increased tomato fruit yield compared with pig manure or NPK fertilizer treatments alone (Giwa, 2004). Also, Adeniyani and Ojeniyi (2005) found that integrated application of poultry manure and NPK fertilizer increased maize yield compared with poultry manure or fertilizer applications alone. Similarly, Islam et al. (2017) concluded combined application of inorganic and organic sources of nutrients as more productive and sustainable.

The BARI Tomato-15 showed significantly better performance in respect of yield contributing parameters (maximum flower cluster plant<sup>-1</sup>, number of flower cluster<sup>-1</sup>, fruit cluster, fruit cluster<sup>-1</sup>, Maximum fruit length) while they were treated with 60% Organic

manure and 40% RFD. Whereas, fruit diameter, individual fruit weight and yield were significantly higher in BARI Tomato-14 while they were treated with 60% Organic manure and 40% RFD. Reddy et al. (2002) found maximum number of tomato fruit per plant and maximum fruit weight with application of 50% nitrogen through Farm yard manure and 50% through Urea. Rafi et al. (2002) also obtained maximum fruit weight from treatment combination of 50% recommended dose of fertilizer + 50% farm yard manure. In case of benefit cost ratio, our experiment revealed maximum BCR from 60% Organic manure and 40% recommended doses of fertilizer which was coherent with the result of Reddy et al. (2002).

## Conclusion

Combination of organic and inorganic fertilizers resulted better yield of tomato. From the findings of the present study, it may be concluded that integrated application of 60% organic manures and 40% RFD can provide the best results for growth and yield of tomato. This study suggests that the effect of these manures can compensate up to 60% reduction of recommended fertilizers. Hence, both organic and inorganic fertilizers should be used by the farmers for profitable tomato production. However, further trials in different locations of the country with other treatment combinations are necessary before final recommendation at farmer's level.

## References

- Adediran, J.A., Taiwo, L.B. and Sobulo, R.A., 2003. Organic wastes and their effect on tomatos (*Lycopersicum esculentus*) yield, *African Soils*, 33: 99–116.
- Adekiya, A.O. and Agbede, T.M., 2009. Growth and yield of tomato (*Lycopersicon esculentum* Mill) as influenced by poultry manure and NPK fertilizer. *Emirates Journal of Food Agriculture*, 21 (1): 10-20. <https://doi.org/10.9755/ejfa.v21i1.5154>
- Adeniyani, O.N. and Ojeniyi, S.O., 2005. Effect of poultry manure, NPK 15-1515 and combination of their reduced levels on maize growth and soil chemical properties. *Nigerian Journal of Soil Science*, 15: 34–41.
- Agele, S.O., 2001. Growth and yield of tomato grown on degraded soil amended with organic wastes. Proceedings of the 35th Conference of the Agricultural Society of Nigeria. Federal University of Agriculture, Abeokuta, Nigeria. pp. 151-154.
- Alam, M.N., Jahan, M.S. Ali, M.K. Islam, M.S. and Khandaker, S.M.A.T., 2007. Effect of Vermicompost and NPKS fertilizers on growth, yield and yield Components of red amaranth. *Australian Journal of Basic and Applied Science*, 1(4): 706–716.
- BBS. 2018. Yearbook of Agricultural Statistics-2017. Statistics and Informatics Division (SID), Ministry of Planning, Govt. of the Peoples' Republic of Bangladesh, Dhaka. pp. xviii.
- FAOSTAT. 2018. Food and Agriculture Organization of the United Nations. [www.fao.org/worldfoodsituation/csdb/en](http://www.fao.org/worldfoodsituation/csdb/en).
- Food and Agriculture Organization (FAO). 2010. Production Year Book; Food and Agriculture Organization of the United Nations: Rome, Italy, 53: 132–133.
- Ghosh, P.K., Ajayi, K.K., Manna, M.C., Mandal, K.G., Mistra, A.K. and Hati, K.M., 2004. Comparative effectiveness of cattle manure, poultry manure, phosphocompost and fertilizer NPK on three cropping systems in Ventisols of semi-arid tropics. II. Dry matter yield, nodulation, chlorophyll

- content and enzyme activity. *Bioresource and Technology*, 95: 85–93. <https://doi.org/10.1016/j.biortech.2004.02.012>
- Giwa, D. D., 2004. Comparative effect of pig manure and NPK fertilizer on soil fertility and performance of tomato (*Lycopersicon lycopersicum Mill.*). M. Agric. Tech. Thesis, Federal University of Technology, Akure, Nigeria. pp. 59.
- Halder, N. K., Saha, M. K., Kabir, A. H. M. F., Sarker, J. U. and Rahman, M. J., 2003 Response of summer tomato to hormone and planting time at hill slope. *Pakistan Journal of Biological Sciences*, 6(2): 146–148. <https://doi.org/10.3923/pjbs.2003.146.148>
- Islam, M.A., Islam, S., Akter, A., Rahman, M. H. and Nandwani, D., 2017. Effect of Organic and Inorganic Fertilizers on Soil Properties and the Growth, Yield and Quality of Tomato in Mymensingh, Bangladesh. *Agriculture*, 7(18). <https://doi.org/10.3390/agriculture7030018>
- Latha, M.R., Savithri, P., Indirani, R. and Kamaraj, S., 2002. Residual effect of zinc enriched organic manures on yield and zinc uptake in sunflower under maize-sunflower cropping sequence. *Agricultural science Digest*, 22 (2): 114–116.
- Manral, H.S. and Saxena, S.C., 2003. Plant growth, yield attributes and grain yield of soybean as affected by the application of inorganic and organic sources of nutrients. *Bioresource and Technology*, 92: 110–118.
- Musa, L.M., Haroun, K.S. and Raja, U.C., 2007. Performance of tomato plants under different levels of organic compost during dry seasons in northern Nigeria. *Journal of arid agriculture*, 21: 591–601.
- Natarajan, K., 2007. Panchagavya for plant. Proc. Nation. Conf. Glory Gomatha, S. V. Veterinary.
- Odiete, I. and Ogunmoye, S.O., 2005. Comparative effect of poultry manure and phosphorus fertilizer on the growth and yield of soybean (*Glycine max*) in Plateau State. The Proceedings of the 39th annual conference of the Agricultural Society of Nigeria, Benin City, pp. 258–259.
- Okwugwu, M. T. and Alleh, M. E., 2003. The effect of organic and inorganic manures on the physico-chemical properties of the soil and yield of okra in Ekpoma, humid tropical rainforest of Nigeria. Proceedings 28th Annual Conference of Soil Science Society of Nigeria, November 3rd-7th, Umudike, Nigeria. Abstract. pp. 26.
- Patil, M.B., Mohammed, R.G. and Ghadge, P.M., 2004. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato. *Journal of Maharashtra Agricultural University*, 29(2): 124–127.
- Qian, P. and Schoenau, J. J., 2002. Availability of nitrogen in solid manure amended with different C: N ratios. *Canadian Journal of Soil Science*, 82: 219–225. <https://doi.org/10.4141/S01-018>
- Rafi, M. Naradkar, P. R. Prabu, T. and Sajindranath, A. K., 2002. Effect of organic and inorganic Fertilizers on growth and yield of tomato (*Lycopersicon esculentum Mill.*). *South Indian Horticulture*, 50(4/6): 522–526.
- Rahman, M. A., Shaha, J. H. U. K., Choudhury, A. R. and Choudhury, M. M. U., 1996. Growth and yield of tomato as influenced by fertilizers and manures. *Bangladesh Agricultural Publication*, 6: 71–74.
- Reddy, C.S., Narayanamma, M. Chiranjeevi, C. and Reddy, I.P., 2002. Effect of nutrient sources on the fruit yield of tomato (*Lycopersicon esculentum Mill.*). *Vegetable Science*, 29(2): 193–194.
- Reddy, S.S. and Ram, R.P., 1996. *Agricultural Finance and Management*, 126-7. Oxford and IBH Publishing Co. Pvt .Ltd.
- Rodge, B. M. and Yadlod, S. S., 2009. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato (*Lycopersicon esculentum Mill.*). *Asian Journal of Horticulture*, 4(1): 221–224.
- Shaheed, M.A., 1997. Effect of manures and nitrogen fertilizers on performance of grafted tomato in pot culture. MS Thesis, Department of Soil Science, Institute of Postgraduate Studies in Agriculture, Salna, Gazipur, Bangladesh. pp. 51–54.
- Sreenivasa, M.N., Nagaraj, M.N. and Bhat, S.N., 2010. Beejamruth: A source for beneficial bacteria. *Karnataka Journal of Agricultural Science*, 17(3): 72–77.
- Van der Berg, H., Faulks, R., Granado, F.H., Hirschberg, J., Olmedilla, B. and Sandmann, G., 2000. The potential for the improvement of carotenoid levels in foods and the likely systemic effects. *Journal of the Science and Food Agriculture*, 80: 880–912. [https://doi.org/10.1002/\(SICI\)1097-0010\(20000515\)80:7%3C880::AID-JSFA646%3E3.0.CO;2-1](https://doi.org/10.1002/(SICI)1097-0010(20000515)80:7%3C880::AID-JSFA646%3E3.0.CO;2-1)