# CHANGES IN MORPHOLOGY AND YIELD OF TOMATO (*Lycopersicon solanum*) AT DIFFERENT TRANSPLANTING TIME

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***Abstract***- This study was carried out to examine the effect of different planting dates on growth, flowering and fruit yield of tomato during November 2013 to April 2014. Three transplanting were done at an interval of 10 days. The different transplanting dates were; December 10, December 20 and December 30. The experimental results showed that different planting dates showed significant influence on growth and reproductive characters of tomato including fruit yield. The first transplanting date, December 10 resulted in improvement of all the attributes including increased plant height (70.22 cm at 60 DAT), leaf number (62.3), branch number (9.07), cluster number (17.43), number of flowers plant$^{-1}$ (148.7), fruit number (86.38), number of fruit plant$^{-1}$ (86.08), fruit diameter (5.51 cm), fruit length (6.29 cm) and yield per hectare (66.46 t) compared to 2nd transplanting date, December 20 and 3rd transplanting date, December 30. Therefore, it is suggesting that earlier transplanting produced higher fruit yield of tomato.

***Index Terms*:** Tomato, Transplanting time, Morphology and Yield

## I. INTRODUCTION

Tomato (*Lycopersicon solanum*) is one of the most important popular fruit vegetable belong to Solanaceae family which is grown throughout the world including, Bangladesh. It is well known that it is the world's largest vegetable crop after potato. Generally, tomato is grown in the winter season, November-April in Bangladesh. In terms of human health, tomato is a major component in the daily diet and constitutes of important sources including antioxidants- like lycopene, which acts as an anti-carcinogen and improves skin's ability to protect against harmful ultra violet (UV) rays. It has been reported that lycopene relieves the oxidative stress in human, lowers the bad cholesterol level LDL. It is rich in vitamins and minerals and dietary fibre (Olaniyi *et al*., 2010).

The average yield being 9.96 ton $ha^{-1}$ was reported by BBS, 2013. This fruit yield is lower in contrast with other tomato producing countries like China (49.87 ton $ha^{-1}$), India (20.11 ton $ha^{-1}$) and USA (87.96 ton $ha^{-1}$). The yield of tomato of Bangladesh is not enough in comparison to requirement. The low yield of tomato in Bangladesh is not the indication of low yield potentiality of this crop but the fact that this may be attributed due to different abiotic and biotic stresses including temperature, salinity, insects, pathogens, residual effect of pesticides, improper application of plant nutrients etc.

It is well known that climate change is a frightening issue on reduction of crop yield not only in Bangladesh but also all over the world. Presently, drought, changes of temperate, salinity, heavy metal contamination etc. affect the growth, development and yield of agricultural crops. In Bangladesh, usually early November is the planting time seems to be the best (Hossain *et al*., 1986) and late planting results in lower yield and enhanced disease infection in tomato. It was reported that fruit set was abundant only when night temperature was between 15°C and 20°C (Went, 1984). Curme (1992) also showed that fruit set varies with temperature as low (7.2°C) and with temperature as high (26.6°C). Tremendous decline in fruit set due to high as well as low temperature which disturb mechanisms involved in the development of male and female parts of the flowers (Lawhori *et al*., 1963). In some areas of our country particularly in the northwestern part, the night temperature falls even sometimes go below 5-6°C which results remarkable yield loss in tomato. These findings suggest that late time of sowing or transplanting-induces cold injury which exhibits a significant reduction on both growth and yield of tomato. Therefore, this experiment was conducted to examine the impact of different of transplanting time on morphology and yield of tomato.

## II. METHOD AND MATERIALS

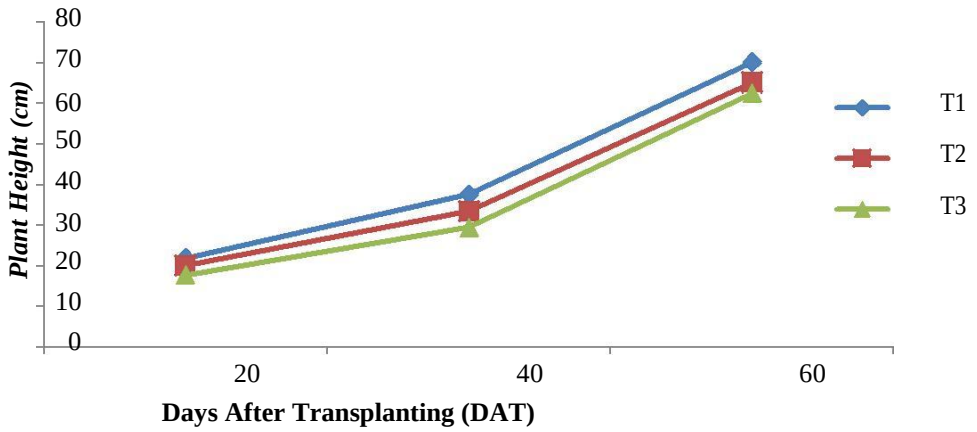
The experiment was conducted in the Agricultural Farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. The location of the experimental site is 23°74'N latitude and $90^0$35'E longitude at an altitude of 8.6 meter above the sea level under the agro-ecological zone of Modhupur Tract, AEZ-28 during December 2013 to April 2014 to examine the response to different planting time on morphology, yield and yield attributes of BARI Tomato-15. The experiment was laid out in single factors randomized complete block design with five replications. Treatments of the experiment was 10 December 2013 = First transplanting time ($T_1$), 20 December 2013 = Second transplanting time ($T_2$), 30 December 2013 = Third transplanting time ($T_3$). The total plot number was 3 x 5 = 15 The unit plot size was 1.8 m × 1.5 m = 2.7 m2. The distance between blocks was 1m and distance between plots was 0.5 m and plant spacing was 50 cm × 60 cm. The land was ploughed with tractor and power tiller for four times. Then the ploughed soil was brought into desirable fine tilth and leveled by laddering. The weeds and stubbles were cleaned properly. The final ploughing and land preparation were done

on 1 December, 2013. According to the lay out of the experiment the entire experimental area was divided into blocks and prepared the experimental plot for the transplanting of tomato seedling. In addition, irrigation and drainage channels were made around the plot. The following data were recorded during the experimental period morphological characters: plant height, number of leaves plant$^{-1}$, and number of branches plant$^{-1}$; yield contributing characters: number of flower clusters plant$^{-1}$, number of flowers plant$^{-1}$, number of fruits plant$^{-1}$, fruit length, fruit diameter, yield (kg plot$^{-1}$) and (t ha$^{-1}$). All the agronomic practices were done as per requirement. No serious diseases were observed during this experiment, but bird attack was a potential problem so that the guard was assigned at the research site

## III. RESULT AND DISCUSSION

**Plant height (cm):**

In this study, the effect of transplanting time of tomato in relation to decline of temperature reduced the plant height. The plant height varied significantly due to the effect of decrease of temperature; observed at 20, 40 and 60 DAT (Figure 1). At 20 days after transplanting (DAT), the highest plant height (22.01cm) was recorded from the $T_1$ (10 December, 2013) and the lowest (17.78 cm) was recorded from $T_3$ (30 December, 2013). At 40 DAT, the highest plant height (37.70 cm) was recorded from the $T_1$ (10 December, 2013) and the lowest (29.52 cm) was recorded from $T_3$ (30 December, 2013). At 60 DAT, the highest plant height (70.22 cm) was recorded from the $T_1$ (10 December, 2013) and the lowest value (62.66 cm) was recorded from $T_3$ (30 December, 2013). These data showed that plant heights are gradually increasing at all transplanting time whereas early transplanting shows maximum plant height than late transplanting. Here it is noted that, the seedlings height was gradually short to late showing (data not shown). Both the plants height and seedlings height were decreased due to decline the environmental temperature. Previous results showed that late transplanting induced cold condition reduced the length of plant height (Chen *et al.*, 1999). These results are consistent with the finding of Lwahori *et al.* (1963) who stated that plant height decreased with decreasing trend of temperature. Recently, Srivastava *et al.* (2007) and More *et al*. (2014) reported that transplanting time has great effect on the regulation of plant architecture as well as plant height of tomato. Altogether, the present results suggest that plant height of tomato decreased with the late planting from optimum time of transplanting.

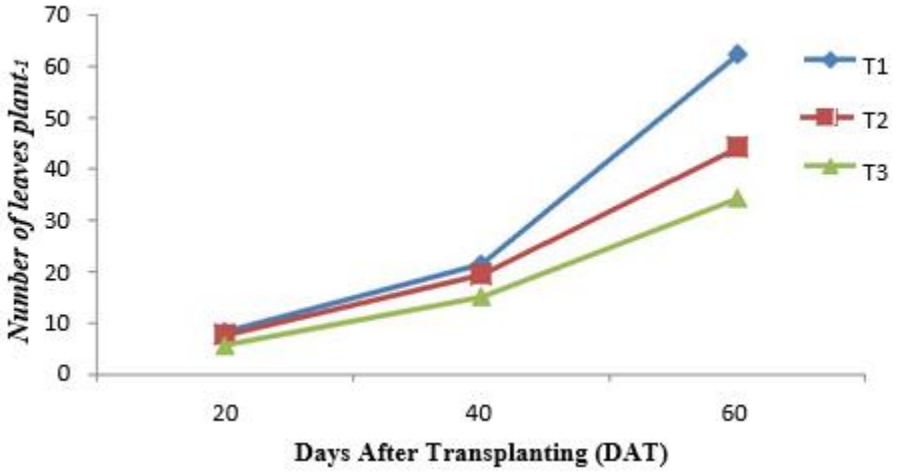



$T_1$ –First transplanting time, 10 December 2013
$T_2$ –Second transplanting time, 20 December 2013
$T_3$–Third transplanting time, 30 December 2013

**Figure 1. Effect of transplanting time on plant height of tomato at different days after transplanting, $LSD_{0.05}$ = 0.6472, 1.816 and 1.714 for 20 DAT, 40 DAT and 60 DAT, respectively.**

**Number of leaves plant$^{-1}$**

It is known to all that leaf is the main photosynthetic organ of plant along with the leaf number is a fundamental morphological character for plant growth and development. The number of leaves was counted to investigate the effect of different transplanting time on changes in the leaf number plant$^{-1}$ of tomato at 20 DAT, 40 DAT and 60 DAT. Different days of transplanting showed a significant influence on the formation of leaves per tomato plant (Figure 2). In this experiment, the number of leaves in each plant was decreased due to increasing level of low temperature stress. At 20 DAT, maximum number of leaves plant$^{-1}$ (8.31) was found from $T_1$ and the lowest value (5.79) from $T_3$ transplanting time. At 40 DAT, the highest number of leaves (21.46) was recorded from $T_1$ and the lowest value (15.20) was found from $T_3$. At 60 DAT, the highest number of leaves (62.39) was recorded from $T_1$ whereas the lowest value (34.35) was recorded from $T_3$. These results indicated that highest number of leaves plant$^{-1}$ found from early transplanting time whereas minimum number of leaves was produced to late transplanting time which created cold injury to plants. Hossain *et al.* (1986) reported that total number of leaves plant$^{-1}$ was enhanced by early showing. Therefore, altogether the experimental results indicate that late planting-induced cold environmental conditions decreased the number of leaves plant$^{-1}$ of tomato.




$T_1$ –First transplanting time, 10 December 2013
$T_2$ –Second transplanting time, 20 December2013
$T_3$ –Third transplanting time, 30 December 2013

**Figure 2. Effect of transplanting time on the number of leaves plant$^{-1}$ of tomato at different days after transplanting, $LSD_{0.05}$ = 0.3610, 0.752 and 2.859 for 20 DAT, 40 DAT and 60 DAT, respectively.**

**Number of branches plant$^{-1}$**

Tomato branches number plant$^{-1}$ was significantly influenced by transplanting times (Table. 1). The highest number of branch plant$^{-1}$ (9.07) was observed from the $T_1$ and the lowest value (5.27) was observed from $T_3$. Among dates of planting, early planting recorded the highest vegetative growth in tomato which was reported by Sing *et.al.* (2005). Mira *et al*. (2011) observed that number of branches plant$^{-1}$ was found to be gradually decreased with the late transplanting dates in same plant. Hence, the obtained results are consistent with many other previous published findings.

**Number of flower clusters plant$^{-1}$**

In this experiment, there was a significant difference in number of flower clusters plant$^{-1}$ at different transplanting time (Table. 1). The highest number of flower clusters plant$^{-1}$ (17.43) of tomato was found from $T_1$ and the lowest number of cluster (10.17) was recorded from $T_2$. Early planting induced early and more flower clusters initiation plant$^{-1}$ of tomato than late transplanting-induced cold injury. These results indicate that lower temperature reduces the formation of number of flower clusters plant$^{-1}$ as other above mentioned morphological characters. Therefore, it is suggesting that low temperature stress significantly affect the both vegetative and reproductive development in tomato.

**Number of flowers plant$^{-1}$**

Planting time had significant effect on number of flowers plant$^{-1}$ of tomato (Table. 1). The highest number of flower plant$^{-1}$ was observed from the $T_1$ (148.7) and the lowest (133.0) was observed from $T_3$ treatment. $T_1$ was statistically similar with $T_2$ (142.9). Hossain *et al.* (1986) reported that early sowing enhanced total number of flowers plant$^{-1}$. From these results, it was found that more flowers were produced from the early transplanted tomato seedlings than lately transplanted seedlings.

**Number of fruits plant$^{-1}$**

Number of fruits plant$^{-1}$ of tomato showed significant differences in response to transplanting time (Table. 1). The highest fruits number plant$^{-1}$ (86.38) was observed from the $T_1$ which was statistically similar to $T_2$ (82.11) and the lowest (73.33) was observed from $T_3$. Maximum number of fruit plant$^{-1}$ was recorded from early transplanting and the minimum from late, due to low temperature (BARI, 1989). Adelana (1976) and Drost and Price (1991) had also reported that late transplanting reduced fruit number and early showed increasing trend. Jong *et al*. (2009) had reported that the initiation of tomato fruit growth, fruit set, is very sensitive to environmental conditions. So, it can easily understand that environmental condition regulates the number fruits plant$^{-1}$ as when near optimum temperature was present produced highest number of fruit and in unfavorable temperature condition decreased the number of fruit plant$^{-1}$.

**Fruit diameter (cm)**

In this study, fruit diameter (cm) of tomato showed significant variation in response to transplanting time (Table. 1). The highest fruit diameter (5.51) was recorded from the $T_1$ which is statistically similar with $T_2$ (5.41) and the lowest (5.29) was observed from $T_3$ treatment. Madhumathi and Sadarunnisa (2013) reported that date of transplanting affected the fruit diameter of tomato. From the study of results it was found that early transplanting provided higher fruit diameter than the late transplanted tomato one and it was also reported by Javaheri *et.al*. (2014).

**Fruit length (cm)**

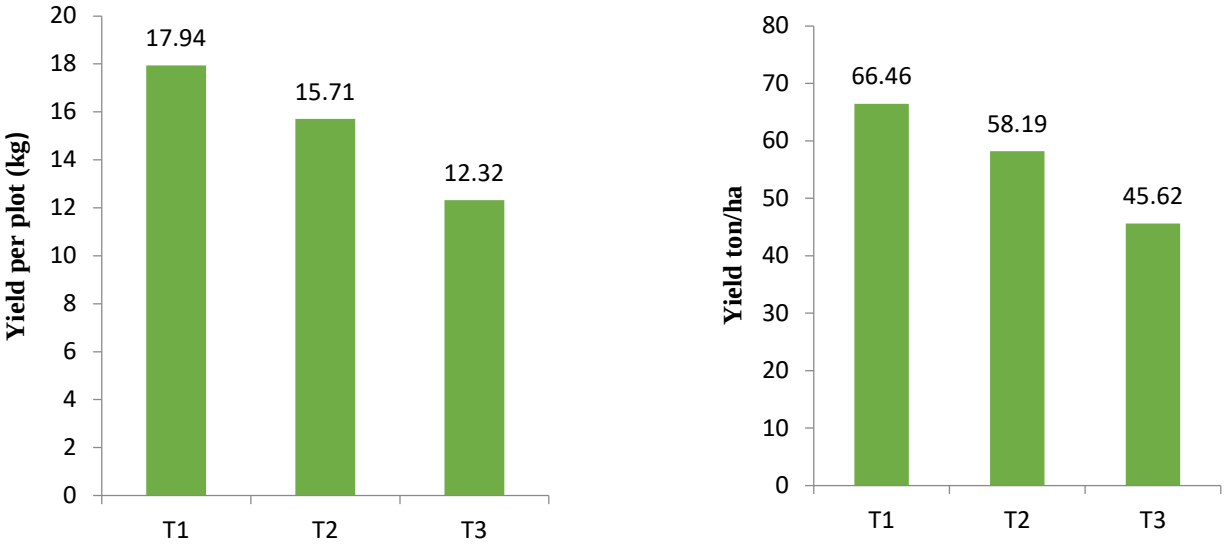
As consistent to fruit diameter planting time had significant influence on fruit length (cm) of tomato (Table. 1). The highest fruit length (6.29) was observed from the $T_1$ and the lowest (5.91) was observed from $T_3$. These data resulted that early transplanting time increased fruit length (cm) in contrast to late transplanting. Madhumathi and Sadarunnisa (2013) had reported that early transplanting showed the maximum fruit length of tomato fruit among different varieties.

**Table: 1. Data on Number of branch, Cluster Number, Flower number, Fruit Number, Fruit Diameter and Fruit length of tomato as influenced by different Transplanting time**

| Treatment | Number of Branch | Cluster No. | Flower No. | Fruit No. | Fruit Diameter (cm) | Fruit Length (cm) |
|---|---|---|---|---|---|---|
| $T_1$ | 9.07 a | 17.47 a | 148.7 a | 86.38 a | 5.514 a | 6.291 a |
| $T_2$ | 7.72 b | 14.05 b | 142.9 a | 82.11 a | 5.411 ab | 6.137 b |
| $T_3$ | 5.27 c | 10.17 c | 133.0 b | 73.33 b | 5.298 b | 5.917 c |
| $LSD_{(0.05)}$ | 0.575 | 1.477 | 6.248 | 5.886 | 0.175 | 0.0791 |
| CV (%) | 11.71% | 15.91% | 6.60% | 10.92% | 4.86% | 1.94% |

**Yield in (kg plot$^{-1}$) and (t ha$^{-1}$)**

As morphological characters the yield of tomato also significantly reduced by late transplanting-induced cold stress (Fig. 3. A and 3. B). The highest yield (17.94 kg plot$^{-1}$) and yield (66.46 t ha$^{-1}$) were observed from the $T_1$ and the lowest yield (12.32 kg plot$^{-1}$) and yield (45.62 t ha$^{-1}$) were observed from $T_3$ or late planting. The results of both yield (kg plot$^{-1}$) and yield (t ha$^{-1}$) of tomato is gradually decreasing with the late transplanting, $T_3$. These results are in consistent with the yield contributing characters which are analyzed in this experiment such as number of branch, number of flower cluster, number of flowers plant$^{-1}$, fruit diameter and fruit length (Table. 1). These information are also dependable on growth measuring parameters of this study (Figure: 1, 2 and Table. 1). In addition, Sanjoy (1999) showed a declining trend in fruit yield and other yield attributing characters when planted lately. Tongova and Zhelev (1975) reported that early sowing or early planting of tomato give increased yield. Previous authors as well reported that early transplanting of tomato give increased fruit weight and yield of tomato (Adelana 1976). These results suggest that suitable transplanting time is more favorable to produce highest plant height, leaf number, branch number as a result higher flower produced which enhance the higher fruit set and development i.e. fruit diameter and length of tomato which contribute to maximum yield than late transplanting-induced cold injury. All together, these results suggest that suitable transplanting time is more favorable to produce highest plant height, leaf number, branch number as a result higher flower cluster, flower produced which enhance the higher fruit set and development i.e. fruit diameter and length of tomato which contribute to maximum yield than late transplanting-induced cold injury.




$T_1$ –First transplanting time, 10 December 2013
$T_2$ –Second transplanting time, 20 December 2013
$T_3$ –Third transplanting time, 30 December 2013

**Figure 3. Effect of transplanting time on the yield in kg plot$^{-1}$ (A) and yield in t ha$^{-1}$ (B) of tomato, $LSD_{0.05}$ = 1.326 and 4.911 respectively.**

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