EVALUATION CORRELATION AND PATH ANALYSIS IN TOMATO

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ABSTRACT

An Experiment was carried out at the research field of vegetable division, Horticulture Research Centre. Bangladesh Agricultural Research Institute, Joydebpur during the period from October 2013 to February 2014. The experimental treatment consisted of five genotypes of tomato namely GPT 0009, GPT 0011, GPT 0015, GPT 0017 and BARI Tomato 3 (check variety). The experiment was laid out in Randomized Complete Block Design with three replication. Genotypic variation for plant height , days to first flowering, days to 50% flowering, days to first harvest, harvest duration, number of fruits per plant, individual fruit weight, pericarp thickness, number of locules, TSS%, fruit length, fruit breadth, fruit yield per plant, fruit yield per plot, fruit yield per ha, fruit shelf life, number of seeds per fruit were significant. The result revealed that the genotype GPT 0009 and GPT 0011 showed better performance compared to the other genotypes. Among the genotypes, the tallest and the shortest plant was produced in GPT 0011 and GPT 0017. Fruit yield per plant was positively correlated with fruit diameter, single fruit weight and yield per hectare suggesting that selection based on these characters would result better genotypes with higher yield. Path coefficient analysis study revealed that positive direct effect for fruit diameter, individual fruit weight, fruits and fruit per plant on yield per plant and selection based on these characters would be more reliable for yield improvement.

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LIST OF ABBREVIATIONS

AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
SRDI	Soil Resource Development Institute
BBS	Bangladesh Bureau of Statistics
FAO	Food and Agricultural Organization of United Nations
cm	Centi-meter
CV	Coefficient of Variance
SE	Standard Error
Df	Degrees of freedom
DMRT	Duncan's Multiple Range Test
Biol.	Biological
etc.	Electra
HI	Harvest Index
i.e.	*id est* (L), That is
Kg	Kilogram (s)
m^2	Meter squares
t ha^{-1}	Ton per hectare
SAU	Sher-E-Bangla Agricultural University
Sci.	Science
viz.	Namely
%	Percentage
^0C	Degree centigrade
@	At the rate of

CHAPTER I

INTRODUCTION

Tomato (*Solanum lycopersicum)* is a well-produced and most popular vegetable in Bangladesh and all over the world. Tomato is one of the important Solanaceous vegetable crops grown in throughout of the world having the chromosome number 2n = 24 (Jenkins, 1948). The genus *lycopersicum* include nine species out of which only two are cultivated, *Solanum lycopersicum* (common tomato) and *Solanum pimpinellifolium* Mill (currant tomato) (Rashid, 1999).

Now-a-days tomato is grown in most of the countries around the globe except the colder regions (Hannan *et al.* 2007). Tomato being a nutritional crop is considered as an important source of vitamin A and C and minerals which are important ingredients for table purpose, samba preparation, chutney, pickles, ketchup, soup, juice pure etc (Sekhar *et al.* 2010). Because of its versatile use as fresh and in processed form demands are increasing. Tomato is a universally popular vegetable. It tops the list among the canned vegetable (Rashid, 1999). As a matter of fact, the number of ways it can be used to improve the flavor and character of other foods is endless. Therefore, its production needs to be increased providing good tomato varieties using genetical manipulation.It is an important fruit vegetable and second most important vegetable crop after potato that is widely grown and consumed worldwide. Due to its diverse use, nutritional value and good taste, it has become one of the most important and popular vegetable in Bangladesh. The area and production is increasing day by day. Tomato thrives at much latitude and under a wide range of soil types and method of cultivation (Villareal, 1980). Optimum fruit setting requires a night temperature of 15 to 20°C (Charles and Harris, 1972; Schiable, 1962). Therefore, tomato growing in Bangladesh is restricted only within winter months.It is rich in calcium, iron vitamin A, B, C etc. It contains a number of nutritive elements almost double

compared to apple and shows superiority with regard to food values. It is consumed as a raw salad, cooked or processed food item like sauce, ketchup, jam, jelly, pickles soup etc. Due to its palatability and vitamin content its demand in general increasing day by day, while its production is not enough from the requirements.

Very recently exotic hybrid varieties are being introduced due to their high yield potentiality but seed costs of those hybrid varieties are very high. Moreover, due to unique nature of hybrid variety, the tomato growers need to buy seeds every year. The main constraints of tomato production are pest and disease incidence, adverse climatic conditions, absence of high yielding varieties. Therefore we need to generate high yielding tomato genotypes suitable for our environment as well as our country. Yield contributing components are interrelated with each other and influenced by the environmental conditions.

A large number of tomato varieties are grown in Bangladesh. Most of them lost their potentiality due to genetic deterioration, diseases and insect infestations. So, in order to increase the tomato production in Bangladesh, it is very much essential to find out the varieties capable of growing round the year, higher yield and resistant to disease and insect pests. Recently various research organizations have developed a few high yielding and disease, insect resistant varieties but these do not show better performance throughout the year.

Tomato is a highly perishable fruit and rapidly deteriorates after ripening. Nutritive value of the fruit is an important aspect of quality in tomato. It is a nutritious and delicious vegetable used in salad, soups and processed into stable products like ketchup, sauce, pickles paste, Chutney, and juice. Lycopene in tomato is a powerful antioxidant and reduces the risk of prostate cancer.

The yield of tomato in Bangladesh is not satisfactory enough in comparison to other advanced tomato growing countries (Sharfuddin and Siddique 1985). In Bangladesh, approximately 15378.38 ha of land is under tomato cultivation and

produce approximately 103000 metric tons of tomato. The yield of this crop in our country is 46.72 t /ha; which is quite low compared to the other countries, like Japan (62.99 t/ha, Brazil (54.55 t/ha), Italy (53.22 t /ha) and USA (66.57 t/ha) (FAO, 2002). To meet nutritional demand of population, it is highly important to increase the yield of tomato per unit area of land; increase of production depends upon many factors such as the use of improved varieties, proper management and awareness about improved production technologies. So, using different types of techniques such as nuclear techniques, fertilizer management, proper spacing, applying plant growth regulator, synthetic mulching, natural mulching and breeding methods may improve production level and quality under the existing environmental conditions.

However, Bangladesh Agricultural Research has Institute (BARI) has released 17 open –pollinated and eight hybrid tomato varieties so far (some of these already obsolete) and several leading seeds companies are also supplying some tomato varieties and some seeds of these tomato varieties are being imported from different countries. On the other hand, most of these varieties are susceptible to viral and wilt diseases and bears poor shelf life. But, growers are interested to grow pest and disease resistant tomato varieties having good shelf life.

The study was conducted to achieve the following objectives:

1. To evaluate some morphological attributes and yield of tomato genotypes;
2. To study correlation of yield attributing characters with yield in tomato; and
3. To select the better genotypes of tomato in respect of quality of fruit and y

CHAPTER II
REVIEW OF LITERATURE

Tomato is one of the most important vegetable crops in Bangladesh and received much attention to the researchers throughout the world. Effect of genotypes has different modifying influences on growth, yield and yield contributing characters of winter tomato. Some of the available research works in this connection have been reviewed with the hope that these may contribute useful information to the present study. In this chapter growth, yield, yield components and correlation, path analysis in tomato have been reviewed.

An experiment was conducted at Wooster, USA with the hybrid processing tomato lines Ohio Ox 38 (Berry *et al.* 1995). It was observed that the yields of this variety in 1992 and 1993 were higher (70.3 and 80.4 t/ha, respectively) compared to other cultivars.

A field trial was conducted in Jordan in 1993 to study the yield of 13 local and introduced open pollinated tomato cultivars and to compare the yield of 3 common hybrids (Maisara F_1 898F, and GS 12 F) in relation to seasonal distribution of marketable and unmarketable yield and fruit number. The cultivars varied in their marketable yield during the harvesting period (10 weeks from 22 June 1993). The results indicated that the cultivars Rio Grande, Nagina and T2 improved were superior to the hybrids (Ajlouni *et al*. 1996).

A significant range of variation for number of fruits per plant among 11 varieties of tomato was reported by Fatunla (1969).

Nandapuri *et al.* (1977) studied variability for number of fruits per plant.

Ahmed (1987) and Das *et al.* (1988) observed wide range of genotypic variation. Genotypic co-efficient of variation was very high for weight of fruit in three

tomato varieties namely, EC 32099, HS 107 and Columbia, respectively, indicating high degree of variability as studied by Dudi *et al*. (1983).

Ahmed *et al*. (1986) studied eight F-7 line of tomato at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh. All the lines had shown indifference in plant height and fruit size. Fruit number had shown significant difference among the varieties. The line 0014-60-3-9-1-0 had highest number of fruit (56.05 ton/ha) followed by 0013-52-10-27-32-0 (50.00 ton/ha).

An experiment with some tomato varieties was conducted by Thomas *et al.* (1979). They reported that Dwarf Money was the highest yielder (50 t/ha) having the longest fruiting period ,the cultivar V.687 and Pare-5 also gave higher yields than gamed, Punjab Chhuhara and Roma.

An investigation was carried out by Sharker and Hoque (1980) to compare the yielding ability and to assass the distinguishing external morphological characters of seven varieties of tomato during te petiod from October, 1977 to March 1978. The varieties were Master No. 2, Ramulas, Roma, Rambo, Marmade, Bigo and world Champion. They reported that prooducd the highest yield (28.38 t/ha) followed by Bigo (24.63 t/ha), World Champion (23.38 t/ha), Master No 2 (21.98 t/ha), Roma (21.03 t/ha), and Ramulas (20.21 t/ha).

Arun *et al.* (2004) conducted a field experiment at solan, Himachal Pradesh, India during 2000-2001 with 37 tomato genotypes. The higher coefficient of variation (genotypic and phenotypic) was observed for fruit shelf life. Moderate genetic gain was observed for fruit per cluster, fruit length, fruit breadth, stem and scar size, number of locules per fruit, whole fruit firmness, ascorbic acid content and plant and plant height indicating additive gene effects on low heritability and low genetic gain was observed for pericarp thickness. Moderate heritability and low genetic gain for harvest duration suggests the presence of dominance and epistatic effects. High heritability combined with high genetic gain was observed for shelf

life indicating additive gene action, the genotype ‘FT-5’ produced the highest yield, plant height, harvest duration and shelf life of fruits, ‘ L05635’ produced the highest number of fruits per plant, ‘ET-13’ and ‘A-2’ produced the highest fruit length and fruit breadth, ‘ET-13’ and ‘A-2’ produced the highest stem and scar size were ‘EC-378632’ gave the highest fruit firmness. ‘EC-114375’ produced the highest number of locules per fruit and total soluble solids content correlation analysis showed that yield per plant was positively and significantly correlated with average fruit weight, fruit length, plant height and harvest duration.

Bhangu and Singh (1993) conducted a field trial with some tomato cultivars (Punjab Kesari, Punjab chhuhara, Punjab Tropic, PNR-7, S-12, Pusa Ruby and the Hybrid THI-2312) in 1990 and 1992. Mean annual yield was highest in Punjab Kesari (123), Punjab Tropic produced the largest fruits (66.69 g).

Biswas and Mallik (1989) carried out an experiment with 18 cultivars with the local cultivar Parharkuchi as control. They reported that, from sowing to first flowering a minimum of 66 days was necessary for CV selection-6, whereas CV Murutham took a maximum of 83 days. A maximum of 74 days was needed to CV Pusa hybrid–l and hybrid -10.

Husain (1970) reported the performance of four varieties of tomato at the Horticulture farm of BAU, Mymensingh during the winter season of 1968-69. In this study it found that Indian River, Marglobe and Gloriana produced comparatively shorter internodes than the Bulgarian variety. The rate of terminal growth was retarded in all the varieties except Bulgarain where the growth the growth continued. He further stated that the fruit of the variety Marglobe were solid, quite firm with thick walls which attained red coloration at the ripening stage, whereas the fruits of the Bulgarian variety were less firm showing four depressions with walls and attained a medium coloration at the ripening stage.

Hussain and Ahmed (1973) conducted varietal trial at the Bangladesh Agricultural Research Institute, Joydebpur. There were six tomato varieties namely Roma, Bulgaria, USA, Anobik, Oxheart and Sanmarzano. They observed that cv. Sanmarzano was the highest yielder (28.98 t/ha), followed by Oxheart, Roma, Bulgaria and Anobik.

In an experiment conducted in Brazil, Gomes *et al*. (1970) found that the cultivar Floradel was slightly superior to the other cultivars in respect of yield and number of fruit.

In another study in Ghana, Nsowah (1970) obtained significant differences in period requirement for floral initiation and anthesis, fruit maturity, plant height, number of flowers and fruits in the first 3 clusters and the yield .he also observed that seven varieties were high yielding (32-34 t/ha) but none was suitable for processing.

In India, Bhutani *et al*. (1983) conducted a varietal trial of 84 genotypes and showed that Set -23, Growthens globe, Punjab Chhuhara, VS 11-2, Pusa Red Plum and HS 102 were the best for number of fruits per plant.

In Japan, it is suggested by Lijima *et al*. (1976) that the optimum harvesting date for processing tomatoes is 55-60 days from flowering. While working with 43 tomato cultivars in the United States of America.

In Nepal, an experiment was conducted by Lohar and Peat (1988) to study the floral characteristics of heat–tolerant and heat sensitive tomato cultivars at high temperature. They observed that flowering was earliest in Pusa Ruby at $28\text{-}23^0$c (day/night) and latest in CL-1131 at $15/10^0$c. They also indicated that cv. CL-1131 was suitable for cultivating at high temperature and producing an earlier crop. Cultivar Pusa Ruby produced fewer flowers and fruits at high temperature than CL-1131 but not in $15/10^0$c regime.

In Pakistan, Baluch and Razvi (1973) worked with tomato varieties namely Gloriana, Mrglobe, Delicious, Rutgers, Beefsteak and Peshawari. They reported that Ruters performed best and yielded 3-7 times more than the local peshawari.

In Pakistan, Hossain *et al*. (1973) reported that Roma V.F. was the highest yielding among the 8 long fruited tomato varieties grown in 3 seasons at Lyallpur with an average yield of 22.10 t/ha and T-43 was the best among the 9 large fruited varieties with an average yield of 22.11 t/ha.

In performance trial of seventeen varieties of tomato in the Agricultural Research Institute's farm at Joydebpur, Hoque *et al*. (1975) reported that only five varieties namely. Oxheart, Sinkurihara, l-7, Marglobe, and Bulgaria gave promising yield. In subsequent study with these five varieties, they found that Oxheart, Sinkurihara were similar in respect of yield and both of them gave better yield the other three varieties .they further stated that the plants of the variety Oxheart were tallest (49") and Bulgaria was the shortest (35"). Bugaria produced highest number of branches (912.25) and fruits (23). Sinkurihara and Oxheart produced the large sized fruits whereas Bulgaria produced the small sized fruits (2.19 oz) and on average produced 37.10 t/ha of fruits.

In USA Jones *et al*. (1980) worked with two varieties of tomato namely, Royal red cherry and Short Red Cherry. They reported that both varieties were indeterminate type. The Royal Red Cherry's clusters bore 612 spherical, smooth fruits 3.1 to 3.5 cm in diameter and the short Red Cherry's bore 6-8 fruits 2 to 2.5 cm in diameter.

Jiregna Tasisa Dufera (2013) were evaluated for agronomic performances, lycopene variability and some quality parameters to identify the genotypes having high yielding and better quality performances. The study was conducted under Mizan agro-ecology (Southwestern Ethiopia) on Mizan-Tepi University trial field during September 2011 to May 2012 using Randomized Complete Block Design with three replications. Analysis of variance showed highly significant differences

among the genotypes (P<0.0001) for all characters evaluated. The genotypes Roma VF, Cochoro/Pace setter), Pirson, Melkashola/Red pear and Fetan/Picador showed over all superior yield and quality performances to the other genotypes, thus they could be recommended as promising varieties for production in the area. Higher genotypic and phenotypic coefficients variation values were recorded by the characters fruit clusters per plant, nodes on main stem, fruits per plant, yield per plant and lycopene content, indicating the presence of variability among the genotypes and the scope to improve these characters through selection. In general, the result indicates the presence of enough variability among the genotypes to select parents with desirable performances and combine with varieties having better lycopene contents for further genetic improvement.

Jitender *et al*. (1989) found that fruits of 11 accessions were harvested at the pink stored in paper bags for 12 days. An Assessment was then made of their shelf life. The lowest physiological weight loss (PWL) was noted for sel-18 and suffered the least decay loss and total loss. Total soluble solids content acidity and ascorbic acid content did not vary to any great extent between accessions and there was no association between these characters and shelf life.

Khalid (1999) conducted an experiment with two winter (Ratan and Bahar) and three summer (Binatomato-2, Binatomato-3 and E-6) varieties of tomato during the winter season of 1998-1999 at the Horticulture Farm, BAU, Mymensingh. He observed that the highest yield per plant was obtained from Binatomato-2 (1.74 kg), followed by Binatomato-3 (1.67 kg). But the yields of these varieties were statistically similar to each other.

Mihalache *et al.* (1981) in Rumania worked with the performance of some processing tomato line planted in different methods, five lines under transplanting and 3 lines under direct sowing were compared with the standard variety ‘Heinz 1370’ for productivity and fruit quality. Under transplanting, 4 out of lines out yielded variety producing 55.1-63 t/ha, line

Nieuwhof *et al*. (1997) reported that on the selection of tomato cultivars for cultivation under glass with lower energy requirements, the effects of temperature (10, 14 and 18) were studied on growth and development of 8 indeterminate cultivars. Plant was harvested at 4 dates varying from 60 to 132 days after sowing. At 10^0c growth was slow while at 18^0c the highest growth rates and earliest fruit formation were recorded. This implies that selection of cultivars adapted to low temperature regimes on the basis of genotypic differences in relative growth rate and underlying morphological and physiological components is not feasible and reproductive characters must be considered.

Phookan *et al.* (1995) studied 29 genotypes of tomato in relation to growth and found "Vaishali" cultivar being the highest yielder.

Plant height has been found to vary from variety to variety and also among different groups such as determinate, indeterminate type. In an experiment with 20 varieties of tomato in Ghana Nsowah (1970) and Norman (1974) observed significant differences between cultivars for plant height.

Prasad and Prasad (1979) and Dudi *et al.* (1983) studied variability for number of fruits per plant. Highest value for number of fruits per plant was recorded in EC 32099, HS 102, HS 107 and Columbia respectively.

Pujari *et al*. (1995) studied variability for 8 yield component characters of tomato and observed high genotypic and phenotypic co-efficient of variation for average fruit weight.

Rashid *et al.* (2000) carried out an experiment to evaluate thirty seven tomato varieties or lines for resistance to bacterial wilt in the sick bed in replicated trial. He observed that, 26, 66, 33.33 and 30% incidence of wilt in BARI Tomato-4, BARI Tomato-6 and BARI Tomato-10 respectively.

Reddy and Reddy (1992) estimated phenotypic and genotypic variances, phenotypic and genotypic co-efficient of variation for yield and quality traits in

139 tomato varieties. They observed considerable variation for individual fruit weight ranged from 1.25 g to 158.57g.

Rupa *et al*. (2004) conducted a field experiment to investigate the effect of different environments on the performance of 30 tomato genotypes during 1996-97 in Uttaranchal, India. The environment were: E1, N:P:K at 0:0:0 kg/ha, E2, N:P:K at 100:60:60 kg/ha, E3, N:P:K at 200:120:120 kg/ha, E4, N:P:K at 300:180:180 kg/ha. The parameter evaluated was plant height. Days to 1st harvest after transplanting, number of marketable fruit /plant, total soluble solids content and ascorbic acid content. The lowest values were obtained in E1. The values of yield components increased with increasing nutrients in the environment up to the nutrients rates in E3. E3 was the most suitable environment for maximizing the yield potential of the genotypes. The cultivars Rupali and Set-7 produced the highest marketable yield under E3 and E4. While sungro-490 gave the best performance under E1. Maitri showed the best performance among the cultivars under E2 cultivars Rupali and plant T-3 were the most widely adopted among the genotypes good yield in all environments.

Sharma and Rastogi (1993) studied variability of seven characters in tomato and observed significant variation for number of fruits per plant. They also reported high genotypic coefficient of variation for number of fruits per plant.

Shiferaw *et al*. (2003) conducted experiment with 13 open pollinated tomato genotypes. NS-101 had the highest total soluble solids (5.13 brix) followed by NS-113 (5.10 brix) and Hissar Anmol (5.00 brix). Ascorbic acid content was highest (28.51 mg/100) in Arka Abha followed by Arka Maghali and Hissar Anmol (28.31 and 26.52 mg/100 ml. respectively). Ascorbic acid content was low in Arka Ahuti (19.77 mg/100 ml), followed by Arka Saurabh (20.36 mg/100ml) and NS-112 (20.81 mg/100ml). Shelf life for breaker stage was longest in NS-113 (31.67 days) followed by Arka Vikas and PKM-1 both (26.67 days). Shelf life was in shortest

(14.83 days) in Hissar Anmol. In the red fruit stage , Shelf life longest in NS-101 (20.17 days) followed NS-112 and NS-113 (18.17 and 16.83 days, respectively) physiological weight loss in the red fruit stage was highest in NS-112 (42.93%) and lowest in Arka Maghai (95.58%).

Shravan *et al.* (2004) carried out an experiment in Faizabad, Uttar Pradesh, India during 2001-02 of 30 tomato genotypes. The number of fruits per plant had significant and positive correlation with fruit yield per plant whereas fruit acidity had significant and positive correlation with number of locules per plant. Average fruit weight was significantly correlated with physiological weight loss.

Sidhu and Singh (1989) from their observation suggested that the maximum genetic improvement would be possible by genetic variability for number of fruits.

Singh *et al*. (1997) derived information on genetic variability, heritability and yield correlations from data on 14 agronomic and yield-related traits in 23 genotypes of tomato. They concluded that based on heritability and genetic advance values, effective selection may be made for fruit weight and number of fruits plant-1as fruit yield showed strong positive correlation with number of fruits plant-1 and number of fruits cluster-1. They recommended that number of fruits plant-1 is the most important character for consideration in a selection program for improvement of yield.

Singh *et al.* (2002) studied variability of 92 genotypes of tomato with regards to number of fruit clusters per plant in India during winter Season 2000-2001.They reported that the high genotypic and phenotypic variation was found for number of fruit clusters per plant.

Sonone *et al.* (1986) studied genotypic and phenotypic variability of different characters of tomato and found the highest genetic variation for fruit number per plant.

Correlation analysis in tomato revealed that per cent fruit set, number of primary branches, number of fruits per plant, average fruit weight, total soluble solids, fruit length, fruit firmness, number of flower trusses per plant and pericarp thickness were positively and significantly associated with yield per plant. Path analysis revealed that average fruit weight had the high positive direct effect on yield per plant followed by number of fruits per plant. Traits viz., fruit diameter and fruit shape, fruit index had negative direct effect on fruit yield per plant. Most of the other traits had indirect effect via fruit weight, fruits per plant, fruit diameter and fruit shape index. Hence, these characters should be given more weight age in selection programme of high yielding genotypes in tomato (Khapte and Jansirani, 2014).

Correlation and path analysis were carried out in 67 tomato genotypes using growth, earliness, quality and yield characters. The results indicated the inverse relationship between growth and earliness characters but strong association between growth and yield characters. Total yield per plant was positively and significantly associated with early yield per plant, equatorial diameter of the fruit, fruit volume, average fruit weight, polar diameter of the fruit, number of fruits per plant, per cent fruit set, stem girth at 90 DAT, number of locules per fruit, plant height at 60 DAT, pericarp thickness and number of seeds per fruit. Total yield per plant was negatively and significantly associated with number of flowers per cluster and number of fruits per cluster. Path analysis revealed that early yield and average fruit weight had high direct positive effects on total yield. Hence, direct selection for early yield and average fruit weight is suggested for yield improvement (Prashanth *et al.* 2008).

Ghosh *et al.* (2010) studied to measure variability, character association and path coefficient analysis. Analysis of variance for each trait showed significant differences among the genotypes. Very little differences were observed between phenotypic coefficients of variation (PCV) and genotypic

coefficients of variation (GCV) for the traits days to first flowering (pcv=9.21, gcv=7.82), fruit length (pcv=17.14, gcv=14.84) and fruit diameter (pcv=17.10, gcv=14.92). High heritability (>50%) was observed for all the yield contributing characters except flowers per cluster (47.83%). High heritability associated with high genetic advance was observed for fruit clusters per plant (105.11), fruits per plant (103.43), branches per plant (34.49), fruits per cluster (47.43), individual fruit weight (77.73) and fruit yield per plant (108.25). Selection for such traits might be effective for the fruit yield improvement of tomato. Significant positive genotypic and phenotypic correlation was observed between plant height at first flowering, flowers per plant, fruits per cluster, fruit clusters per plant, fruits per plant with fruit yield per plant. Fruits per plant showed the highest positive direct effect (1.096) on fruit yield per plant followed by individual fruits per plant (0.674). Direct selection may be executed considering these traits as the main selection criteria to reduce indirect effect of the other characters during the development of high yielding tomato variety.

Haydar *et al*. (2007) conducted an experiment in genetic parameters, character association and path coefficient analysis between yield and yield contributing characters of different tomato genotypes. The genotypes exhibited a wide range of variability for all the traits studied. The traits were also found to be highly heritable. High genetic advance as percentage of mean was exhibited for fruit weight/plant followed by number of fruits in three cluster/plant and number of flowers in three clusters/plant. Fruit yield had high positive rp and rg with total number of fruits at harvesting period and number of fruits in three clusters/plant. Plant height at flowering, number of flowers in three clusters/plant, days to flowering and total number of fruits at harvesting period also contributed yield directly. The results indicate that for increasing yield, selection should be based on plants bearing more fruits of larger size and weight.

Heterogeneous landrace populations are important sources of genetic variation and are utilized for agronomic and genetic improvement of the crop in plant breeding programs. Therefore, thirty tomato landraces collected from North West of Iran with three commercial cultivars “Korall, Fauna and Peto Early CH” were studied in completely randomized design in four replications at the Kahriz Station of Agriculture and Natural Resources Research Center of West Azerbaijan. Analysis of variance has shown the significant difference among genotypes for all the evaluated characters. The highest and lowest of heritability were observed for number of seeds per fruit and number of flowers per inflorescence respectively. In principal component analysis, the first five components clarified 77% of total variations in tomato germplasm. These five components were entitled fruit pH, yield, vegetative growth, fruit size and fruit maturing respectively. In component yield, characters of fruit weight and fruit diameter had high positive coefficients.

Hidayatullah *et al*. (2008)Thirty six tomato genotypes, including cultivar, were evaluated at National Agricultural Research Centre, Islamabad, during summer, 2002 and 2003 to estimate the nature and magnitude of genetic variability based on days to first harvest, number of pickings, plant height, number of fruit plant-1, fruit weight plant-1, fruit size, single fruit weight, number of locules, pericarp thickness, TSS, fruit pH, seeds fruit-1 and 1000 seed weight. A wide range of variation was observed among the characters studied which have a great interest for tomato breeders. Heritability for (broad sense) ranged from 51.8 to 99.8 % in 2002 and from 86.0 to 99.9 % in 2003. Single fruit weight gave the highest heritability during 2002, however, it was at maximum for days to first harvest during 2003. Fruit weight plant-1showed high and positive genotypic and phenotypic correlation with number of picking and with number of fruits plant-1, thus indicating that these traits were the most important yield components. On

the basis of performance and keeping in view the selection criteria observed in the present study, 14 genotypes were identified for future testing under wide range of environments.

Islam *et al*. (2010) determined to find out the inter relationship among the characters studied. Yield per plant was found highly significant and positively correlated with flowers per plant, fruits per plant, fruit length, fruit diameter and individual fruit weight which indicated that yield could be increased by improving a traits. In order to obtain a clear picture of the inter relationship between yield per plant and its components, direct and indirect effects were measured using path coefficient analysis. Fruits per plant showed the highest positive direct effect (0.980) on yield per plant followed by individual fruit weight (0.958). On the other hand, the highest negative direct effect on yield per plant showed by days to first flowering (-0.277) followed by fruit length (-0.141). The characters showed high direct effect on yield per plant indicated that direct selection for these traits might be effective and there is a possibility of improving yield per plant through selection based on these characters. Residual effect was considerably low (0.183) which indicated that characters included in this study explained almost all variability towards yield.

Monamodi *et al*. (2013) carried out using six determinate tomatoes at Sebele Agricultural Research Station, during 2010/11 season. The objectives of the experiment were to; (1) determine the correlation among the components that explain variation in tomato yield, (2) determine the direct and indirect effects of the morpho-physiological traits on tomato yield. Data collected were fruit yield, marketable fruit number, single fruit weight, number of trusses per plant, number of fruits per truss, fruit weight per truss, plant height, total soluble solids, fruit dry matter, days to 50% flowering, fruit number per plant, fruit weight per plant and flower number per truss. Yield of Sixpack (control) was 62.4t/ha significantly ($P <$

0.05) higher from lines, CNL3022F2-154-22-9-3, CNL3022F2-37-29-10-17 and CNL3022F2-154-22-5-5.Yield was positive and significantly ($P < 0.001$) correlated to marketable fruit number ($r = 0.64$) and plant height ($r = 0.52$). The relationship between yield and the parameters measured was analysed using stepwise multiple regression. This analysis was used as a bridge leading to path coefficient analysis. Path coefficient analysis results showed that marketable fruit number and single fruit weight were directly related to yield with direct effect of 0.752 and 0.446 respectively. Results obtained suggest that fruit number and single fruit weight are relevant components to use as selection criteria for improving tomato yield. Using correlation coefficients alone would have lead to the erroneous conclusion that single fruit weight is not an important components as its correlation was low and not significant ($P>0.05$) at ($r = 0.30$).

Om Prakash Meena and Vijay Bahadur (2015) initiated to generate genetic information on characters associations for tomato germplasm under open field condition. Nineteen indeterminate tomato germplasm were evaluated to estimate the nature and magnitude of associations of different characters with fruit yield and among themselves at Vegetable Research Farm, Department of Horticulture, SHIATS, Allahabad (India) during 2012-2013. The experiment was conducted using a Randomized Complete Block Design (RCBD) with three replications. Estimates of genetic parameters revealed that fruit yield was significantly and positively correlated with number of flowers per plant (0.2894 and 0.2891) followed by number of fruits per plant (0.4480 and 0.4486) and fruit weight (0.6223 and 0.6230) at genotypic and phenotypic level, respectively, strong association of these traits revealed that the selection based on these traits would ultimately improve the fruit yield and it is also suggested that hybridization of genotypes possessing combination of above characters is most useful for obtaining desirable high yielding segregation. In order to obtain a clear picture of the inter relationship between fruit yield per plant and its components, direct and indirect

effects were measured using path coefficient analysis. Fruit weight had a very high positive direct genotypic and phenotypic effect 0.9566 and 0.9442, respectively on fruit yield per plant followed by number of flowers per plant, fruit set per cent, number of fruits per plant, TSS Brix, plant height, radial diameter of fruit, leaf curl incidence per cent and days to 50% flowering. The characters showed high direct effect on yield per plant indicated that direct selection for these traits might be effective and there is a possibility of improving yield per plant through selection based on these characters. Residual effect was considerably low (0.0611 and 0.0751) which indicated that characters included in this study explained almost all variability towards yield.

Paul *et al.* (2014) conducted to the study was to reveal the genetic variability among the yield contributing traits and their direct and indirect contribution of these parameters towards the yield and identify better combinations as selection criteria for developing high yielding tomato genotypes. Significant differences among genotypes were observed in all characters except height of first leaf appearance at seedling stage. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were high for days to germination, fruits per bunch, harvest index and yield per plant (g). All characters were highly heritable in broad sense. The characters germination(%), fruits per bunch, harvest index, vitamin C content, sugar content(%) were positively correlated with yield per plant. Among them germination (%), fruits per bunch, harvest index were significantly correlated with yield per plant. Germination percent (0.26), height of first leaf appearance (0.19) days to first flowering (0.20) and harvest index (0.42) exhibited direct effect on grain yield. On the basis of correlation and path analysis, percent germination, days to first flowering, fruits per bunch and harvest index are important characters to be considered for the development of high yielding tomato genotype.

Saleem *et al*. (2013) were evaluated to study the quantitative genetics of yield and some yield related traits during 2009-10. Worth of room was realized for improvement due to highly significant genetic variations among all traits studied. The highest estimates of genotypic and phenotypic coefficients of variability were recorded for number of fruits per plant while fruit width was the most heritable trait. Plant height, number of fruits per plant and fruit weight revealed significant positive genotypic and phenotypic association along with direct positive effect on fruit yield per plant. It is therefore, recommended that fruit weight, number of fruits per plant and plant height should be given due importance in selection of promising crosses to develop commercial hybrid variety in tomato.

CHAPTER III

MATERIALS AND METHOD

The experiment was conducted at the research field of Olericulture Division of Horticulture Research Centre (HRC), BARI, Gazipur, Bangladesh during the winter season 2013-14. The experiment field was prevailed loamy soil having P^H 6.5 with well drained location. The AVRDC supplied four hybrid tomato lines viz.: (Tomato line's name) along with one local check (BARI Tomato 3) were included in this study. Seeds were sown on October 10, 2013 and thirty days old seedlings were transplanted in the main plot on November 11, 2013. The materials and methods that was used and followed for conducting experiment are presented under the following headings:

3.1 Experimental site

The experiment was conducted at the research farm of Olericulture Division, Horticultural Research Centre (HRC), Bangladesh Agriculture Research Institute (BARI) Joydebpur, Gazipur during the winter season of 2013-2014. The experimental sites of Joydebpur are located at the site of 24˚.09´N longitude at an elevation of 8.4 meter from the sea level and 26˚.54´E latitude covering 53.00 meter altitude, respectively. Brief descriptions of the ecological conditions of the experimental areas are given below:

3.2 Climate

The early and later period of the year is suitable for tomato cultivation in Bangladesh including Joydebpur, Gazipur. The minimum temperature prevails during cool season (December to February) and higher during hot season. The average annual rainfall was recorded 2000 mm. In Bangladesh overall mean temperature in summer ranges between 25^0C and 33^0C, and in winter, between 15^0C to 27^0C (Anon. 2014). (Appendix II)

3.3 Soil

The soils of the experimental areas of Joydebpur were silt loam having pH in the range from 6.10 to 6.58. Chemical analysis of the soils of experimental fields (0-30 cm depth) was performed in the Soil Science Division of BARI, Joydebpur, Gazipur and the morphological characteristics of the soils of experimental sites shown in Appendix I(B).

3.4 Planting Material:

In this study of the four tomato genotypes and one variety were used and seeds of these line were collected from the Olericulture Division of HRC, BARI. The list of materials is appended below:

1. GPT 0009
2. GPT 0011
3. GPT 0015
4. GPT 0017
5. BARI Tomato 3(Check variety)

3.5 Design and layout of the experiment

The experiment was laid out in the randomized complete block design (RCBD) with 3 replications. Ten treatment combinations were randomly allotted in each block. The size of a unit plot was 4.8 m × 1 m, and the plant spacing was 60 cm × 40 cm. Each unit plot contained 2 rows of plants (24 plants/ plot) and border rows were planted with same tomato entries in the four sides. The space in between plots was 40cm.

3.6 Seedling raising

Five parents were seeded in the seedbed on October 10, 2013.seedling of 30m days aged was transplanted in the main plot on November 11, 2013. After

germination of seed, the bed was covered with 60 mesh nylon net to avoid whitefly infestation that act as vector of virus diseases.

3.7 Land preparation

The land was prepared by several ploughing and cross ploughing followed by laddering to have good tillage and weeds and other unwanted plants were removed thoroughly. Pits were prepared for transplanting seedling.

3.8 Application of manure and fertilizers

The following doses of fertilizer were applied in the plots-

Cow dung- 10 ton/ha
Urea- 500 kg/ha
TSP-450 kg/ha
MOP-250 kg/ha
Gypsum-120 kg/ha
Boron-2 kg/ha

Before planting of seedlings, land was prepared properly and basal dose of fertilizers were applied then seedlings were top dressed as following doses (ha) and procedures: Half of cow dung; the entire quantity of TSP, Boron, Gypsum, and 1/3rd of MOP were applied during final land preparation. The remaining half of cow dung was applied during pit preparation. The remaining 2/3rd of MOP was applied in two equal installments at 20 and 40 days after transplanting. The entire Urea was applied in 3 equal installments at 20, 40 and 60 days after transplanting.

3.9 Transplanting of seedling

Healthy and uniform tomato seedlings of 30 days old seedlings with 4-5 leaves were transplanting in the experimental plots on November 11, 2013. The seedlings were uploaded carefully from the seed bed to avoid damage to the root system. To

minimize the damage to the roots of seedlings, the seed beds were watered one hour before uprooting the seedlings. Transplanting was done in the afternoon. The seedlings were watered immediately after transplanting. Seedlings were sown in the plot with maintaining distance between row to row and plant to plant was 60 cm and 40 cm, respectively.

3.10 Intercultural operation

After raising seedlings, various intercultural operations such as gap filling, weeding, earthing up, irrigation pest and disease control etc. were accomplished for better growth and development of the tomato seedlings.

3.10.1 Irrigation

Four irrigations were given throughout the growing period. The second irrigation was given 40 days after planting followed by irrigation at 20 days after the first irrigation. Mulching was also done after each-irrigation at appropriate time by breaking the soil crust.

3.10.2 Control of pest and diseases

Admire 10EC @ 0.5 ml per liter of water was applied at 10 days interval starting from transplanted plants and continued up to 60 DAT for controlling vectors of virus diseases and tomato fruit borer (*Helicoverpa armigera*). Early blight caused by *Alternaria solani*, and *Cercospora* leaf spot are two major diseases of tomato. Therefore, Ridomil Gold 50WP @ 2g and Bavistin DF @2g per liter of water was applied for controlling early blight and *Cercospora* leaf spot diseases at the appearance of disease symptoms.

3.10.3 Staking and pruning practices

When the plants were well established, staking with bamboo stick was used to support each plant to keep them erect. Pruning was started just after first flower

cluster initiation. Usually, 2 to 3 pruning were done during the whole period of the cropping period. All side suckers, fruits and old leaves were pruned up to last stage of crop.

3.11 Harvesting

Different genotypes matured progressively at different times. Harvesting started 90 days after transplanted and continued for about 45 days.

3.12 Data collection

Five plants were randomly selected for data collection from each unit which was recorded plot wise. Data were collected in respect of the following parameters to assess plant growth; yield attributes and yields.

3.13 Measured characteristics

3.13.1 Days to first flowering

Number of day's required from sowing to first harvesting of plants of each replication.

3.13.2 Days to 50% flowering

Number of days required from sowing to first flower opening of the 50% plants of each replication.

3.13.3 Plant heights at last harvest

The average length in centimeter of the main stem from the ground level to the tip, measured in centimeters at the time of last harvest of the five randomly selected plants.

3.13.4 Days to first harvest

Number of days required was counted from five randomly selected plants and average value was calculated.

3.13.5 Number of fruits per plant

Total number of fruits per plant counted forms five randomly selected plants of each plots and average was calculated.

3.13.6 Individual fruit weight

Individual fruit weight in gram was calculated form 20 selected plants of each plots and average was calculated.

3.13.7 Number of seed per fruit

Total number of seeds per fruit was counted from five random plants and their average was calculated as seeds per fruits of each plot.

3.13.8 Fruit length

Fruit length was measured with a digital slide calipers from the neck of the fruit to the bottom of the same from five respective fruits from each plot and their average was calculated as their length and expressed in centimeter.

3.13.9 Fruit diameter

The diameter of individual fruit was measured in several directions with meter scale and the average of all directions was finally recorded and expressed in centimeter (cm).

3.13.10 Number of locules

Total number of locules present in fruit was counted by cutting 20 mature fruits from each plant from each plot and their average was taken as locule per fruit.

3.13.11 Pericarp thickness

Thickness of pericarp was measured with slide calipers from five selected fruits from each plot and their average was calculated as their pericarp thickness and expressed in millimeter.

3.13.12 TSS%

TSS% was recorded by hand refractometer.

3.13.13 Fruit yield per plant

Total yield of fruits in grams of five plants from each plot was weighted and their average was calculated as total yield of fruits per plants and expressed in kilogram.

3.14 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference among the tomato lines. The mean values of all the characters were evaluated and analysis of variance was performing by the 'F' test. The significance of the difference among the treatments means was estimated by the least significant difference (LSD) test at 5% and 1% level of probability (Gomez and Gomez, 1984).

3.15 Estimation of Correlation

Simple correlation was estimated for different traits with the following formula Singh and Chaudhary, 1985):

$$r = \frac{\sum xy - \frac{\sum x . \sum y}{N}}{\left[\left\{\sum x^2 - \frac{(\sum x)^2}{N}\right\}\left\{\sum y^2 - \frac{(\sum Y)^2}{N}\right\}\right]}$$

Where,

$\sum$ =Summation

x and y are the two variables

N= Number of observation

3.16 Path co-efficient analysis

Path co-efficient analysis was done according to the procedure employed by Dewey and Lu (1959) also in quoted in Singh and Chowdhury (1985), using simple correlation values .In path analysis, correlation co-efficient is partitioned into direct and indirect of independent variables on the dependent variable.

In order to estimate direct and indirect effect of the correlated characters, say x_1, x_2, x_3 yield y, a set of simultaneous equations (three equations in this example) is required to be formulated as given below:

$$ryx_1 = Pyx_1 + Pyx_2 rx_1x_2 + Pyx_3 rx_1x_3$$

$ryx_2 = Pyx_1 rx1x2 + Pyx_2 + Pyx_3 rx_2x_3$

$ryx_1 = Pyx_1 rx_1x_3 + Pyx_2 rx_2x_3 + Pyx_3$

Where, r's denotes simple correlation co-efficient and P's denote path co-efficient (unknown). P's in the above equations may be conveniently solved by arranging them in matrix form. Total correlation, say between x_1 and y is thus partitioned as follows:

Pyx_1 = The direct effect of x_1 on y

$Pyx_1 rx_1x_2$ = The indirect effect of x_1 via x_2 on y

$Pyx_1 rx_1x_3$ = The indirect effect of x_1 via x_3 on y

After calculating the direct and indirect effect of the characters, residual effect (r) was calculated by using the formula given below (Singh and Chaudhary, 1985):

$$P^2RY = 1 - \sum Piy.riy$$

Where,

$P^2RY = (R)^2$; hence residual effect, $R = (P^2RY)^{1/2}$

Piy = Direct effect of the character in yield

riy = Correlation of the character with yield

CHAPTER IV

RESULTS AND DISCUSSION

An experiment was conducted to determine the effects of five genotypes on growth, yield and harvesting period of winter tomato. Data on different parameters were statistically analyzed and have been presented in different forms, such as table and figures. The summaries of analysis of variances of the parameters studied and weather report have been presented in the appendix. The results obtained from the experiments, under study have been presented and discussed in this chapter.

4.1 Yield contributing characters and yield

4.1.1 Plant height

The plant height at last harvest stage found to be significant among different tomato genotypes (Table 1). The tallest plant (93.67 cm) was measured in control (BARI Tomato 3) while the shortest plant (77.13 cm) was exhibited by the genotype GPT 0017. Remaining three genotypes contributed statistically identical plant height which was 79.93 cm, 80.47 cm and 89.73 cm in GPT 0015, GPT 0011 and GPT 0009 respectively. This result is supported by the findings of Norman (1974), Nsowah (1970), Ahmed *et al.* (1986) and Ghosh *et al.* (1995) when they studied with the different genotypes of tomato.

4.1.2 Days to first flowering

The effect of genotypes on days to first flowering was significantly different (Table 1). The genotypes GPT 0015 and check variety required highest days (49.00) for first flowering which indicates late flowering habit compare to other genotypes. The genotypes GPT 0017 showed statistically identical days to

flowering and it was varied from 46-48 days that indicated the earliness of the genotypes (Table 1). The result is supported by the result of Biswas and Mallik (1989) when they studied with the different genotypes of tomato.

4.1.3 Days to 50% flowering

Days to 50% flowering of the genotypes was not significantly influenced by the genotypes (Table 1). Days required for 50% flowering varied from 53-56 days. The highest days for 50% flowering recorded in GPT 0015 (55.67 days) and the lowest days were required in GPT 0011 (53 days).

4.1.4 Days to first harvesting:

Days to first harvest of the genotypes of tomatoes was not varied significantly (Table 1). The highest days to first harvest (89.33) required in BARI Tomato 3 which is followed by GPT-9 (89.00). The lowest day to first harvest (87.67) was required for genotype GPT 0015(87.67).This results indicate that the genotype GPT 0015 provide facilities of early harvesting i.e earliness of genotype. Numerically highest value was observed in control variety that indicated lateness of the genotype. Days needed for harvesting varied from 87-89 days.

4.1.5 Harvesting duration

Statistically insignificant variation was observed in respect of harvest duration among studied tomato genotype. The range of harvest duration was from 29.33 to 33.67. The highest harvest duration (33.67 days) was found in genotype GPT 0011 and the lowest harvest duration was recorded in BARI Tomato 3(29.33days). Results of this parameter indicate that genotype GPT 0011 is suitable for long time harvest.

4.1.6 Number of fruits per plant

Number of fruits per plant showed significantly difference among the genotype (Table 2). The number of fruits per plant of check variety (BARI Tomato 3) was 32.76. Compare to the check variety, the highest number of fruits per plant was found in GPT 0017 (58.75) which was statistically identical with that of the genotype GPT 0009 (58.42) while second highest and statistically different number of fruits per plant was exhibited from the genotypes GPT 0011(47.86) and GPT 0015(43.53). The lowest number of fruits per plant observed in BARI Tomato 3 (32.76). The variation in number of fruits per plant is controlled by the genetical characteristics of the genotypes. Nandpuri *et al*., (1977), Prasad and Prasad (1979), Bhutani *et al*., (1983), Singh et al. (2002) found genetically significant variation for the number of fruits per plant among different genotypes.

4.1.7 Individual fruit weight

Weight of individual fruit was significantly influenced by different genotypes of tomato (Table 2). The highest individual fruit weight was weighed in BARI Tomato 3 (67.23 g) which was followed by genotype GPT 0011 (62.62g), while the genotypes GPT 0017(62.08 g), GPT 0011(62.62 g), GPT 0009(60.03 g) exhibited statistically similar values. The lowest fruit weight was observed in GPT 0015(46.49gm).This variation of individual fruit weight might be due to genetic makeup of the genotype of tomato. Reddy *et al*. (1992) also observed considerable variation for individual fruit weight for different genotypes.

Table 1: Effect of different genotypes on plant height, days to first flowering, days to 50% flowering, days to first harvest

Genotype	Plant height(cm)	Days to first flower	Days to 50% flower	Days to first harvest
GPT 0009	89.73 ab	47.67 ab	54.00	89.00
GPT 0011	79.93 ab	46.67 b	53.33	88.33
GPT 0015	80.47 ab	49.67 a	55.67	87.67
GPT 0017	77.31 b	48.33 ab	55.00	88.00
BARI Tomato 3	93.67 a	49.00 a	55.33	89.33
LSD(0.05)	14.05	2.161	4.165	4.266
CV (%)	8.86	2.28	4.08	2.567

Figure having common letter or without letter in a column do not differ significantly at 5% level as per DMRT

4.1.8 Pericarp thickness

The Pericarp thickness significantly influenced by the different genotypes of tomato (Table 2). The pericarp thickness was varied ranged from (0.66 mm to 0.83 mm). The pericarp thickness of check variety (BARI Tomato 3) was showed 0.70 mm. The highest pericarp thickness observed in GPT 0009 (0.83 mm) which was statistically different to GPT 0017 (0.76 mm), GPT 0011 (0.73 mm). The lowest pericarp thickness was found in GPT 0015 (0.67 mm). Arun *et al*., (2004) also reported that different tomato genotypes showed statistically different pericarp thickness.

4.1.9 Number of locules

The variations in respect of number of locules were found statistically significant among the genotypes (Table 3).The maximun number of locules counted in check variety (BARI Tomato 3) is 5.00. The number of locules were found lowest in GPT 0009 (2.00), GPT 0015(2.00) and GPT 0017(2.00) and which were statistically identical. The number of locules indicated the compactness of tomato fruits. Arun *et al*. (2004) also reported that different genotypes had effect on number of locules which support the findings of present study.

4.1.10 Percent total soluble Solids (TSS%)

There was found significant difference of Total soluble solids (TSS%) among the genotypes studied (Table 3). TSS content of check variety (BARI Tomato 3) was recorded 4.67. Total soluble content significantly influenced by different genotypes of tomato 4.67. The highest TSS% was exhibited by the genotypes in GPT 0011 (5.77) with statistically different genotypes in GPT 0015 and GPT 0009(4.37). The lowest TSS% was observed in GPT 0009 (4.37). Rupa *et al.* (2004) and Jitender *et al.* (1989) studied that genotypic difference of tomatoes had effect in TSS % variations in tomato which support the findings of present study.

Table 2 Effect of different genotypes on harvest duration, number of fruits/plant, individual fruit weight, pericarp thickness.

Genotypes	Harvest duration(days)	Number of fruits per plant	Individual Fruit weight (gm)	Pericarp thickness(mm)
GPT 0009	33.00 a	58.42 a	60.03 a	0.83 a
G PT 011	33.67 a	47.86 ab	62.62 a	0.73 ab
GPT 0015	31.00 a	43.53 bc	46.49 b	0.67 b
GPT 0017	33.33 a	58.75 a	62.08 a	0.77 ab
BARI Tomato 3	29.33 a	32.76 c	67.23 a	0.70 b
LSD(0.05)	4.63	11.56	7.94	0.13
CV(%)	7.66	12.72	7.06	9.87

Figure having common letter or without letter in a column do not differ significantly at 5% level as per DMR

4.1.12 Fruit diameter

Fruit diameter significantly influenced by different genotypes of tomato (Table 3). It was varied from (4.98 mm to 6.07 mm). The fruit diameter of check variety (BARI Tomato 3) was 5.90mm. Among other lines fruit diameter was observed in GPT 0011 (6.06 mm) which ranked as the highest which was statistically different to GPT 0017 (5.25 mm), GPT 0009 (5.18 mm). While the lowest fruit diameter was recorded in GPT 0015 (4.99mm). The findings of this study supposed by the results of Arun *et al* (1992) when he was conducted experiment with different tomato genotypes.

4.1.13 Shelf life

The effect of genotypes on shelf life was significant (Table 3). The best shelf life of tomato fruits exhibited by the check variety (16 days). Rest of genotypes GPT 0011 (9.33), GPT 0017 (9.00), GPT 0015 (7.67) showed statistically identical shelf life. Jitender *et al*. (1989) reported that genotypic differences of tomato may cause of different shelf life.

4.1.14 Number of seeds per fruit

Statistically insignificant variation was observed in respect number of seed per fruit (Table 3). The magnitude of seeds per fruit was confined in 133.70 to 154.00. The highest number of seed per fruit (154.00) was recorded in genotype GPT 0009 which was followed by genotype GPT 0017 (147.00). While the lowest number of seeds per fruit (133.70) was found in BARI Tomato 3 (check variety). It might be genetically divers character of tomato genotype.

Table 3 Effect of different tomato genotypes on number of locules, TSS%, fruit length, fruit breadth, shelf life, number of seeds per fruit

Genotypes	Number of locules	TSS%	Fruit Length (cm)	Fruit diameter(cm)	Shelf life	Number seeds per fruit
GPT 0009	2.00 c	4.37 b	5.64 b	5.19 d	10.00 b	154.0
G PT 011	3.00 b	5.77 a	5.53 c	6.07 a	9.33 b	138.0
GPT 0015	2.00 c	4.90 ab	4.93 e	4.98 e	7.67 b	145.3
GPT 0017	2.00 c	4.07 b	6.76 a	5.25 c	9.00 b	147.0
BARI Tomato3	5.00 a	4.67 b	5.03 d	5.90 b	16.33 a	133.7
LSD (0.05)	0.06	1.05	0.06	0.06	3.25	36.40
CV (%)	0.00	11.82	0.58	0.17	16.50	13.46

Figure having common letter or without letter in a column do not differ significantly at 5% level as per DMRT

4.1.15 Fruit yield per plant:

Different genotypes had significant effect on fruit yield per plant (Fig.1). The highest fruit yield per plant was recorded for the genotype GPT 0017 (3.63 kg) while the second highest yield harvested in GPT 0009 (3.46 kg). The lowest fruit yield per plant was exhibited by the check variety (2.19 kg) while statistically similar yield was observed in the genotypes GPT 0011 and GPT 0015 and GPT 0017 were 2.99kg, 2.28kg and 3.63kg which was similar to GPT 0009 (3.46kg). In contrast, the lowest fruit yield per plant was observed in BARI Tomato 3 (2.28kg). Khalid *et al*. (1999) reported that genotypic differences had effect on fruit yield per plant.

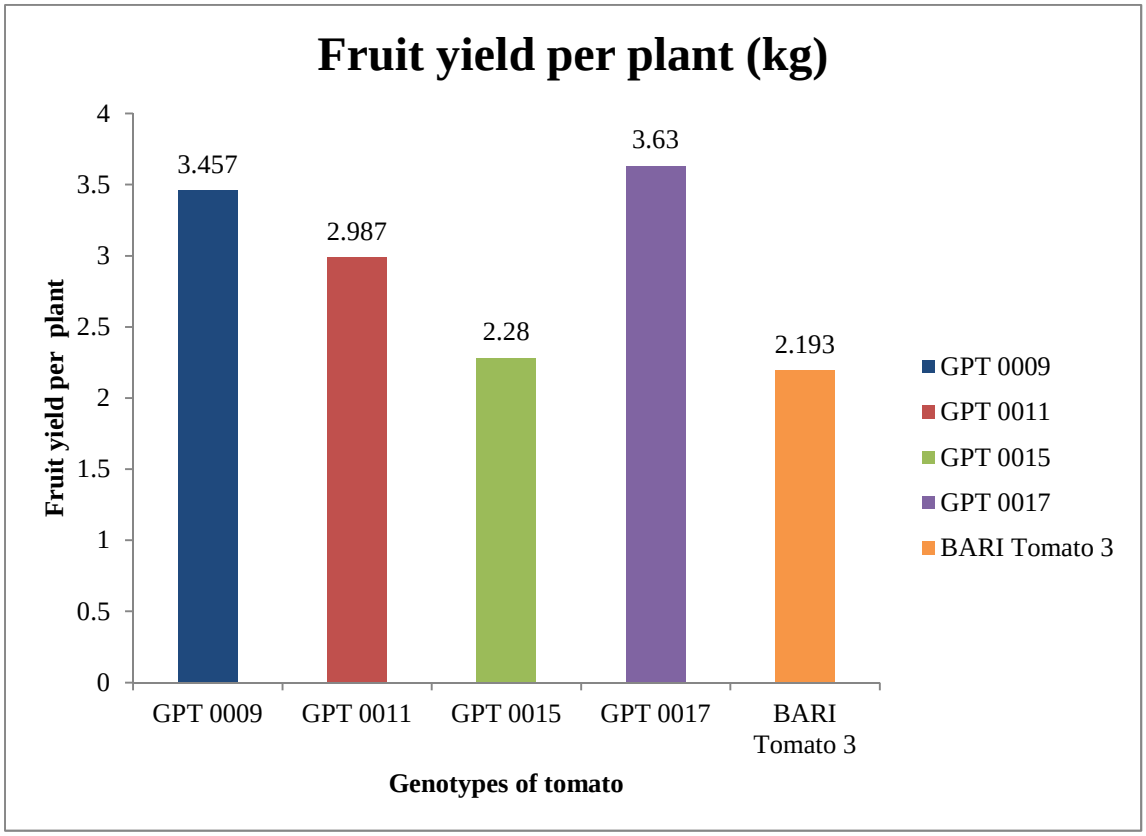

Fig. 1: Effect of different tomato genotypes on fruit yield per plant.

4.1.16 Fruit yield per plot:

The effects of genotypes on fruit yield per plot were found statistically significant (fig 3). Fruit yield per plot were significantly influenced by different genotypes of tomato. The range of fruit yield per plot of the different genotypes was (43.32 kg to 61.29 kg). The fruit yield per plot of check variety (BARI Tomato 3) is 46.23 kg. The highest fruit yield per plot was observed in GPT 0017 (61.29 kg) which was statistically similar to GPT 0009 (56.38 kg). In contrast, the lowest fruit yield per plot was observed in GPT 0015 (43.32 kg). Thomas *et al.* (1979) indicated that genotypic differences of tomato had the effect of variation in fruit yield per plot.

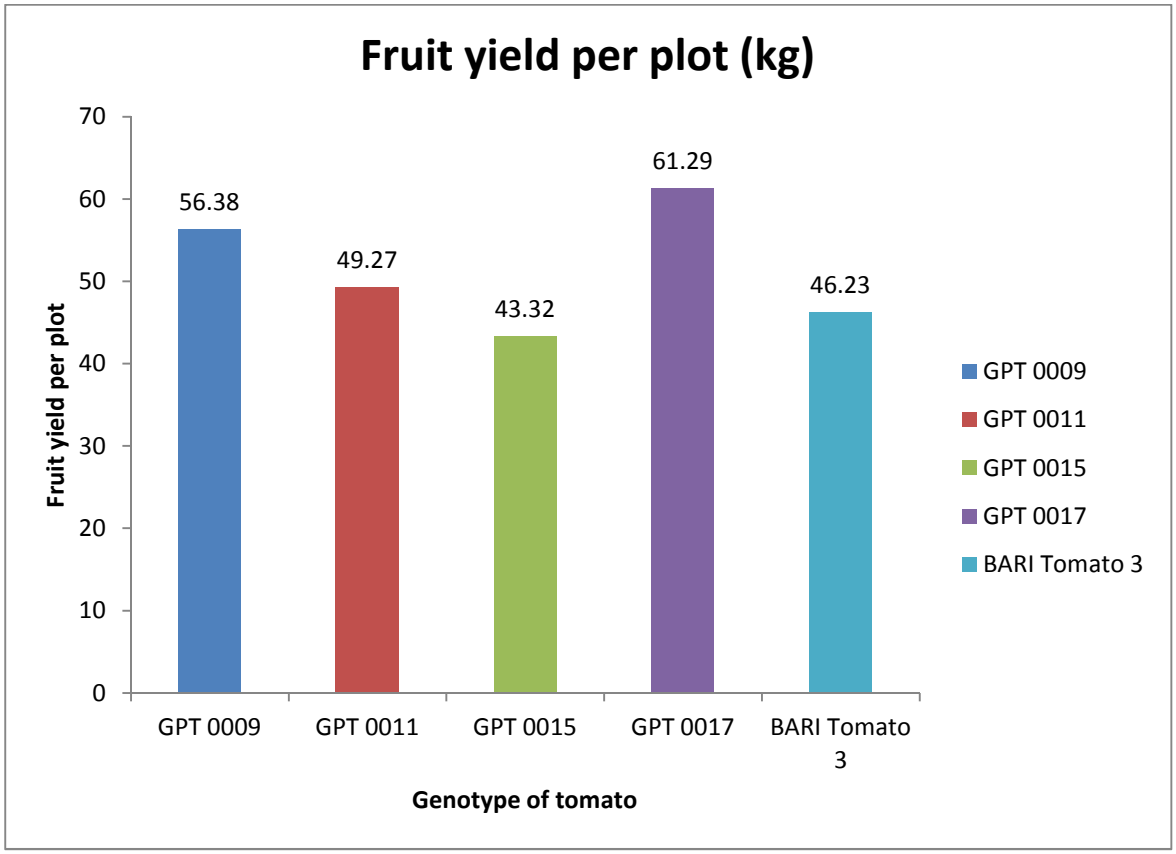

Figure 2: Effect of tomato genotypes on fruit yield per plot

4.1.17 Fruit yield per hectare

The fresh tomato fruit yield per hectare as influenced by genotypes was statistically significant (Fig 3).The highest fruit yield per hectare was recorded for the genotype GPT 0017 (77.23 ton) while the second highest fruit yield per hectare was recorded to GPT 0009 (71.04 ton) and then GPT 0011(62.08 ton), GPT 0015 (54.59 ton). The lowest fruit yield per plant was exhibited by BARI Tomato 3(58.25 ton). Different fruit yield per hectare were observed among the tomato genotypes under study which indicates that the genotypes were genetically divers in nature. These results were in agreement with the findings of Thomas et al. (1979).

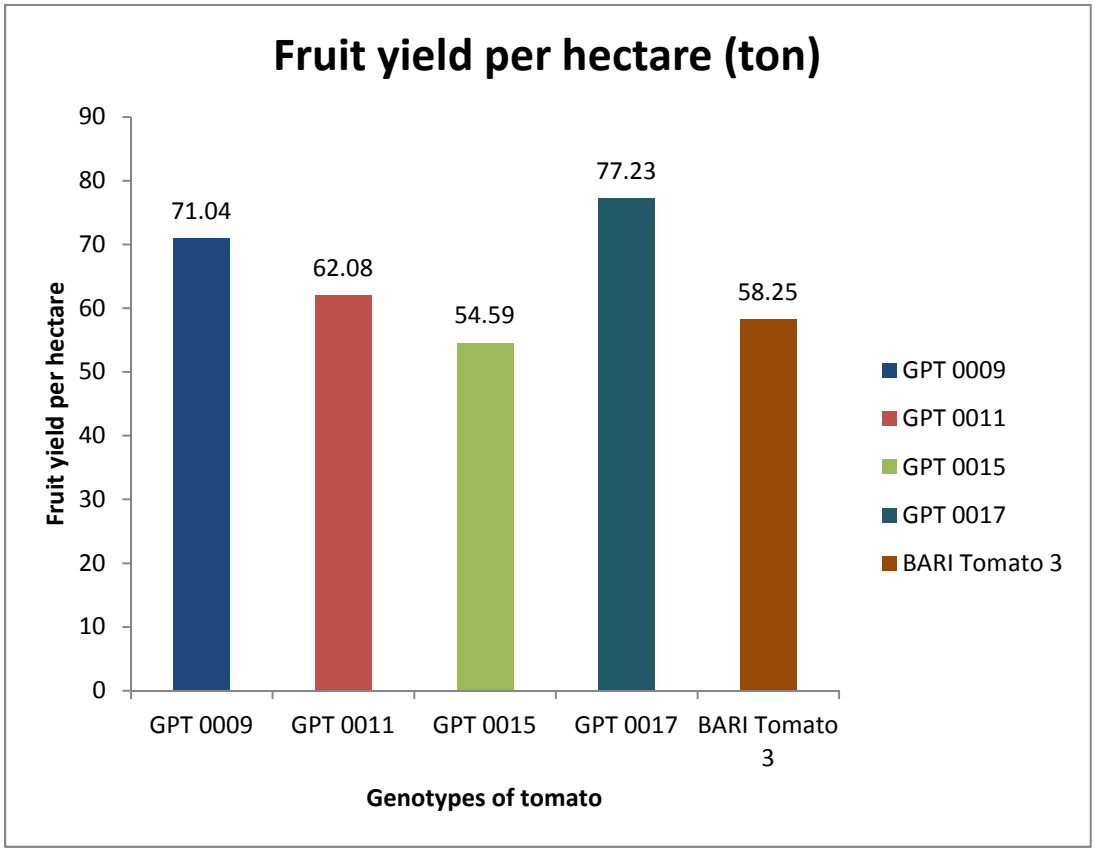

Figure 3. Effect of genotypes on Fruit yield per hectare

4.2 Correlation co-efficient:

Correlation analysis was done to measure the mutual relationship among yield and yield contributing characters of tomato. The correlation co-efficient between ten characters presented in (Table 4). In the present study out of 45 associations 7 associations were highly significant. Among them, 5 associations were positively and 2 associations were negatively. The significant and positive association between the characters suggested additive gene there by less affected by the environmental fluctuation. Beside this 12 relationships were positive and insignificant and 25 were negative and insignificant. The positive and insignificant associations referred information of inherent relation among the pairs of combination while the negative and insignificant associations referred a complex linked of relation among the pair of combinations. Phenotypic coefficients among different pairs of yield and yield contributing characters for different genotype of tomato are given in Table 4.

4.2.1 Days to first flowering

Positive association was recorded for days to first flowering in respect of days to 50% flowering (0.74), plant height (0.01) from results. While the negative association for harvest duration (-0.58), number of fruits per plant (-0.32), individual fruit weight (-0.29), total soluble solids (-0.13), fruit diameter (-0.38), fruit length (-0.25) and fruit yield per hectare (-0.36). Highly Positive significant association was observed with days to 50% flowering (0.74), while negative and significant association was observed with harvest duration (-0.58). All other association was found non-significant (table 4). Islam *et al.* (2010) observed that the highest negative direct effect on yield per plant showed by days to first flowering .The characters showed high direct effect on yield per plant indicated that direct selection for these traits might be effective and there is a possibility of improving yield per plant through selection based on these characters.

4.2.2 Days to 50% flowering

Days of 50% flowering, showed highly positive and significant association with days to first flowering (0.74) at phenotypic level. Significant positive associations between days to 50% flowering and days to first flowering indicates that the traits are governed by same gene. However it had negative and non-significant association with plant height (-0.33), harvest duration (-0.41), number of fruits per plant (-0.31), individual fruit weight (-0.02), total soluble solids (-0.17), fruit diameter (-0.19), fruit length (-0.07) and fruit yield per hectare (-0.24). Non- significant association of these traits indicated that the association between these traits was largely influenced by environmental factors. Yield improvement can be achieved by selection for days to 50% flowering were reported by Om Prakash Meena and Vijay Bahadur (2015).

4.2.3 Plant height

Positive and non-significant association was recorded for plant height with days to first flowering (0.01), number of fruits per plant (0.03), individual fruit weight (0.07), total soluble solids (0.04), fruit diameter (0.15) at phenotypic level indicated that non- significant association of these traits indicated that the association between these traits was largely influenced by environmental factors. It had strongly negative and significant association was observed with harvest duration (-0.61 at phenotypic level. It indicated that if plant height increased harvest duration decreased. It had negative and non-significant association with days to 50% flowering (-0.33), fruit length (-0.34), fruit diameter (-0.19) and fruit yield per hectare (-0.3).). Saleem *et al*. (2013) observed that highest positive direct effect on yield per plant showed by plant height. The characters showed high direct effect on yield per plant indicated that direct selection for these traits might be effective and there is a possibility of improving yield per plant through selection based on plant height.

4.2.4 Harvesting duration

Positive association was recorded for harvesting duration in respect of number of fruits per plant (0.28), individual fruit weight (0.10), fruit length (0.44) and fruit yield per hectare (0.33) while negative association for days to first flowering(-0.58), days to 50% flowering(-0.42), plant height(-0.61), total soluble solids (-0.02), fruit diameter (-0.05). Among the association, strong but negative association of harvest duration with days to first flowering, plant height was recorded (Table 4) which indicates that if plant height decrease harvest duration will be increase.

4.2.5 Number of fruits per plant

Number of fruits per plant showed positive and non-significant association with plant height (0.03), harvest duration (0.28), fruit length (0.67) and fruit yield per hectare (0.79) at phenotypic level. Positive association with fruit length (0.67) and fruit yield per hectare (0.79) was significant indicates that the traits are governed by same gene and simultaneous improvement would be effective. It had negative and non-significant association recorded through days to first flowering (-0.32), days to 50% flowering (-0.03), individual fruit weight (-0.25), total soluble solids (-0.21), fruit diameter (-0.42).). Insignificant association of these traits indicated that the association between these traits was largely influenced by environmental factors. Yield improvement can be achieved by selection for number of fruits per plant was reported by Om Prakash Meena and Vijay Bahadur (2015).

4.2.6 Individual fruit weight

Results revealed that a positive significant association of individual fruit weight was recorded with fruit diameter (0.65) of tomato at phenotypic level indicates that if fruit weight is increased, then fruit diameter also increased. It had positive non-significant association was recorded in plant height (0.07), harvesting duration (0.10), fruit length (0.28), fruit yield per ha (0.28). Non-

significant and negative association was observed in days too first flowering (-0.29), days to 50% flowering (-0.02), total soluble solids (-0.06) and number of fruits per plant (-0.25). Non- significant association of these traits indicated that the association between these traits was largely influenced by environmental factors. Yield improvement can be achieved by selection for number of fruits per plant was reported by Om Prakash Meena and Vijay Bahadur (2015).

4.2.7 Total soluble solids

Total soluble solids with fruit diameter (0.47), plant height (0.04) showed non-significant positive association at phenotypic level indicates that non-significant association of these traits indicated that the association between these traits was largely influenced by environmental factors while negative association of total soluble solid was recorded through days to first flowering (-0.13), days to 50% flowering (-0.17), harvesting duration (-0.02), fruit length (-0.37), fruit yield per ha (-0.41), number of fruits per plant (-0.21), individual fruit weight (-0.06). Both Positive association and negative association was non-significant. Yield improvement can be achieved by selection for total soluble solids were reported by Om Prakash Meena and Vijay Bahadur (2015).

Table 4 Correlation co-efficient different yield contributing characters and yield of tomato as influenced by genotype

Traits	Days to first flowering	Days to 50% flowering	Plant height (cm)	Harvest duration	Number of fruits per plant	Individual fruit weight (g)	Total soluble solids %	Fruit length (mm)	Fruit diameter (mm)
Days 50% flowering	**0.74****								
Plant height	0.01	-0.33							
Harvest duration	**-0.58***	-0.41	**-0.61***						
Number of fruits per plant	-0.32	-0.31	0.03	0.28					
Individual fruit weight	-0.29	-0.02	0.07	0.10	-0.25				
Total soluble solids %	-0.13	-0.17	0.04	-0.02	-0.21	-0.06			
Fruit length	-0.25	-0.07	-0.34	0.44	**0.67****	0.28	-0.37		
Fruit diameter	-0.38	-0.19	0.15	-0.05	-0.42	**0.65****	0.47	-0.16	
Field yield per hectare	-0.36	-0.24	-0.03	0.33	**0.79****	0.28	-0.41	**0.89****	-0.22

4.2.9 Fruit length

Findings showed that a positive significant association of fruit length was recorded in fruit yield per hectare (0.89), number of fruits per plant (0.67), while positive non- significant association was recorded in harvesting duration(0.44), individual fruit weight (0.28). Negative association was observed in days to first flowering (-0.25), days to 50% flowering (-0.07), plant height (-0.34), total soluble solids (-0.37) and fruit diameter (-0.16). The rest of the positive association and other negative association were non- significant. Non- significant association of these traits indicated that the association between these traits was largely influenced by environmental factors. Yield improvement can be achieved by selection for fruit length was reported by Om Prakash Meena and Vijay Bahadur (2015).

4.2.10 Fruit diameter

Through path analysis positive significant association was recorded for fruit diameter in respect of individual fruit weight (0.65) while positive association was recorded in plant height (0.15), total soluble solids (0.47). Negative association was recorded in days to first flowering,(-0.38), days to 50% flowering (-0.19), harvesting duration(-0.05), fruit length (-0.16), number of fruits per plant (-0.42), fruit yield per ha (-0.22). Except positive association of individual fruit weight other positive and negative association was non-significant. Non- significant association of these traits indicated that the association between these traits was largely influenced by environmental factors. Yield improvement can be achieved by selection for fruit diameter was reported by Om Prakash Meena and Vijay Bahadur (2015).

4.2.11 Fruit yield per hectare

Yield per hectare was positively correlated with harvest duration (0.33), number of fruits/plant (0.79), individual fruit weight(0.28), fruit length (0.89). Among them number of fruits per plant , fruit length were significantly correlated with yield per ha which suggested that, the genotypes with these traits will be effective for high yielding varieties and the genotypes will have high partitioning efficiency increase in yield per ha. . Yield per ha was negatively correlated with days to first flowering (-0.36), days to 50% flowering (-0.24), plant height (-0.03), total soluble solid (- 41) and fruit diameter (-0.22) indicated that yield per ha would be increased with the decrease of the mentioned characters. Among them, all showed negative and non significant correlation with yield per hectare.

4.3 Path co-efficient analysis:

The relationship between yield and its components characters were further analyzed by path coefficient. It helps to ascertain the effects of each and every character to yield through direct and alternate pathway. Path coefficient analysis was performed using simple's correlation values. Path co-efficient analysis screens the components of correlation into direct and indirect effects and indicates the relationship in more meaningful way.

4.3.1 Days to first flowering vs yield per hectare

Days to first flowering had positive direct effect (0.11) on yield/ha (Table 5). Considerable positive indirect effect of it yield per ha was contributed via days to 50% flowering, and considerable negative indirect effect of it to yield per ha exhibited in harvesting duration, individual fruit weight, total soluble solids, fruit length, fruit diameter, number of seeds per fruit. Haydar *et al*. (2007) conducted an experiment in genetic parameters, character association and path coefficient analysis between yield and yield contributing characters of different tomato genotypes. The genotypes exhibited a wide range of variability for all

the traits studied. He observed that days to flowering also contributed yield directly

4.3.2 Days to 50% flowering vs yield per hectare

Days to 50% flowering had positive direct effect (1.04) on yield/ha (Table 5) Considerable positive indirect effect of it yield per ha was contributed via days to first flowering, days to first harvest, number of seeds per fruit and considerable negative indirect effect of it to yield per ha exhibited in plant height, harvesting duration, number of fruits per plant, individual fruit weight, total soluble solid, fruit length, fruit diameter. Om Prakash Meena and Vijay Bahadur (2015 reported that, days to 50% flowering showed high direct effect on yield per plant indicated that direct selection for these traits might be effective and there is a possibility of improving yield per plant through selection based on these characters.

4.3.3 Plant height vs yield per hectare

Path analysis revealed that plant height had positive direct effect (1.31) on yield per hectare (Table 5). Positive indirect effect of it yield per ha was contributed via plant height, number of fruit per plant, individual fruit weight, total soluble solids, fruit diameter and considerable negative indirect effect of it to yield per hectare exhibited in days to 50% flowering, days to first harvest, harvesting duration, fruit length. Om Prakash Meena and Vijay Bahadur (2015) reported that plant height, showed high direct effect on yield per plant indicated that direct selection for these traits might be effective and there is a possibility of improving yield per plant through selection based on these characters.

4.3. 4 Harvesting duration vs yield per hectare

Harvesting duration had positive direct effect (1.38) on yield/ha (Table 5). Considerable positive indirect effect of it yield per ha was contributed via number of fruits per plant, individual fruit weight, fruit length and considerable negative indirect effect of it to yield per ha exhibited in days to first flowering ,days to 50% flowering, plant height, harvesting duration, total soluble solid ,

fruit diameter. Paul *et al.* (2014) repoated that yield contributing traits and their direct and indirect contribution of these parameters towards the yield and identify better combinations as selection criteria for developing high yielding tomato genotypes. Harvesting duaration were significantly correlated with yield per plant. On the basis of path analysis, harvesting duration are important characters to be considered for the development of high yielding tomato genotype.

4.3.5 Number of fruits per plant vs yield per hectare

In consideration of path analysis revealed that number of fruit per plant had negative direct effect (-0.09) on yield per hectare (Table 5). Considerable positive indirect effect of it yield per ha was contributed via days to first flowering, days to 50% flowering, individual fruit weight, total soluble solids, fruit diameter and considerable negative indirect effect of it to yield per ha exhibited in harvesting, fruit length. Islam *et al*. (2010) determined to find out the inter relationship among the characters studied. Yield per plant was found highly significant and positively correlated number of fruits per plant which indicated that yield could be increased by improving a traits.

4.3.6 Individual fruit weight vs yield per hectare

Individual fruit weight had positive direct effect (0.28) on yield per hectare (Table-5). Considerable positive indirect effect of it yield per ha was contributed via plant height, harvesting duration, fruit length, fruit diameter and considerable negative indirect effect of it to yield per ha exhibited in days to first flowering, days to 50% flowering, number of fruits per plant, total soluble solids. Islam *et al*. (2010) determined to find out the inter relationship among the characters studied. Yield per plant was found highly significant and positively correlated with individual fruit weight which indicated that yield could be increased by improving a traits.

Table 5 Path co-efficient analysis showing the direct and indirect effect of different yield contributing characters on fruit yield per ha

Traits	Days to First Flowering	Days to 50% flowering	Plant height	Harvest duration	Number of fruits per plant	Individual fruit weight	Total soluble solid %	Fruit length	Fruit diameter	Field yield per ha
Days to First Flowering	**0.11**	0.77	0.02	-0.79	0.03	-0.08	-0.02	-0.19	0.04	-0.36
Days to 50% flowering	0.08	**1.04**	-0.43	-0.57	0.03	-0.01	-0.03	-0.05	0.02	-0.24
Plant height	0.00	-0.34	**1.31**	-0.84	0.00	0.02	0.01	-0.25	-0.01	-0.03
Harvest duration	-0.06	-0.43	-0.80	**1.38**	-0.03	0.03	0.00	0.33	0.00	0.33
Number of fruits per plant	-0.04	-0.32	0.04	0.39	**-0.09**	-0.07	-0.04	0.50	0.04	0.79
Individual fruit weight	-0.03	-0.02	0.09	0.13	0.02	**0.28**	-0.01	0.21	-0.06	0.28
Total soluble solid %	-0.01	-0.18	0.05	-0.03	0.02	-0.02	**0.18**	-0.27	-0.04	-0.41

Fruit length	-0.03	-0.07	-0.44	0.61	-0.06	0.08	-0.07	**0.75**	0.01	0.89
Fruit diameter	-0.04	-0.20	0.20	-0.07	0.04	0.18	0.09	-0.12	**-0.09**	-0.22

Residual effect = 0.000000005411846

4.3.7 Yield per hectare vs total soluble solids

Total soluble solids had positive direct effect (0.18) on yield per hectare (Table 5). Considerable positive indirect effect of it yield per ha was contributed via plant height, fruit diameter and considerable negative indirect effect of it to yield per ha exhibited in days to first flowering, days to 50% flowering, number of fruits per plant, individual fruit weight, fruit length. Ahirwar and Prasad (2014) was found that TSS (Brix) showed positive correlation with fruit yield per ha.

4.3.8 Fruit length vs yield per hectare

Fruit length had positive direct effect (0.75) on yield per hectare (Table 5). Positive indirect effect of it yield per ha was contributed via harvesting duration, number of fruits per plant, individual fruit weight and considerable negative indirect effect of it to yield per ha exhibited in days to first flowering, days to 50% flowering, plant height, days to first harvesting, total soluble solids , fruit breadth. Islam *et al*. (2010) determined to find out the inter relationship among the characters studied. Yield per plant was found highly significant and positively correlated with fruit length which indicated that yield could be increased by improving a traits.

4.3.9 Fruit diameter vs yield per hectare

Fruit diameter had negative direct effect (-0.09) on yield per hectare (Table-5). Positive indirect effect of it yield per ha was contributed via days to first flowering, days to 50% flowering, number of fruits per plant, fruit length and considerable negative indirect effect of it to yield per hectare exhibited in plant height, individual fruit weight, total soluble solids. Islam *et al*. (2010) determined to find out the inter relationship among the characters studied. Yield per plant was found highly significant and positively correlated with fruit diameter which indicated that yield could be increased by improving a traits.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the research field of Bangladesh Agricultural Research Institute (BARI) Joyadebpur, during the period from October 2013 to February 2014 to evaluate some morphological characters and yield attributes of tomato genotypes .The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications .The experiment treatment consisted of five tomato genotypes viz, GPT 0009, GPT 0011, GPT 0015, GPT 0017and BARI Tomato 3 as Local check variety. The unit plot size was 4.8 m × 1m and the plant spacing was 60 cm × 40 cm. The seedlings of tomato genotypes were transplanted in the field on 11 November 2013.

Data on plant height, days to first flowering, days to 50% flowering, harvesting duaration, days to first harvesting, number of fruits per plant, total soluble solids, individual fruit weight, pericarp thickness, number of locules, fruit yield per plant, fruit yield per plot, fruit yield per hectare, shelf life, number of seeds per fruit were recorded and statistically analyzed to evaluate the treatment effects.

Results revealed that there were significant genotypic variation on plant height, days to first flowering, number of fruits per plant, total soluble solids, individual fruit weight, pericarp thickness, number of locules, fruit yield per plant, fruit yield per plot, fruit yield per hectare, shelf life. However, days to 50% flowering, days to first harvesting, harvesting duration and number of seeds per plant was not significant. Among the genotypes the tallest plant was recorded in BARI Tomato 3 (93.67cm), while the shortest plant was obtained from the genotype GPT 0017 (77.31 cm) and other genotype showed intermediate in plant height. The longest period to first flowering of genotype was observed in GPT 0015 (49.67 days) while the lowest days to first flowering was observed in GPT 0011 (46.67days). The highest number of fruits

per plant was observed in GPT 0017 (58.75) while the lowest number of fruits per plant was observed in BARI Tomato 3 (32.76).

The highest individual fruit weight was observed in BARI Tomato 3 (67.23 g) while the lowest fruit weight was observed in GPT 0015 (46. 49 g). The highest pericarp thickness observed in GPT 0009 (0.83 mm) while the lowest pericarp thickness was observed in GPT 0015 (0.67 mm). The highest number of locules observed in BARI Tomato 3 (5.00). The number of locules was statistically similar to GPT 0009 (2.00), GPT 0015 (2.00) and GPT 0017 (2.00 cm). The highest TSS% observed in GP 0011 (5.77) and the lowest TSS% was observed in GPT 0017 (4.07). The highest fruit length was observed in GPT 0017 (6.76) while the lowest fruit length was observed in GPT 0015(4.93 cm). The highest fruit diameter observed in GPT 0011 (6.06 cm) while the lowest fruit diameter was observed in GPT 0015 (4.98 cm). The highest fruit yield per plant observed in GPT 0017 (3.63 kg) and the lowest fruit yield per plant was observed in BARI Tomato 3(2.19 kg). The highest fruit yield per plot observed in GPT 0017 (61.29 kg) and the lowest fruit yield per plot was observed in GPT 0015(43.32 kg). The highest fruit yield per hectare observed in GPT 0017 (77.23 ton) and the lowest fruit weight was observed in GPT 0015 (54.59 ton). The highest shelf life observed in BARI Tomato 3 (16.33 days) and the lowest shelf life was observed in GPT 0015 (7.66 days).

Yield per hectare was positively correlated with number of fruits per plant (0.79), individual fruit weight (0.28), fruit length (0.89), harvesting duration (0.33). Among them number of fruits per plant, fruit length were significantly correlated with yield per hectare which suggested that, the genotypes with these traits will be effective for high yielding varieties and the genotypes will have high partitioning efficiency increase in yield per ha. Yield per ha was negatively correlated with days to first flowering (-0.36), days to 50% flowering (-0.24), plant height (-0.03), total soluble solids (-41) and fruit diameter (-0.22)

Path analysis revealed that days to first flowering had positive direct effect (0.11) on yield per hectare. Days to 50% flowering had positive direct effect (1.04) on yield per hectare. Plant height had positive direct effect (1.31) on yield per hectare. Harvesting duration had positive direct effect (1.38) on yield per hectare. Number of fruit per plant had negative direct effect (-0.09) on yield per hectare. Individual fruit weight had positive direct effect (0.28) on yield per hectare. Total soluble solids had positive direct effect (0.18) on yield per hectare. Fruit length had positive direct effect (0.75) on yield per hectare. Fruit diameter had negative direct effect (-0.09) on yield per hectare.

Conclusion:

Considering the above findings of the present experiment, the following conclusion may be made:

1. In respect of field performance, genotype GPT 0017 is promising.
2. Path analysis revealed that plant height, individual fruit weight, total soluble sugar content, fruit length showed positive direct effect on yield. Therefore. For the selection of tomato genotypes the above parameters should have to be taken with due consideration.
3. Promising genotype GPT 0017 may be subjected for regional trial aiming to release as variety.

Plate 1: Photograph showing fruits of GPT 0009 tomato genotype

Plate 2: Photograph showing fruits of GPT 0011 tomato genotype

Plate 3; Photograph showing fruits of GPT 0015 tomato genotype

Plate 4: Photograph showing fruits of GPT 0017 and BARI Tomato 3 tomato genotype

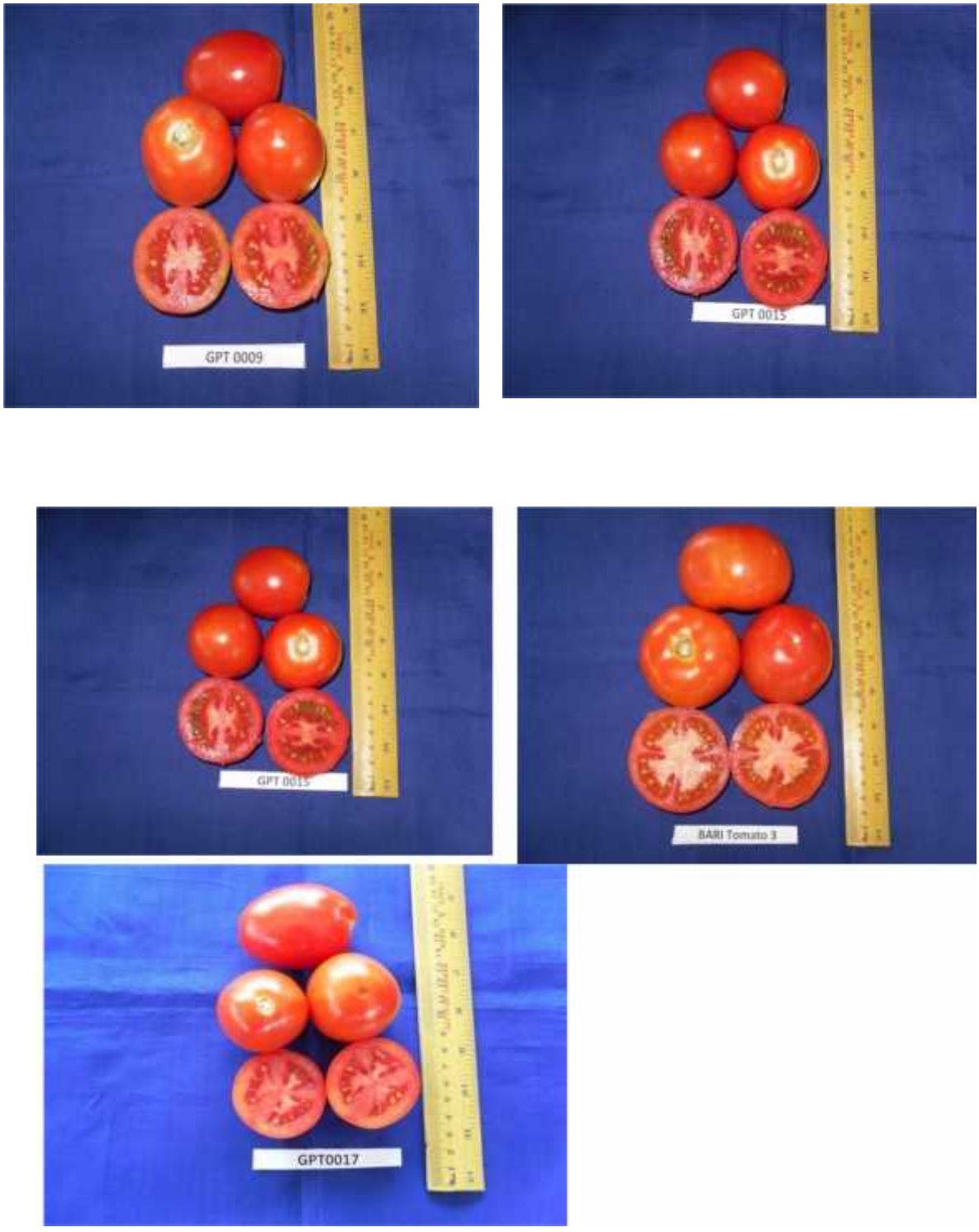

Plate 5: Photograph showing slice of tomato fruits of GPT 0009, GPT 0011, GPT 0015, GPT 0017 and BARI Tomato.

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APPENDICES

Appendix I. Characteristics of experimental field soil analyzed by Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur

A. Morphological characteristics of the experimental field.

Morphological features	Characteristics
Location	Vegetable Division, Horticulture Research Institute, BARI
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Topography	Fairly leveled

B. The results of the chemical analysis of soil sample of BARI, Joydebpur, and Gazipur

Soil properties	2014	Critical limit
Soil p^H	6.58	-
Organic matter (%)	0.75	-
Total nitrogen (%)	0.067	0.12
Available P (µg/ml)	20	14
Exchangeable K (meq/100ml)	0.19	0.2
Boron (µg/ml)	0.21	0.2

Source: Soil resources, soil survey project, Bangladesh.

Appendix II. Weather data of the experimental site during the period of October, 2013 to April, 2014

Month	Air temperature (^{o}C)			Relative Humidity (%)		Total Rainfall (mm)
	Maximum	Minimum	Mean	9:00 am	2:00 pm	
October	32.12	23.54	27.83	77.74	71.10	393.3
November	29.40	19.51	24.455	74.63	53.20	63.0
December	26.08	13.82	19.95	73.10	51.19	0
January	25.20	12.51	18.85	76.87	46.90	0
February	31.46	18.23	24.84	75.03	43.31	0
March	33.72	20.24	26.98	69.80	40.80	0
April	33.63	22.83	28.23	78.76	63.03	97.24

Source: Meteorological department, BARI.

Appendix IV: Analysis of variance of yield and yield contributing characters of tomato

Source	Degrees of freedom	Days to first flower	Days to 50% flower	Plant height	Days to first harvest	Harvest duration	Number of fruits/plant	Individual Fruit wt.
		Mean square						
Replication	2	1.067	5.067	0.002	6.467	2.867	60.877	24.656
Factor A	4	4.067*	2.833*	0.012	1.433	10.233	357.087*	184.247*
Error	8	1.317	4.983	0.005	5.133	6.033	37.686	17.784
CV%		2.38	4.08	8.86	2.56	7.66	12.72	7.06

- Significant at 5% level of significance

Appendix IV: Cont'd

Source	Degrees of freedom	Pericarp thicknes	Number of locules	TSS%	Fruit Length	Fruit Breadth	Fruit yld /plant	Fruit yld/plot	Fruit yld/ha	Shelf life	Number of Seed Per Fruit	Pericarp thicknes
		Mean Square										
Replication	2	0.002	0.000	0.501	0.002	0.000	0.018	3.562	5.669	4.067	65.00	0.002
Factor A	4	0.012*	5.100*	1.258*	1.605*	0.676*	1.300*	164.25*	260.784*	34.433*	189.567*	0.012*
Error	8	0.005	0.000	.3160	0.001	0.000	0.087	6.004	9.540	2.983	373.667	0.005
CV%		9.87	0.00	11.82	0.58	0.17	10.14	4.78	4.78	16.50	13.46	9.87

- * Significant at 5% level of significance