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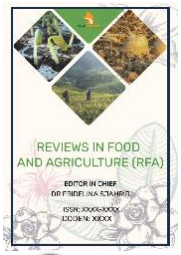


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RESEARCH ARTICLE

# GROWTH AND YIELD RESPONSES OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) UNDER DIFFERENT COMBINATIONS OF PLANTING TIMES AND FERTILIZERS

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**ABSTRACT**

This experiment was conducted to study the influence of planting date and fertilizer management on the growth and yield of tomato cv Ratan. The experiment consisted of two factors; Factor A: three planting dates, viz. 20 October, 5 November, 20 November and Factor B: four different doses of fertilizer, viz., control; 100 kg urea + 75 kg TSP + 100 kg $M_0$P/ha; 200 kg urea + 150 kg TSP + 200 kg $M_0$P/ha and 300 kg urea +225 kg TSP + 300 kg $M_0$P/ha were used in 12 treatment combinations. The experiment was laid out in randomized complete block design with three replications. Combined effects of planting date and fertilizer management exhibited significant variation on plant height at 30 DAT, 45 DAT, and 60 DAT, number of flowers per plant, number of mature fruits per plant, fruit diameter, weight of individual fruit, weight of fruits per plant, fruit yield per plot and fruit per hectare. The highest fruit yields per plot (23.94 kg) as well as per hectare (73.89 t) were achieved from the treatment combination of planting at 5 November with 200 kg urea + 150 kg TSP + 200 kg $M_0$P/ha.

**KEYWORDS**

tomato, planting time, fertilizer doses, growth, yield.

## 1. INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is a self-crossing annual crop that belongs to the Solanance family. It is a great source of vitamins (A & C) and minerals (Hobson and Davies, 1971; Kalloo, 1991). It is also a good source of vitamin A, B, C and D, minerals, Ca, P and Fe (Islam, 1996). In Bangladesh, more than 7% of total Vitamin-C of vegetables comes from tomato. It is cultivated in home gardens and also in the crop field due to its adaptability to wide ranges of climate and soil (Ahmed, 1976). It aligns next to potato & sweet potato in the world vegetable production (Rashid, 1983). It has taproot system and having determinate, semi-determinate and indeterminate growth habit (Reddy et al., 2013). Tomato is one of the most vital "protective foods" because it has special nutritive value (Shankar et al., 2013). Tomato takes on a large quantity of water (%), calcium (%) and Niacin all of that are of great importance in the metabolic activities of a person (Olaniyi et al., 2010). BARI proved that matured ripen tomato contains 94 g water, 0.8 g fibre, 0.5 g minerals, 0.9 g protein, 356 mg carotene, 0.12 mg vitamin B-1, 0.06 mg vitamin B-2 and 27 mg vitamin C in each 100 g (BARI, 2010). This crop plant can be semi-perennial or perennial, but commercially it is recognized an annual (Geisenberg and Stewart, 1986). The crop is affluent in vitamin C and contains lycopene, a very important antioxidant which prevents cancers (Beckles, 2012). In Bangladesh, suitable atmosphere remains for tomato production from October to March. It is predominantly grown in winter season. High temperature reduces flower production and causes bud & flower drop.

Went proved that fruit set was enormous only when night temperature was between 15$^0$C to 20$^0$C, that might over simplify the issue (Went, 1984). The worth of temperature in fruit set was clearly evident. Curme assumed that fruit set in specific varieties with temperature as low (7.2$^0$C) and with temperature as high (26.6$^0$C) had created more flexible situation in case of the variety temperature interactions (Schaible, 1990; Curme, 1992). Climate change is a main threat for crop production not only in Bangladesh but also in all over the world. The meteorological data for the last 10 years proved that the crop suffer from cold injury at the month of January which result decreasing yield of this crop (Anonymous, 2007). In some areas of Bangladesh, specifically in the northwestern part, the night temperature falls even goes below 5-6$^0$C sometimes which results huge yield loss in tomato. The low yield of tomato in Bangladesh is not an indication of low yield potentially of this crop but the reduced yield may be characterized to a number of reasons such as improper management of fertilizer, late planting and lack of suitable crop management practices. Tomato production may be boosted up tremendously through optimum time of planting and proper fertilizer management.

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Vegetables (e.g. tomato) production is significantly influenced by weather conditions. Proper production technique and proper management are the vital factors to increase production in Bangladesh. In this respect, time of planting is very important factor and early November seems to be the best time of transplanting than that of September and October (Hossain et al., 1986). Late planting generates low yield and amplify disease infestation. Early harvesting of tomato provides better income to the farmers as the market price of early crop is generally very high (BBS, 2015). in Bangladesh, growers usually cultivate this crop over a long period of time starting from late September to late November.

Tomato usually takes up large amounts of nutrients from the soil (Ortas, 2013). Tomato responded significantly to Nitrogen and Phosphorus fertilizers (Abu-Alrub et al., 2019). Ortas, found that the two fertilizer (N and P) levels influence growth, yield and fruit quality of fresh market tomato (Ortas, 2013). Nitrogen and phosphorus are the two essential macronutrients to crops (e.g. tomato) that improve their growth, yield and product quality (Chen et al., 2008). The tomato crop is extremely responsive to nitrogen (N) fertilizer application where N availability may be limited and application time is critical (Taber, 2001). It promotes vegetative growth, flowering & fruit set of tomato, but excess of nitrogen delays maturity and decreases fruit size (Bose and Som, 1990). A group researcher recognized that N fertilizer influence plant height, leaf number per plant, fruit number per plant, fruit mean weight and total yield per plant in tomato crops (Akanbi et al., 2003). Management of N fertilizer e.g. rate, type of N fertilizer, application time is very important (De Pascale et al., 2006). Phosphorus is recognized as the "key of life" for plant because of its direct involvement in most life processes (Amapu, 1998). Singh and Sangama investigated that phosphorus is a constituent of nucleoprotein, known to play a leading role in photosynthesis, cell division and tissueformation (Singh and Sangama, 2000). It might be due to availability of nitrogen and their uptake that progressively promoted the vegetative growth of the plant in tomato (Ewulo et al., 2015). Ortas reported that high fruit quality in tomato is influenced by high levels of potassium (K). K is important in horticultural crops for better fruit quality (Savvas et al., 2008; Ortas, 2013). Gupta and Sengar showed that K fertilizer increases plant growth, quality, yield and the chemical composition of tomato (Gupta and Sengar, 2000). Potassium is the most predominant inorganic chemical influencing plant physiology with a significant role to play in the plant energy status for storage of assimilates and tissue water relation (Marschner, 1995). Furthermore, K improves fruit size and promotes root growth which contributes enormously to fruit quality (El-Bassiony, 2006). Ortas proved that increase in N and K uptake and constant level of P contributes to increased yield tomato (Ortas, 2013). Indiscriminate use of nitrogenous, phosphatic and potassic fertilizer is believed to make deterioration of soil fertility, microbial activity, quality of ground water and finally decrease crop yield. Emphasis should be provided to increase tomato yield through the adoption of proper planting time and nutrition management. A study was therefore undertaken to find out appropriate dose of NPK fertilizers grown under a suitable time of planting practice for maximum tomato yield.

## 2. Materials and Methods

### 2.1 Location of the experimental plot

The field experiment was carried out at the Horticulture Farm of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October, 2015 to February, 2016 to find out the effect of planting time and fertilizer management on the growth and yield of tomato.

### 2.2 Characteristics of soil

The soil of the experimental area was silty loam and belongs to the Old Brahmaputraputra Flood Plain Alluvial Tract of Agro Ecological Zone 9 (AEZ-9) having non-calcarious soil (UNDP, 1988). The selected site was a medium high land and the pH of the soil was 6.3 with organic matter content of 1.21%.

### 2.3 Climate of the experimental site

The experimental area was situated in the subtropical climatic zone characterized by low rainfall, low humidity, low temperature and short-day period during Rabi season (October to March). Rabi season is favorable for tomato cultivation.

### 2.4 Plant materials used

The variety of tomato used in the experiment was Ratan. This is a high yielding indeterminate type plant and the seeds were collected from the Horticulture Farm of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh.

### 2.5 Raising of seedlings

The land selected for seed bed was well drained and the soil was sandy loam. The size of each seed bed was 3 m × 1 m raised above the ground level maintaining a spacing of 50 cm between the beds. Two seed beds were prepared for raising the seedlings. Ten grams of seed was sown in each seed bed on 15 September 2015. After sowing, the seeds were covered with light soil. Weeding, mulching and irrigation were done as and when required. No chemical fertilizer was used in the seed bed.

### 2.6 Treatments of the experiment

The experiment consisted of two factors as follows:
**Factor A:** Three different levels of planting dates
$T_1$: 20 October
$T_2$: 5 November
$T_3$: 20 November
**Factor B**: Four different levels of fertilizer
$F_0$: Control
$F_1$: Urea 100 Kg/ha + TSP 75 Kg/ha + $M_0P$ 100 Kg/ha
$F_2$: Urea 200 Kg/ha + TSP 150 Kg/ha + $M_0P$ 200 Kg/ha
$F_3$: Urea 300 Kg/ha + TSP 225 Kg/ha + $M_0P$ 300 Kg/ha

### 2.7 Experimental design and layout

The experiment consisting of 12 treatment combinations was laid out in randomized complete block design (RCBD) with three replications. The whole field was divided into three blocks each containing 12 plots. In total, there were 36-unit plots. The treatment combinations were randomly assigned to each unit plot so as to allot one treatment combination only one in each block of unit plot was 1.8 m × 1.8 m. The distance between the blocks and that of between plots was 50 cm.

### 2.8 Land preparation

The land was gradually ploughed and cross-ploughed several times with power tiller to bring the land under a good tilth. During land preparation, weeds and stubbles of the previous crop were collected and remove from the land.

### 2.9 Manure and fertilizer application

The entire quantity of cowdung (10 t/ha) was applied just after opening the land. Urea and TSP were applied as the source of nitrogen and cowdung respectively as per treatment. A basal dressing of potassium at 200 kg $M_0P$ ha was given to all treatments including the control plots. Urea and MOP were applied in three instalments. Urea and MOP were applied by broadcasting, four days before transplanting (BRAC, 2015). The fertilizers were mixed thoroughly with soil by hand. TSP was applied as per dose. The second and third doses of Urea and MOP were added as top dressing at 21 and 35 days after transplanting.

### 2.10 Transplanting of seedlings

seedlings were grown separately in different seedbed for each treatments. Healthy and uniform sized 35 days old seedlings were taken separately from the seed bed and were transplanted in the experimental field on 20 October, 5 November, 20 November maintaining a spacing of 60 cm and 40 cm between the rows and plants respectively. The seed beds were watered before uprooting the seedlings so as to minimize damage to the

roots. This operation was carried out during late hours in the evening. The seedlings were watered after transplanting. Shading was provided by pieces of banana leaf sheath for three days to protect the seedlings from the direct sun. Seedlings were also grown around the experimental area to do gap filling.

### 2.11 Intercultural operations

After transplanting the seedlings, various kinds of intercultural operations were accomplished for better growth and development of the plants.

#### *2.11.1 Gap filling*

A few gaps filling was done by healthy plants whenever it was required.

#### *2.11.2 Weeding*

Weeding was accomplished as and whenever necessary to keep the crop free from weeds for better soil aeration and to break the crust.

#### *2.11.3 Staking and pruning practices*

When the plants were well established, staking was given to each plant by daincha *(Sesbania* sp.*)* sticks to keep them erect. After a few days of staking, as the plants grew up, the plants were pruned uniformly having single main stem per plant.

#### *2.11.4 Irrigation*

Two irrigations were given throughout the growing period by watering can. The first irrigation was given 40 days after planting followed by another irrigation 20 days after the first irrigation.

#### *2.11.5 Plant protection*

As preventive measure against the insect pests like cut worm, leaf hopper and others; Diazinon 60 EC was applied at the rate of 2 ml/litre. The insecticide applications were made fortnightly from a week after transplanting to a week before first harvesting. During foggy weather precautionary measures against disease infestation especially late blight of tomato was taken by spraying Dithane M-45 fortnightly @ 2 g/l.

#### *2.11.6 Harvesting*

Fruits were harvested at 5 days intervals during maturing and ripening stage. The maturity of the crop was determined on the basis of red coloring of fruits. Harvesting was started from 20 January and completed by 22 February.

### 2.12 Procedure of data collection

Data on the following parameters were recorded form the sample plants during the course of experiment. Ten plants were selected randomly from each plot in such a way that the border effect was avoided for the highest precision.

#### *2.12.1 Plant height*

Plant height at final harvest was measured from 10 randomly selected plants in centimeter from the ground level to tip of the longest stem and mean value was calculated. Plant height was also recorded at 15 days interval starting from 30 days of planting up to 60 days to observe the growth rate of plants.

#### *2.12.2 Days to first flowering*

Different dates of first flowering were recorded. Then the observation was calculated from the date of transplanting. It was considered when flower was fully opened.

#### *2.12.3 Number of flower cluster per plant*

The number of flower clusters was counted from the sample plants and the average number of flower cluster produced per plant was recorded at the time of final harvest.

#### *2.12.4 Number of flowers per cluster*

The number of flowers per cluster was calculated by following formula:

$$\text{Number of flowers per cluster} = \frac{\text{Total number of flowers in sample plants}}{\text{Total number of flower clusters in sample plants}}$$

#### *2.12.5 Number of flowers per plant*

The number of flowers per plant was calculated by following formula:

Number of flowers per plant= Number of flower cluster per plant × Number of flowers per cluster

#### *2.12.6 Number of fruit cluster per plant*

The number of fruit clusters was counted from the sample plants and the average number of fruit cluster produced per plant was recorded at the time of final harvest.

#### *2.12.7 Fruit length*

The length of fruit was measured with a slide calipers from the neck of the fruit to the bottom of 10 selected marketable fruits from each plot and their average was taken as the length of fruit.

#### *2.12.8 Fruit diameter*

Diameter of fruit was measured at the middle portion of 10 selected marketable fruits from each plot with a slide calipers and their average was taken as the diameter of fruit.

#### *2.12.9 Number of fruits per plant*

It was calculated by the following formula.

$$\text{Number of fruits per plant} = \frac{\text{Total number of fruits from 5 sample plants after hrvest}}{5}$$

#### *2.12.10 Weight of individual fruit*

Among the seven harvesting of marketable fruits during the period from first to final harvests, first and last harvests were omitted and five intermediate harvests were taken for individual fruit weight by the following formula.

$$\text{Weight of individual fruit} = \frac{\text{Total weight of marketable fruits from 5 harvest of sample plant}}{\text{Total number of marketable fruits from 5 harvest of sample plant}}$$

#### *2.12.11 Weight of fruit per plant*

It was measured by the following formula:
Weight of fruit per plant = Number of fresh ripe fruit per plant x weight of individual fruit.

#### *2.12.12 Fruits yield per plot*

A pan scale balance was used to take the weight of fruits per plot. It was measured totaling from each unit plot separately during the period from first to final harvests.

#### *2.12.13 Fruit yield per hectare*

Fruit yield of tomato per plot was finally converted to yield per hectare and expressed in ton (t).

$$\text{Fruit yield per hectare (t)} = \frac{\text{Fruit yield per plot (kg)} \times 10000}{\text{Area of plot(m 2)} \times 1000}$$

### 2.13 Analysis of data

The means for all the treatments were calculated and analysis of variances for most of the characters under consideration was performed by F variance test. The significance of the difference among the means was evaluated by Least Significant Difference (LSD) test at 5% and 1% for interpretation of the results. (Gomez and Gomez, 1984).

## 3. Results

The combined effects due to different planting date and different doses of fertilizer and their interaction on the growth, yield and yield contributing characters have been presented under the following headings.

### 3.1 Plant height & Days to first flowering

The variations in plant height at different days after planting due to combined effect of different planting time and fertilizer doses were found to be statistically significant at 30 DAT, 45 DAT and 60 DAT (Table 1). The plant height ranged at 60 DAT from 62.33 cm to 91.00 cm. The tallest plant (91.00 cm) was observed from the treatment combination of 5 November planting with Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha and the shortest plant (62.33 cm) was found from the control treatment (20 October planting with zero fertilizer). The interaction effect of different planting time and fertilizer doses was significantly influenced on the days to first flowering. Days to first flowering ranged from 32.00 days to 38.00 days. The plants transplanted at 5 November and fertilized with treatment combination of Urea 200 kg/ha + TSP 150 kg/ha + MOP 200 kg/ha produced early flowering (32.00 days) and the control treatment (20 October planting with zero fertilizer) produced delayed (38.00 days) flowering shown in table (1).

**Table 1:** Combined effect of planting time and fertilizer management on plant height and days to first flowering of tomato

| Treatment combination | Plant height (cm) | | | Days to first flowering |
|---|---|---|---|---|
| | 30 DAT | 45 DAT | 60 DAT | |
| $T_1F_0$ | 31.58 | 47.00 | 62.33 | 38.00 |
| $T_1F_1$ | 44.25 | 61.42 | 77.75 | 37.00 |
| $T_1F_2$ | 54.21 | 69.67 | 84.42 | 35.00 |
| $T_1F_3$ | 47.17 | 68.42 | 80.33 | 36.00 |
| $T_2F_0$ | 37.92 | 56.33 | 76.42 | 34.00 |
| $T_2F_1$ | 56.58 | 70.83 | 82.92 | 33.00 |
| $T_2F_2$ | 65.25 | 78.25 | 91.00 | 32.00 |
| $T_2F_3$ | 62.67 | 75.75 | 88.42 | 33.00 |
| $T_3F_0$ | 33.83 | 52.25 | 68.92 | 35.00 |
| $T_3F_1$ | 50.25 | 67.83 | 81.83 | 35.00 |
| $T_3F_2$ | 55.00 | 76.33 | 89.17 | 33.00 |
| $T_3F_3$ | 51.50 | 75.08 | 88.00 | 34.00 |
| $LSD_{0.05}$ | 1.04 | 1.08 | 1.42 | 0.645 |
| $LSD_{0.01}$ | 1.42 | 1.47 | 1.93 | 0.876 |
| Level of significance | 15.38** | 1.76** | 14.33** | 0.417* |

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

### 3.2 Flowering and fruiting characters

#### 3.2.1 Number of flower clusters per plant

There were significantly differences between different planting time and fertilizer doses on flower cluster number per plant. The highest number of flower clusters per plant (14.42) was recorded in 5 November with Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha). The lowest number of flower clusters per plant (4.75) was observed in control plot (Table 2).

#### 3.2.2 Number of flower per cluster

Effect of different planting time and fertilizer doses on the number of flowers per cluster was significant. The highest number of flowers per cluster (8.33) was recorded in 20 October with Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha) whereas the lowest number of flower clusters per plant (4.00) was observed in control plot (Table 2).

#### 3.2.3 Number of flower per plant

The combined effect between different planting time and fertilizer doses on the number of flowers per plant was significant. The total number of flowers per plant ranged from 39.17 to 83.67. It is evident from the results shown in (Table 3) that the highest number of flowers per plant (83.67) was recorded in 5 November planting with Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha. The lowest number of flowers per plant (39.17) was observed in control treatment (20 October planting without fertilizer application) shown in table 2.

#### 3.2.4 Number of fruit clusters per plant

The combined effect of different time of planting and fertilizer levels on the number of fruit clusters per plant was significant. The highest number of fruit clusters per plant (12.00) was recorded in 5 November with Urea 200 kg/ha + TSP 150 5g/ha + $M_0$P 200 kg/ha) and the lowest number of fruit clusters per plant (7.10) was recorded from 20 October with the control treatment plants (Table 2).

#### 3.2.5 Fruit length

It was observed that the interaction effect of different planting time and fertilizer doses on fruit length was significant. The highest fruit length (3.89 cm) was noted in 5 November with Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha) while the control treatment gave the lowest fruit length (2.04 cm) (Table 2).

#### 3.2.6 Fruit diameter

Interaction between different planting time and fertilizer levels on fruit diameter was found to be statistically significant. The plants of 5 November transplanting treated with Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha ($F_2$) gave the highest fruit diameter (5.17 cm) when oppositely the lowest fruit diameter (2.32 cm) was found in control plot (Table 2)

**Table 2:** Combined effect of planting time and fertilizer management on Flowering and fruiting characters of tomato

| Treatment combination | No. of flower cluster/ plant | No. of flowers/ cluster | No. of flowers/ plant | No. of Fruit cluster/plant | Fruit length (cm) | Fruit diameter (cm) |
|---|---|---|---|---|---|---|
| $T_1F_0$ | 4.75 | 4.00 | 39.17 | 7.10 | 2.04 | 2.32 |
| $T_1F_1$ | 5.17 | 4.33 | 46.33 | 9.00 | 2.38 | 3.28 |
| $T_1F_2$ | 8.42 | 5.67 | 57.00 | 11.00 | 3.53 | 4.14 |
| $T_1F_3$ | 5.33 | 4.33 | 50.33 | 10.00 | 3.15 | 3.86 |
| $T_2F_0$ | 10.42 | 4.67 | 53.33 | 9.97 | 2.63 | 3.15 |
| $T_2F_1$ | 11.00 | 6.33 | 54.33 | 11.38 | 3.52 | 4.20 |
| $T_2F_2$ | 14.42 | 8.33 | 83.67 | 12.00 | 3.89 | 5.17 |
| $T_2F_3$ | 12.00 | 6.67 | 62.67 | 11.33 | 3.58 | 4.43 |
| $T_3F_0$ | 8.75 | 4.33 | 45.00 | 9.20 | 2.38 | 2.57 |
| $T_3F_1$ | 10.75 | 5.33 | 50.33 | 10.52 | 3.18 | 4.16 |
| $T_3F_2$ | 12.33 | 7.33 | 63.67 | 11.66 | 3.64 | 4.83 |
| $T_3F_3$ | 11.92 | 5.67 | 56.00 | 10.33 | 3.42 | 4.25 |
| $LSD_{0.05}$ | 0.428 | 0.404 | 1.04 | 0.438 | 0.131 | 0.186 |
| $LSD_{0.01}$ | 0.582 | 0.550 | 1.41 | 0.596 | 0.178 | 0.252 |
| Level of significance | 1.44** | 0.60** | 57.67** | 0.75** | 0.12** | 0.09** |

** = Significant at 1% level of probability

### 3.3 Number of fruits per plant

The combined effect between different planting time and fertilizer doses on the number of fruits per plant was significant. The highest number of fruits per plant (37.33) was recorded in 5 November with Urea 200 Kg/ha + TSP 150 Kg/ha + $M_0$P 200 Kg/ha). The lowest number of fruits per plant (20.67) was observed in control plot where the plants were transplanted at 20 October and no fertilizer used (Figure 1).

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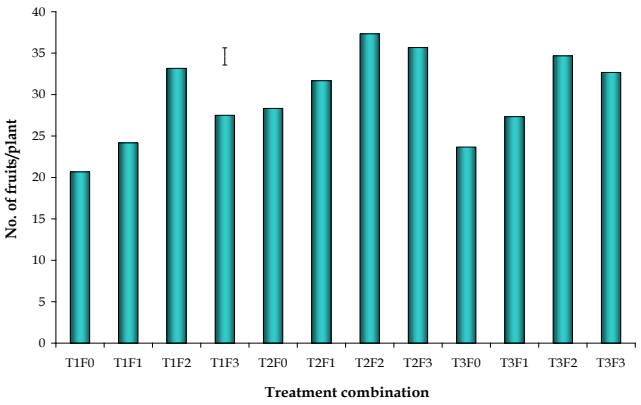


**Figure 1:** Combined effect of planting time and different fertilizer doses on number of fruits per plant in tomato. Vertical bar represents LSD at 1% level of significance

### 3.4 Yield contributing characters

#### *3.4.1 Weight of individual fruit*

There was significant interaction effect between different planting time and fertilizer doses on individual fruit weight. The highest individual fruit weight (53.43 g) was recorded in 5 November with Urea 200 kg/ha + TSP 150 kg/ha + $M_0P$ 200 kg/ha) and the lowest individual fruit weight (15.53 g) was obtained from control plot (Table 3).

#### *3.4.2 Weight of fruits per plant*

The conjoined effect between different planting time and fertilizer doses on fruit weight per plant was significant. The highest fruit weight per plant (2.00) was recorded in 5 November with Urea 200 kg/ha + TSP 150 kg/ha + $M_0P$ 200 kg/ha as because this combination received sufficient nutrient and other suitable conditions than other treatment combinations. The lowest fruit weight per plant (0.32) was observed in control plot (Table 3)

#### *3.4.3 Fruit yield per plot*

The combined effect between different planting time and fertilizer doses on fruit yield per plot was significant. The highest fruit yield per plot (23.94 kg) was recorded in 5 November with Urea 200 kg/ha + TSP 150 kg/ha + $M_0P$ 200 kg/ha). The lowest fruit yield per plot (3.85 kg) was observed in control plot with 20 October planting. (Table 3).

**Table 3:** Combined effects of planting time and nutrient management on yield contributing characters of tomato

| Treatment combination | Individual fruit wt. (g) | Fruit weight/plant (kg) | Fruit yield/plot (kg) |
|---|---|---|---|
| $T_1F_0$ | 15.53 | 0.32 | 3.85 |
| $T_1F_1$ | 30.58 | 0.74 | 8.86 |
| $T_1F_2$ | 44.80 | 1.49 | 17.83 |
| $T_1F_3$ | 35.87 | 0.99 | 11.88 |
| $T_2F_0$ | 20.33 | 0.58 | 6.90 |
| $T_2F_1$ | 37.40 | 1.19 | 14.22 |
| $T_2F_2$ | 53.43 | 2.00 | 23.94 |
| $T_2F_3$ | 44.67 | 1.59 | 19.12 |
| $T_3F_0$ | 16.22 | 0.38 | 4.62 |
| $T_3F_1$ | 35.40 | 0.97 | 11.63 |
| $T_3F_2$ | 51.20 | 1.78 | 21.30 |
| $T_3F_3$ | 44.53 | 1.45 | 17.46 |
| $LSD_{0.05}$ | 1.93 | 0.076 | 0.712 |
| $LSD_{0.01}$ | 2.62 | 0.103 | 0.968 |
| Level of significance | 8.74** | 0.03** | 3.71** |

** = Significant at 1% level of probability

### 3.5 Fruit yield per hectare

The interaction effects of different planting time and fertilizer levels on fruit yields per hectare were found to be statistically significant. The maximum fruit yield per hectare (73.89 t/ha) was recorded in 5 November with Urea 200 Kg/ha + TSP 150 Kg/ha + $M_0P$ 200 Kg/ha). The minimum fruit yield per hectare (11.89 t/ha) was observed in control plot (Figure 2).

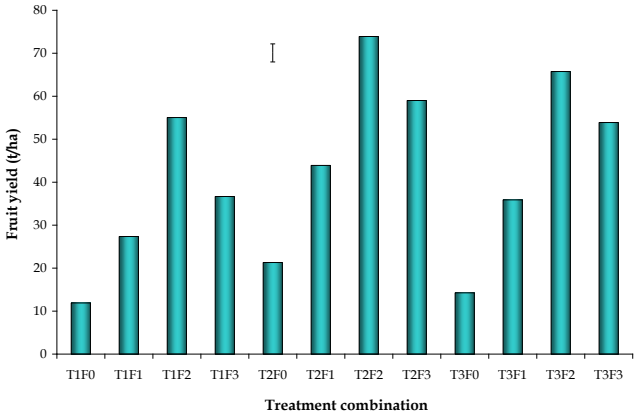


**Figure 2:** Combined effect of planting time and fertilizer management on fruit yield in tomato. Vertical bar represents LSD at 1% level of significance.

## 4. Discussion

The combined effects of different planting times and various levels of fertilizer had significant effect on vegetative growth and yield of tomato. Plant height was gradually increased with the age of plant. The highest plant height (91.00 cm) was observed from the treatment combination of 5 November planting with Urea 200 kg/ha + TSP 150 kg/ha + $M_0P$ 200 kg/ha. Murakami *et al.* (1997) reported that red light interception caused low ratio of red and far red light that results in increase in plant height. Various days of transplanting-induced cold condition showed the reduction of length of height or plant axis (Chen *et al.,* 1999). These findings are consistent with the results of Lawahori *et. al.*, (1963) who reported that plant height decreased with decreasing trend of temperature. Srivastava and Srivastava (2007) stated that transplanting time had great effect on the regulation of plant height and plant architecture of tomato. Plant height of tomato decreased with the late planting from optimum time of environmental conditions (Islam, et al., 2017).

These results are agreement with the findings earlier stated by Singh and Kumar (2010), Haque *et al.* (2011) and Solaiman and Rabbani (2006) in tomato. The plants transplanted at 5 November and fertilized with treatment combination of Urea 200 kg/ha + TSP 150 kg/ha + MOP 200 kg/ha provided first early flowering (32.00 days). The first flowering was detected at first of October followed by 15 October and 1 November (Hamid et al., 2010). Similar results have been stated by El Hilo, 1970. The highest number of flower clusters per plant (14.42), the highest number of flowers per plant (83.67), the highest number of fruit clusters per plant (12.00), the highest fruit length (3.89 cm), the highest fruit diameter (5.17 cm), the highest number of fruits per plant (37.33), the highest fruit yield per plot (23.94 kg) and the maximum fruit yield per hectare (73.89 t/ha) were recorded in 5 November with Urea 200 Kg/ha + TSP 150 Kg/ha + $M_0P$ 200 Kg/ha).

The highest number of flowers per cluster (8.33) was recorded in 20 October with Urea 200 kg/ha + TSP 150 kg/ha + $M_0P$ 200 kg/ha). The result of fruits per plant was similar with findings of Taha *et al.,* (1984). According to Islam, et al., 2017, the first transplanting date, December 10 resulted in improvement of all the characteristics including increased plant height, flower number, fruit number, number of flowers plant$^{-1}$, number of fruit plant$^{-1}$ and yield per hectare compared to 2nd transplanting date, December 20 and 3rd transplanting date, December

30. Earlier transplanting produced higher fruit yield of tomato (Islam, et al., 2017). The highest total yield was gained by 27, 12.5, and 49 g/1.75 $m^2$ plot/week of, respectively, N, P, and K fertilizers (Al-Mohammadi and Al-Zub'I, 2011). Peyvast 2001, stated that the early sowing date significantly affected tomato inflorescence. The sowing date first of October was obtained a highest number of fruits (Hamid et al., 2010).

The planting of tomato with 15th September with Heemsona variety was founded better in respect of yield (77.74 t/ha) compared to 15th July planting with Ranganga variety (16.66 t/ha) (Cheena et al., 2018). Widders (1989) made the importance of increasing the seedling nutrient content to promote growth after field planting. Peyvast (2001) investigated that the early sowing significantly influenced tomato inflorescence initiation. Cluster per plant of tomato were influenced significantly by sowing dates (Hossain et al., 2014). This result was almost consistent to the findings of Haque *et al.* (1999). Hossain *et al.* (1986) stated that early sowing enhanced total number of flowers per plant. Almost similar trend was found in respect of fruit setting per cluster. Singh and Tripanthy (1995) exhibited variation in yield of tomato when sown in different dates from June to August at Orissa state of India. The yield of tomato was significantly influenced by different sowing dates and tomato genotypes (Hossain et al., 2014).

Tomato yield in the tropics is much lower than that in the temperate zone due to various factors like high humidity, high temperature, excessive rainfall, disease and pest (Villareal, 1980, Opena, 1985). In the research fields productivity of tomato is about 3.5-4.5 ton $ha^{-1}$ (Mohammed, 1995). Sharma and Tiwari (1996) stated that transplanting on 13 February resulted in more fruit set (82.23%) and number of fruit/plant (48.70) than transplanting on 5 or 25 March. Flower and fruit abortion are common phenomena in tomato. A large proportion of tomato reproductive structures abscise before maturity, which is the main cause of low yield in summer season (Mondal *et al.* 2011). In terms of duration to flowering and maturity, the earliest flowering & maturity were recorded in plants applied with $N_{100}P_{60}K_{100}$ $kgha^{-1}$ (Ddamulira et al., 2019). The results similar with Heather et al. (2012) who noticed that potassium in N and K combination applied to tomato enhanced early flowering and maturity.

The deficiency of P in control plants where N, P and K was not applied influenced to make late flowering and prolonged maturity (Ddamulira et al., 2019). Zeri and Obreza (2003) who reported that low levels of N, P and K limit plant growth and development for their negative effects on photosynthetic and carbohydrate production, that prolong vegetative and reproductive growth stages of tomato hence leading to late flowering & maturity. The minimum days to appearance of first flowering by the application of nitrogen and phosphorus might be for the availability of nitrogen and phosphorus has positive effect, especially of the nutrient phosphorus, on flower initiation and on its formation (Kumar *et al.* 2013). These results are conformity with findings of earlier stated by Balemi (2008) in tomato. Major nutrients supply such as nitrogen and phosphorus resulted better performance in fruit formation (Balemi, 2008). Higher yield with the level of nitrogen and phosphorus was may be due to better fertilizer response of tomato (Mishra *et al.,* 2004).

According to Aminifard *et al.* (2010), the base of flowering and fruiting was formed by stimulating effect of nitrogen on the vegetative growth attributes. The more carbohydrate production and assimilation in fruit might be possible by the effect of nitrogen, phosphorus and potassium reported by Bidari and Hebsur (2011). Similar results were obtained by Ahmad and Butt (1999) in tomato. The sowing at 1 October increased the productivity of tomato as it positively influenced the plant height, days to 50% flowering, fruit yield (Hamid et al., 2010). Proper transplanting time is more favorable to produce highest plant height, leaf number, branch number as a result higher flower produced which stimulate the higher fruit set and development i.e. fruit diameter and length of tomato which helps to obtain maximum yield (Islam, et al., 2017). When 120 kg N/ha was applied, the plant height, flower per plant, number of cluster per plant, fruit per plant, weight of fruit per plant and yield were the highest (Karim, *K. A.,* 2015).

According to Ddamulira et al., 2019, nitrogen and potassium fertilizer influenced plant height, flowering, maturity period and yield of cherry tomato. The highest tomato plant height and yield were achieved from plots applied with 100, 60, 100 kg ha-1 of N, P and K. Tomato plants applied with nitrogen and potassium fertilizers below 100, 60, 100 kg ha-1, flowered and matured earlier. The influence of N and K application reduced days to flowering, maturity and increased yield. Application of $N_{100}P_{60}K_{100}$ $kgha^{-1}$ enhance plant growth such as plant height during the vegetative growth stage (Ddamulira et al., 2019). Ortas (2013) noticed that nitrogen and potassium fertilization significantly increased tomato plant height. The optimum production of tomato can be achieved with combined application of 100 per cent Nitrogen + 75 per cent Phosphorus (Dhiman *et al.* 2018). Differences levels N significantly influenced most of characteristics e.g. plant height, fruit number per the inflorescence, fruit number per plant, fruit mean weight and fruit yield (Direkvandi et al., 2008).

With the increment supply of essential nutrients to tomato, there availability, acquisition, mobilization and influx into the plant tissues increased and by this way improved of numbers of flower $cluster^{-1}$ and numbers of fruits $cluster^{-1}$ (Shukla *et al.,* 2009). Similar findings have been reported by Haque *et al.* (2011) in tomato. According to Aminifard *et al.* (2012) reported that nitrogen stimulated and enhanced the reproductive growth that were in agreement with findings of Satpal and Saimbhi (2003), Nawaz *et al.* (2012), Kumar *et al.* (2013) and Hozhbryan (2013) in tomato. The sufficient supply of the three major nutrients nitrogen, phosphorus and potassium is anticipated to regulate plant physiological functions and morphological responses favorably (Shree *et al*., 2014).

Increasing level of nitrogen along with phosphorus can increase fruit number and it can be possible probably because nitrogen is the element to be absorbed in larger quantity for plants of Solanaceae family (Campos *et al.,* 2008). Oliveira *et al.* (1999) noticed that nitrogen is fundamental of growth and development of plants. Similar findings were reported from Solaiman and Rabbani (2006), Mahato *et al.* (2009) and Kumar *et al.* (2010) in tomato. The total yield of tomato was increased with increasing levels of applied N up to 600 kg $ha^{-1}$ and P 200 kg $ha^{-1}$ (Abu-Alrub et al., 2019).

## 5. Conclusion

The result of the experiment revealed that planting date and fertilizer management in combination had significant effects on the growth and yield of tomato. Maximum growth and yield were obtained in the treatment combination of Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha) with 5 November planting. So, it may be recommended that use of Urea 200 kg/ha + TSP 150 kg/ha + $M_0$P 200 kg/ha) with 5 November planting gave best growth and yield performance of tomato.

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## Conflict of interest

The authors declare that they have no conflict of interest.

## References

Abu-Alrub, I., Saleh, S., Awaga, A.A., 2019. Effect of Different Rates of Nitrogen and Phosphorus Fertilizers on Yield and Quality of Greenhouse Tomato Under the UAE Condition. EC Agriculture, 5 (3), Pp. 139-146.

Ahmad, M.S., Butt, S.J., 1999. Effect of nitrogen, phosphorus and potassium on some yield components of tomato (Lycopersicon esculentum Mill.). Journal of Arctic and Antarctic Research Institute, 9 (1), Pp. 56-62.

Ahmed, K.V., 1976. Phul phol o shaksabji, 3rdedn. Alhaj Kamisuddin Ahmed, Banglow no. 2, Farmgate, Dhaka, Bangladesh, Pp. 470.

Akanbi, W.B., Dris, R., Togun, A.O., 2003. Influence of compost and nitrogen

fertilizer on growth, nutrient uptake and fruit yield of tomato (Lycopersicon esculentum). Crop Res., 26, Pp. 98-105.

Al-Mohammadi, F., Al-Zu'bi, Y., 2011. Soil Chemical Properties and Yield of Tomato as Influenced by Different Levels of Irrigation Water and Fertilizer. J. Agr. Sci. Tech., 13, Pp. 289-299.

Amapu, I.Y., 1998. Potential of Sokoto phosphate rock as alternative phosphate fertilizer for the sub-humid savanna of Nigeria. Ph. D. Thesis, Ahmadu Bello University, Zaria, Nigeria.

Aminifard, M.H., Aroiee, H., Fatemi, H., Ameri, A., Karimpour, S., 2010. Responses of eggplant (Solanum melongena L.) to different rates of nitrogen under field conditions. Journal of Central European Agriculture, 11 (4), Pp. 453-458. https://doi.org/10.5513/jcea01/11.4.863

Aminifard, M.H., Aroiee, H., Nemati, H., Azizi, M., Khayyat, M., 2012. Effect of nitrogen fertilizer on vegetative and reproductive growth of pepper plants under field conditions. Journal of Plant Nutrition, 35, Pp. 235-242. https://doi.org/10.1080/01904167.2012.636126

Anonymous., 2007. The year book of Agricultural Statistics of Bangladesh. Bangladesh Bur. Stat., Ministry of Planning, Govt. People's Republic of Bangladesh. Pp. 10.

Balemi, T., 2008. Response of tomato cultivars differing in growth habit to nitrogen and phosphorus fertilizers and spacing on vertisol in Ethiopia. Acta Agriculturae Slovenica, 91 (1), Pp. 103 - 119. https://doi.org/10.2478/v10014-008-0011-8

BARI., 2010. KrishiProjuktiHatboi, Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. Pp. 304.

BBS., 2015. Hand Book of Agricultural Statistics, December 2015. Bangladesh Bureau of statistics, Ministry of Planning, Govt. Peoples Republic of Bangladesh, Dhaka. Pp.14.

Beckles, D.M., 2012. Factors affecting the postharvest soluble solids and sugar content of tomato (*Solanum lycopersicum L.*) fruit. Postharv. Biol. Technol., 63, Pp. 129-140. https://doi.org/10.1016/j.postharvbio.2011.05.016

Bidari, B.I., Hebsur, N.S., 2011. Potassium in relation to yield and quality of selected vegetable crops. Karnataka Journal of Agriculture Science, 24 (1), Pp. 55-59.

Bose, T.K., Som, M.G., 1990. Vegetable Crops in India. Naya Prokash, 206 Bidhan Sarani, Calcutta, India. Pp. 249.

BRAC., 2015. Fertilizer Recommendation guide. Bangladesh Agricultural Research Council, Framgate, Dhaka-1215. Pp. 1-72.

Campos, V.B., Oliveira, A.P., Cavalcante, L.F., Prazeres, S.S., 2008. Chilli income subjected to nitrogen applied through irrigation water in Protegido. Revista Environment Biology and Earth Sciences, 8 (2), Pp. 72-79.

Cheena, J., Saidaiah, P., Geetha, A., Tejaswini, N., 2018. Effect of sowing dates on yield and growth of indeterminate tomato varieties under poly house conditions. Journal of harmacognosy and Phytochemistry, 7 (2), Pp. 880-882.

Chen, J., Sun, Y., Sheen, T., 1999. Use of Cold Water for Irrigation Reduces Stem Elongation of Pluggrown Tomato and Cabbage Seedlings. Hortscience, 34 (5), Pp. 852–854. https://doi.org/10.21273/hortsci.34.5.852

Chen, Y.F., Wang, Y., Wu, W.H., 2008. Membrane transporters for nitrogen, phosphate and potassium uptake in plants. Journal of Integrative Plant Biology, 50, Pp. 835-848. https://doi.org/10.1111/j.1744-7909.2008.00707.x

Curme, J.H., 1992. Effect of low night temperatures on tomato fruit set. Proc. Plant Sci. Symp., Campbell Soup. Co. Pp. 99-108.

Ddamulira, G., Idd, R., Namazzi, S., Kalali, F., Mundingotto, J., Maphosa, M., 2019. Nitrogen and Potassium Fertilizers Increase Cherry Tomato Height and Yield. Journal of Agricultural Science, 11 (13), Pp. 1916-9760. https://doi.org/10.5539/jas.v11n13p48

De Pascale, S., Tambu1Tino, R., Maggio, A., Barbieri, G., Fogliano, R., Pemice, R., 2006. Effect of nitrogen fertilization on the nutritional value of organically and conventionally grown tomatoes. Acta Hortic. 700, Pp. 107-110. https://doi.org/10.17660/actahortic.2006.700.14

Dhiman, J.S., Raturi, H.C., Kachwaya, D.S., Singh, S.K., 2018. Effect of Nitrogen and Phosphorus on tomato (*Solanum lycopersicum L.*) grown under polyhouse condition. Bulletin of Environment, Pharmacology and Life Sciences. Bull. Env. Pharmacol. Life Sci., 7 (1), Pp. 25-29 ©2017 Academy for Environment and Life Sciences, India. Online ISSN 2277-1808. Journal's URL:http://www.bepls.com

Direkvandi, S.N., Ansari, N.A., Dehcordie, F.S., 2008. Effect of Different Levels of Nitrogen Fertilizer with Two Types of Bio-Fertilizers onGrowth and Yield of Two Cultivars of Tomato (Lycopersicon esculentum Mill). Asian Journal of Plant Sciences, 7 (8), Pp. 757-761. ISSN 1682-3974. https://doi.org/10.3923/ajps.2008.757.761

El Hilo, H.A., 1970. Evaluation of some tomato varieties. Hdeiba Research Station. Ann. Rep. Sudan.

El-Bassiony, A.M., 2006. Effect of Potassium Fertilization on Growth, Yield, and Quality of Onion Plants. J. Appl. Sci. Res., 10, Pp. 780-785.

Ewulo, B.S., Sanni, K.O., Adesina, J.M., 2015. Response of tomato (*Lycopersicum esculentum Mill.*) to different levels of nitrogen and phosphorus fertilizer in South Western Nigeria. International Journal of Applied and Pure Science and Agriculture, 1 (10), Pp. 13-20.

Geisenberg, C., Stewart, K., 1986. Field crop management", in Atherton, J.G. and J. Rudich (eds.), The Tomato Crop: A Scientific Basis for Improvement, Chapman & Hall, London, Pp. 511-557. https://doi.org/10.1007/978-94-009-3137-4_13

Gomez, G.J., Gomez, A.A., 1984: Statistical Procedure for Agricultural Research.2nd Edition. John Wiley and Sins, New York. Pp. 97-111.

Gupta, C.R., Sengar, S.S., 2000. Response of tomato (*Lycopersicon esculentum Mill.*) to nitrogen and potassium fertilization in acidic soil of Bastar. Vegetable Science, 27, Pp. 94-95.

Hamid, A.A., Salih, S.O., Abdalla, A.E., Naim, A.M.E., 2010. Effect of Sowing Date and Plant Density on Growth and Yield of Tomato (*Lycopersicon Esculentum, Mill.*). Research Journal of Agriculture and Biological Sciences, 6 (5), Pp. 665-669.

Haque, M.A., Hossain, A.K.M.A., Ahmed, K.U., 1999. Varietal response of different seasons and temperature in respect of yield and yield components. Bangladesh Hort., 26, Pp. 39-45.

Haque, M.E., Paul, A.K., Sarker, J.R., 2011. Effect of nitrogen and boron on the growth and yield of tomato (*Lycopersicon esculentum Mill.*). International Journal of Bio-resource and Stress Management, 2 (3), Pp. 277-282.

Heather, L.M., Hamid, A., Majid, R.F., 2012. Selective genotyping to identify late blight resistance genes in an accession of the tomato wild species Solanum pimpinellifolium. Euphytica, 187, Pp. 63-75. https://doi.org/10.1007/s10681-012-0729-6

Hobson, G., Davies, J.N., 1971. The Tomato. The Biochemistry of Fruits and their Products. Hulme (ed) Academic press, New York. London., 2, Pp. 337-482.

Hossain, M.F., Ara, N., Islam, M.R., Hossain, J., Akhter, B., 2014. Effect of Different Sowing Dates on Yield of Tomato Genotypes. Int. J. Agril. Res. Innov. and Tech., 4 (1), Pp. 40-43.

Hossain, M.M., Karim, M.M., Haque, M.M., Hossain, A.M.A., 1986. Performance of some tomato lines planted at different dates. Bangladesh Hort., 14 (1), Pp. 25-28.

Hozhbryan, M., 2013. Effect of different levels of urea on the growth and yield of tomato. Journal of Novel Applied Sciences, 2 (S3), Pp. 1031-1035.

Islam, M.A., Farrooque, A.M., Siddiqua, A., Siddique, A., 1996. Effect of planting patterns and different nitrogen levels on yield and quality of tomato, Bangladesh. J. Agril. Sci., 24 (1), Pp. 4-5.

Islam, S., Islam, M.M., Siddik, M.A., Afsana, N., Rabin, M.H., Hossain, M.D., Parvin, S., 2017. Variation in Growth and Yield of Tomato at Different Transplanting Time. International Journal of Scientific and Research Publications, 7 (2), Pp. 2250-3153.

Kalloo, G., 1991. Genetic Improvement of Tomato, Springer verlag, Berlin Heidelberg, Germany, Pp. 358.

Karim, K.A., 2015. Effect of Nitrogen on Growth and Yield of Bari Tomato-2 And Bari Tomato- 14. MS Thesis. Department of Soil science, Sher-e-Bangla Agricultural University, Dhaka. Registration No.:06-02014.

Kumar, M., Meena, M.L., Kumar, S., Maji, S., Kumar, D., 2013. Effect of nitrogen, phosphorus and potassium fertilizers on the growth, yield and quality of tomato var. Azad T-6. The Asian Journal of Horticulture, 8 (2), Pp. 616-619.

Kumar, V., Malik, M.F., Singh, B., 2010. Effect of integrated nutrient management on growth yield and quality of tomato. Progressive Agriculture, 10 (1), Pp. 72-76.

Lawahori, S.R., Sakiyana, Takahashi, 1963. High temperature injures in tomato-1. Effect of different temperature of the fruit setting and yield of seedlings treated at different stages of growth. J. Japan Soc. Hort. Sci., 32, Pp. 197-204.

Mahato, P., Badoni, A., Chauhan, J.S., 2009. Effect of Azotobacter and nitrogen on seed germination and early seedling growth in tomato. Researcher, 1 (4), Pp. 62-66.

Marschner, H., 1995. Mineral Nutrition of High Plants (2nd ed.). London: Academic Press.

Mishra, B., Gowda, A., Reddy, S.S., 2004. Influence of graded levels of nitrogen, phosphorus and potassium on growth, yield and economics of three leaf curl resistant tomato varieties. Karnataka Journal of Agriculture Science, 17 (1), Pp. 33-37.

Mohammed, B.M., 1995. Vegetable production in central Sudan. Integrated pest management Medani, Sudan, Pp. 106.

Mondal, M.M.A., Akter, M.B., Razzaque, A.H.M., 2011. Effect of seasonal seeds on growth and yield in tomato genotypes. Int. J. Expt. Agric., 2 (1), Pp. 12-16.

Murakami, K., Cui, H., Kiyota, M., Aiga, I., Yamane, T., 1997. Control of plant growth by covering materials for green house which alter the spectral distribution of transmitted light. Acta Horticulturae, 435, Pp. 123-130. https://doi.org/10.17660/actahortic.1997.435.11

Nawaz, H., Zubair, M., Derawadan, H., 2012. Interactive effects of nitrogen, phosphorus and zinc on growth and yield of Tomato (Solanum lycopersicum). African Journal of Agricultural Research, 7 (26), Pp. 3792-3769. https://doi.org/10.5897/ajar12.1027

Olaniyi, J.O., Akanbi, W.B., Adejumo, T.A., Akande, O.G., 2010. Growth, fruit yield and nutritional quality of tomato varieties. African Journal of Food Science, 4 (6), Pp. 398 – 402.

Oliveira, L.M., Silva, M.I.A., Oliveira, A.S., Souza, R.F., Costa, J.A., 1999. Effects of different nitrogen dosages, through irrigation, the yield of pepper (*Capsicum annuum L.*). Magistra, 11 (1), Pp. 87-96.

Opena, R.T., 1985. Development of Tomato and Chinese Cabbage cultivars adapted to the Hot, Hamid tropics, Acta Hort., 153, Pp. 421-436. https://doi.org/10.17660/actahortic.1985.153.59

Ortas, I., 2013. Influences of nitrogen and potassium fertilizer rates on pepper and tomato yield and nutrient uptake under field conditions. Academic Journals, 8, Pp. 1048-1055.

Peyvast, G.H., 2001. Study of some quality and quantity factors of tomato. Journal of vegetable crop production., 1049-6467, Pp. 15-22. https://doi.org/10.1300/j068v07n01_03

Rashid, M.M., 1983. Sabjirchas, 1st edn., Begum Shahla Rashid. Joydebpur, Gazipur, Pp. 86.

Reddy, B.R., Reddy, M.P., Reddy, D.S., Begum, H., 2013. Correlation and path analysis studies for yield and quality traits in tomato (*Solanum lycopersicum L.*). Journal of Agriculture and Veterinary Science, 4 (4), Pp. 56-59. https://doi.org/10.9790/2380-0445659

Satpal, S., Saimbhi, M.S., 2003. Effect of varying levels of nitrogen and phosphorus on earliness and yield of brinjal hybrids. Journal of Research of Crops, 4, Pp. 217–222.

Savvas, D., Ntatsi, G., Passam, H.C., 2008. Plant Nutrition and Physiological Disorders in Greenhouse-Grown Tomato, Pepper, and Eggplant. Eur. J. Plant Sci. Biotechnol., 2, Pp. 45-61.

Schaible, L.W., 1990. Fruit setting response of tomatoes to high night temperatures. Campbell Soup Co., camden, N.J., Pp. 89-98.

Shankar, A., Reddy, R.V.S,K., Sujatha, M., Pratap, M., 2013. Genetic variability studies in F1 generation of tomato (*Solanum lycopersicum L.*). Journal of Agriculture and Veterinary Science, 4 (5), Pp. 31-34.

Sharma, N.K., Tiwari, R.S., 1996. Effect of time of planting on yield and yield contributing characters of tomato (Lycopersicon esculentum Mill). Recent Hort., 3 (1), Pp. 82-85.

Shree, S., Singh, V.K., Kumar, R., 2014. Effect of integrated nutrient management on yield and quality of cauliflower (Brassica oleracea L. var. botrytis). An International Quarterly Journal of Life Sciences, 9 (3), Pp. 1053-1058.

Shukla, Y.R., Thakur, A.K., Joshi, A., 2009. Effect of inorganic and bio-fertilizer on yield and horticultural traits in tomato. Indian Journal of Horticulture, 66 (2), Pp. 285-287.

Singh, D.N., Tripanthy, P., 1995. Growth and yield of tomato genotypes and technology. Indian J. Agril. Sci., 65 (12), Pp. 863-865.

Singh, K.P., Sangama., 2000. Effect of graded level of nitrogen and phosphorus on China aster (Callistephus chinensis) cv. 'Kamini'. Indian Journal of Horticulture, 57 (1), Pp. 87-89.

Singh, R.V., Kumar, S., 2010. Effect of nitrogen and phosphorus fertilization in seed production of tomato. Vegetable Science, 37 (1), Pp. 86-88.

Solaiman, A.R.M., Rabbani, M.G., 2006. Effect of nitrogen, phosphorus, potassium, sulphur and cow dung on growth and yield of tomato. Bulletin of the Institute of Tropical Agriculture, Kyushu University, 29, Pp. 31-37.

Srivastava, N.K., Srivastava, A.K., 2007. Influence of gibberellic acid on 14 CO2 metabolism, growth, and production of alkaloids in Catharanthusroseus. Photosynthetica, 45, Pp. 156-160. https://doi.org/10.1007/s11099-007-0026-0

Taber, H.G., 2001. Petiole sap mtrate sufficiency values for fresh market tomato production. J. Plant Nutr., 24, Pp. 945-959. https://doi.org/10.1081/pln-100103783

Taha, A.A., Abdelfattah, Hassan, M.S., Ali, A.W., 1984. Effect of sowing date and stage of maturity at harvest on yield and quality of tomato for export. Acta. Hort. 143. Tropical Horticulture VIII., 6 (5), Pp. 665-669. https://doi.org/10.17660/actahortic.1984.143.61

UNDP., 1988. Land Resource Appraisal of Bangladesh for Agricultural Report 2: Agro-ecological Region of Bangladesh. FAO, Rome, Italy. Pp. 577.

Villareal, R.L., 1980. Tomatoes in the Tropics. Boulder, Colorado: USA, west view press, Pp. 10.

Went, F.W., 1984. Plant growth under controlled conditions. II. Thermoperiodicity in growth and fruiting of the tomato. American J. Bot., 31, Pp. 135-150. https://doi.org/10.1002/j.1537-2197.1944.tb08011.x

Widders, I.E., 1989. Pretransplant treatment of N and P influence growth and elemental accumulation in tomato seedlings. J. Amer. Soc. Hort. Sci., 114, Pp. 416-420.

Zeri, M., Obreza, A., 2003. Plant nutrients for a citrus tree, soil and water science department. Institute of Food and Agricultural Sciences, University of Florida, USA.