PERFORMANCE OF EXOTIC TOMATO LINES AT SHER-E-BANGLA AGRICULTURAL UNIVERSITY

SANGEETA DAS

DEPARTMENT OF HORTICULTURE

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

DECEMBER, 2017

PERFORMANCE OF EXOTIC TOMATO LINES AT SHER-E-BANGLA AGRICULTURAL UNIVERSITY

BY
SANGEETA DAS

REGISTRATION No. 16-07570

A thesis submitted to
The Department of Horticulture, Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka-1207
In partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
HORTICULTURE

SEMESTER: JULY-DECEMBER, 2017

Approved by

Prof. Dr. Mohammad Humayun Kabir	**Dr. A. H. M. Solaiman**
Department of Horticulture	Associate Professor
SAU, Dhaka	Department of Horticulture
Supervisor	SAU, Dhaka
	Co-Supervisor

Prof. Dr. Mohammad Humayun Kabir
Chairman
Examination Committee

Department of Horticulture

Sher-e-Bangla Agricultural University

Sher-e -Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the thesis entitled ***"PERFORMANCE OF EXOTIC TOMATO LINES AT SHER-E-BANGLA AGRICULTURAL UNIVERSITY"*** *submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in HORTICULTURE****, embodies the result of a piece of bona fide research work carried out by* ***SANGEETA DAS,*** *Registration No.* ***16-07570*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of their investigation has been duly acknowledged.

Dated: December, 2017
Dhaka, Bangladesh

Prof. Dr. Mohammad Humayun Kabir
Department of Horticulture
Sher-e-Bangla Agricultural University
Dhaka-1207
Supervisor

ACKNOWLEDGEMENTS

The author seems it a much privilege to express her enormous sense of gratitude to the almighty God for there ever ending blessings for the successful completion of the research work.

The author wishes to express her gratitude and best regards to her respected Supervisor. ***Prof. Dr. Mohammad Humayun Kabir,*** *Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, for his continuous direction, constructive criticism, encouragement and valuable suggestions in carrying out the research work and preparation of her thesis.*

The author wishes to express her earnest respect, sincere appreciation and enormous indebtedness to her reverend Co-supervisor, ***Dr. A. H. M. Solaiman,*** *Associate Professor, Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, for his scholastic supervision, helpful commentary and unvarying inspiration throughout the research work and preparation of the thesis.*

The author feels to express her heartfelt thanks to the honorable chairman of along with all other teachers and staff members of the department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, for their co-operation during the period of the study.

The author feels proud to express her deepest and endless gratitude to all of her course mates and friends to cooperate and help her during taking data from the field and preparation of the thesis. The author wishes to extend her special thanks to her classmates and friends for their keen help as well as heartiest co-operation and encouragement.

The author expresses her heartfelt thanks to her beloved parents and Sourav Nandi who gave her courage in every steps. She also thankful to her Elder Sister and Brother specially Arjun Chandra Roy and all other family members for their prayers, encouragement, constant inspiration and moral support for my higher study. May Almighty bless and protect them all.

The Author

PERFORMANCE OF EXOTIC TOMATO LINES AT SHER-E-BANGLA AGRICULTURAL UNIVERSITY

BY

SANGEETA DAS

ABSTRACT

The experiment was carried out at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh from October 2016 to April 2017. The experiment was conducted with nine exotic tomato lines and a commercial variety BARI Tomato-14 to study the performance of the exotic tomato lines under the environmental condition of this University. The experiment was laid out in Randomized Complete Block Design with three replications. Among the all parameters of growth and yield performance, the tallest plant (137.7cm), high fruit set (56.28%), highest yield (95.6 t/ha) was observed in L3 while shortest plant (80.66cm), minimum fruit set (16.27%) and lowest yield (28.13 t/ha) was observed in L8. Considering the quality parameters, Vitamin-C content was found highest (26.96 mg per 100 g fruit) in L9 and maximum TSS (4.35) was also found in L9 while the pH was recorded highest (4.88) in L2. Regarding storage, maximum shelf life (16.67 days) was recorded in L3. In the present study it was observed that L3 gave better performance but other lines were also adopted well and gave good performance in respect of yield and quality parameters.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

SAU	: Sher-e-Bangla Agricultural University
TSS	: Total Soluble Solid
BARI	: Bangladesh Agricultural Research Institute
L	: Tomato Line
g	: Gram unit
Vit-C	: Vitamin C
cm	: Centimeter
pH	: Potential hydrogen
DAT	: Days after transplanting
LSD	: Least Significant Difference
AEZ	: Agro-Ecological Zone
ANOVA	: Analysis of Variance
df	: Degrees of freedom
CV%	: Percentage of Coefficient of Variation
BBS	: Bangladesh Bureau of Statistics
Kg	: Kilogram
%	: Percentage

CHAPTER I
INTRODUCTION

Tomato *(Lycopersicon esculentum* Mill*)* is a member to the family *Solanaceae* and is one of the important, acquainted, consuming and widely usable vegetable crops. It is self-pollinated annual crop with 2n=24 chromosome number (Jenkins, 1948). It is grown easily and widely various countries including Bangladesh. It was originated in tropical America (Salanke *et al.*1987), particularly in peru, Ecuador and Bolivia of the Andes (Kalloo, 1989). Soon after the innovation of the new world, tomato was taken to Europe and then gradually it was extent throughout the rest of the world (Heiser, 1969). It is one of the healthful vegetables also grown in Bangladesh in both winter and summer season around all parts of the country (Haque *et al.* 1999). Bangladesh produces 389 thousand tons of tomato from 27.67 thousand hectares of land, the average yield being 14.05 t/ha (BBS, 2016).

The organic products are having a wide exhibit of profitable supplements viz. nutrient B (biotin, B6, folate and niacin); C (22%); K (6%) and molybdenum. It is a decent source of full scale of phosphorus, potassium and micronutrients (copper, manganese), dietary fiber (4%) and E. The organic products can be consumed from multiple way of view like crude or cooked vegetable or prepared into different items, for example, canned tomato, sauce, juice, ketchup, puree, stews and soup.

Tomatoes have an exceptional antioxidant property. Health benefits of tomatoes are; it drops the danger of cancer (especially prostate cancer), cardiovascular diseases and total cholesterol, LDL cholesterol, and triglycerides. Tomato consist of lycopene pigment which is a vital anti-oxidant that assistances to fight against cancer cell formation as well as other kind of health complications and diseases (Kumavat and Chaudhari, 2013). A single tomato can provide 40% of the daily requirement of Vitamin-C which is a natural anti-oxidant. Tomatoes are full of Vitamin-K which assumes a remarkable job in blood clotting. The fundamental antioxidants in tomatoes are ascorbic acid, carotenoids and phenolic

compounds (Giovanelli *et al.* 1999). The essentialness of tomato as a useful yield is remarkably important. Americans consume the fresh fruit directly for kidney, liver complications, as a purifying and for good digestion. Tomatoes are also extraordinary in vitamin values such as Calories 97, Iron 2.7 mg, Protein 4.5 g, Vitamin A 4080 I.U, Fat 0.9 g, Thiamine 0.23 mg, Carbohydrates 17.7 g, Riboflavin 0.15 mg, Niacin 3.2 mg, phosphorus 123 mg and Ascorbic Acid 102 per 1 pound edible portion (Lester, 2006).

However, the yield is low in Bangladesh in comparison with other tomato developing countries. This low yield might be because of utilization of low yielding lines and varieties and poor crop production management. With the increase of population, the demand of tomato is increasing day by day. It is also possible to get large amount of foreign currency by generating high quality tomatoes and exporting them. The growing demand can be met only with rise in production per unit area. The lower yield in tomato could be due to the traditional grown cultivars used by our farmers are much sensitive to hot climate, which limits the production of the crop. Some cultivars have wider adoption while others provide a valuable source of variability in breeding material. The yielding ability of a genotype is the result of its interaction with the environment. The diverse variation of agro climatic condition in different regions of Bangladesh and the effect of global climate change can affect the growing conditions, thus the performance of different tomato cultivars also varies greatly.

The advantages of exotic tomato cultivars are uniformity in shape and size, increased vigor, early maturity, high yield and resistance to specific pests and pathogens (Hossain, 2003). Anon. (2010) evaluated different exotic tomato for higher yield. Under current scenario all these hybrid seeds for vegetables including tomato for open field and off-season cultivation are being imported from different countries like Holland, Japan, USA and China, etc. at a very high price. So an experiment was made in small area to observe the further development i.e. the growth characters and nutritional quality, yield and shelf life of these exotic lines of tomatoes. Selection of high yield and nutritious lines

of tomatoes is important under existing agro climatic condition of Bangladesh for commercial purpose. It was therefore considered appropriate to make a study of exotic tomato lines of screening high yield in comparison with a native and renowned commercial variety suitable to our agro-climatic conditions.

So, considering the above circumstances, the present study was undertaken with the following objectives:

Objectives

1) To evaluate the performance of exotic tomato lines.

2) To determine the adaptability of exotic tomato lines under SAU environmental condition.

3) To find out best exotic tomato line(s) suited Bangladeshi environmental conditions.

CHAPTER II

REVIEW OF LITERATURE

Among all vegetable crops Tomato is one of the most valuable and popular and nutritious one that produces in Bangladesh. Many researcher get much priorities on this vegetable and a lot of works has been done to improve the performance like growth, yield and qualities like physical, storage, shelf life of tomatoes for screening, selection and development of better varieties to tomatoes.

2.1 Review related to growth parameter:

For the growth parameter, Kumar (2011) experimented on 74 Lines of tomatoes in Vanarashi, India and observed that the height of plant was the highest mean value for plant height was recorded in PANT-T-7 (129.4 cm) which was highly significant and followed by NUN-4 (120.20 cm) and RCMT-2 (119.30 cm). The lowest value (31.47 cm) was found in CTS-05-05-2 and the mean value of population for this trait was observed to be 71.78 cm. The maximum and minimum plant height was observed in HTH-18 (156.8 cm) and Rupali (53.8 cm) respectively. Jayprakashnarayan (2007) was recorded TP 60 had maximum (102.05cm) plant height and minimum (72.56 cm) was recorded in TP 37.

Mohonta (2005) observed the highest plant height was found in Bari tomato-7 (89.07) which found similar to the line TM-135(85.33cm). Hossain (2003) conducted an experiment in comparative morphological study in Bangladesh among 10 Lines (Bahar ,BINA Tomato-2, BINA Tomato-3, Rangamati, J-1,J-2,J-3, J-4 and J-5) during the period of October 2001 to March 2002 and the genotype J-1 gave the highest plant height (149.02) and Rangamati gave the lowest plant height (78.79cm). Singh *et al.* (1994) conducted an experiment to evaluate the performance of tomato varieties (Akra Vikas, LE12, BT 14, Punjab chhuhara, Bwri and Pusa Roby). They found that LE12 was the tallest plants (75.90 cm) and BT14 produced the shortest plants (62.52cm) respectively. Sharma and Rastogy (1993) carried out and experiment on the evaluation of

some tomato cultivars. They found significant variation among plant height of the cultivars.

The number of leaves per plant of tomato significantly varied among the plant. The results of number of leaves were in confirmation with Deepa and Thakur (2008) .The maximum number of leaves (60.2) was recorded from G4 whereas the minimum (22.1) was recorded from G21. The variation may be resulted due to genotypic characteristics of plant. Arun *et al.* (2004) showed that leaves are very important vegetative organs, as they are chiefly concerned with the physiological processes, photosynthesis and transpirations. Thus it influences the growth of a plant very much and is positively correlated with the yield of a plant.

Schwarz and Karling (2001) to leaf area of tomato and showed that total leaf alone conducted for 75% of tomato leaf area variance and length of the rachis to the distal end of the petiole had the same variance as total length. They stated that leaf area estimation was much better using only leaf width, which accounted for 90% of leaf area variance and use of a universal relationship may lead to a considerable systematic error estimation of leaf area for some lines and during strong changes in assimilate partitioning. Khan (1981) was found that, leaf area index measures leafiness and photosynthetic surface area of a crop and it depends on the leaf growth, number of leaf, plant density and senescence and the lead area index increases due to number of leaves.

Jayprakashnarayan (2007) reported that the maximum number of branches were recorded in TP 45 (12.89) and minimum was recorded in TP 19 (7.78). On the other hand, Hossain (2003) made a comparative study among 10 tomato cultivars (Bahar, Binatomato-2, Binatomato-3, Rangamati, J-1, J-2, J-3, J-4, J-5) at BINA and showed J-1 Had the highest number of branches per plant (16.96) while Rangamati showed the lowest (6.09). Patil (1997) observed the maximum

number of branches (12.67) per plant in DWD-1 X 79B 1390-29-3-sp-2-2 and the minimum (7.33) in DWD-1 X DWD-2-20-2-cc and DWD-1 X 79B 1390-24-2 during rabi season. Nandi and Singh (1991) in their field trials to evaluate promising tomato varieties during rainy season and they observed the maximum number of branches (7.3) per plant in BT-10 and lowest (3.8) in T-30.

Sandoval *et al.* (2002) set am experiment for the study of chlorophyll content of four tomato cultivars (Max, Match, Caruso and Jumbo). The observed chlorophyll were not equal across tomato cultivars were being tested. Higher content was found in Max and lower for the other cultivars. Engelmann (1982) suggested that light energy absorbed by the chlorophyll is utilized for photosynthesis.

2.2 Review related to flowering and yield parameter:

One of the most important yield parameter is Days to 1st flowering for tomato line performance. Khan *et al*. (2017), who carried out an experiment in Haripur on exotic lines of tomato reported that, maximum days to flowering (47.66) were taken by LINE-105, significantly followed by LINE-103 with 45.33 days to flowering LINE-114 took the least days to flowering (24.67) significantly followed by LINE-112 (27.00) respectively. Again, the tomato LINE-105 had utilized food reserves in attaining vegetative growth which delayed flowering.

Gangolee *et al*. (2015) was made an investigation on four tomato varieties and reported significant varience. Chernet *et al*. (2014) was found during the first season, earliest flowering (28.35 days) was observed in the genotype NS-6666 and in second season, Meenakshi (23.80 days) was observed to be earlier under open condition. Experimentation on six exotic cultivars of tomatoes was done at Battal Valley of District Mansehra, Pakistan and concluded that days to

flowering ranged was between 37 to 47 days. Naz *et al*. (2011) found the similar result when made the experiment. Ejaj *et al.* (2011) evaluated the performance of 24 tomato lines under polyhouse and open condition for yield characters and observed the earlier flowering in lines raised under open condition than polyhouse condition.

It is the considerable variability is the variation first day of fruit maturity for harvesting. According to, Khan *et al.* (2017), maximum days to picking were taken by LINE-105 (116.6 days) while least days to harvest were found in LINE-112 and LINE-114 by taking 93.33 days and 89.00 days respectively. Ahmad *et al.* (2007) was conducted an experiment on 11 tomato cultivars at Northern Areas of Pakistan was conducted during 2003 and found out similar range for first picking between 82 to 96 days. Biswas and Malik (1989) was recorded minimum number of days (50 days recorded for hybrid-11 and Pusa Ruby) required from flowering to harvest. Nandpuri *et al.* (1974) found a high degree of variation for all characters.

Roy (2009) carried out an investigation on comparison of yield ability of tomato varieties. He found highest number of flower per cluster was 6.77 and lowest one was 4.43. Patoary (2009) conducted an experiment for evaluating the performance of 20 Lines of tomato and observed maximum number of flower cluster (11.09) in HT 016 and minimum 5.09 in TMS 008**.** Ghosh (2008) observed the maximum flowers per cluster in the variety TH10 and minimum in Supera. Kabir (2005) reported P-51 produced minimum flower per cluster (5.9) whereas maximum flowers per cluster were found in Anupama.

For the fruit per cluster Khan *et al.* (2017) showed in his experiment that the highest number of fruits per cluster (4.88) in LINE-105, significantly followed by LINE-103 with 4.66 fruits per cluster and the lines were statistically at par

with each other.LINE-114 produced only 1.77 fruits per cluster significantly followed by LINE-112 with 2.10 fruits per cluster. Ramzan *et al*. (2014) found that, the differences among tomato lines of fruit per cluster might be due to environment and temperature prevailed at the experimental area. Singh *et al*. (2002a) reported highly significant variation was observed when carried out an experiment among 92 lines of tomato incase of number of fruit per cluster. Analyzed data showed significant difference between the lines for this parameter.

Cordova *et al.* (1991) conducted an experiment with two lines (L322 and L101) derived from hybrid Lucy and observed that the number of flower number varies markedly with line L322 having highly branch of inflorescence, although line is closely related. They also found that, there were significant genotype and treatment genotype had interaction in the number of flower set and number of flower that developed into mature fruits was greater in line L101 than L322.

Jayprakashnarayan (2007) recorded highest number of fruits per plant in TP 35 (125.44) and minimum in TP 54(21). Singh *et al*. (2002a) found a great variation on number of fruit per plant in 92 lines of tomato. He reported that the highly significant variation was observed under agro climatic condition of the area and to compare performance of local variety. On the other hand, Rehman *et al.* (2000) reported that, Chico had the highest number of fruit per plant (52.50) while FM B9 and local check variety had the lowest number of fruit per plant was 24.75 and 26 respectively. He reported that the highly significant variation was observed under agro climatic condition of the area and to compare performance of local variety.

Bhutani *et al.* (1983) carried out a varietal trial of 84 genotype and showed that Set-23, Growthens Globe, Punjab, Chhuhara, VS 11-2, Pusa Red Pulm and GS 102 had the differences in the number of fruit per plant. Dudi *et al.* (1983) observed the variation in the number of fruit per plant. Highest value was recorded in EC 32099, HS 102, HS 107. Fantuna (1969) was experimented on 11 varieties of Tomato and found wide range of variation in number of fruits per plant.

The fruit set percentage was significantly affected by the tomato lines. Singh *et al.* (2013) carried out an experiment and observed that, the range of fruit set percentage was 50.65-84.09%.The highest fruit set (84.09%) was observed in the hybrid Himraja which was significantly higher than all the other hybrids tested in the present investigation. Hybrid PS-61 had the lowest fruit set percentage (50.65%). This finding is in conformity with Pandey *et al.* (2006) who reported the fruit set percentage ranging from 83.1-93.9%. The results revealed that the fruit set percentage was directly related to the fruit yield. Higher the fruit set, more would be the fruit yield.

In the term of individual fruit weight, Khan *et al.* (2017) worked on screening of different exotic lines of tomato under the agro climatic condition of Haripur and fruit weight data showed significant difference among all the lines. Highly significant data depicted that significantly maximum fruit weight were found in LINE-112 and LINE-114 with 105.10, 95.50 g respectively. On the other hand, LINE-101 showed minimum fruit weight (45.90 g) significantly followed by LINE-103 with 59.43 g fruit weight respectively. On the contrary, Hossain (2003) was made a study on the variation for the individual fruit weight and observed considerable amount of variability. Individual fruit weight found in J-4 gave the highest weight on individual fruit 124g whereas the lowest weight showed by J-1 as 8g. Ahmed (1987) and Das *et al.* (1998) found a wide range of variation in the weight of three tomato varieties namely, EC 32099, HS 107 and

Columbia which was very high. Singh *et al.* (1994) was carried out an experiment on the performance of tomato varieties were Akra Vikas,LE12, BT14, Punjub Chhuhara , BWRI and Ruby and the found Vikas had the highest fruit weight 54.52g and Punjab chhuhara the lowest one 21.93g. by Reddy and Reddy (1992) estimated the variation for individual fruit weight range from 1.25g to 158.57g when they carried out an experiment upon 139 varieties.

Ramzan *et al.* (2014) was worked upon fifteen new cross of tomato lines were investigated at Horticultural Research Institute NARC, Islamabad, Pakistan in spring 2011 and similar results for fruit length were concluded. These differences among the lines for this character may be attributed to the differences in the genetic makeup of the lines and the testing environment of the study. Significant differences for fruit length were also supported by Islam *et al*. (1999) studied nineteen segregate lines of tomato at the BARI Horticulture Research Centre during winter season.

For the fruit diameter, Khan *et al*. (2017) was recorded significant data regarding fruit diameter revealed that tomato LINE-105 produced maximum fruit diameter (5.83 cm) very closely followed by LINE-103 with 5.60 cm fruit diameter respectively. Least response was observed in LINE-114 (4.09 cm) and LINE-112 (4.26 cm). Rehman *et al.* (2000) was carried out an experiment on Different Exotic tomato cultivars under the climatic conditions of Northern Areas (GILGIT) and showed that the diameter of the fruit ranged from 2.03 to 5.65 cm. The variety Eva produced the fruit of maximum diameter (5.65cm) while Local check produced the fruit of minimum diameter (2.03 cm).

Jayprakashnarayan (2007) recorded highest yield per plant in TP 31 (2.95 kg) and minimum in TP 14(0.84 kg). Dudi and Sanwal (2004) observed the highest yield per plant in HTH-11(63.8 t/ha) and lowest was in Rupali (40.9 t/ha).

Sheferaw Nesgea (2001) carried out an investigation under Bangalore conditions and found the Arka Alok yielded highest (1.93 kg per plant) and Arka Ahuti yielded lowest (0.65 kg per plant). Shivakumar (2000) reported the highest yield per plant (4.03 kg) in H7711 and lowest (2.78 kg) in Ruchi. Joshi *et al.* (1998b) evaluated 21 tomato lines and recorded highest yield plant-1 (1.85 kg) in Sutton's Prolific. Matiar *et al.* (1994) reported the maximum (2.67 kg) and the minimum (1.32 kg) yield per plant were recorded in Manik and TMO 290 respectively, among the twelve Lines compared for yield potentiality. Jasmine and Ramadass (1994) observed the highest fruit yield per plant (1.06 kg) in hybrid ARTH-4 and the lowest (0.40 kg) in FM-2. Gulshan *et al.* (1991) evaluated nine varieties during summer in Tarai region and reported maximum yield plant-1 in Pant-4 followed by Pant Bahar. Kumaraswamy and Madalageri (1989) evaluated tomato lines in three seasons and found a general mean yield of 1.92 kg per plant. Singh *et al.* (1994) reported that the individual plant selection should be based on yield per plant. Cavicchi and Silveta (1976) reported that yield was highly dependent on the number of fruits. The cultivar producing the highest yield had the largest fruit number (Kaur *et al.*1976).

Sheferaw Nesgea (2001) was conducted a study and exhibited the variety Arka Alok gave highest yield per hectare (53.88 t/ha) and Arka Ahuti the lowest (19.72 t/ha). Shivakumar (2000) reported the highest yield per hectare (79.92 t/ha) in H7711 and the lowest (55.26 t/ha) in Ruchi. Islam *et al.* (1999) was carried out an experiment during 1997 to 1998 with three advanced tomato Lines TM0833, TM0834, TM0835 and local Ratan to observe the performance. The result showed that, the line TM0835 had the highest yield (97.16 Ton/ha) which was more than 47.36% over the control (BARI, 1998). Simon *et al.* (1994) reported that the cultivar INIFAT-163 performed well under spring conditions producing 29.5 tons per hectare. Bhangu and Singh (1993) observed the highest yield in Punjab Kesri under rain fed conditions.

2.3 Review related to quality parameter:

The soluble solids in tomatoes are predominantly sugars which are important contributors to flavor. According to Jayprakashnarayan (2007), who was reported the genotype TP 56 recorded maximum (5.4) TSS and minimum (1.91) was recorded in TP 29. Siambhi *et al.* (2001) reported a TSS percentage ranging from 3.2 to 4.4 in a study conducted on exotic tomato varieties. Brar and Singh (1998) reported the highest mean total soluble solid content (4.5%) in T-1 among the twenty varieties evaluated. Mittal *et al. (*1996) conducted on the variability evaluation of twenty-seven tomato Lines found that a mean TSS content of 3.97 per cent. Jasmine and Ramadass (1994) was evaluated the maximum TSS value was recorded in MTH 10 among the fifteen tomato hybrids and varieties. Bajaj *et al.* (1991) compared 34 tomato varieties for chemical compositions and recorded the TSS in the range of 3.5 to 7.50. Berry *et al.* (1988) studied the stability of insoluble solids and citric acid of eight processing cultivars and found that Ohio 7870 was the least variable in soluble solids.

Razzak *et al.* (2013) reported that the cherry tomato to pruning systems under greenhouse conditions reported maximum ascorbic acid in (23.75 mg per 100g) over (20.69 mg per 100g tomato lines. Prema *et al.* (2011) reported that the vit-C content of six cherry tomato fruit varied between 21.22 mg per 100 g (EC-1) to 27.48 mg per 100 g (Podland Pink). Aguirre and Cabrera (2012) conducted the fruit quality of 30 cherry tomato introductions reported that the commercial check presented the highest value for Vitamin-C content of 84.5 mg 100g-1 fresh weight followed by introduction, IAC445 with 72.5 mg 100g-1 fresh weight and LA2710 with 58.8 mg 100 g-1 fresh weight. Thangam and Thamburaj (2008) reported higher content under open field over the shade conditions in all the tomato cultivars. Vitamin C content ranged from 18.71 to 26.65 mg per 100g in open field condition as against 16.33 to 25.21 mg per 100g under shade. Shivanand (2008) observed the highest ascorbic acid in the hybrid US 2175

(22.85 mg per 100g) followed by Surya (20.18 mg per 100g) and minimum Vit-C was found in Bhoomi (9.62 mg per 100g). Kumar *et al*. (2007) observed the 42 tomato lines under green house and open field conditions and results reveals that lines CH151, CH154, CH155 and CH157 exhibited highest ascorbic acid under open field conditions over greenhouse conditions. Phookan *et al.* (1998) reported that significant variation among different tomato cultivars for ascorbic acid content. Highest ascorbic acid content is reported in the cultivar DRD-8014 (16.56 mg per 100g).

Ravinder and Cheema (2005) recorded the maximum and minimum pericarp thickness in Sel 2547-4-1-1(0.85 cm) and Small Boy-1 (0.22 cm) respectively. Sheferaw Nesgea (2001) reported a maximum pericarp thickness of 8.23 mm in NS – 113 and minimum of 3.23 mm in Pusa Ruby. Siambhi *et al.* (2001) reported a maximum pericarp thickness in Punjab Kesri (5.2 mm) in a study conducted at Ludhiana. Shivakumar (2000) evaluated some tomato hybrids for growth yield and quality parameters under Bangalore condition and recorded the maximum (6.14 mm) and minimum pericarp thickness (5.02 mm) in Virat and Avinash hybrids, respectively. Reddy and Singh, (1989) evaluated 31 lines sown in first and third week of March for various characters including pericarp thickness and found that varieties sown during third week performed poor because of the prevalence of high temperature during fruit development. Joshi *et al.* (1998b) observed in maximum pericarp thickness (7.2 mm) in Meenakshi and minimum (4.00 mm) in Punjab Kesri, Pusa Ruby, Red Stone, Selectin-7 and Sutton Roma among 21 lines evaluated. Bhardwaj and Thakur (1994) evaluated 26 lines of tomato for their growth and yield attributes and recorded maximum (5.6 mm) and minimum (2.7 mm) pericarp thickness in Roma and EC 191535 varieties respectively. Randhwa *et al.* (1988) evaluated four varieties of tomato for processing and recorded the maximum (7.0 mm) and minimum (4.7 mm) pericarp thickness in Punjab Chhuhara and S-12, respectively.

Jitender kumar *et al.* (2005) studied the keeping quality of several hybrids and varieties at room temperature the genotype BT-117-5-3-1 had the longest shelf life (25.69 days) and the least (7.61 days) shelf life was observed in NTH-229. Sheferaw Nesgea (2001) studied the keeping quality of thirteen open pollinated varieties under ambient conditions and reported the highest shelf life (20.17 days) for NS-101 and lowest was (6.83) for Hissar Anmol at red ripe stage. Pathak and Mahajan (1988) studied the keeping quality of eight tomato cultivars at room temperature until they decayed the shelf life from 17 days to 19 days.

CHAPTER III
MATERIALS AND METHODS

In this chapter materials and method that were described in shortly that was carried out during the experiment. The experiment was continued from October 2016 to April 2017. This includes with a short report about location of the experiment, Characteristics of soil, climates, material used, land preparation, manuring, fertilizing, transplanting, gap filling and collection of data:

3.1 Experimental site

This study was conducted at the Horticulture Farm in Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. The location of the experimental site is 23°74′N latitude and 90°35′E longitude with the altitude of 8.6 meter above the sea level, which have been shown in the Appendix I.

3.2 Soil of the experimental field

The soil of the experimental area belongs to the Modhupur Tract under AEZ No. 28. The characteristics of the soil under the experiment were analyzed in the Laboratory of Soil science Department, SAU, Dhaka and details of soil characteristics have been presented in Appendix I.

3.3 Climatic Condition of the experimental site

The site of experiment is situated in the sub-tropical climatic zone of monsoon, where heavy rainfall is occurred during the months from April to September (Kharif season) and scanty of rainfall during the rest of the month of the year (Rabi season). The sunshine is enough and moderately temperature is present during Rabi season, which are suitable for growing of tomato in Bangladesh. Temperature, rainfall, relative humidity and sunshine hours etc. information is prevailed at the experimental site during the cropping season October 2016 to March 2017 have been found in Appendix II.

3.4 Planting materials

Seeds of nine exotic tomato lines which were from Taiwan and a commercial variety was used as planting material. The commercial one is BARI Tomato-14, a high yielding tomato variety, developed by Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, was used as a check variety for comparison. The planting materials were:

i. BARI Tomato-14 (Check Variety)
ii. Exotic line 1 (Taiwan).
iii. Exotic line 2 (Taiwan).
iv. Exotic line 3 (Taiwan).
v. Exotic line 4 (Taiwan).
vi. Exotic line 5 (Taiwan).
vii. Exotic line 6 (Taiwan).
viii. Exotic line 7 (Taiwan).
ix. Exotic line 8 (Taiwan).
x. Exotic line 9 (Taiwan).

The nine lines were exotic and collected from Taiwan and supplied by Horticultural Biotechnology and Stress Management Lab, SAU, Dhaka-1207 and these all seedlings are raised in at the nursery of Horticulture Farm in Sher-e-Bangla Agricultural University, Dhaka-1207.

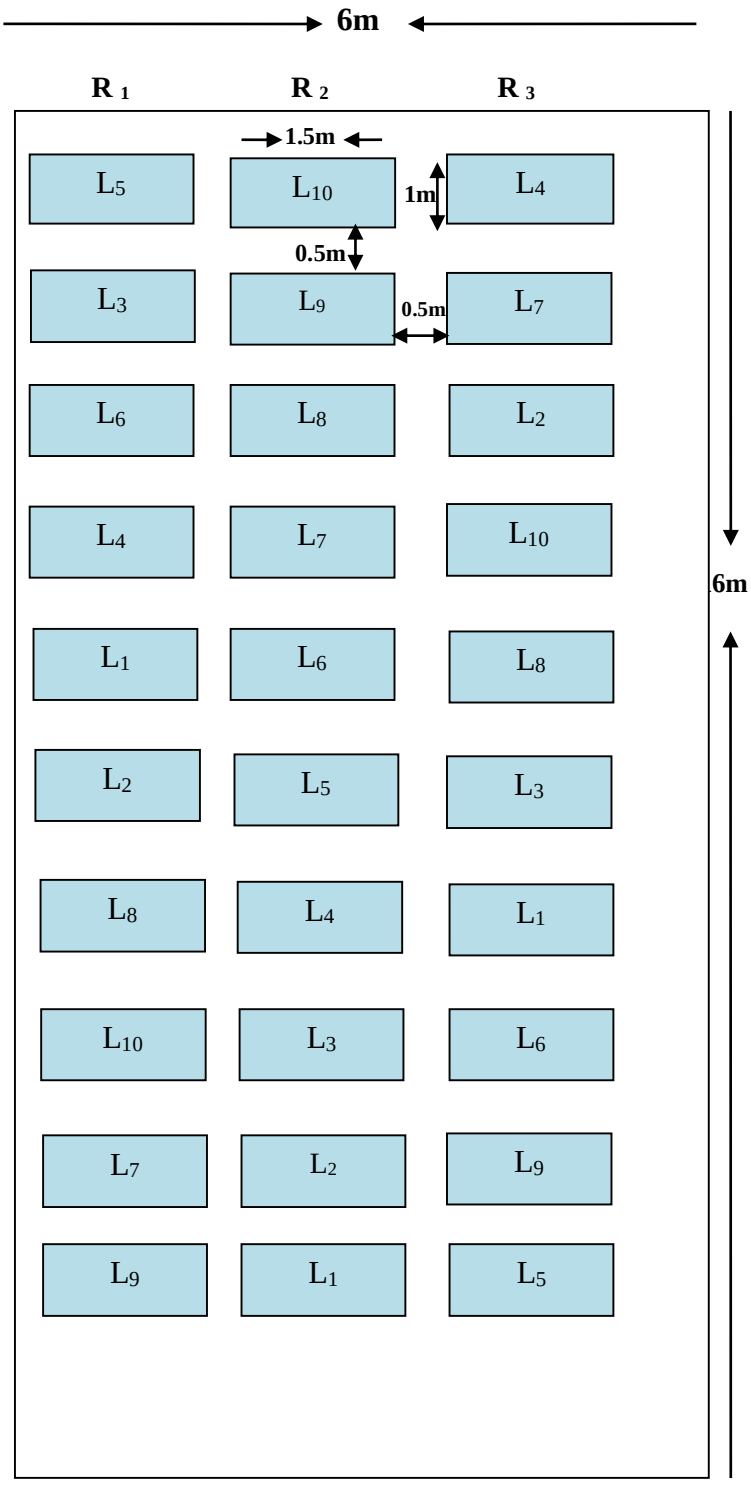
3.5 Treatments of the experiment

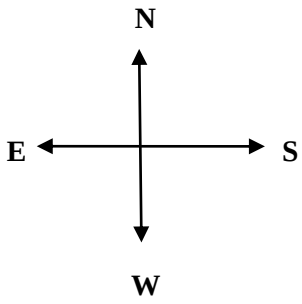
Ten elite genotype of tomatoes were used in the experiment as treatments. They were described as-

i. Line 1 (BARI Tomato-14)
ii. Line 2 (Exotic line 1)
iii. Line 3 (Exotic line 2)
iv. Line 4 (Exotic line 3)
v. Line 5 (Exotic line 4)
vi. Line 6 (Exotic line 5)
vii. Line 7 (Exotic line 6)
viii. Line 8 (Exotic line 7)
ix. Line 9 (Exotic line 8)
x. Line 10 (Exotic line 9)

3.6 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications were maintained in this experiment.





Tomato Genotypes/genotype

L_1 : BARI Tomato-14

L_2 : Exotic line-2

L_3 : Exotic line-3

L_4 : Exotic line-4

L_5 : Exotic line-5

L_6 : Exotic line-6

L_7 : Exotic line-7

L_8 : Exotic line-8

L_9 : Exotic line-9

L_{10} : Exotic line-10

Experiment layout:

Plant spacing = 50 cm × 50 cm

Replication to replication distances = 50 cm
Row to Row distance= 50 cm
Replication = 3
Total plot area =16m × 6m= 96m^2

Fig.1. Design and Layout of the research work

Each replication containing 10 plots of 1.5 m x 1 m size, giving 30 unit plots. The space was kept 0.5 m between replications. Row to row and plant to plant distance were 50 cm and 50 cm, respectively. The layout of the experiment is shown in Figure 1.

3.7 Seedbed preparation and raising of seedlings

Preparation of seedbed was done on 23 November, 2016 for raising 30 days old tomato seedling and the size of the seedbed was 3 m × 1 m. For making seedbed, the soil was well ploughed and transformed into friable loose and dried masses to achieve good tilth. Weeds, stubbles and dead roots were removed and 5kg well rotten cowdung was applied to the seedbed. The soil was treated by sevin 80 WP to protect the young plants from the attack of mole crickets, ants and cutworm. Germination was visible 3 days after sowing of seeds. After sowing, seeds were covered with light soil to a depth of about 0.6 cm. Banana leaves shading was provided over the seedbed to protect the young seedlings from scorching sun or heavy rain. Weeding, mulching and irrigation were done from time to time as and when mandatory to deliver seedlings of a good condition for growth and no chemical fertilizer was applied in this seedbed.

3.8 Land preparation

The experimental field was thoroughly ploughed and cross ploughed and prepared prior to seed sowing and application of fertilizers and manure (Appendix III) were done in the field. The experimental field was prepared through ploughing followed by laddering to have good tilth. Finally the land was properly leveled before transplanting then the plots were prepared as per the design.

3.9 Transplanting of seedlings

30 days old healthy and uniform seedlings were uprooted separately from the seedbed and transplanted in the experimental plots in 27 November, 2016 maintaining required seedlings in each plot. The seedbed was watered before uprooting the seedlings from the seedbed to minimize damage to the roots with ensuring maximum retention of roots. Transplanting was done in the afternoon. The seedlings were watered after transplanting and continued up to three days. Shading was provided using banana leaf sheath for three days to protect the seedlings from the scorching sun and after seedlings were established the sheath was removed (Plate 1.)

Plate 1: Seedling after transplanting

3.10 Intercultural operations

3.10.1 Irrigation

Light watering was given with water cane immediately after transplanting the seedlings and this technique of irrigation was done as every day at early morning and sometimes also in evening throughout the growing period but the irrigation frequency became less during harvesting stage. The amount of irrigation water was reduced up to that quantity which does not leached out through the bottom.

3.10.2 Staking

When the plants were well established, staking was given to each plant by bamboo sticks for support to keep them erect.

3.10.3 Gap filling

Few seedlings were damaged after transplanting and these were replaced by the new seedlings from the same stock.

3.10.4 Weeding

Weeding was done whenever it was necessary, mostly in vegetative stage.

3.10.5 Plant protection measures

Sevin 80WP was dusted to the soil before irrigation to control mole crickets and cut w0rms and others at on 3rd December, 2016. During foggy weather precautionary measure against disease attack of tomato was taken by spraying Diathane M-45 fortnightly @ 2 g/l of water at the early vegetative stage. Ridomil gold was also applied @ 2 g/l of water against blight disease of tomato. All the insecticide application was stopped before second week of first harvest.

3.11 Harvesting

Fruits were harvested at 2-3 days interval during early ripening stage. When they developed red color slightly. Harvesting was started from 15 February, 2017 and was continued up to last week of March, 2017.

3.12 Recording of data

Experimental data were recorded from 30 days after transplanting and continued until harvest in field. In laboratory, quality analysis data also recorded based on the parameters. Data were collected from six plants of each plot.

3.13 Detailed procedures of recording data

A brief outline of the data recording procedure monitored during the study is given below:

3.13. 1. Plant height

Plant height was measured at 30, 45 and 60 DAT. The plant height was determined in centimeter by measuring this distance from the soil surface to the tip of the highest leaf.

3.13. 2. Number of leaves per plant

Leaf number was counted at 30, 45 and 60 DAT. The number of leaves per plant was counted from each plant.

3.13. 3. Leaf area

Leaf area was measured at 30, 45 and 60 DAT by non-destructive method using CL-202 Leaf Area Meter, (USA).Only the nature leaves were measured for all the time and were expressed in cm^2.

3.13. 4. Foliage coverage

Foliar coverage was measured with a meter scale. It was assessed at the point where the plant was highly covered the area by the expansion of leaves. It was done six times during experimentation. It was measured at 30, 45 and 60 days after seedling transplant.

3.13. 5. Length of internode

Plants were selected to determine internode length of plants. A scale was used to measure the distances of two consequence node of a plant.

3.13.6. Diameter of stem

Recording of stem diameter was taken from six plants of each plot. Stem diameter was measured at the 5 cm above the ground. The average value was recorded as stem girth in cm.

3.13. 7. Number of branches per plant

The total number of branches per plant was considered from each plant at 30, 45 and 60 DAT. Estimation of an average value was collected from the value of six plants was retained per plot.

. 3.13. 8. Chlorophyll content

Measurement of leaf chlorophyll content was done by using a hand-held chlorophyll content SPAD-502 Plus (KONKA MINOLLTA). For each evaluation the content was measured in 5 times from five leaves at different positions per plant and the average was used for analysis.

3.13.9. Days of first flower initiation

The date of flower blooming was recorded from the number of days of 1st the date of flower blooming after transplanting (Plate 2).

Plate 2: First flowering

3.13. 10. Number of cluster per plant

The number of cluster per plant was collected from the six sample plants and the average number of clusters produced was recorded.

3.13.11. Number of flowers per cluster

The number of flower cluster record was collected from the six sample plants at different days after transplanting, and the average number of flower clusters produced per plant was noted.

3.13. 12. Number of fruit per cluster

The number of fruits per cluster was taken from sample plants were calculated as follow:

$$\text{Number of fruit per cluster} = \frac{\text{Total number of fruit in sample plants}}{\text{Total number of fruit cluster in sample plants.}}$$

Plate 3: Fruit per cluster

3.13. 13. Number of flowers per plant

The number of flower per plant was counted and recorded.

3.13. 14. Total number of fruits per plant

The total number of fruit was recorded from six sample plants at different days after transplanting and the average number of fruit produced per plant was recorded.

3.13. 15. Fruit set percentage

Fruit set percentage (%) was counted by following formula was:

$$\text{Fruit set (\%)} = \frac{\text{Number of fruit set}}{\text{Number of flower set}} \times 100$$

3.13. 16. Weight of individual fruit

Among the total number of fruits during the period from first to final harvest, fruit was considered for determining the individual fruit weight by the following formula:

$$\text{Weight of individual fruit (g)} = \frac{\text{Total weight of fruits}}{\text{Total number of fruits}}$$

3.13. 17. Days to 1st harvest

It was assessed as the number of days estimated from transplanting to harvest of first mature fruit from a plant of each replication

3.13.18. Length of fruit

Fruit length was measured from the neck of fruit to the bottom of the same by using slide calipers of five fruits randomly selected from each of the pot.

3.13. 19. Diameter of fruit

Fruit diameter was measured along the equatorial part of the same six represented fruit by distal slide calipers and their average was taken.

.3.13.20. Fruit yield per kg per plant

Yield per kg of tomato was calculated from was calculated from the six plants and taken the average and was expressed in kg.

3.13. 21. Fruit yield per hectare

Yield per hectare of tomato was calculated from the six plants from the each plot and was expressed in ton.

3.13.22. Measurement of total soluble solids (TSS)

The machine tool named Brix refractometer (Model RHB 32 ATC) was used to measure TSS. One tomato sample was collected from each of the treatment. Tomato sample was cut with the sharp knife and inside was squeeze with the needle for sample juice. A drop of juice was placed on the transparent glass and it was covered by the upper glass. Brix Refractometer was directly gave the result of the TSS as percentage.

3.13.23. Measurement of tomato pH

For the measurement two tomato samples were collected from each treatment which was fully ripened. Each sample was blended and it was made in liquid form. All the samples were taken in clean and transparent plastic pots. Electric pH meter (Model H 12211 pH/OPR meter of Hanna Company) was adjusted in buffer solution of pH 7.0; later on again it was adjusted in buffer solution containing pH 4.0. Finally, Electric pH meter was inserted in first sample and data was recorded. Again, pH meter was inserted in buffer solution containing pH 4.0 to adjust the p^H meter and again it was inserted in second sample of tomatoes and data was recorded. The same procedure was followed to measure pH of all other samples.

3.13.24. Measurement of Vitamin-C

Vitamin-C was measured by Oxidation Reduction Titration Method. A fruit was blend and extract of tomato was filtrated by Whatman No.1 filter paper. It was then mixed with 3% metaphosphoric acid solution. The titration was conducted in presence of glacial acetic acid and metaphosphoric acid to inhibit aerobic oxidation with dye solution (2,6-dichlorophenol indophenol). The solution was titrated with dye. The observations mean will give, the amount of dye required to oxidize definite amount of L-ascorbic acid solution of unknown concentration, using L-ascorbic acid as known sample. It was measured in Genetics and Plant Breeding Lab, Sher-e-Bangla Agriculture University, Dhaka.

3.13.25. Pericarp thickness (mm)

Firstly the fruit was cut by a sharp knife in the middle portion for the measurement of the pericarp thickness. Then the length of the exposed pericarp was estimated by digital slide calipers in mm**.**

3.13.26 Shelf life (Days)

Half ripen or greenish red tomato are harvested from the each line's plant and kept them under modified temperature and humidity at Horticultural Biotechnology and Stress Management Lab, SAU, Dhaka. The days of shelf life was counted up to 50% tomato are eligible market sell.

3.14. Statistical Analysis

All the data collected on different parameters were statistically analyzed following the analysis of variance (ANOVA) technique using MSTAT-C computer package program and the mean differences were adjudged by least significant difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The present chapter deals with experimental findings and discussion obtained during the course of Investigation entitled "Performance of Exotic Tomato Lines at Sher-e-Bangla Agricultural University. The field experiment was conducted during Rabi(2016-17) at Horticultural Research Farm, Sher-e-bangla Agricultural University.

The experimental findings were statically analyzed and presented in appropriate Tables, graphs and few also depicted through figure, the obtained results are presented below.

4.1. Morphological parameters

4.1.1 Plant height (cm)

Plant height differed significantly in different tomato lines at 30 DAT,45 DAT and 60DAT.(Appendix IV). The result related to plant height (cm) has been presented in (Fig.2). The mean value of maximum plant height was found in L2 (39.98cm) whereas the minimum height was L4 (16.34cm) which followed by L10 (19.48cm) at 35DAT (Fig.2).

At 45DAT, the maximum height was observed in L1 (91.52cm) which was statistically similar to L3 (87.73cm) and the minimum height was L8 (66.12cm) and at 60DAT the maximum height was observed in L3 (137.cm) followed by L1 (128.9cm) whereas the minimum plant height was L8 (80.66cm) which was statistically similar from L4 to L10 except the L2 (Fig.2).

Plant height is one of the important characters which is positively correlated to yield. Kumar (2011) experimented on 74 Lines of tomatoes in Vanarashi, India and observed that the similar result in plant height.

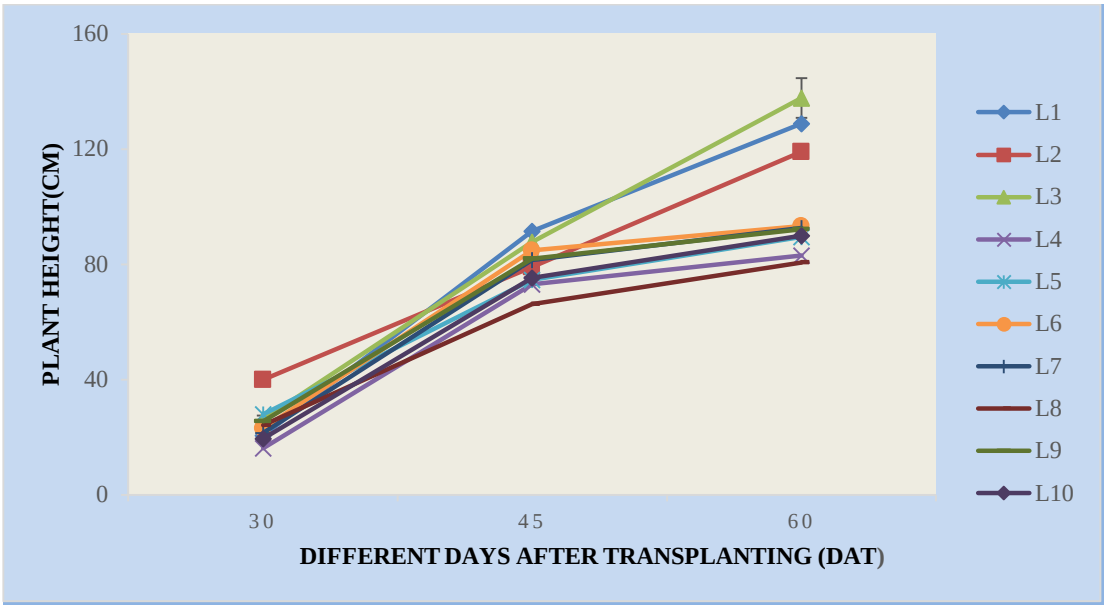


Figure 2. Effect of different tomato lines on the plant height of tomato at different days after transplanting ($LSD_{0.05}$=3.86, 12.94 and 16.48 at 30, 45 and 60 DAT, respectively). **[L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.1.2 Number of Leaves per plant

In different tomato lines, significant variation was also found in number of leaves at 30DAT, 45DAT and 60DAT. (Appendix. V). Number of leaves of a plant is very essential parameter because it has important physiological role in photosynthetic activities and number of leaves is directly associated with yield of tomato.

Number of leaves of a tomato line at 30DAT was observed highest in L2 (11.67) and minimum at L4 (6.33) (Table 1). Number of leaves per plant was gradually increased with the age of plant up to final harvest. It was ranged from 39.39 to 26.52 at 45days after transplanting (DAT). The maximum leaves observed in L1 (39.39) observed in L4 (26.52) (Table 1).

At the 60 Days of transplanting (DAT) the number of leaves per plant was increased. It was ranged from 52.48 to 32.39. The highest number of leaves were observed in L3 (52.48) followed by L1 (52.28) and lowest number of leaves found in L4 (32.39) followed by L8 (33.17) (Table 1). The different observed in number of leaves due to genetic variations existing in lines. Similar results were reported by Sharma and Tiwari (1993).

Table 1. Effect of different tomato lines on the number of leaves per plant of tomato at different days after transplanting

Treatments	Number of leaves per plant at different days after transplanting (DAT)		
	30	**45**	**60**
L_1	9.18 b	39.39 a	52.28 a
L_2	11.67 a	33.32 b	45.87 ab
L_3	9.55 b	32.11 b	52.48 a
L_4	6.33 c	26.52 c	32.39 d
L_5	9.13 b	33.37 b	38.61 c
L_6	8.93 b	31.32 bc	42.75 bc
L_7	9.13 b	29.33 bc	37.79 cd
L_8	8.50 b	29.70 bc	33.17 d
L_9	9.34 b	31.69 bc	37.93 cd
L_{10}	8.06 b	32.53 b	37.47 cd
LSD $_{(0.05)}$	**1.65**	**5.22**	**7.37**
CV (%)	**10.71**	**9.23**	**10.46**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. [**L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.1.3 Leaf area per plant (cm^2)

The results related to leaf area differed significantly in different tomato lines have been presented (Table 2) at 30, 45 and 60 days after transplanting (DAT) (Appendix VI). The mean value at 30 DAT of maximum leaf area was found in L1 (38.69 cm^2) followed by L6 (36.04 cm^2) and L5 (35.90 cm^2) while minimum leaf area was observed in L4 (17.48 cm^2). Leaf area depends upon the number and size of leaf.

Leaf area was gradually increased with the age of plant up to final harvest. So the value was increased at 45 and 60 DAT. At 45 DAT the range of leaf area was from 134.2 cm^2 to 282.0 cm^2. The height value was L1 (282.0 cm^2) followed by L3 (231.3cm^2) and the lowest value found in L4 (134.2 cm^2) (Table. 2).

At 60 DAT the range of leaf area was highest in L3 (456.8 cm^2) and lowest in L4 (217.4 cm^2). It was observed that leaves area was high in L3 and lowest in L4 at 30, 45 and 60 DAT (Table.2). Leaves play an important role in absorption of light radiation and using it in photosynthesis process, leaf size is influenced by light moisture and nutrients, hence yield is depends on leaf area of crop. Similarly result found by Lakshmi and Mani (2004).

Table 2. Effect of different tomato lines on the leaf area plant per plant of tomato at different days after transplanting

Treatments	Leaf area per plant (cm^2) at different days after transplanting (DAT)		
	30	**45**	**60**
L_1	38.69 a	282.00 a	407.50 b
L_2	30.58 b	173.70 c-e	253.20 de
L_3	34.19 ab	231.30 b	456.80 a
L_4	17.48 d	134.20 f	217.40 e
L_5	35.90 a	166.10 d-f	231.10 e
L_6	36.04 a	199.80 b-d	319.20 c
L_7	34.51 ab	191.20 cd	295.30 cd
L_8	22.32 cd	147.90 ef	224.60 e
L_9	22.12 cd	203.00 bc	296.60 cd
L_{10}	24.18 c	185.80 cd	246.40 e
LSD $_{(0.05)}$	**5.01**	**34.47**	**46.33**
CV (%)	**9.42**	**10.49**	**9.16**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. **[L1=BARI Tomato-14, L2=Exotic Line 1, L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.1.4 Foliage coverage (cm)

The results related to foliage coverage differed significantly in different tomato lines have been presented (Table 3) at 30, 45 and 60 days after transplanting (DAT) (Appendix.VII). The mean value at 30 DAT of maximum foliage coverage was found in L3 (48.91 cm) statistically similar with L2 (48.38 cm) whereas minimum foliage coverage observed in L7 (34.36 cm) (Table 3).

Foliage coverage was increased with the age of plant up to final harvest. So the value was increased at 45 and 60 DAT. At 45 DAT the range of foliage coverage was from 80.81 cm 55.73 cm (Table 3). The highest value was found in L1 (80.81cm) followed by L3 (72.08 cm) and L9 (72.07 cm) and the lowest value found in L8 (55.73 cm) (Table 3).

At the 60 DAT the range of foliage coverage was highest in L1 (82.90 c m) and lowest in L8 (62.54 cm) which was statistically similar with L2, L4, L5, L7 and L10 (Table 3). The results were similar with Ali *et al.* (2014).

Table 3. Effect of different tomato lines on the foliage coverage per plant of tomato at different days after transplanting

Treatments	Foliage coverage per plant (cm) at different days after transplanting (DAT)		
	30	**45**	**60**
L_1	43.45 ab	80.81 a	82.90 a
L_2	48.38 a	64.75 b-d	68.40 b
L_3	48.91 a	72.08 ab	74.83 ab
L_4	41.33 bc	62.99 b-d	65.21 b
L_5	47.91 ab	66.27 bc	69.32 b
L_6	48.32 ab	66.12 bc	82.57 a
L_7	34.36 c	59.29 cd	66.09 b
L_8	44.80 ab	55.73 d	62.54 b
L_9	43.58 ab	72.07 ab	74.83 ab
L_{10}	41.94 ab	64.55 b-d	65.17 b
LSD $_{(0.05)}$	**7.03**	**9.88**	**12.52**
CV (%)	**9.25**	**8.66**	**10.25**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. [**L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.1.5 Length of internode (cm)

Significant variation was observed among different tomato lines which have been presented (Table 4) at 30, 45 and 60 days after transplanting (DAT) (Appendix.VIII). The mean value at 30 DAT was ranged from 3.96 cm to 2.30cm. The maximum length of internode was found in L2 (3.96 cm) followed by L3 (3.557 cm) while minimum length of internode observed L8 (2.30cm) (Table 4).

Length of internode was gradually increased with the age of plant up to final harvest. The value was found also increasing at 45 and 60 DAT. At 45 DAT the range of length of internode was from 5.30cm to 3.42cm The highest value was found in L2 (5.30cm) followed by L3 (4.67cm) which is statistically similar L6 and L9 and the lowest value found in L8 (3.42 cm) (Table 4).

At the 60 DAT the range of length of internode was high in L3 (6.46cm) followed by L2 (5.83cm) and lowest in L8 (4.31 cm) (Table 4). Similarly result found by Lakshmi and Mani (2004).

Table 4. Effect of different tomato lines on the length of internode of tomato at different days after transplanting

Treatments	Length of internode (cm) at different days after transplanting (DAT)		
	30	**45**	**60**
L_1	3.08 c-e	4.75 ab	5.38 bc
L_2	3.96 a	5.30 a	5.83 ab
L_3	3.56 ab	4.67 ab	6.46 a
L_4	2.67 ef	3.67 cd	4.47 de
L_5	3.19 b-d	4.45 bc	5.02 c-e
L_6	2.83 de	4.94 ab	5.08 b-d
L_7	3.14 b-d	4.50 b	4.86 c-e
L_8	2.30 f	3.42 d	4.31 e
L_9	3.42 bc	4.58 ab	5.08 b-d
L_{10}	3.03 c-e	4.36 bc	5.25 bc
LSD $_{(0.05)}$	**0.42**	**0.80**	**0.77**
CV (%)	**7.79**	**10.39**	**8.64**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. [**L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.1.6. Number of branches per plant

Significant variation was observed in number of branches per plant in the different tomato lines at 30, 45 and 60 Days after transplanting (DAT) (Appendix.X). At 30 DAT the maximum number of branches per plant were found in L2 (1.17) which was statistically similar with L1 (1.09) while minimum number of branches per plant observed in L4 (0.25 cm) (Table 5).

Number of branches per plant was increased with the age of plant up to final harvest gradually. Then value was found also increasing at 45 and 60 DAT. At 45 DAT the range of number of branches per plant was from 2.303 to 3.75. The highest value was found in L3 (3.75) followed by L1 (3.29) and the lowest value

found in L4 (2.303) which was statistically identical from L2 to L10 except L3(Table.5).

At the 60 DAT the range of number of branches per plant were highest in L3 (4.25) followed by L1 (4.05) and lowest in L4 (2.84) was identical with L8 (2.95) (Table 5). Akteruzzaman (2012), Amarchandra and Verma (2003) finds similar result.

Table 5. Effect of different tomato Lines on the branches per plant of tomato at different days after transplanting

Treatments	Branches per plant (No.) at different days after transplanting (DAT)		
	30	45	60
L_1	1.09 a	3.29 b	4.05 ab
L_2	1.17 a	2.58 c	3.70 a-d
L_3	0.67 bc	3.75 a	4.25 a
L_4	0.25 f	2.30 c	2.84 e
L_5	0.75 b	2.58 c	3.12 de
L_6	0.67 bc	2.67 c	3.82 a-c
L_7	0.59 cd	2.67 c	3.19 de
L_8	0.42 e	2.45 c	2.95 e
L_9	0.70 b	2.64 c	3.61 b-d
L_{10}	0.50 de	2.67 c	3.29 c-e
LSD (0.05)	**0.11**	**0.43**	**0.61**
CV (%)	**9.71**	**9.12**	**10.15**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. [**L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.1.7 Stem Diameter (cm)

In the different tomato lines variation was observed significantly in stem diameter at 30, 45 and 60 Days after transplanting (DAT) due to various environmental condition (Appendix.IX). At 30 DAT, the maximum stem diameter was observed in L1 (0.99cm) followed by L9 (0.96cm), while minimum stem diameter was observed in L4 (0.71 cm) (Table 6).

Stem diameter was slowly but increased with the age of plant up to final harvest. Then value was found also increasing at 45 and 60 DAT. At 45 DAT the range stem diameter of a plant was from 1.36cm to 0.86cm. The highest value was found in L3 (1.36cm) followed by L1 (1.21cm) and the lowest value found in L4 (0.86cm) (Table 6).

At the 60 DAT the range of stem diameter was found maximum in L3 (1.73cm) followed by L6 (1.59) and it was statistically similar with L5 and L10 lowest in L2 (1.020cm) was identical with L8 and L4 (Table 6). These results are in conformity with Siddique *et al.* (2009).

Table 6. Effect of different tomato lines on the stem diameter of tomato at different days after transplanting

Treatments	Stem diameter (cm) at different days after transplanting (DAT)		
	30	**45**	**60**
L_1	0.99 a	1.21 ab	1.40 bc
L_2	0.81 cd	0.93 cd	1.02 d
L_3	0.93 a-c	1.36 a	1.73 a
L_4	0.71 d	0.86 d	1.06 d
L_5	0.87 a-c	1.08 bc	1.53 ab
L_6	0.93 a-c	1.07 bc	1.59 ab
L_7	0.83 b-d	1.04 bc	1.18 cd
L_8	0.85 a-d	0.93 cd	1.05 d
L_9	0.96 ab	1.10 bc	1.74 a
L_{10}	0.92 a-c	1.16 b	1.53 ab
LSD $_{(0.05)}$	**0.14**	**0.18**	**0.25**
CV (%)	**9.74**	**9.75**	**10.74**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. [**L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.1.8 Chlorophyll content on Leaf (%)

Chlorophyll content differed significantly in different tomato lines was presented in Figure.3 (Appendix.XIV).Variance of the Chlorophyll content on leaf (%) was ranged from 48.23 to 58.68. Highest chlorophyll content was recorded at 60 DAT in L6 (58.68%) followed by L1 (56.17%) which found statistically similar with L10 (56.10%), L7 (55.55) and L2 (55.18), while least chlorophyll content was recorded in L5 (48.23). As the chlorophyll is the green pigment of the plant which is essential for photosynthesis, so that yield contributing factor. Similar result was recorded by Sanoval *et al.* (2002).

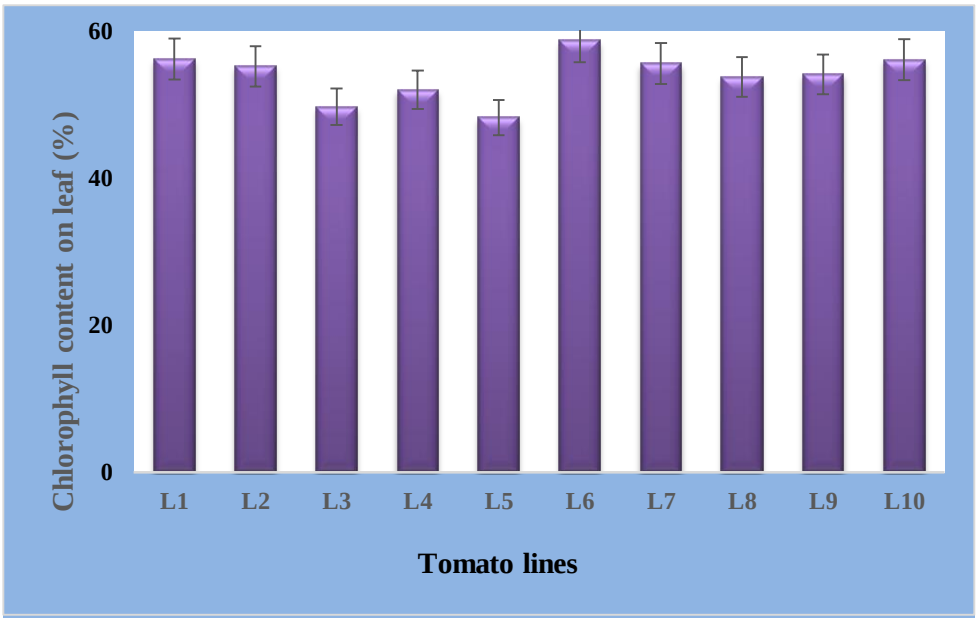


Figure 3. Effect of different tomato lines on chlorophyll content on leaf of tomato ($LSD_{0.05}$=6.86) [L1=BARI Tomato-14, L2=Exotic Line 1, L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].

4.2 Yield parameter

4.2.1 Days of first flower initiation

Days of first flower initiation differed significantly in different tomato lines has been presented in Table 8 (Appendix. XII). The mean performance of days to first flowering was recorded L3 (26 days) followed by L6 (27 Days). Latest flowering was recorded by L4 (36 days) (Table 8).

Early flowering is an indication of early fruit formation and consequently helps in getting early and high yields. The early flower initiation might be occurred due to higher capacity of these growing types. Similar results of significant differences for days to first flower among lines and potential use of these growing conditions for early flower initiation was also reported by Oum (1995), Pandey *et al*. (2006).

4.2.2 Number of cluster per plant

Significant differences existed among different tomato lines with respect to number of cluster per plant presented in Table 7. (Appendix XI). The mean of number of cluster per plant ranged from 6.0 (L2) to 2.08 (L7).Significantly highest number of cluster was recorded by the L2 (6.00) which was superior to all other lines like L10 (4.56), L5 (3.72), L8 (3.56), L3 (3.56) respectively. Least number of cluster was observed in L7 (2.08) (Table 7). Yadav (2006), also found the closure result.

4.2.3 Number of flower per cluster

The flower per cluster showed significant variation in the tomato lines (Table 7) (Appendix.XI). The largest number of flower per cluster (26.06) was found in L7 which is statistically different from other lines. The lowest number of flower per cluster (12.50) was found in L5 which is statistically identical with L10 (12.74) , L8(12.88) and L2 (13.14) (Table 7). The similar result also mentioned by Naresh (2002).

4.2.4 Number of fruit per cluster

Significant differences exist among different tomato lines with respect to number of fruit per cluster presented in Table 7 (Appendix XI). The mean of number of fruit per cluster ranged from 11.39 (L1) to 2.10 (L8). Significantly highest number of fruit per cluster was recorded by the L1 (11.39) which was statistically superior to all other lines. Least number of flower per cluster was observed in L8 (2.10) (Table 7).

Table 7. Effect of different tomato lines on the clusters per plant, flowers per cluster and fruits per cluster of tomato

Treatments	Clusters per plant	Flowers per cluster	Fruits per cluster
L_1	2.67 e-g	22.42 b	11.39 a
L_2	6.00 a	13.14 e	3.02 fg
L_3	3.56 cd	17.41 d	9.82 b
L_4	2.41 fg	21.63 bc	4.46 de
L_5	3.72 c	12.50 e	3.58 ef
L_6	3.08 c-e	18.79 cd	6.49 c
L_7	2.08 g	26.06 a	9.98 b
L_8	3.56 cd	12.88 e	2.10 g
L_9	3.00 d-f	18.38 cd	5.27 d
L_{10}	4.56 b	12.74 e	3.32 f
LSD $_{(0.05)}$	**0.65**	**3.53**	**1.12**
CV (%)	**10.96**	**11.68**	**11.02**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. **[L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.2.5 Number of flower per plant

The flower per plant showed significant variation in the tomato lines (Fig.4) (Appendix. XII). The largest number of flower per plant (77.80) was found in L2 which was statistically different from other lines and then it was followed by L3 (61.83). The Lowest number of flower per plant (45.85) was found in L8

which was statistically similar with L5 (46.24) (Fig.4). These results are in conformity those obtained by Papadopoulos and Ormrod (1991).

4.2.6 Number of fruit per plant

A significant variation was observed in the number of fruit per plant among the tomato lines (Appendix. XII). The highest number of fruits per plant was recorded in L3 (34.75) followed by L1 (30.33) and the lowest number of fruits per plant were recorded in L8(116.27) (Fig.5). A good number of literatures showed significant genotypic variation exists in the number of fruit per plant. Islam *et al.* (1999) found the highest found the highest genetic variability for this trait, which support the present result.

4.2.7 Fruit set percentage (%)

Fruit set percentage showed significant variation in the tomato lines (Appendix.XII). The largest number of fruit set percentage (56.28%) was found in L3 which was statistically different from other lines and then it was followed by L1 (50.77%). The Lowest fruit set (16.27%) was found in L8 which was statistically similar with L4 (20.68%) (Fig.6). Similar result was also found by Naz *et al.* (2011), Patil *et al.* (2010).

4.2.8 Individual fruit weight (g)

Highly significant differences was existed among different tomato lines with respect to individual fruit weight (g) presented in Figure 7 (Appendix.XIII). The mean of individual fruits weight ranged from 113.1g to 65.88g. Significantly highest individual fruit weight was recorded by the L3 (113.1g) which was superior to all other lines like L1 (101.8g) and least number of fruits weight was noticed in L7 (65.88g) (Fig.7). The results of present investigation are in accordance with the finding of Hatwar *et al.* (2003), Raghav and Sharma (2003), Rafique *et al*. (2004).

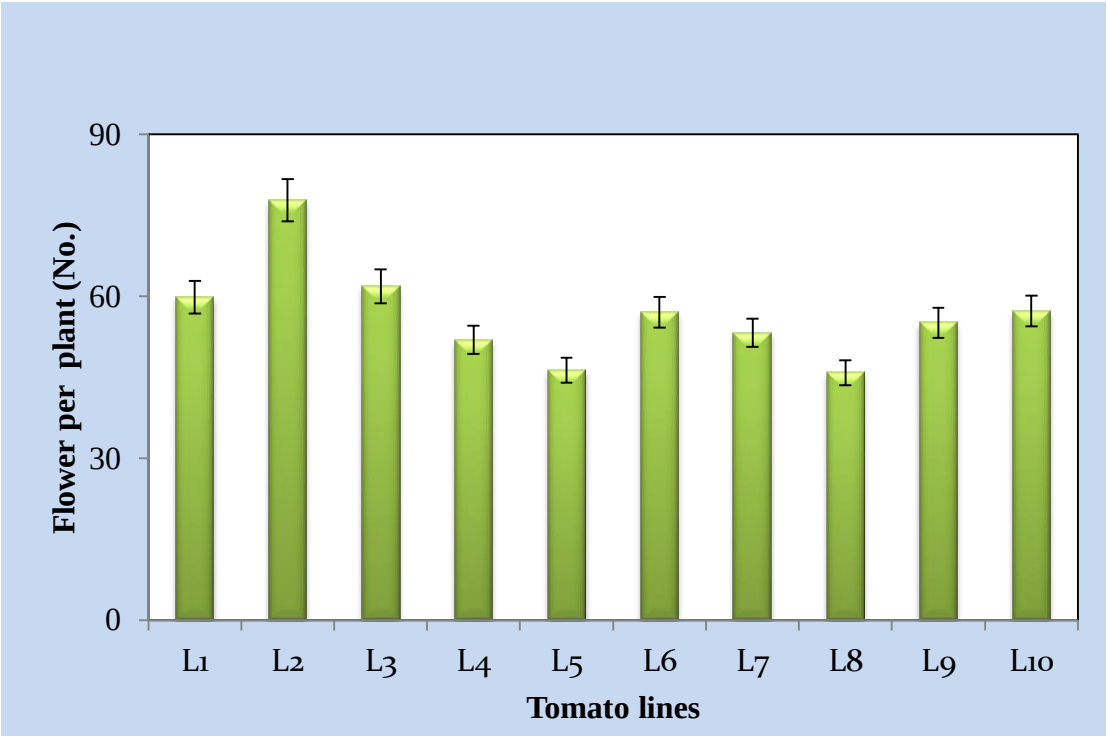


Figure 4. Effect of different tomato Lines on the flowers per plant of tomato ($LSD_{0.05}$=9.40). [L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].

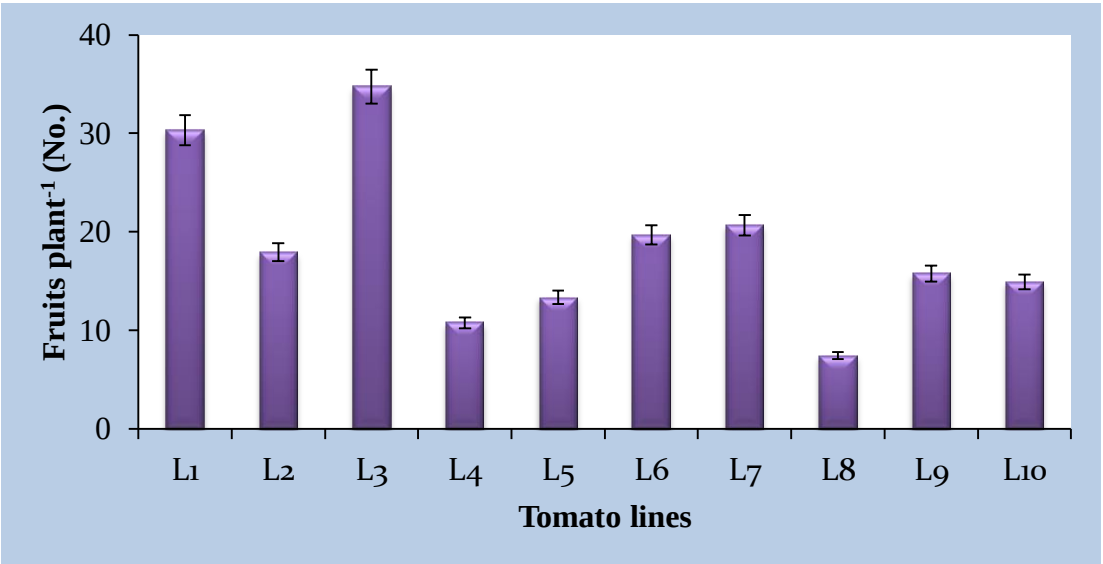


Figure 5. Effect of different tomato lines on the fruits plant^{-1} of tomato ($LSD_{0.05}$=2.61)[L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].

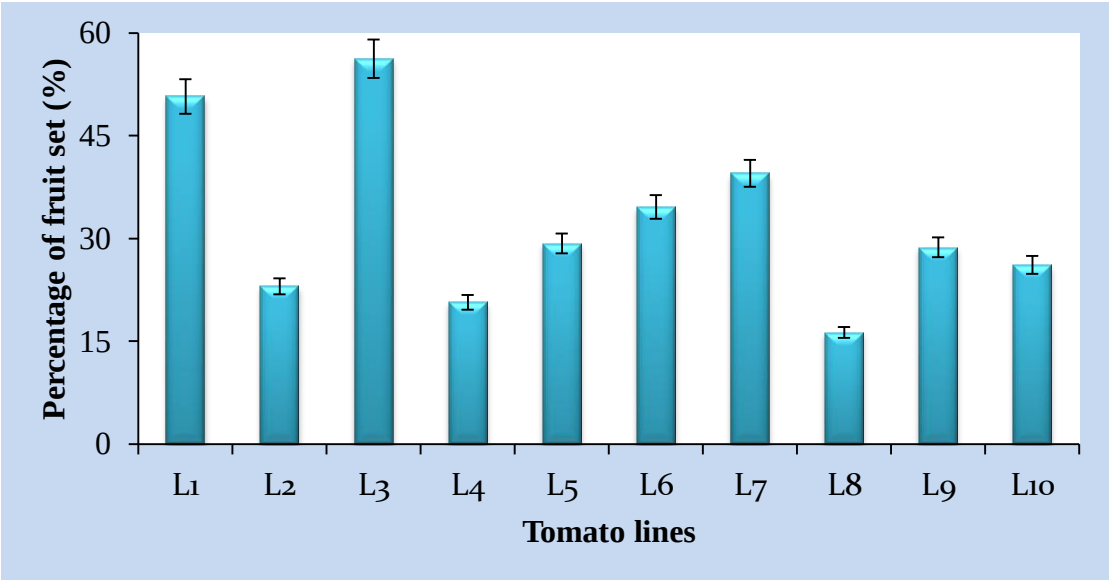


Figure 6. Effect of different tomato lines on the parentage of fruit set of tomato ($LSD_{0.05}$=5.33) L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9

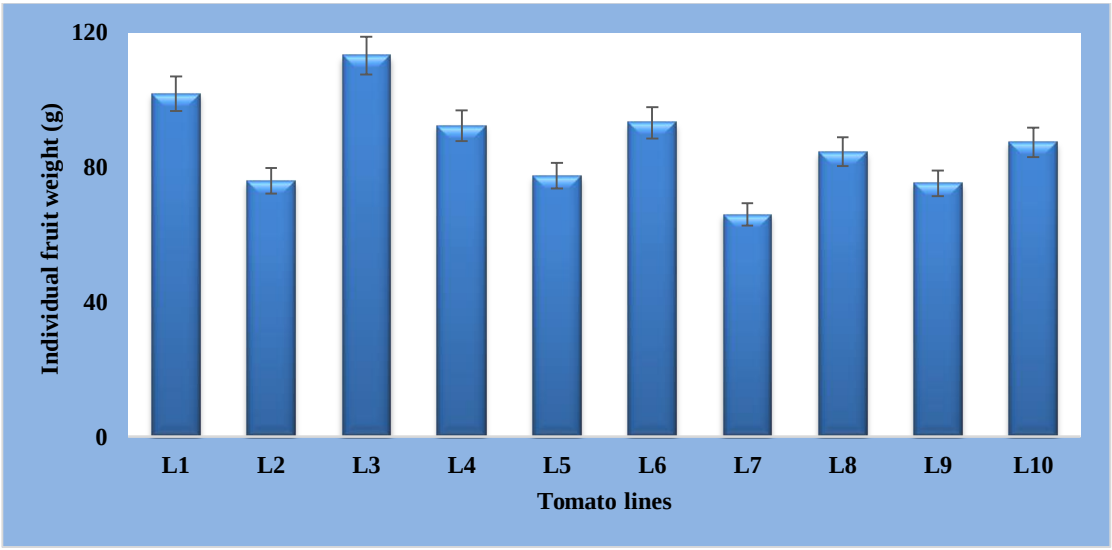


Figure 7. Effect of different tomato lines on the individual fruit weight of tomato ($LSD_{0.05}$=10.49) L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9

4.2.9 Days to first fruit harvesting

Significant differed were observed with respect to days to first fruit harvesting among the tomato (Appendix. XII). The mean number of days taken for first fruit picking ranged from 76.75 to 90.05 days. (Table 8).

The L3 (76.75days) took shortest period from transplanting to first fruit harvest followed L6 (77.07 days), but both are statistically found similar with each other. While, L9 (90.05 Days) took maximum number of days for first fruit harvest. Earliness plays important role on fetching higher price and more income. Therefore early varieties are generally preferred for cultivation on commercial scale.

Early harvest in this experiment might be occurred due to the varietal response to the congenial growing natural environment and early flowering. Whereas delayed fruit ripening was due to late flowering. Similar results obtained Wahundeniya *et al. (* 2013) in tomato growing in poly house and Prema *et al*. (2011) in cherry tomato.

Table 8. Effect of different tomato Lines on the days of 1st flowering and days of 1st fruit harvest of tomato

Treatments	Days of 1st flowering	Days of 1st fruit harvest
L_1	27.00 ef	87.23 ab
L_2	31.00 cd	86.22 a-c
L_3	26.00 f	76.05 e
L_4	36.00 a	83.13 bc
L_5	32.00 bc	83.17 bc
L_6	27.00 ef	77.07 de
L_7	34.00 ab	83.31 bc
L_8	29.00 de	81.29 cd
L_9	30.00 cd	90.05 a
L_{10}	29.33 d	83.28 bc
LSD (0.05)	**2.09**	**5.09**
CV (%)	**4.03**	**3.57**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability.[**L1=BARI Tomato-14, L2=Exotic Line 1 ,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.2.10 Fruit Length (cm)

There also found some significant variation in fruit length in different tomato lines (Appendix.XIII). It was recorded that the maximum length of tomato fruit was recorded in L6 (5.31cm) which is followed by other all lines except the L4 and L8, while the minimum length of fruit was recorded in L4 (4.27cm) that was followed by L8 (4.237cm) (Fig. 8). Similar results also mentioned by Ejaz *et al.* (2011), Yildirim (2007).

4.2.11 Fruit Diameter (cm)

Significant differences existed in the different tomato lines (Appendix.XIII). The variance of diameter of tomato fruit was recorded from 6.067cm to 4.647cm (Fig. 8). It was found that, the highest value was presented in L6 (6.6067cm) which was statistically similar with L3, L5 and L10. Least value was presented in the L8 (4.647cm) was found through analysis (Fig. 8). . These results were also supported by Salam *et al*. (2004), and Devi *et al*. (2013).

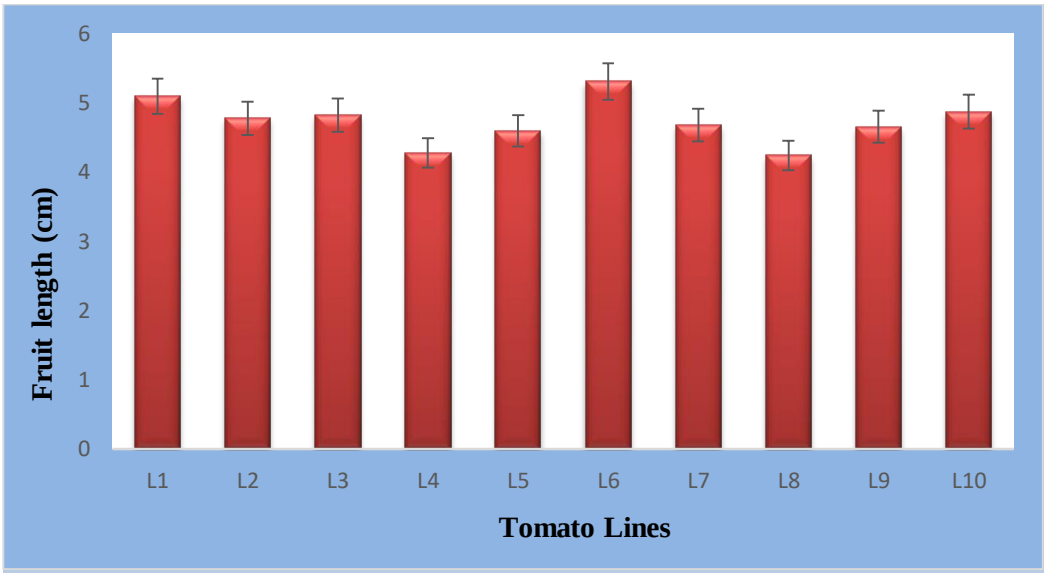


Figure 8. Effect of different tomato lines on the fruit length of tomato ($LSD_{0.05}$=0.89). [L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].

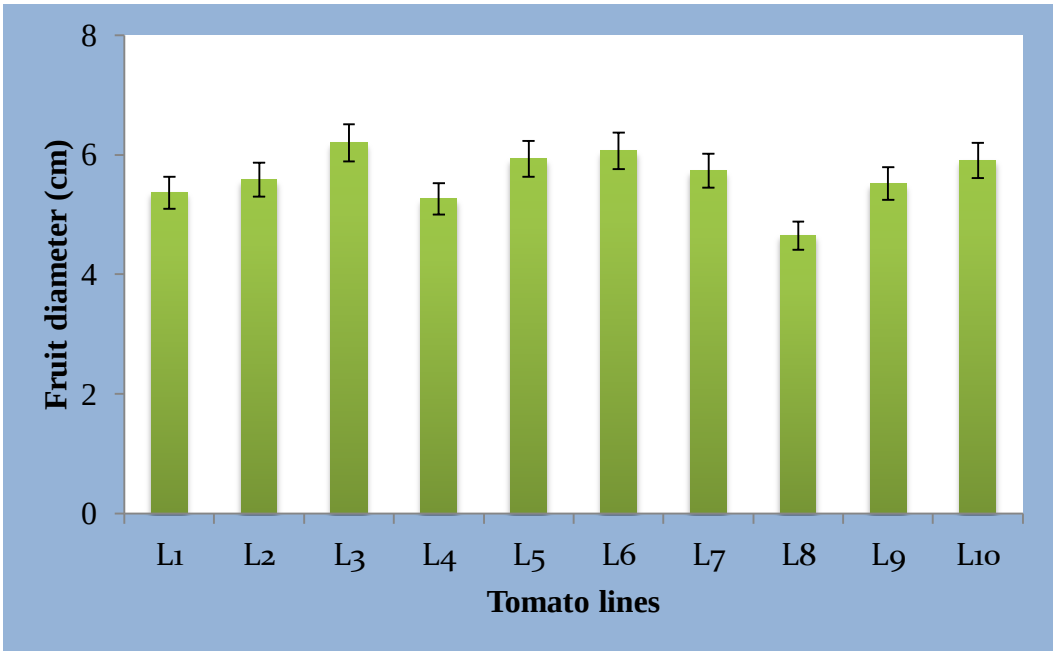


Figure 9. Effect of different tomato Lines on the fruit diameter of tomato ($LSD_{0.05}$=1.02) [L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].

4.2.12 fruit yield (kg/plant)

Average fruit yield showed highly significant values among all the tomato varieties presented in figure.10 (Appendix. XIII). The mean fruit yield kg per plant ranged from 2.39kg per plant to 0.7033 kg per plant. Significantly superior fruit yield kg per plant was recorded in L3 (2.39kg) followed by L1 (1.94kg) and L8 (0.7033 kg) had recorded minimum individual fruit yield (Fig.10).

This variation in fruit yield kg per plant might be due to inverse relationship existing between average fruit weight, and number of fruits per cluster. This was conformity with the findings of Prema *et al.* (2011), Islam *et al*. (2012) who opined higher or lower fruit weight may also be ascribed to the varietal characteristics.

4.2.13 Fruit yield (t/ha)

The fruit yield differences among the lines with respect to fruit yield ton per hectare were highly significant (fig. 11) (Appendix. XIII). The highest fruit yield ton per ha was recorded in the L3 (95.60 t/ha) followed by L1 (80.71 t/ha). The L8 (28.13 t/ha) has recorded significantly lowest fruit yield per hectare which is attributed mainly due to the less number of fruiting clusters per plant, poor fruit set and poor response of these line in environmental conditions.

The highest fruit yield ton per hectare was attributed to better vegetative growth, early flowering, more number of fruits per cluster, highest average fruit weight, higher fruit set percentage over the other lines. This may be due to the inherent ability of the lines and their better response to SAU natural conditions. Similar reports of better performance of lines due to genetic makeup was reported by Singh *et al*. (2001), Pandey *et al.* (2006), Razzak *et al.* (2013) in tomato.

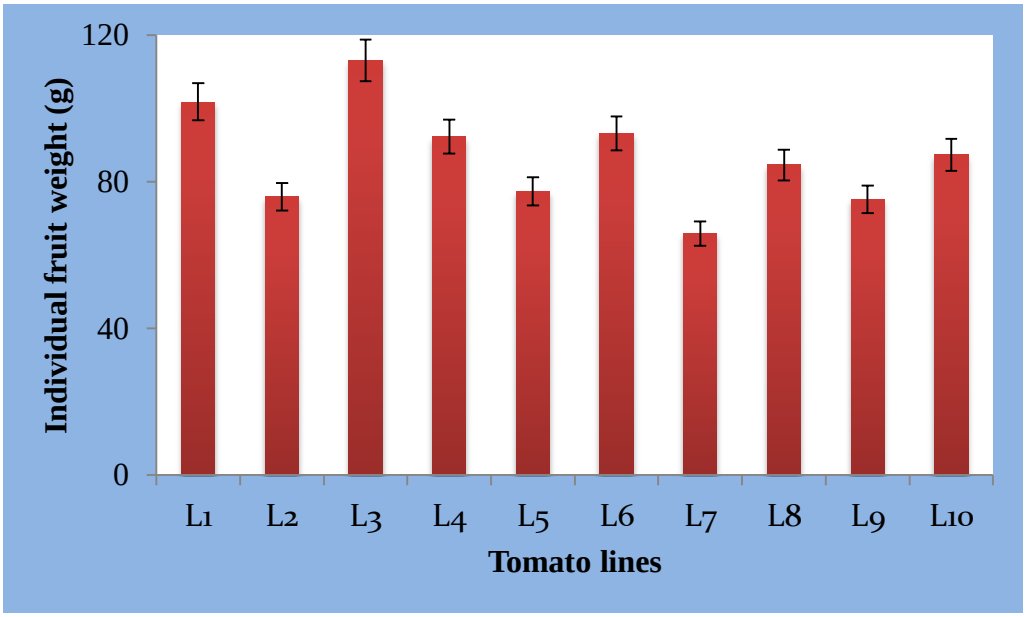


Figure 10. Effect of different tomato Lines on the fruit yield plant^{-1} of tomato ($LSD_{0.05}$=0.28). [L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].

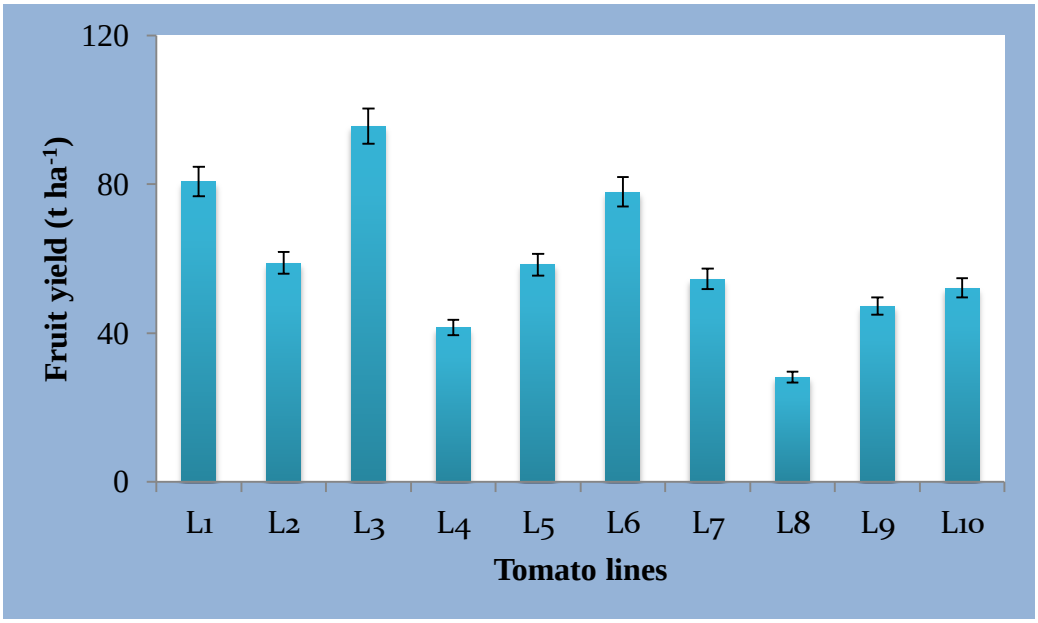


Figure 11. Effect of different tomato Lines on the fruit yield of tomato ($LSD_{0.05}$=10.15). [L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].

4.3. Quality Parameter

4.3.1 Total soluble sugar (%)

The data pertaining to total soluble solids (TSS) are presented in the (Table 9) data showed highly significant differences among the tomato line (Appendix. XIV). The L9 (4.35%) followed by L3 (4.17%) recorded significantly maximum total sugar content. Lowest total sugar was found in L2 (3.00%). High TSS and low acidity are the major factors considered for fruit processing products. Higher TSS in L9 and L8 might be due to the enhanced deposition of solids and more conversion of organic acids to sugars. Similar studies were conducted by the earlier workers Sucheta *et al*. (2004), Kumar *et al*. (2007), Shivanand (2008) and Prema *et al*. (2011) in tomato.

Table 9. Effect of different tomato Lines on the total soluble sugar, fruit pH, vitamin-C content on fruit, Pericarp Thickness and self life of fruit of tomato

Treatments	Total soluble sugar	Fruit pH	Vitamin-C content on fruit	Pericarp Thickness (mm)	Shelf life of fruit (days)
L_1	3.89 abc	4.27 d	14.14 e	6.37 b	14.67 b
L_2	3.00 f	4.88 a	20.12 c	3.57 e	10.67 c
L_3	4.17 ab	4.38 c	22.36 b	6.73 ab	16.67 a
L_4	3.25 ef	4.53 b	15.05 e	4.60 d	9.67 cd
L_5	3.33 def	4.21 e	14.43 e	6.43 b	9.00 cd
L_6	3.33 def	4.26 de	20.93 c	5.17 c	9.67 cd
L_7	3.58 cde	4.26 de	17.64 d	3.73 e	10.33 c
L_8	3.17 ef	4.24 de	14.37 e	6.63 ab	6.00 e
L_9	4.35 a	4.58 b	26.96 a	5.13 c	8.33 d
L_{10}	3.75 bcd	4.22 de	18.65 d	6.97 a	10.67 c
LSD $_{(0.05)}$	**0.48**	**0.05**	**1.05**	**0.51**	**1.91**
CV (%)	**7.77**	**0.61**	**3.31**	**5.37**	**10.54**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per as 0.05 (%) level of probability. [**L1=BARI Tomato-14, L2=Exotic Line 1,L3=Exotic Line 2, L4=Exotic Line 3, L5=Exotic Line 4, L6=Exotic Line 5, L7=Exotic Line 6, L8= Exotic Line 7, L9= Exotic Line 8, L10=Exotic Line 9].**

4.3.2 Total pH

The data was exhibited significant variation in different tomato lines (Appendix XIV). The result showed that the high value of pH at L2 (4.88) which was totally different from the pH of other line. On the other hand, the least value was found in L5 (4.21) (Table9) .Similar result were reported by Mohammad *et al*. (1999).

4.3.3 Vitamin-C content

The vitamin-C content of tomato was significantly varied on tomato line (Appendix XIV). The data obtained from several tomato line was shown that the highest value of Vitamin-C was present in L9 (26.96mg per 100g of tomato) which is significantly followed by L3 (22.36 mg per 100g of tomato), while the lowest value was found in L5 (14.45 mg per 100 g of tomato) that statistically similar with rest other line except the L2, L10 and L7 (Table 9). Toor and Savage (2006) was investigated Vitamin-C content on different tomato lines and have found the similar result.

4.3.4. Pericarp Thickness (mm)

Pericarp thickness of the flesh of fresh fruit is one the important quality parameter which was found significantly differentiated among the different exotic tomato line presented in Table 9 was ranged from 6.97mm to 3.57mm (Appendix. XIV). The highest value of pericarp thickness from flesh of fresh fruit was presented in L10 (6.97mm) followed by L3 (6.73mm) was statistically similar with L8(6.63mm). The least value pericarp thickness from flesh of fresh fruit was found in L2 (3.57mm) was identical with L7 (3.73mm). Similar result was exhibited by Shivakumar (2000).

4.3.5 Shelf life of Tomato (Days)

Significant differences existed in the shelf life different tomato lines (Appendix XIV). The variance of shelf life of tomato fruit was recorded from 16.67 days to 6.00 days (Table 9). It was found that, the highest value was presented in L3 (16.67days) followed by L1 (14.67 days). Least value was presented in the L8 (6.00days) was found through analysis. Kumar *et al.* (2007) studied the keeping quality of several hybrids and varieties at room temperature which result was mostly similar to it.

CHAPTER V
SUMMARY AND CONCLUSION

The experiment was conducted with 10 lines of tomato where 9 were exotic tomato and the other one was used as check variety called BARI Tomato-14 at the experimental field of Horticulture Farm, Sher-e-bangla Agricultural University, Sher-e-Bangla Nagar,Dhaka to study the Performance of Exotic Tomato lines. 30 plot were used for the ten planting materials for with three replication in Random Complete Block Design (RCBD). The transplanting was done in 27 November,2016 . Data on growth, yield and quality contributing characters of tomato was recorded at 30 DAT, 45DAT and 60DAT respectively. The collected data were statistically analyzed for evaluation using the computer programme. The salient findings of the present study summarized below:

In the present study , all tomato lines showed significant variation almost all the growth , yield and quality characters of tomato. For the growth parameter,at 60 DAT, it was recorded that the tallest plant (137.7cm) was observed in L3 followed by L1 and the shortest plant was found in L8 (80.66 cm). Different lines exhibit the marked variation in number of leaves per plant. Among the all lines at 60 DAT the maximum number of leaves (52.48) were observed in L3 followed by L1 while the minimum number of leaves was found in L8 (33.17). The leaf area per plant was highest (456.8 cm^2) in the L3 follwed by L1 and the lowest value (217.4cm^2) was found in the L4 was statistically similar with L5, L8 and L10 at 60 DAT. The foliage coverage was significantly varried from line to line. AT 60 DAT ,the foliage coverage was found high (82.90 cm) at L1 as it was followed by L3 (74.83 cm) and the lowest value was observed in L8 (62.54 cm). Significantly the maximum(4.25) branch per plant was found in L3 followed by L1 (4.05) and the minimum numbwe of branches were found in L8 (2.95). Variation was recorded when the length of internode was found at final collection of data at 60 DAT. Result showed the most value was observed in the

L3 (6.46 cm) followed by L2 (5.83cm) and least value was found in L8 (4.31 cm). Stem Diameter was also shown the significant variation in the line to line. The highest value was carried out by L9 (1.74cm) was identical with the L3 (1.73 cm) and the lowest value was found in L8 (1.05 cm) was statistically identical with L4 (1.06cm). In respect on chlorophyll content on leaf (%) of tomato plant, the maximum value was found in the L6 (58.66%) followed by L3 (55.55%) which was statisticall identical with L1 and L7 and the minimum value was recordrd in L5 (48.23%).

In the yield contributing character, the tomato lines also showed the significant variation fom line to line. The days of 1st flower initiation aslo found the variation among line to line. It was recorded that the early flowering was occured in L3 (26days) where as the late flowering was occured in L4(36days). The number of cluster per plant was found highest in L2 (6.00) and the least number of cluster was found in L7 (2.08).The maximum value of the flower per cluster was recorded in L7 (26.06) and the minimum value was recorded in L5 (12.50) which was statistically similar with L8. The fruit per cluster was highest in L1 (11.39) followed by L3 (9.82) and lowest in L10 (3.32). On the other hand, the high value of flower per plant was observed in L2 (77.80) followed by L3 (61.83) and the least value was obseved in L8 (45.85). Again, the number of fruit per plant was recorded highest in L3 (34.75) followed by L1 (30.33) and the least value was recorded in L10 (14.92). Fruit percentage is very much imortant yield character that was recorded high in L3 (56.28%) followed by L1 (50.77%) and the least value was recorded in L8 (16.27%). The individual fruit weight was exhibited highly in L3 (113.1 g) and the lowest fruit weight was found in the L7 (65.88g). The fruit yield per plant (kg) was high in L3 (2.39kg) with highest yield of ton per hacter (95 t/ha) which was superior over L1 yield,which was found yield per plot was 1.937kg and yield per ha 80.71 ton. Here, the lowest yield per plot was L8 (0.73kg) and the yield per ton/ha was also found low in L8 (28.13 t/ha).

Qualititive character is the another most important character in which the tomato lines showed the significant variation. Highest TSS is found in L9 (4.35%) followed by L8 (4.17%) where as the lowest TSS was found in L2 (3%). On the other hand, the highest pH was exhibited L2 (4.88) followed by L4 (4.53) and the least pH was L5 (4.21). Vitamin-C was recorded maximum in L9 (26.96 mg per 100 g of tomato) followed by L3 (22.36 mg per 100 g of fruit) and the least amount was recorded in L8 (14.37 mg per 100 g of fruit). Percarp thickness was highest L10 (6.97mm) followed by L3 (6.73mm) where as the lowest value in L2 (3.57mm). Shelf life (days) is the most qualitive character which also showed significant variation and was observed maximum in L3 (16.67 days) followed by L1 (14.67 days) and the lowest persistency was showed in L8 (6 days).

Conclusion:

Based on above description, it was clearly revealed that, performance of L3 was better than other nine tomato lines. The L3 was obtained the maximum growth and yield parameter. The tomato lines L1, L6 and L2 also gave good yield performance.

In the quality performance L3 also showed the good storage performance specially showed high shelf life (days). High Vitamin-C content and TSS was recorded in L9 and high pH was found in L2. On the other hand, L3 also performed good in TSS, pH and vitamin-C content.

The research was conducted at Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka foe one season. As per performance of L3 was good in growth, yield storage, so further trial of this research is needed to justify the result foe the result for precise recommendation.

REFERENCES

Ahmed, S. U., Saha, H.K., Rahman, L. and Sharfuddin, A.F.M. (1986). Performance of some advance Lines of tomato. *Bangladesh Hort.*,**14**(1):47-48.

Ahmed, S. U. (1987). Variability and correlation studies in tomato. *Bangladesh J. Agric.*,**12**(1):1-4.

Ahmad F, Khan O, Sarwar S, Hussain A & Ahmad S (2007). Performance evaluation of tomato cultivars at high altitude. *Sarhad J Agric* 23(3): 581-585

Akteruzzaman, M. (2012). Effect of boron on growth, yield and quality of three varities of tomato. MS thesis. Department of Agricultural Chemistry. Bangladesh Agricultural University, Mymensingh. pp. 62.

Ali, A. S., Reza, M. H., Ali, M., Hossain, M. D., Mahabub, S. T., & Hoque, M. A. (2014). Performance of local and exotic hybrid tomato varieties in Bangladesh. *Int. J. Nat. Soc. Sci.,* **1**: 100-105.

Amrachandra, S. and Verma, B. K. (2003). Effect of boron and calcium on plant growth and seed yield of tomato. *JNKVV Res. J. of India*., **37**(2): 13-14.

Anonymous. (2010). www.faostat.fao.org, FAO Static Division. Rome, Italy.

Arun, J., Amit, V. and Thakur, M. C. (2004). Studied on genetic variability, correlation and path analysis for yield physiochemical traits in tomato (Solanum lycopersicum) . *Prog. Hort.,* **36**(1): 51-58.

Bajaj, K.L., Mahajan, R., Kaur, P.P. and Chuma, D.S., (1991), Chemical constituents of processing tomatoes (*Lycopersicon esculentum* M). *J.Res. Punjab. Agric. Univ.*, **27**(2): 226-230.

BBS. (2016). Statistical Yearbook of Bangladesh. **In**: Summary of crop statistics and crop indices. Bangladesh Bureau of Statistics, Ministry of Planning, Dhaka. p. 41.

Berry, S.Z., Uddin, M.R., Gould, W.A., Bisges, A.D. and Dyer, G.D., (1988). Stability in fruit yield, soluble solids and citric acid of eight machine-harvested processing tomato cultivars in Northern Ohio. *J. Am. Soc. Hort. Sci.,* **113**(4): 604-608.

Bhangu, J. S. and sing, S. (1993). Comparative performance of tomato cultivars under rain fed conditions of kandi area (*Punjab Hort*., **33**(1& 2): 123-126.

Bharadwaj, L.M. and Thakur, M.C., (1994). Genotype difference of growth and fruit yield in tomato sub-tropical areas of Himachal Pradesh. *South Indian Hort.,* **42**(3): 147-151.

Bhutani, R. D., Kallo and Pinnata, M. L. (1983). Genetic variability studies for yield and physic-chemical traits of tomato (*Lycopersicon esculentum* Mill). *Haryana J. Hort. Sci.,* **12** (1 and 2):96-100.

Biswas, J. and Malik, S.C. (1989). Days required for flowering and harvesting of some promising cultivars tomato (*Lycopersicon esculentum* Mill). *Environ, Ecol.* 7(4):1003-1095.

Brar, P.S. and Singh, H., (1998). Variability and correlation studies in different varieties of tomato (*Lycopersicon esculentum* Mill.) *Punjab Veg. Grower.*, **33**: 23-26.

Cavicchi, S. and Silveta, E., (1976). Yield in tomato II Multivariate analysis on yield components. *Genetica Agraria.,* **30**: 315-326.

Chernet S, Belew D & Abay F (2014). Performance evaluation and Path Analysis Studies in Tomato (*Solanum lycopersicon L*.) Lines under Humera, Northern Ethiopia Condition. *World J of Agricultural Res* 2(6): 267-271.

Cordova, P.E., Fos, M., Nuez, F., Fernandez, D. and Malvar, R.A. (1991). Number of flower per truss and improvement of yield in tomato. Actas de horticultura, Department de biotechnologia. Universidad Politecnica, Velencia, Spain. 14:73-81.

Das, B. Hazarika, M. H. and Das, P. K. (1998). Genetic variability and correlation in fruit character of tomato (Lycopersicon esculentum Mill). *Ann. Res. Agril.* 19(1):77-80.

Deepa, S. and Thakur, M. C. (2008). Evaluation of diallel progenies for yield and its contributing traits in tomato under mid-hill conditions. *Indian J. Hort.,* 65(3): 297-301.

Devi, C. P., Singh, D. K. and Jain, S. K. (2013). Effect of foliar feeding of micronutrients on growth and yield of chilli (*Capsicum annuum* var. *accuminatum* L.) cultivar Pant C- 3. *Pantnagar J. Res*., **11**(1): 105-111.

Dudi, B.B., Dixit, J. and Pratap, P.S. (1983). Components of viability, heritability and genetic advance studies in tomato. *Agric. Univ. J. Res.*, 13(1):135-139.

Dudi, B.S. and Sanwal, S.K. (2004). Evaluation of potential F1 hybrids of tomato. *Haryan J. Hort. Sci.,* **33**(1&2): 98-99.

Ejaz, M., Rahman, S., Waqas, R., Manan, A., Imran, M. and Bukhari, M. A. (2011). Interaction efficacy of macronutrients and micronutrients as foliar application on growth and yield of tomato. *Int. J. Agro Vet. & Med. Sci*., **5**(3): 327-335.

Engelmann, R. (1982). The relation between maximum rate of photosynthesis and concentration of chlorophyll. Gen Physiol., 12:609-622.

Fatunla, T. (1969). Qualitative characterization of yield components in pure Lines of tomatoes, Proc. Agric. Soc. of Nigeria. 47 (En). Univ. life, Nigeria.

Ghosh, K.P. (2008). Genetic variabity in F_2 segregating population f exotic tomato hybrids. MS Thesis, Dept. of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agric. Univ., Gazipur, Bangladesh. P.32.

Gomez, K. A. and Gomez, A. A. (1984).Statistical procedure for Agricultural research. Jihn Willey and Sons Ltd. New York. pp.28-192.

Gongolee GAK, Osei MK, Akromah R, Nyadanu D & Aboagye LM (2015). Evaluation of Some Introduced tomato cultivars. *Horiz J Agric Food Sci* 1(1): 001-006.

Giovanelli G., Lavelli V., Peri, C. and Nobili S. (1999). Variation in ripening. *J. Sci. Food Agric.*, **79**: 1583–1588

Gulsan, L.,Singh, K.K. and Tiwari. (1991). Performance of some tomato cultivars during summer in Tarai region. *Veg. Sei*., **18**(1): 99-101.

Hatwar, G. P., Gondane, S. U.; Prude, S. M. and Gahukar, O. V. (2003). Effect of micronutrients on growth and yield of chilli. *J. of Soils and Crops.*,**13** (1): 123- 125.

Hazarika, T. K and Phookan, D. B, (2005). Performance of tomato cultivars for polyhouse cultivation during spring summer in Assam. *Indian J. of Hort.* 62(3): 268-271.

Heiser, C. J. (1969). Love Apples. Nightshade: The paradoxical plants. Freeman, San Francisco, CA pp. 53-105.

Hoque, M.S., Islam, M.I. and Rahman, M. (1999). Studies on the preservation of semi-concentrated tomato juice. *Bangladesh J. Agril. Sci*., 26(1): 37-43.

Hossain, M. M. (2003). Comparative morpho-physiological studies of some exotic and local Lines of tomato. M. S. Thesis, Department of Crop Botany. BAU, Mymensingh, pp. 26-28.

Islam, P., Prakash, S. and Singh, A. K. (1999). Variability studies in tomato (*Lycopersicon esculentum* Mill) under sub-humid conditions of Himachal Pradesh. South Indian Hort., 44: 132-134.

Jasmine, J.A.P. and Ramadass, S., (1994). Qualitative evaluation of tomato hybrids and varieties. *South Indian Hort*., **42**(1): 26-28.

Jayprakashnarayan, R.P., (2007). Genetics of yield attributes and resistance to tomato leaf curl virus and bacterial wilt in tomato. *Ph.D Thesis*, University of Agricultural Sciences Bangalore.

Jenkins, J.A. (1948). The origin of the cultivated tomato. *Economic Botany*. **2**: 379-392.

Jitender Kumar, S. Lal, V.K. Batra and Malik., T.P., (2005). Evaluation of tomato Lines for shelf life at ambient room temperature. *Haryana J. Hort. Sci.*, **34** (1-2): 199.

Joshi, A.K., Kumar, A. and Sharma, B.K., (1998b). Evaluation of tomato Lines for horticultural characteristics. *Punjub vegetable grower.*, **33**:21-22.

Kabir, M. E. (2005). Performance of heat tolerant tomato hybrids (Lycopersicon esculentum Mill.) varieties of Bangladesh. MS Thesis, Dept. Hort., Bangabandhu sheikh Mujibur Rahman Agric. Univ., Gazipur, Bangladesh. p.28.

Kalloo. (1989). Tomato (*Lycopersicon esculentum* Mill). *Indian Hort*., 33(1):12-15.

Kaur, G., Jaiswal, S.P. and Kanwar, J.S., (1976). Variability in certain physicochemical characters of tomato. *Ind. Fd. Pack*., **30**(6):5-9.

Khan, I., Hussain, I., Ahmed. M. and Mohammad, S. (2017). Screening of different exotic Lines of tomato (*Lycopersicon esculentum* L.) under the agro climatic condition of Haripur. *Pure Appl. Biol., 6(4):1251-1259.*

Khan, M. A. H. (1981). The effect carbon dioxide enrichment on the pattern of growth and development in rice and mustard. Ph. D. dissertation. Royal Vet. And Agric. Univ., Copenhagen. P.43.

Kumar, R. A, Vijayalatha, K. R, Alagesan, A and Veeraragavathatham, D. (2007). Performance of certain tomato (*Lycopersicon esculentum*) Lines under greenhouse and open conditions in summer. Journal of Ecobiology. **19**(2):105-112.

Kumar K. (2011). Evaluation of superior Lines of tomato (*Lycopersicon esculentum* Mill. MS thesis, Dpt. of Horticulture, Institute of Agric. Sci., Banaras Hindu University, Varanasi. P.45.

Kumar, R. A, Vijayalatha, K. R, Alagesan, A and Veeraragavathatham, D. (2007). Performance of certain tomato (*Lycopersicon esculentum*) Lines under greenhouse and open conditions in summer. *Journal of Ecobiology*. 19(2):105-112.

Kumaraswamy, D. and Madalageri, B.B., (1989). Evaluation of new tomato Lines and their stability for fruits yield. *South Indian Hort*., **37**(4): 220-222.

Kumavat, S. D. and Chaudhari,Y. S. (2013). Lycopene and it's role as prostate cancer chemo preventive agent. *Int. J. of Res. in Phar. and Chem.*,**3**(3): 545-551.

Lakshmi, K and Mani, V. P. (2004). Association and contribution of different characters towards fruit yield in tomato (*Lycopersicon esculentum* Mill.) in north western Hill zone. *Indian J. of Hort*. 62(4): 327- 330.

Lester, G.E. (2006). Environmental regulation of human health nutrients (ascorbic acid, β-carotene and folic acid) in fruits and vegetables. HortScience 41(1), 59-64.

Matiar, R.A.K.M., Hoque, M. and HOSSAIN, M. S.M., (1994). Yield potentiality of some advance tomato Lines compare to local cultivars. *Punjab Veg. Grower.*, **29**: 10-12.

Mittal, P., Prakash, S. and Singh, A.K., (1996). Variability studies in tomato (*Lycopersicon esculentum* M.) under sub-humid conditions of Himachal Pradesh. *South Indian Hort.*, **44**(5-6): 132-134.

Mohammed, M., Wilson, L. A. and Gomes, P. L. (1999). Postharvest sensory and physiochemical attributes of processing and non-processing tomato cultivar. *J. Food Qual.,* **22**:167–182.

Mohanta, A.R. (2005). Effect of nitrogen on yield and yield attributes of tomato Lines. MS Thesis, Dept. Crop Bot. Bangladesh Agric. Univ., Bangladesh. p.45.

Nandi, A. and Singh, D.N. (1991). Performance of Taiwanian tomato varieties in rainy season at keojphore. *Oriss. J. Hort.,* **19** (1&2):11-13.

Nandpuri, K. S., Kunwar, J. S. and Singh, S. (1974). Genetic variability and correlation of some economic characters in tomato. *J. Res. Punjab. Agric. Univ*., 11(3): 242-246.

Naresh, B. (2002). Response of foliar application of boron on vegetative growth, fruit yield and quality of tomato var. Pusa-Ruby. *Indian J. of Hilly Farming*., **15**(1): 109-112.

Naz, F, Haq IU, Asghar S, Shah AS & Rahman A (2011). Studies on growth, yield and nutritional composition of different tomato cultivars in battal valley of district Mansehra, Khyber Pakhtunkhwa, Pakistan. *Sarhad J Agric* 27 (4): 569-571.

Oum, E.S. (1995). Cherry tomato varietal trial. Kasetsart University, Training Report, Thailand. 325-327.

Pandey, A.K. and Rai, M., (2004). Production technology for hybrid vegetables. *National Symposium on Harnessing Heterosis in Crop Plants.*, 13-15 March, Varanasi, India, pp. 130-136.

Pandey, Y.R., A.B. Pun and K.P. Upadhyay, (2006). Participatory varietal evaluation of rainy season tomato under plastic house condition. Nepal Agric. J., 7: 11-15.

Papadolpoulos, A. P and Ormord, D. P. (1991). Plant spacing effect on growth and development of greenhouse tomato. Canadian Journal of Plant Sciences.71: 297-304.

Pathak, S.R. and Mahajan, P.R., (1988). Study on keeping quality of tomato cultivars. Mahatma Phule Krishi Vidyapeeth, Lal-Bangh, Maharashtra., **30**(1): 34-36.

Patil, M.G., (1997). Investigations on genetic improvement and production practices in processing tomatoes (*Lycopersicon esculentum* M.) *Ph. D. Thesis*, University of Agricultural Sciences, Dharwad.

Patil, V. K., Yadlod, S. S., Tambe, T. B., & Narsude, P. B. (2010). Effect of foliar application of micronutrients on flowering and fruit set of tomato (*Lycopersicon esculentum* Mill.) cv. PHULE RAJA. *Int. J. of Agric. Sci*., **6**(1): 164-166.

Patoary, M. M. A. (2009). Genetic diversity and heterosis in heat tolerant tomato. Ph. D. Thesis, Dept. Hort., Bangabandhu Sheikh Mujibur Rahman Agric. Univ., Gazipur, Bangladesh. pp. 19-22.

Phookan, D. B.,Talukder, P., Shadeque, A. and Chakravarty, B. K. (1998). Genetic variability and heriabity in tomato (*Lycopersicon esculentum* mill) Lines during summer season under plastic house condition. *Indian J. Agril. Sci*., 68(6):304-306.

Prema, G, Indiresh, K. M and Santhosha, H. M. (2011). Evaluation of cherry tomato (*Solanum lycopersicum* var. *Cerasiforme*) Lines for growth, yield and quality traits. *Asian J. of Horticulture.* 6(1): 181-184.

Rafique, A. M. and Ahmed, A. (2004). Effect of micronutrient supplement in growth and development of okra (*Abelmoschus esculentus* L. Moench) Bangladesh. *J. of Bot.,* **33**(2): 129-131.

Raghav, M. and Sharma, R. D. (2003). Growth and yield in tomato, okra, vegetable pea cropping sequence as affected by levels and methods of zinc application. *Prog. Hort.,* **35**(1): 96-99.

Ramzan A, Khan TN, Nawab NN, Hina A, Noor T & Jillani G (2014). Estimation of genetic components in F1 hybrid and their parents in determinate tomato (*solanum lycopersicum l.*). *J Agric Res* 52(1): 65-75.

Randhawa, K.S., Saimbhi, M.S. and Gill, B.S., (1988). Commercial evaluation of tomato varieties for processing. *Veg.Sci*., **15**(2) : 181-184.

Ravider Kaur, and Cheema, D.S., (2005). Assessment of quality and biochemical traits of different Lines of tomato. *Haryan J. Hort.Sci.* **34**(3-4): 327-329.

Razzak, H. A, Ibrahim, A, Wahb-Allah, M and Alsadon, A. (2013). Response of cherry Tomato (*Solanum lycopersicum* var. *cerasiforme*) to pruning systems and irrigation rates under greenhouse conditions. Asian Journal of Crop Science. 5(3): 275-285.

Reddy, V.V.P. and Reddy, K. V. (1992). Studies in variability in tomato. South Indian Hort., 40:257-266.

Reddy, M.L.N., G. and Singh, D.K., (1989). Screening of tomato (*Lycopersicon esculentum* M.) germplasm under high temperature environment during summer season in Tarai region. *Indian J.Agri. Res.,* **23**(3): 131-137.

Rehman, F., Khan, S., Faridullah, M. and Shafiullah, M. (2000). Peformance of different tomato cultivars under the climatic conditions of northern areas (GILGIT). *Pakistan J. Biol. Sci.,* 3(5):833-835.

Roy, S. K. (2009). Comparative yield and storage quality of commercial; tomato varieties of Bangladesh. MS Thesis, Dept. Hort., Bangabandhu Sheikh Mujibur Rahman Agric. Univ., Gazipur, Bangladesh. pp. 19-22.

Saimbhi, M.S., Surjan Singh and Cheema, D.S, (2001). Physicochemical characters of exotic varieties of tomato. *Haryana J. Hort. Sci.*, **30**(3&4): 279-280.

Salanke, D. K., Desai, B.B. and Bhat, N.R. (1987). Vegetables and flower seed production. 1st Edn. Agricola Publishing Academy, New Delhi, India. pp. 118-119.

Salam, P. K. (2004). Effect of boron on growth and yield of bean. *Ann. Agric. Res*., **25**(2): 329-332.

Sandoval, V. M., Wood, C. W. and Guertal, E. A. (2002). Tomato leaf Chlorophyll meter reading as affected by variety, nitrogen form and night time nutrient solution strength. J. Plant Nutr. 25(10): 2129-2142.

Schwarz, D. and Karling, H. P. (2001). Allometry to estimate leaf area of tomato. J. Plant Nutr. 24(8): 1291-1309.

Shah AH, S-ul- Munir, N-ul-amin & Shah SH (2011). Evaluation of two nutrient solutions for growing tomatoes in a non-circulating hydroponics system. *Sarhad J Agric* 27(4).

Sharma, S.K. and Rastogi, K.B. (1993). Evaluation of some tomato cultivars for seed production under mid hill condition of Himachal Pradesh. Ann. Agric. Res. 14(4):494-496.

Sharma, N. K and Tiwari, R. S. (1993). Effect of shade on growth contributing characters and factors in relation to yield of tomato cv. Pusa Ruby. Progressive Horticulture. 25: 180-84.

Sheferaw Nesgea, (2001). Evaluation of open pollinated tomato Lines for growth, yield and quality parameters in Eastern dry zone of Karnataka. *M.Sc.* (*Agri*.) *Thesis*, University of Agricultural Sciences, Bangalore.

Shivanand, V.H. (2008). Evaluation of tomato (*Lycopersicon esculentum* M) hybrids under eastern dry zone of Karnataka. M.Sc. (Hort.) Thesis, UAS, GKVK, Bangalore.

Shivkumar, K.C., (2000). Evaluation of tomato hybrids for growth, yield and quality parameters under Bangalore condition. M.Sc.(Hort.)*Thesis*, University of Agricultural Sciences, Bangalore.

Siddique, M. H., Fateh, C., Abbasi, M. and Gandahi, A. (2009). Effect of NPK, micro nutrients and N-placement on the growth and yield of sunflower. *Sarhad J. Agric.*, **1**(5): 46-52.

Singh, D. N., Nandi, A., Tripathy, P., Senapati, N. and lenka, D. (1994). Performance of tomato (*Lycopersicon esculentum* Mill) varieties in autumn under rainfed conditions. *J. Environ. Ecol*., 12(4): 949-955.

Singh, D. K, Lal, G and Shukla, G. S, (2001). Performance of indeterminate hybrids of tomato during summer in Tarai conditions of Uttar Pradesh. Scientific Horticulture. 7:93-98.

Singh AK, Bhalla SK and Verma S (2002a). A note on the variability in tomato (*Lycopersicon esculentum* Mill.). Himachal Journal of Agricultural Research, 19: 98-100.

Singh, V. A. K, Bhatia, D, Duhan, D, Majoka, M and Amit Singh. (2013). Performance of different tomato hybrids under greenhouse conditions. Crop Research. Hisar.46(1/3): 188-191.

Singh, T., Singh N., Bahuguna, A., Nautiyal, M. and Sharma, V.K. (2014). Performance of Tomato (Solanum lycopersicum L.) Hybrids for Growth, Yield and Quality Inside Polyhouse under Mid Hill Condition of Uttarakhand. *American J. of Drug Discovery and Development, 4: 202-209.*

Sucheta, S. M. S, Dhaliwal and Cheema, D. S. (2004). Evaluation of tomato hybrids for quality attributes. *Haryana J. of Hort. Sci.*. 33 (3&4):305-306.

Thangam, M and Thamburaj, S. (2008). Comparative performance of tomato varieties and hybrids under shade and open conditions. Indian Journal of Horticulture. 65(4): 429-433.

Toor, R. K. and Savage, G. P. (2006). Changes in major antioxidant components of tomatoes during post-harvest storage. *J. Food Chem.*, **99**: 724–727.

Wahundeniya, W. M. K. B., Ramanan, R., Wicramathunga, C and Weerakkody, W. A. P. (2013). Comparison of growth and yield performances of tomato varieties under controlled environment conditions. Ann M Veneman Department of Agriculture. 8, 251-262.

Yadav, M., Singh, D. B., Chaudhary, R. and T. A. Reshi, T. A. (2006). Effect of boron on yield of tomato. *Plant Archives*, **6**(1): 383-384.

Yildirim, E. (2007). Foliar and soil fertilization of humic acid affect productivity and quality of tomato. *Soil and Plant Sci.*, **57**: 182-186.

APPENDICES

Appendix I. Results of mechanical and chemical analysis of soil of the experimental plot

Mechanical analysis

Constituents	Percent
Sand	32.45
Silt	61.35
Clay	6.10
Textural class	Silty loam

Chemical analysis

Soil properties	Amount
Soil pH	6.15
Organic carbon (%)	1.32
Total nitrogen (%)	0.075
Available P (ppm)	19.5
Exchangeable K (%)	0.2

Appendix II. Monthwise average recorded data

Month	*Air temperature (°c)		*Relative Humidity (%)	Total Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
October, 2016	26.5	19.4	81	22	6.9
November, 2016	25.8	16.0	78	00	6.8
December, 2016	22.4	13.5	74	00	6.3
January, 2017	24.5	12.4	68	00	5.7
February, 2017	27.1	16.7	67	30	6.7
March, 2017	31.4	19.6	54	11	8.2

* Monthly average

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka –1212

Appendix III. Basal fertilizer dose

Sl. No.	Fertilizers/ Manures	Dose	
		Applied in the field	Quantity/ha
1.	Urea	5.5 kg	550 kg
2.	TSP	4.5 kg	450 kg
3.	MOP	2.5kg	250 kg
4.	Cow dung	100 kg	10 ton

Appendix IV. Analysis of variance of the data on plant height as influenced by different lines of tomato

Source of variation	df	Mean square of plant height at different days after transplanting (DAT)		
		30	45	60
Replication	2	0.54	3.17	76.07
Tomato Lines	9	124.21*	170.08*	1215.00*
Error	18	5.07	56.88	92.35

*Significant at 5% level of significance

Appendix V. Analysis of variance of the data on leaves per plant of tomato as influenced by different tomato lines

Source of variation	df	Mean square of leaves plant^{-1} at different days after transplanting (DAT)		
		30	45	60
Replication	2	0.23	5.08	3.84
Tomato Lines	9	5.28*	62.25*	153.04*
Error	18	0.93	9.24	18.47

*Significant at 5% level of significance

Appendix VI. Analysis of variance of the data on leaf area per plant of tomato as influenced by different tomato lines

Source of variation	df	Mean square of leaf area plant^{-1} at different days after transplanting (DAT)		
		30	45	60
Replication	2	8.86	297.97	1264.09
Tomato Lines	9	153.64*	5382.89*	19539.17*
Error	18	8.52	403.90	729.53

*Significant at 5% level of significance

Appendix VII. Analysis of variance of the data on foliage coverage of tomato as influenced by different tomato lines

Source of variation	df	Mean square of foliage coverage at different days after transplanting (DAT)		
		30	45	60
Replication	2	2.34	78.41	3.99
Tomato Lines	9	60.55*	151.41*	159.06*
Error	18	16.77	33.15	53.28

*Significant at 5% level of significance

Appendix VIII. Analysis of variance of the data on length of internode as influenced by different tomato lines

Source of variation	df	Mean square of length of internode at different days after transplanting (DAT)		
		30	45	60
Replication	2	0.280	0.028	1.254
Tomato Lines	9	0.650*	0.935*	1.176*
Error	18	0.059	0.215	0.200

*Significant at 5% level of significance

Appendix IX. Analysis of variance of the data on stem diameter of tomato as influenced by different tomato lines

Source of variation	df	Mean square of stem diameter at different days after transplanting (DAT)		
		30	45	60
Replication	2	0.007	0.005	0.009
Tomato Lines	9	0.021*	0.065*	0.241*
Error	18	0.007	0.011	0.022

*Significant at 5% level of significance

Appendix X. Analysis of variance of the data on branches per plant of tomato as influenced by different tomato lines

Source of variation	df	Mean square of branches per plant at different days after transplanting (DAT)		
		30	45	60
Replication	2	0.028	0.038	0.078
Tomato Lines	9	0.234*	0.557*	0.682*
Error	18	0.004	0.063	0.125

*Significant at 5% level of significance

Appendix XI. Analysis of variance of the data on clusters per plant, flowers per cluster, and fruits per cluster of tomato as influenced by different tomato lines

Source of variation	df	Mean square of		
		Clusters per plant	Flowers per cluster	Fruits per cluster
Replication	2	0.06	0.13	0.004
Tomato Lines	9	3.91*	68.32*	33.25*
Error	18	0.14	4.23	0.43

*Significant at 5% level of significance

Appendix XII. Analysis of variance of the data on days to 1st flower initiation, days of harvesting of first fruit, flowers per plant, fruits per plant and fruits set percentage of tomato as influenced by different tomato lines

Source of variation	df	Mean square of				
		Days to 1st flower initiation	Days of 1st fruit harvest	Flowers per plant	Fruits per plant	Fruits set percentage
Replication	2	3.03	6.56	7.51	8.56	11.80
Tomato Lines	9	30.76*	54.82*	248.76*	213.47*	503.59*
Error	18	1.48	8.80	30.04	2.32	9.66

*Significant at 5% level of significance

Appendix XIII. Analysis of variance of the data on days to individual fruit weight, fruit length, fruit diameter, fruit yield plant^{-1} and fruit yield of tomato as influenced by different tomato lines

Source of variation	df	Mean square of				
		Individual fruit weight	Fruit length	Fruit diameter	Fruit yield plant^{-1}	Fruit yield
Replication	2	295.63	0.19	0.02	0.02	4.22
Tomato Lines	9	591.04*	0.32*	0.63*	0.67*	1211.35*
Error	18	37.42	0.27	0.35	0.03	35.03

*Significant at 5% level of significance

Appendix XIV. Analysis of variance of the data on days to total soluble sugar, pH, chlorophyll content on leaf, vitamin-C content on fruit, pericarp thickness and shelf life of tomato as influenced by different tomato lines

Source of variation	df	Mean square of					
		Total soluble sugar	pH	Chlorophyll content on leaf	Vitamin-C content on fruit	Pericarp thickness	Shelf life
Replication	2	0.27	0.000	1.96	0.79	0.18	0.76
Tomato Lines	9	0.60*	0.143*	30.39*	53.44*	4.83*	28.00*
Error	18	0.08	0.001	15.99	0.37	0.09	1.24

*Significant at 5% level of significance