PERFORMANCE OF FIVE TOMATO VARIETIES AT DIFFERENT PLANTING DATES

BY

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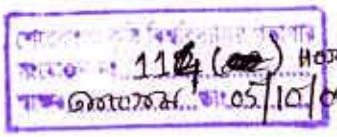

CERTIFICATE

This is to certify that the thesis entitled, ***"PERFORMANCE OF FIVE TOMATO VARIETIES AT DIFFERENT PLANTING DATES"*** *submitted to the Department of Horticulture and Postharvest Technology, Faculty of Agriculture, 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 bonafide research work carried out by* ***MD. MAHABUB-AL-KAWSAR, Registration No. 02179*** *under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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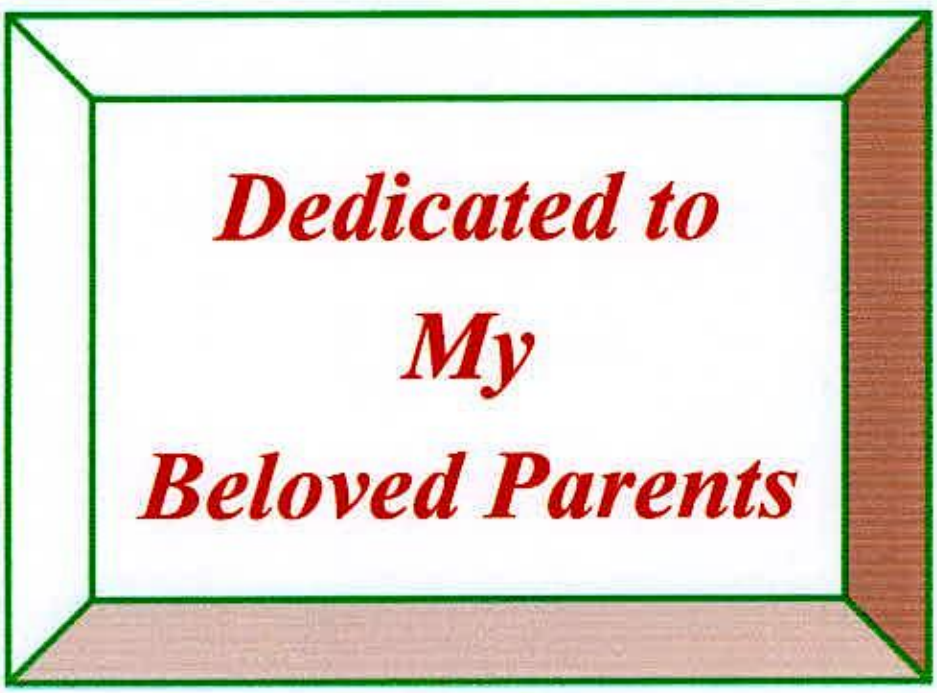
Dedicated to
My
Beloved Parents

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ABSTRACT

The experiment was conducted at the Horticulture Research Center farm in Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during October 2007 to March 2008. There were five tomato varieties, viz., BARI Tomato-2, BARI Tomato-3, BARI Tomato-4, BARI Tomato-9 and BARI hybrid Tomato-4 and two planting dates viz., November 01, November 15. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Varieties had significant influence on growth and yield of tomato. The variety BARI hybrid Tomato-4 produced the highest yield (83.42 t/ha) and BARI Tomato-9 produced the lowest yield (40.42 t/ha).The highest percent of fruit set (63.47) was found in BARI Tomato-4 and lowest (47.91) in BARI Tomato- 9.The variety BARI Tomato-3 produced largest fruit (121.3 gm) compared to other four varieties. Planting dates had no significant influence on growth and yield of tomato. However, growth and yield were best in November 15 planting. The highest yield of tomato (87.42 t/ha) was obtained from November 15 planting and lowest yield (59.20 t/ha) from November 01 planting. Combined effect of varieties and planting dates had significant influence on growth and yield of tomato. BARI hybrid Tomato-4 gave the highest yield (91.15 t/ha) on November 15 planting and BARI Tomato-9 gave the lowest yield (41.47 t/ha) on November 15 planting. It may be concluded that, BARI hybrid Tomato-4 planted on November 15 would be beneficial for the farmer due to its higher yield (91.15 t/ha).

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LIST OF ABBREVIATION AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
HRC	=	Horticulture Research Centre
BBS	=	Bangladesh Bureau of Statistics
FAO	=	Food and Agricultural Organization
N	=	Nitrogen
TSP	=	Triple Super Phosphate
MOP	=	Muriate of Potash
RCBD	=	Randomized complete block design
DAT	=	Days after Transplanting
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
LSD	=	Least Significant Difference
NS	=	Not significant
NPK	=	Nitrogen, Phosphorus and Potassium
CV	=	Coefficient of Variance

Chapter 1

Introduction

CHAPTER I

INTRODUCTION

Tomato (*Lycopersicon esculentum Mill.*) belonging to the family Solanaceae, is one of the important, popular and nutritious vegetables grown in Bangladesh during winter season and cultivated in all parts of the country (Haque *et al.*, 1999). The origin of tomato is South America (Salunkhe *et al.*, 1987) particularly the Peru-Ecuador-Bolivia areas of Andes. It is adapted to a wide variety of climates. At present, tomato ranks third, next to potato and sweet potato, in terms of world vegetable production (FAO, 2002). The leading tomato producing countries of the world are China, India, Egypt, Turkey, Iran, Italy, Mexico, Brazil and Indonesia (FAO, 1999).

Its food value is very rich because of higher contents of vitamins A, B and C including calcium and carotene (Bose and Som, 1990). It is much popular as salad in the raw state and is made into soups, juice, ketchup, pickles, sauces, conserved puree, paste, powder and other products (Ahmad, 1986; Thompson and Kelly, 1983 and Bose and Som, 1990).

Bangladesh produced 102 thousand tons of tomato in 15.790 thousand hectares of land during the year 2002-2003 and the average yield being 6.46 t ha^{-1} (BBS, 2004), Which is very low in comparison with that of other countries, namely India (15.67 t/ha), Japan (52.82 t/ha) and USA (63.66 t/ha). The yield of tomato in our country is not satisfactory enough in comparison to requirement (Aditya *et al.*, 1999). The low yield of tomato in Bangladesh, however, is not an indication of low yielding ability of

this crop, but of the fact that the tomatoes grown here are not always of high yielding cultivars and that the cultural practices commonly used by the growers are not improved. Since the soil and climatic conditions of Bangladesh during the winter season are congenial to proper growth of tomato, it is expected that improved management practices would augment the yield considerably. Tomato has a great demand throughout the year, but its production is concentrated during the months from January to march in our country. Although production of summer tomatoes has just started in this country, there is still a long away to go for successful commercial production.

The meteorological data for the 10 years indicate that the crop suffer from cold injury during the month of January (anon, 2007) which result shy yield of this crop. In some areas of the country particularly in the northern part the night temperature falls even below 10-12° c which results tremendous yield loss in tomato. This is why it is important to identify an appropriate planting time for successful production of tomato. The yield of tomato also depends on variety by this time BARI released a good number of varieties viz, BARI Tomato-2, BARI Tomato-3, BARI Tomato-4, BARI Tomato-9, and BARI hybrid Tomato-4, but their performance against cold injury at different planting dates have yet not been studied.

An attempt has, therefore, been made in this experiment to study the performance of some tomato varieties at different planting dates to avoid cold injury and higher yield with the possibility of extending the picking period of tomato.

Considering the above situation, the present experiment was designed with the following objectives:

i. To find out the optimum planting time for higher yield of five BARI released tomato varieties (viz, BARI Tomato-2, BARI Tomato-3, BARI Tomato-4,BARI Tomato-9, and BARI hybrid Tomato-4), and

ii. To identify the best variety which produce higher yield and is economical to the farmer.

iii. To extend the fruit picking period of tomato in order to satisfy the consumer's need making the vegetable available for a longer period of the year.

Chapter 2

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Tomato is an important vegetable crop and received much attention of the researchers throughout the world to develop its suitable production technique. Establishment and growth of tomato plants largely depend on the time of planting and variety. Large number of researchers has studied the effect of planting and variety on the growth, yield and picking period of tomato in different countries of the world, but their findings have little relevance to the agro-ecological situation of Bangladesh. However, literature available in this respect at home and abroad has been reviewed here, which will contribute useful information to the present study.

2.1 Influence of planting date

Hossain *et al.* (2004) experiment was conducted to study, the effect of different planting date and variety on the extension of picking period of tomato at the Horticulture Farm, BAU, Mymensingh during 2000-2001. Yield and yield contributing characters were best in October 25 planting. The highest yield of tomato (86.40 t ha^{-1}) was obtained from October 25 planting, compared to the lowest (16.8 t ha-1) from February 24 planting. The variety BARI Tomato 7 produced the highest yield (57.02 t ha-1) and BARI Tomato 5 produced the lowest yield (51.38 t ha-1). All the parameters showed decreasing response with delay in planting.

A field study was conducted in Karaj, Iran, each year for 3 years (from 1984 to 1986) to investigate whether tomato cultivar or transplant age would reduce flower drop or increase fruit set and thereby increase yield. Seeds of tomato cultivars Ace 55 VF,

Primo Early, Koral and Pacesetter 502 were sown in an unheated glasshouse on 6 March, 21 March and 5 April. Transplants at different growth stages were transferred to the field simultaneously on 10 May. Fruit setting rate was measured for 2 successive inflorescences per plant and at 2 periods (before and during the onset of high summer temperatures). Before the onset of high temperatures, Koral had the highest fruit setting rate (88.58%), followed by Pacesetter 502 (84.73%), Ace 55 VF (71.47%) and Primo Early (68.14%). Young (5-week-old) transplants had highest fruit setting rate (81.69%), followed by medium-aged (7-week-old) transplants (76.94%) and old (9-week-old) transplants (76.04%). During the onset of high temperatures, fruit setting rate was highest for 1986 (91.7%), followed by 1985 (83.6%) and 1984 (42.7%), but there were no significant differences in yield and number of fruits harvested among the different cultivars and transplant ages. Overall, fruit setting rate before the onset of high temperatures was higher than that during the onset (82.9% and 72.7%, respectively). Cultivar and transplant age had no significant effects on mean yield per plant. In conclusion, sowing date of tomatoes did not have any effect on the reduction of flower drop (Benedictos *et al.*, 2000).

The optimum sowing time for producing off-season tomatoes (cv. House Momodaro) in highland areas of Korea Republic was investigated by Jang *et al.* (1997). They mentioned that, seeds were sown on 25 June, 15 July and 15 August. Time from sowing to anthesis was 25, 13 and 12 days for the June, July and August plantings, respectively. Fruit weight for the June and July plantings was 182-194 g. marketable fruits were produced primarily between September and October for June plantings and between October to November for July and August plantings. Marketable yield

during the off-season (October-November) was hughest (42.74 t/ha) for plants sown in July.

Sharna and Tiwari (1996) carried out an experiment in India during 1989-90 to study the effect of planting time (13 February, and 5 and March) on yield and yield contributing characters of tomato. They reported that, transplanting on 13 February resulted in greater percentage of fruit set (82.23%) and number of fruits/plant (48.70) than transplanting on 5 or 25 March. But individual fruit weight, diameter and total and marketable yields were greater with transplanting on 5 March.

Drost and Price (1991) while investigating into the effect of planting date and tillage system on the growth and yield of tomato (cv. VC 82) at Michigan State USA, and reported that, planting date had no lasting effect on plant height, but late planting (2 June) led to fewer flower trusses than early planting (7 May). Late planting reduced the number of fruit and yields, but increased the weight of fruit compared to early plantings (7 or 19 May).

Kadam and Deore (1990) studied the influence of planting time on the yield and fruit characters of tomato (cv. Pusa Ruby) in India, and found that, the highest yield (.0911 kg/plant) was obtained from planting on 15 November. Similar result was also obtained in another experiment conducted by Kadam *et al.* (1990)

The vegetable section of Bangladesh Agricultural Research Institute (BARI, 1989) reported that, 15 November planting produced significantly higher tomato yield (68.68 t/ha), followed by 1 October (35.82 t/ha) and 1 January (5.44 t/ha) planting.

The maximum number (21/plant) as well as weight (1.85 kg/plant) of fruits per plant. The minimum number (5/plant) and weight (0.19 kg/plant) of fruits in plants obtained from 1 January planting were possibly due to adverse effect of high temperature on fruit setting.

An experiment was conducted by Hoque and Rahman (1988) at the Bangladesh Agricultural Research Institute Farm, Joydebpur, Gazipur, to study the performance of some promising tomato lines at different planting dates. The reported that, the earlier planting produced tallest plant with highest number of flowers, fruits as well as highest yield than delayed planting.

In Uruguay, Maeso (1982) observed that, when tomato seeds were sown in the nursery on 17 September, 6 October, 25 October and 12 November and transplanted on 1 November, 21 November, 6 December and 21 December, respectively, the yield was maximum at the first sowing date. Similar results were also reported by Nandpuri *et al.* (1974). They found that November planting gave by far the best yield.

While working with tomato, Abrams and Julia (1979) reported that, date of planting had a significant effect on yield and number of marketable tomatoes. The highest yield was obtained from January, intermediate yield from November and March and lowest yield from July, September and May planting.

Adelana (1977) reported that, the earliest planting resulted in greater leaf area, higher yield and number of fruits per plant and greater average fruit weight than later planting.

Sowing date and age of transplanting had a tremendous effect on growth and yield of tomato in Bulgaria (Tongova and Zhelev, 1975). The authors reported that both early sowing and early planting gave increased yield. The highest early and total yields were produced by sowing on 20 September and transplanting at 4-5 leaf stage.

In Yugoslavia, Popovic (1975) found that, the sowing date affected the maturity and yield of tomato significantly. He also reported that, the best result was obtained from the early sown crop.

2.2 Effect of variety on growth and yield of tomato

Hamid *et al.* (2005) carried out an experiment to study the performance of five Russian (Raickoi Naclazdenie, Belai Nalev, Ceberckoi Ckorocpelai, Novichok, Patris) and one local variety of tomato under Rawalakot conditions during the year 2003. The results indicated that maximum plant height and size of fruit were observed in variety Raickoi Naclazdenie, whereas maximum number of flower clusters and fruits per plant were observed in 'Patris'. Minimum plant height, number of flower clusters and fruits were noted in Novichok, where as minimum number of branches and fruit weight/plant %vas noted in Local Kashmir. Varieties Ceberckoi ckorocepali and Patris gave maximum fruit weight of 4.96 and 4.85 kg/plant compared to the minimum of 1.60 kg/plant by local check and Novichok. Exotic varieties Patris and Ceberckoi ckorocpali are recommended for commercial cultivation due to high production.

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.

Khalid (1999) conducted an experiment with two winter (Ratan and Bahar) and three summer (BINA Tomato-2, BINA Tomato-3 and E-6) varieties of tomato during the winter season of 1998-99 at the Horticulture farm, BAU, Mymensingh. He observed that, the highest yield/plant was obtained from BINA Tomato-2 (1.74 kg), followed by BINA Tomato-3 (1.67 kg). But the yields of these varieties were statistically similar to each other.

In Nepal, an experiment was conducted by Lohar and Peat (1998) 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 28-23° C (day/night) and latest in CL-1131 at 15/10° C. they also indicated that, cv. CL-1131 was suiable 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° C regime.

An experiment was conducted with two summer tomato varieties (BINA Tomato-2 and3) to study the yield performance at 3 locations (Maguraqa, Comilla and Khulna) during the summer season (BINA, 1998). It was obsertved that, BINA Tomato-2 produces higher fruit yield at Magura (38 t/ha) and Khulna (17 t/ha), while BINA

Tomato-3 gave higher yield (29 t/ha) at Comilla. However, mean fruit yield from three locations showed that, the variety BINA Tomato-2 produced higher fruit yield than BINA Tomato-3.

Singh and Sahu (1998) conducted a field experiment at Keonjhar, Orissa, India during rabi 1991-92 and 1992-93 to evaluate 23 tomato cultivars to find out a suitable variety for winter season cultivation. They reported that, BT 12 produced the highest yield 17(34.09 t/ha) closely followed by BT 17, PED, BT14, Sel 120, BT 1 and Punjab Chhuhara. The variety Sel 120 had the highest weight and girth of fruit, whereas Punjab chhuhara produced the maximum number of fruit/plant and took less time to mature. The variety Arka Alok was earliest and haf large fruits. Marglobe had the maximum vegetative growth.

A field trial was conducted in Jordan 1993 to study the yield of 13 local and introduced open pollinated tomato cultivars, and to compare the yields to that of 3 common hybrids (Maisara F_1, 898 F_1 and GS12F_1) in relation to seasonal distribution of marketable and unmarketable yield and fruit number. The cultivars varied in their marketable yield during the harvested period (10 weeks from 22 June 1993). The results indicated that the cultivars Rio Grande, Nagina and T_2 improved were superior to the hybrids (Ajlouni *et al.,* 1996).

An experiment was conducted at Wooster, USA with the hybrid processing tomato 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.

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 THL-2312) in 1990 and 1992. Mean annual yield was highest in Punjaab Kesari and lowest in Punjab Tropic. The number of fruits per plant was highest in Punjab Kesari (123). Punjab Tropic produced the largest fruits (66.69g).

Kallo (1989) worked with some tomato varieties (Pusa Early Dwarf, HS 102, Hisar Arun (Sel 7) And Punjab Chhuhara) in northan India, Kalloo (1989) repored that, HS 102 and Punjab Chhuhara were fit for summer cultivation, and Pusa Early Dwarf and Hisar Arun were suitable for getting early fruits.

Ahmed *et al.* (1986) aassessed eight F-7 lines of tomato at the Horticulture Farm, Bangladesh Agricultural University, Myensingh. All the lines had shown indifference in plant height and fruit size. In contrast, fruit number had shown significant difference among the varieties. The line 0014-60-3-9-1-0 gave the highest yield of fruit (56.9 t/ha), followed by 0013-52-10-27-32-0 (50.0 t/ha).

An experiment was carried out under a BARC financed project BVRD, at its Joydebpur Sub-Centre, Gazipur during the summer season of 1976 with three tomato varieties. It was found that, the variety Hope-1 was more adapted to our summer climate than the other two. Although Hope-1 produced smaller fruits, it produced the highest number of fruits (16) per plant, as well as the highest yield (9.24 t/ha), indicating that the variety could tolerate heat and high humidity of Bangladesh better than the other two varieties (Hossain and Haque, 1984).

An investigation was carried out by Sarker and Hoque (1980) to compare the yielding ability and to assess the distinguishing external morphological characters of seven varieties of tomato during the period from October, 1977 to March 1978. The varieties were Master No. 2, Ramulas, Roma, Rambo, Marmande, Bigo and World Champion. They reported that, the Rambo produced the highest yield (28.28 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 Ramuas (20.21 t/ ha).

An experiment was conducted by Thomas *et al.* (1979) in India with some tomato varieties to study the yield and fruit characters. They reported that dwarf money maker was the highest yielder (50 t /ha) having the longest fruiting period. The cultivar V. 687 and Parc-5 also gave higher yields that Gaamed, Punjab Chhuhara and Roma.

Prasad and Prasad (1977) carried out an experiment with 8 varieties tomato in India. The highest yield was obtained from Kalyanpur Angurlate followed by kolyanpur T_1 and Sioux. The Kolyanpur T_1 had the highest fruit.

In 1969-70, a yield trial was conducted with five varieties of tomato (Oxheart, Sinkurihara, L-7, Marglobe and Bulgaria) at the Vegetable Division of Agricultural Research Institute, Dhaka. The experiment was repeated in 1971-72. In both years, the varieties Oxheart and Sinkrihara were found to be similar and significantly higher yielder than the other (Hoque *et al.*, 1975).

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

2.3 Influence of planting date and variety

An experiment was carried out by Hossain M. M. (2001) at the Horticulture Farm, BAU, Mymensing with four tomato varieties namely BARI Tomato-4, BARI Tomato-5,BARI Tomato-7, BARI Tomato-8 and three planting dates (October -25, December-25, and February-24).Planting dates and varieties had significant influence on growth, yield contributing parameters and yield of tomato. The highest yield of tomato (86.40 t/ha) was obtained from October 25 planting compared to lowest in February planting. Variety BARI Tomato-7 gave the highest yield (100.13 t/ha) in October 25 planting.

Nessa *et al.* (2000) conducted an experiment to study the comparative performance of ten genotypes of tomato in late planting and reported that the genotype BAU/TM 0058 was the best in late planting. It was closely followed by BAU/TM 0041. They also state that, fruit number and fruit weight should be considered as important criteria for higher yield.

Islam (2000) conducted a field experiment with four dates of planting (16 October, 15 November and 14 January) and four varieties (BINA Tomato- 2, BARI Tomato- 3, BARI Tomato- 4, BARI Tomato- 5) at the horticulture farm, BAU, Mymensingh during the period from September, 1999 to May, 2000, to extend the pocking period of tomato through selection of variety and adjustment of date of planting. He mentioned that, the highest yield of tomato (53.65 t/ha) was achieved from 16 October planting. The variety BARI tomato-3 produced the highest yield (50.65 t/ha) and BINA Tomato- 2 gave the lowest yield (34.80 t/ha). On average, fruit picking period was the longest (33.81 days) in October 16 planting, while it was shortest in January 14 planting. The picking period was the longest (40.28 days) in BARI Tomato- 3 planted on October 15, while it was shortest (14.80 days in BINA Tomato- 2 planted on January 14. In all plantings, BARI Tomato- 3 exhibited relatively longer picking period.

An investigation was carried out at Joydebpur to determine the optimum time of planting for BARI developed hybrid tomatoes, during summer (BARI, 1998). There were four dares of planting, namely, 15 May, 15 June, 15 July and 15 August, and three tomato varieties, namely, TM 0836, TM 0831 and TM 0832. It was observed that, planting time did not result any significant variation on the plant characters, except TSS. However, the maximum yield was found, when the crop was planted on 15 August. On the contrary, TM 0832 was the highest yielding hybrid (59 t/ha), which was significantly different from other hybrids.

While working with seven tomato cultivars (BTI, Arka Alok, LE79, VC 48-1, Best of All, Arka Abha and AC 238), Phokan *et al.* (1997) mentioned that, the varieties were planted in March and July under a plastic cover at Jorhat, Assan, India. The highest fruit set of 27.85% was observed in BTI in the March planting and 22.38% in July planting.

Hanson *et al.* (1996) conducted a field experiment to assess the seasonal variation in fruit yields among 22 determinate tomato inbred lines (commonly grown in low land and Mid-elevation areas of southwest Asia) grown during the simmer and a dry season at Los Banos, Philippines and Kamphaengsaen, Thailand. The lines, MTi, Mapula and CL 5915-93D4-1-0-3 performed well in both seasons, although they had small fruits. Marikit had the highest mean yield in both locations in the dry season, but did not perform well in the summer season.

Singh and Tripathy (1995) stated that, a field experiment was conducted at Regional Research Station, Orissa, India during the rainy season of 1992 to study the growth and yield of four tomato genotypes (Pusa Ruby, LE79, BT1 and Arka Alok). The cultivars showed significant genotypic variation for vegetative growth, fruit characters and yield when sown on different dates (20 June, 5 and 20 July and 5 and 20 August). The line LE97 gave the highest fruit yield (12.2 t/ha) and Arka Alok produced significantly larger fruits (20.3 cm in diameter and 136 g in weight). Sowing on 20 June was significantly favourable for fruit yield as well as its contributing characters, like fruits weight (60.8 g), length (9.8cm) and girth (16.2 cm).

An experiment was carried out by Bhardwaj *et al.* (1995) to study the effect of planting time (1,10 or 20 May) and spacing on the growth and yield of three tomato cultivars (Solan Gola, Money Maker and Naveen) in Himachal Prodesh of India. They found that, close spacing and early planting increased harvest duration. The yield was not significant affected by planting time and spacing. Naveen had the largest fruits (83.2g) and produced the highest yield (44.1 t/ha). They also found that, the heaviest fruits were produced in 10 May planting.

A varietal trial was conducted by Berenyi (1995), with 16 tomato varieties and hybrids at seven sowing dates on two experimental stations in Vietnum for adaptation. Thirteen varieties were also tested on farmer's plots. Due to climatic conditions and plant physiology, the varieties were not suitable for sowing between 1 May and 8 August. The main sowing seasons were from 30 January to 15 February and from 15 August to 10 December. Four varieties (Chico III, Mobil, Washington F_1 and Gala F_1) were recommended for the first sowing date, and seven (K. Korai Bibor, Nivo (K-555), Treff, Mobil, Chico III, Peto-98 and UC 134-1-2) for the second planting date.

A field Experiment was conducted by Jamwal *et al* (1995) at the Regional Research Station, Bajaura, India during the summer of 1990 with two tomato cultivars, Roma and Sioux. The varieties were planted on 20 April and 20 May. They reported that, yield per hectare was similar for both cultivars; Roma produced significantly more

fruits per plant, but had lower individual fruit weight than Sioux. Planting on 20 April gave better result than later planting.

An experiment was carried out by Phookan and Shadeque (1995) at Jorhat, Assam, India in order to test different genotypes of tomato during 4 seasons, Viz. early spring, spring, summer and autumn. Out of 29 genotypes, 7 were common in all the 4 seasons. Seedlings of one month age were planted on 7 March, 7 May, 7 July and 7 September in 1991 under plastic rain shelter. The authors reported that the crop planted in September gave the highest yield, being 91.10, 74.66 and 67.88% higher than that planted in May, July and March, respectively. Among the different varieties, the highest yield was recorded in Arka Abha (1.5 kg/plant) followed by Arka Alok (1.19 kg/plant).

Effect of different varieties (Punjab Chhuhara, Pusa Ruby and Pusa Early dwarf) and planting season (summer, Kharif and Rabi) on seed yield and quality of tomato was investigated at maharastra, India during 1988-89 by Meher *et al.* (1994). They reported that the varieties Pusa Ruby and Pusa Early Dwarf produced the highest fruit yield/ha during all three planting seasons. Among the different seasons, all three varieties performed very well during Rabi season is respect of fruit yield. The Pusa Early Dwarf was able to give substantially high fruit yield during summer season than Pusa Ruby and Punjab Chhuhara Punjab Chhuhara, suggesting its wider adaptability over different seasons and special ability to perform under summer season in comparison to Punjab Chhuhara. Punjab Chhuhara appeared to be very specific to Kharif and Rabi seasons. The variety and seasonal interactions have been

reported by various workers, such as, Gautam *et al.* (1981), Hossain and Haque (1984).

To study the effect of planting time (15 November, 30 November and 15 December) on the growth and yield of tomato variety Marglobe, Taleb (1994) conducted an experiment at the horticulture farm of Bangladesh Agricultural University, Mymensingh. He found that November 15 planting produced the tallest plants (129.4cm) and maximum yield per plant (4.29 kg), which was statistically different from all other dates of planting.

Akhter (1993) carried out an experiment at the regional Agricultural Research Station, Ishurdi, Pabna during the period from February to July 1992 to study the effect of different doses of NAA and planting dates (1 March and 1 April) on two heat tolerant tomato advance lines (TM 0111 and TM 0367). He observed that, March planting produced significantly higher yield (21.45 t/ha) than April planting (7.81 t/ha). The yield of TM 0111 (15.05 t/ha) was higher than TM 0367 (14.22 t/ha), but that was not statistically significant.

Shukla *et al.* (1990) conducted an experiment with seven diverse tomatos F_1 hybrids, namely Rupaly, Vaishali, Mangala, Karnatka, MTH-1, MTH-2 and MTH-3 compared with a local standard variety Solan Gola at two transplanting dates (May and June). They reported that, Mangala and Solan Gola produced the maximum and minimum fruit length, respectively. Transplanting in May and widest spacing (90 x 45 cm) resulted in larger fruit than June transplanting and closer spacing.

Reddy *et al.* (1989) carried out an experiment to study the screened tomato germplasms suitable for summer cultivation in North Indian conditions. For this, they followed early and late plantings during March 1981. They observed that, two genotypes in early planting, two in late planting and one in both planting were earliest of all the genotypes. One accession, Shift had produced commercially acceptable fruit size in the first planting. In the second planting, all the accessions showed very poor performance with respect to fruit setting, weight and yield.

In another experiment, conducted at the Vegetable Section of Bangladesh Agricultural Research Institute (BARI, 1986) with some tomato lines planted at different dates, larger fruits were obtained from late planting. It was also noticed that, tomatoes when planted early in October or November required more time to mature than planted in January.

Hossain *et al.* (1986) conducted an experiment with 15 tomato lines in the grey flood plain soils of the Regional Agricultural Research Station, Jamalpur during the period 1983-84 to study the performance of some tomato lines sown at different dates (2 Sep. 2 Oct. and 2 Nov.). They reported that, November was the best time for sowing tomato seed in seed beds as compared to October or September sowing. The line TM 0367 gave significantly higher yield (52.2 t/ha) than other lines. They also reported that, early November sowing gave significant higher yield than September or October sowing. The results in general are in agreement with the findings of a study conducted at Joydebpur (Hoque, 1983). The line TM 0367 produced significantly

higher yield (54.2 t/ha) than other lines under study. The line TM 0369 yielded the lowest (27.9 t/ha).

Ravikumar and Shanmugavelu (1983), while investing into the effect of different planting method and time of sowing on yield and quality of some tomato varieties found that, the number of fruits per plant and mean yield per plant decreased with delay in sowing date. Similar results were also reported by Dayan et al. (1978). They indicated delayed planting reduced over all yields.

A varietal trial was conducted by Bhuya and Haque (1983) at the Agricultural Research Sub-station, Pahartali, Chittagong to evaluate tomato varieties for winter and summer cultivation. They observed better performance of all the varieties in winter season, while only five varieties survived in the summer season under the excessive rainfall. In the winter season, the yield, however, appeared statistically similar amongst the varieties. However, of the two seasons, yield in summer was lower. The result further suggested that, there were specific genotypes for summer cultivation here in Bangladesh.

Popovic (1977) mentioned in report that, sowing date affected the duration of developmental phases and total growth period of tomato varieties. Mid April was found to be the optimum time for planting tomato in Yugoslavia. On the other hand, Zakoyan (1974) reported that, the highest yield was obtained from plants transplanted on 20 April.

From the above mentioned review of literature it appears that the date of planting time and varieties play an important role on the growth and yield of tomato in a particular location. The date if planting time and variety may have variable effects on the extension of picking period of tomato depending upon location, season, and management practices. The present study will be conducted to find out suitable varieties and their optimum planting time to achieve longer picking period and maximum yield of tomato.

Chapter 3

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in carrying out the experiment. It includes a short description of location of the experimental plot, characteristics of soil, climate and materials used for the experiment. The details of the experiment are described below.

3.1 Location of the experiment field

The field experiment was conducted in the Horticulture farm of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during October 2007 to March 2008.

3.2 Climate of the experimental area

The experimental area is characterized by subtropical rainfall during the month of May to September (Anon., 1988) and scattered rainfall during the rest of the year. Information regarding average monthly, Soil temperature as recorded by Bangladesh Meteorological Department (climate division) during the period of study has been presented in Appendix I.

3.3. Soil of the experimental field

The soil of the experimental field was sandy clay loam in texture having a pH around 6.0. The soil belongs to the chita soil series of red brown terrace soil with in the AEZ number 28 (Brammer, 1971; and Shaheed, 1984). The soil was later developed by riverbed silt. The chemical analysis of the soil was performed and its characteristics have given in Appendix II

3.4 Plant materials used

In this research work, the seeds of five tomato varieties were used as planting materials. The tomato varieties used in the experiments were BARI Tomato-2, BARI Tomato-3, BARI Tomato-4, BARI Tomato-9 and BARI hybrid Tomato-4. All varieties are semi-indeterminate type and the seeds were collected from the Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI) at Joydebpur.

3.5. Raising of seedlings

Tomato seedlings were raised in two seedbeds of 3 m x 1m size. A distance of 50 cm was maintained between the beds. The soil was well prepared and converted into loose friable and dried mass by spading. All weeds and stubbles were removed and 10 kg well rotten cowdung was mixed with the soil. Four gram of seeds was sown on each seedbed, according to the date. The seeds were sown in the seedbeds (including trays) at two different dates, namely, 01 October and 15 October, 2007. After sowing, seeds were covered with light soil. Sevin 85sp was applied around each seedbed as precautionary measure against ants, worm and other harmful insects. The emergence of the seedlings took place with 6 to 8 days after sowing. Shading by polythene with bamboo structure was provided over the seedbed to protect the young seedlings from the scorching sunshine or rain. After 10 days emergence, the seedlings were transferred into a second bed to obtain healthy and vigorous seedlings. Dithane M-45 was sprayed in the seedbeds @ 2 g/litre, to protect the seedlings from damping off and other diseases. Weeding, mulching and irrigation were done as and when required.

3.6 Treatments and layout of the experiment

The experiment consisted of two factors; (A) two dates of transplanting and (B) five varieties of tomato. The levels of the two factors were as follows:

Factor A: dates of transplanting

i) 01 November (T_1)

ii) 15 November (T_2)

Factor B: variety of tomato

i) BARI Tomato-2 (V_1)

ii) BARI Tomato-3 (V_2)

iii) BARI Tomato-4(V_3)

iv) BARI Tomato-9 (V_4)

v) BARI hybrid Tomato-4(V_5)

For which 10 treatment combinations were as follows:

Variety / Dates of transplanting	V_1	V_2	V_3	V_4	V_5
T_1	T_1V_1	T_1V_2	T_1V_3	T_1V_4	T_1V_5
T_2	T_2V_1	T_2V_2	T_2V_3	T_2V_4	T_2V_5

The seedlings were 30 days old in each date of transplanting

3.7 Design and layout of the experiment

The experiment was laid out in Randomized complete Block Design (RCBD) having two factors with three replications. An area was divided into three equal blocks. Each block was consists of 10 plots where 10 treatments were allotted randomly. These

there were 30 unit plots altogether in the experiment. The size of each plot was 4.8m x 1m. The distance between two blocks and two plots were kept 60 cm and 30 cm respectively.

3.8 Cultivation procedure

3.8.1. Land preparation

The land for growing the crop was first opened with a tractor on 15 October, 2007. Later on the land was ploughed three times followed by laddering to obtain desirable tilth. The corners of the land were spaded and larger clods were broken into smaller pieces. After ploughing and laddering, all the stubbles and uprooted weeds were removed and then the land was ready. Finally, the unit plots were prepared as 15 cm raised beds. Ten pits were made in each plot in two rows maintaining a recommended spacing of 60cm × 40cm. The field layout and design or the experiment was followed immediately after land preparation.

3.8.2. Manure and fertilizers and its methods of application

Manure and fertilizers were applied in the experimental field as per the following doses in accordance with the recommendation of BARI (1996).

Manure/ fertilizer	Total amount per hectare	Applied during land preparation	Applied in pit a week before transplanting	Applied as top dressing in rows	
				1st installment after 3 weeks of transplanting	2nd installment after 5 weeks of transplanting
cowdung (t)	10	5	5	-	-
Urea (Kg)	550	-	200	175	175
TSP (Kg)	450	-	450	-	-
MP (Kg)	250	-	100	75	75

3.8.3 Transplanting of seedlings

Healthy and uniform 30 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots in the afternoon of 01 November and 15 November, 2007 for the first and second planting, respectively. The seedbed was watered before uprooting the seedlings from the seedbed so as to minimize damage to the roots. The seedlings were watered after transplanting. Shading was provided using banana leaf sheath for three days to protect the seedling from the hot sun and removed after seedlings were established. Seedlings were also planted around the border area of the experimental plots for gap filling.

3.8.4 Intercultural operations

After transplanting the seedlings, various kinds of intercultural operations were accomplished for better growth and development of the plants, which are as follows,

a) Gap filling

When the seedlings were well established, the soil around the base of each seedling was pulverized. A few gaps filling was done by healthy seedlings of the same stock where initial planted seedling failed to survive.

b) Weeding and mulching

Weeding and mulching were accomplished as and whenever necessary to keep the crop free from weeds, for better soil aeration and to break the crust. It also helped in soil moisture conservation.

c) Staking and pruning

When the plants were well established, staking was given to each plant by Dhaincha (Sesbania sp.) and bamboo sticks to keep them erect. Within a few days of staking, as the plants grew up, the plants were given a uniform moderate pruning.

d) Irrigation

Light irrigation was provided immediately after transplanting the seedlings and it was continued till the seedlings established in the field. Thereafter irrigation was provided.

e) Plant protection

Insect pests: Malathion 57 EC was applied & 2 ml l^{-1} against the insect pests like cut worm, leaf hopper, fruit borer and others. The insecticide application was made fortnightly for a week after transplanting to a week before first harvesting. Furadan 10 G was also applied during final land preparation as soil insecticide.

Disease: During foggy weather precautionary measured against disease infection of tomato was taken by spraying Dithane M-45 fortnightly & 2 g l^{-1}, at the early vegetative stage. Ridomil gold was also applied @ 2 g l^{-1} against blight disease of tomato.

3.9 Harvesting

Fruits were harvested at 5-day intervals during early ripe stage when they attained slightly red color. Harvesting was started from 26 February, 2008 and was continued up to 29 March 2008.

3.10 Data collection

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

i) Plant height (cm)

Plant height at final harvest was measured from sample plants in centimeter from the ground level to the tip of the longest stem and mean value was calculated. Plant height was also recorded at 15 days interval starting from 15 days of planting up to 65 days to observe the growth rate of plants. Lastly, the height was recorded at final harvest.

ii) Number of leaves per plant

It was recorded by the following formula

$$\text{Number of leaves per plant} = \frac{\text{Total number of leaves from ten sample plants}}{10}$$

iii) Length and breadth of the largest leaf

Length and breadth of the largest leaf of each sample plant was recorded and sum total of them was divided by the total number of leaves of the sample plant.

iv) Days to 50% flowering

The date of 50% flowering on the sample plants was recorded, and the period required in days from the date of transplanting was calculated. The date of opening of the first flower of fifty percent was considered as the date of 50% flowering.

v) Number of flowers per cluster

Total number of flowers was counted from selected flowers cluster of sample plant and was calculated by the following formula:

$$\text{Number of flowers per cluster} = \frac{\textbf{Total number of flowers from ten sample plants}}{\textbf{Total number of flowers clusters from ten sample plants}}$$

vi) Number of fruits per cluster

Total number of fruits was counted from selected cluster of sample plant and was calculated by the following formula:

$$\text{Number of fruits per cluster} = \frac{\text{Total number of fruits from ten sample plants}}{\text{Total number of fruits clusters from ten sample plants}}$$

vii) Number of fruits per plant

It was recorded by the following formula

$$\text{Number of fruits per plant} = \frac{\text{Total number of fruits from ten sample plants}}{10}$$

viii) Percent of fruit set

It was recorded by the following formula

$$\text{Percent of fruit set} = \frac{\text{Total number of fruits per cluster from ten sample plants}}{\text{Total number of flowers per cluster from ten sample plants}} \times 100$$

ix) pollen viability

Five flowers were collected from each of the sample plants and pollen from individual flower were collected on slides and treated with reagent (aceto carmine) and then observed under microscope. The viable pollen remain stained (pink color) where the non-viable are darken. Finally, pollen viability was calculated by the following formula

$$\text{Pollen viability} = \frac{\text{Total number of viable pollen}}{\text{Total number of pollen}} \times 100$$

x) Days to first harvesting

Dates of first harvesting were recorded treatment wise and the period of time for first harvesting in days was calculated from the date of transplanting.

xi) Days to last harvesting

Dates of last harvesting were recorded treatment wise and the period of time for last harvesting in days was calculated from the date of transplanting.

xii) Fruit picking period

It was determined from the difference between days to first and last harvesting.

xiii) Weight of individual fruit

Among the total number of fruits harvests during the period from first to final harvest, the fruits, except the first and last harvests, were considered for determining the individual fruit weight in gram.

xiv) Fruit length (cm)

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

xv) Fruit diameter (cm)

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

xvi) Total soluble solid (TSS) content

A fruit was sliced into two halves horizontally with a sharp knife and a small quantity of juice from them was used to determine TSS in percentage with TSS meter.

xvii) Firmness

It was determined with a digital Firmness recording meter. A fruit was touched with one end of the meter and slight pressure was given on the fruit skin and then it shows average result digitally.

xviii) Number of branches per plant

It was measured by the following formula

$$\text{Number of branches per plant} = \frac{\text{Total number of branches from ten sample plant}}{10}$$

xix) Weight of fruits per plant (kg)

It was measured by the following formula

$$\text{Weight of fruits per plant (kg)} = \frac{\text{Total wt of fruits from ten sample plants}}{10}$$

xx) Yield of fruits per plot (kg)

A per scale balance was used to take the weight of fruits per plot. It was measured by totaling the fruit yield of each unit plot separately during the period from fruit to final harvest and was recorded in kilogram (kg).

xxi) Yield of fruits per hectare (ton)

It was measured by the following formula

$$\text{Fruit yield per hectare (ton)} = \frac{\text{Fruit yield per plot (kg) x 10000}}{\text{Area of plot in square meter x 1000}}$$

3.11 Statistical analysis

The recorded data on various parameters were statistically analyzed. Using MSTAT statistical package programmed. The mean for all the treatments was calculated and analysis of variance for all the characters was performed by F-test. Difference between treatment means were determined by Duncan's new Multiple Range Test (DMRT) according to Gomez and Gomes, (1984).

Chapter 4

Results and Discussion

CHAPTER IV

Results and Discussion

This chapter comprises the presentation and discussion of the results from the experiment. The experiment was conducted to determine the effects of different planting dates and five varieties on the growth, yield components and yield of tomato. Some of the data have been presented and expressed in Table (s) and others in Figures for ease of discussion, comparison and understanding. A summary of the analysis of the variances in respect of all the parameters have been shown in appendices, and possible interpretation wherever necessary have given under the following headings.

4.1 Plant height

Plant height is one of the impotent parameter, which is positively correlated with the yield of tomato, Taleb (1994). Plant height was recorded at different days after transplanting (DAT) and during the final harvest. The trends of plant height at different DAT have been presented graphically (Fig. 1).

The effect of two different dates of transplanting on plant height at final harvest was no significant (Appendix III). At final harvest, November 01, 2007 planting produced the tallest plant (120.08 cm) and the shortest plant (120.06 cm) was produced by November 15, 2007 planting, which statistically similar to both time (Table 1).In general, earlier planting produced taller plants than delayed planting in the present study. The present result agreed with the reports of Hoque and Rahman (1998).

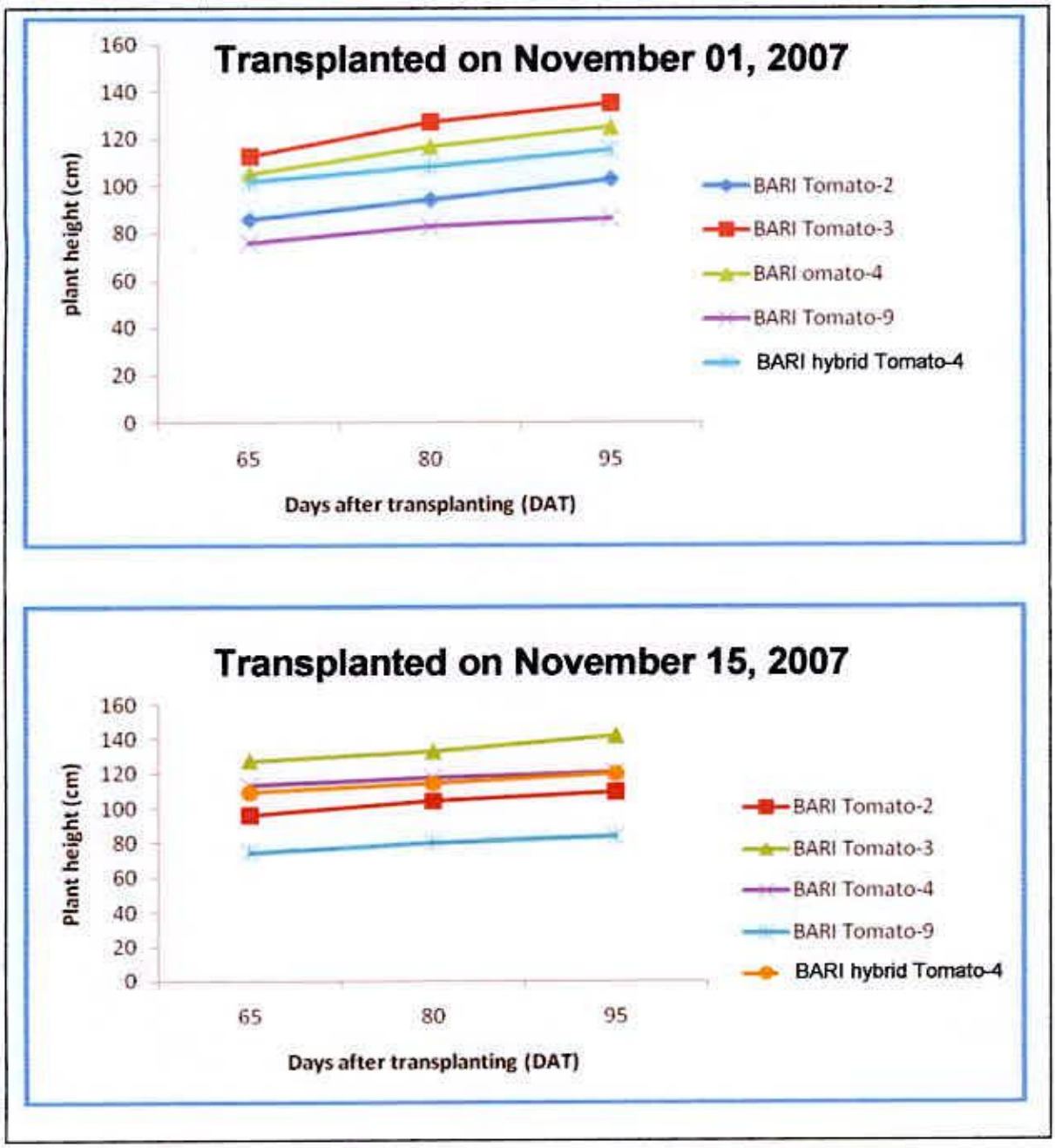

Figure 1.Combined effects of date of planting and variety on the height of tomato plants at different days after transplanting.

Table 1 Main effects of date of transplanting on the growth of tomato

Treatment	Plant height at final harvest	Number of branches per plant	Number of leaves per plant	Leaf length(cm)	Leaf breadth(cm)
November 01, 2007	120.08	2.73	128	32.64	29.18
November 15, 2007	120.06	2.93	133.47	34.43	31.11
$LSD_{(0.05)}$	33.36	4.40	60.98	17.03	10.31
Level of significance	NS	NS	NS	NS	NS
CV (%)	2.68	14.99	4.5	4.9	3.3

NS- non significant

Table 2 Main effects of the variety on the growth of tomato

Treatment	Plant height at final harvest	Number of branches per plant	Number of leaves per plant	Leaf length(cm)	Leaf breadth(cm)
BARI Tomato-2	110.7d	3.25	107.8bc	33.32b	29.68b
BARI Tomato-3	144.1a	2.54	234.5a	38.07a	32.4a
BARI Tomato-4	132.6b	2.71	121.2b	31.6b	29.53b
BARI Tomato-9	89.73e	3.21	95.67c	32.07b	29.7b
BARI hybridTomato-4	123.2c	2.46	94.5c	32.62b	29.4b
$LSD_{(0.05)}$	7.293	0.9618	13.33	3.72	2.26
Level of significance	*	NS	*	*	*
CV (%)	2.68	14.99	4.5	4.9	3.3

Means bearing the common letter (s) in a column do not differ significantly at 5% level

*significant at 5% level of probability

NS- non significant

Plant height at final harvest due to the influence of different varieties was significant (Appendix III). The variety BARI Tomato-3 had the highest plant height (144.1 cm) which was statistically different from other four varieties. However, the lowest plant height (89.73 cm) was obtained from the variety BARI Tomato-9 (table 2). Varietal influence on plant height was also reported by Hossain *et al.* (1986).

The analysis of variance (Appendix III) indicated a significant variation among the treatment combinations in plant height at final harvest. The tallest plant height (146.6cm) was found in BARI Tomato-3 planted on November 15, 2007 planting, whereas the smallest plant height (98.55 cm) was found in BARI Tomato-9 planted on November 01, 2007 (Fig. 2). The variation among the treatment combination was characteristics of different varieties and variation in the prevailing temperature under different dates of planting. The plant height at different DAT has been presented graphically in Fig. 1 to understand the growth pattern of different varieties planted at different dates. Plant height increased gradually up to a certain limit with the passing of time. The interaction effect of date of planting and variety in plant height at final harvest was significant (Appendix III).

4.2 Number of branches per plant

The different time of planting showed no significant variation in the number of branches per plant. The maximum number of branches per plant (2.93) was produced by November 15, 2007 planting. November 01, 2007 planting produced the minimum number of branches per plant (2.73) (Table 1).Number of branches per plant due to the influence of different varieties was no significant (Appendix III).

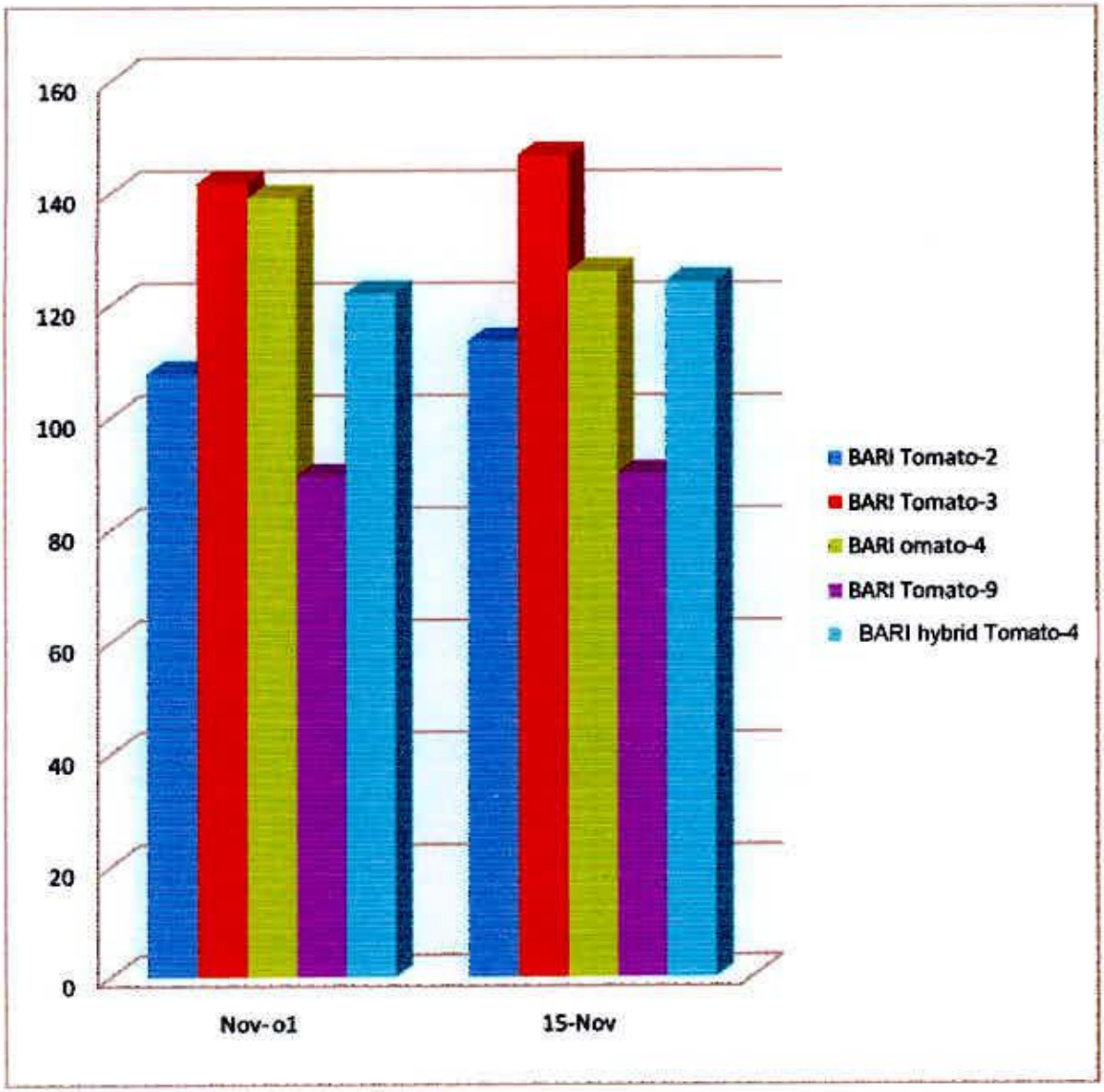

Figure 2. Combined effects of date of planting and variety on plant height of tomato at final harvest.

The variety BARI Tomato-2 had the highest number of branches per plant (3.25) and the lowest number of branches per plant (2.46) was obtained from the variety BARI hybrid Tomato-4 (Table 2).

The interaction between different time of planting and variety was found significant on the number of branches per plant (Appendix III). The maximum number of branches per plant (3.33) was found in BARI Tomato-9 planted on November 01, 2007 planting, whereas the lowest number of branches per plant (2.25) was found in BARI hybrid Tomato-4 planted on November 01, 2007 (Table 3).

4.3 Number of leaves per plant

A good number of leaves indicted better growth and development of crop. It is also possibly related to the yield of tomato. The greater number of leaf, the greater the photosynthetic area which may result higher fruit yield. The different time of planting showed no significant variation in the number of leaves per plant. The maximum number of leaves per plant (133.47) was produced by November 15, 2007 planting November 01, 2007 planting produced the lowest number of leaves per plant (128) (Table 1).

Number of leaves per plant due to the influence of different varieties was significant (Appendix). The variety BARI Tomato-3 had the highest number of leaves per plant (234.5) which was statistically different from other four varieties. However, the lowest number of leaves per plant (94.5) was obtained from the variety BARI hybrid Tomato-4 and BARI Tomato-9 is statistically similar (Table 2).

Table 3 combined effects of date of planting and variety on the growth of tomato

Treatment combination		number of branches per plant	number of leaves per plant	leaf length(cm)	leaf breadth(cm)
Planting time	Variety				
November 01, 2007	BARI Tomato-2	3.25a	113.3de	32.83bc	28.37e
	BARI Tomato-3	2.42bc	271.3a	35.4b	31b
	BARI Tomato-4	2.42bc	99.33f	30.87c	28.6cde
	BARI Tomato-9	3.33a	85.33g	32.4bc	29.47b-e
	BARI hybridTomato-4	2.25c	70.67h	31.7c	28.47de
November 15, 2007	BARI Tomato-2	3.25a	102.3f	33.8bc	31b
	BARI Tomato-3	2.67abc	197.7b	40.73a	33.8a
	BARI Tomato-4	3 abc	143c	32.33bc	30.47bc
	BARI Tomato-9	3.08ab	106ef	31.73c	29.93b-e
	BARI hybridTomato-4	2.67abc	118.3d	33.53bc	30.33bcd
$LSD_{(0.05)}$		0.7278	10.08	2.187	1.707
Level of significance		*	*	*	*
C V (%)		14.99	4.5	4.9	3.3

Means bearing the common letter (s) in a column do not differ significantly at 5% level

*significant at 5% level of probability

The interaction between different time planting and variety was found significant on the number of leaves per plant (Appendix III). The maximum number of leaves per plant (271.3) was found in BARI Tomato-3 planted on November 01, 2007 planting, whereas the lowest number of leaves per plant (70.67) was found in BARI hybrid Tomato-4 planted on November 01, 2007 (Table 3).

4.4 Length of the leaf

The date of planting did not influence significantly in the length of the leaf (Appendix III). The largest leaf length (34.43 cm) was found in November 15, 2007 planting and the shortest leaf length (32.64 cm) was found in November 01, 2007 planting (Table 1).

A significant variation in the length of leaf was found among the varieties (Appendix III). The largest leaf length (38.07 cm) was obtained from BARI Tomato-3 and the shortest leaf length (31.6 cm) was obtained from BARI Tomato-4, which was statistically similar to other varieties (Table 2).

The variation in leaf length due to combined effect of date of planting and variety was found statistically significant (Appendix III). The largest leaf length (40.73 cm) was found in BARI Tomato-3 planted on November 15, 2007. Whereas the shortest leaf length (30.87 cm) was found in BARI Tomato-4 planted on November 01, 2007, which was statistically similar to BARI Tomato-9 planted on November 15, 2007 and BARI hybrid Tomato-4 planted on November 01, 2007 (Table 3).

4.5 Breadth of leaf

The variation in the breadth of leaves two different date of planting did not exhibit significant variation (Appendix III). The largest leaf breadth (31.11 cm) was found in November 15, 2007 planting and the shortest leaf breadth (29.18 cm) was found in November 01, 2007 (Table 1).

A significant variation in the breadth of leaves was found among the varieties (Appendix III). The largest leaf breadth (32.4 cm) was obtained from BARI Tomato-3 and the shortest leaf breadth (29.4 cm) was obtained from BARI hybrid Tomato-4, which was statistically similar to other varieties (Table 2).

The variation in leaf breadth due to combined effect of date of planting and variety was found statistically significant (Appendix III). The largest leaf breadth (33.8 cm) was found in BARI Tomato-3 planted on November 15, 2007. Whereas the shortest leaf breadth (28.37 cm) was found in BARI Tomato-2 planted on November 01, 2007 (Table 3).

4.6 Days to 50% flowering

The different times of planting shows no significant variation in the days to 50% flowering (Appendix IV). The seedling transplanted on November 15, 2007 required the maximum time of time of 50% flowering (26.07 days). Seedlings transplanted on November 01, 2007 were the earliest in flowering (24.20 days) (Table 4). This result agreed with the result reported by Hossain *et al.* (1986). There was a marked difference among the varieties in the days to 50% flowering (Appendix IV). Delayed flowering (29 days) was found in BARI Tomato-3 and flowering was earliest

(21 days) in BARI hybrid Tomato-4 (Table 5). This difference in flower initiation was due to its varietal characters. Sing and Sahu (1998) also reported varietal influence on days to flowering.

The combined effect of different varieties and dates of planting on days to 50% flowering was found to be significant (Appendix IV). Data in Table 6 Shows that, the days to 50% flowering was minimum (20 days) in BARI hybrid Tomato-4 planted on November 01, 2007, while it was maximum (32 days) in BARI Tomato-3 planted on November 15, 2007. In case of all treatment combinations, days to 50% flowering decreased gradually with delay in planting, which might have happened due to the effect of temperature.

4.7 Number of flowers per cluster

The different time of planting showed no significant variation in the number of flowers per cluster (Appendix IV). The maximum number of flowers per cluster (6.55) was produced by November15, 2007 planting and November 01, 2007 planting produced the minimum number of flowers per cluster (5.96) (Table 4). The number of flowers per cluster decreased gradually as the temperature increased later. Similar result was reported by Hossain (2001).

There was a significant difference among the varieties in the number of flowers per cluster (Appendix IV). As evident from Table 5, the maximum number of flowers per cluster (7.36) was produced in BARI hybrid Tomato-4, which was statistically similar to BARI Tomato-4. The minimum number of flowers per cluster (4.88) was produced in BARI Tomato-3.

Table 4 Main effects of date of transplanting on the yield components of tomato

Treatment	Days to 50% flowering	Number of flower per cluster	Number of fruits per cluster	Number of fruit per plant	Fruit set (%)	Pollen viability (%)	Fruit picking period	TSS (%)	Firmness (kg)
November 01, 2007	24.2	5.95	3.88	47.2	65.20	79.99	44.17	4.58	0.99
November 15, 2007	26.07	6.55	3.19	35.07	50.74	78.54	27.17	4.33	1.10
$LSD_{(0.05)}$	25.29	6.82	4.21	45.83	23.78	3.81	22.09	3.84	1.30
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	9.71	10.53	11.50	7.8	3.96	5.2	5.73	8.38	12.10

NS- non significant

Table 5 Main effects of the variety on the yield components of tomato

Treatment	Days to 50% flowering	Number of flower per cluster	Number of fruits per cluster	Number of fruit per plant	Fruit set (%)	Pollen viability (%)	Fruit picking period	TSS (%)	Firmness (kg)
BARI Tomato-2	24.17abc	5.07b	3.03b	47.2c	59.84ab	89.47b	44.17a	4.58	0.99
BARI Tomato-3	29a	4.88b	2.70b	35.07d	55.84b	90.63a	27.17b	4.33	1.10
BARI Tomato-4	23.17bc	7.00a	4.33a	61.33b	63.47a	84.77c	44.83a	4.5	1.06
BARI Tomato-9	28.33ab	6.95a	3.33b	67.57ab	47.91c	79.6d	21c	4.33	1.16
BARI hybridTomato-4	21c	7.36a	4.30a	72.2a	62.76a	51.83e	48.83a	4.42	0.96
$LSD_{(0.05)}$	5.534	1.493	0.9236	10.03	5.198	0.8329	4.829	0.8421	0.2868
Level of significance	*	*	*	*	*	*	*	NS	NS
CV (%)	9.71	10.53	11.50	7.8	3.96	5.2	5.73	8.38	12.10

Means bearing the common letter (s) in a column do not differ significantly at 5% level

*significant at 5% level of probability, NS- non significant

Table 6 combined effects of date of planting and variety on the yield components of tomato

Treatment combination		Days to 50% flowering	number of flower per cluster	number of fruit per cluster	number of fruit per plant	Percent of Fruit set	Percent of Pollen viability	TSS (%)	Firmness (kg)
Planting time	Variety								
November 01, 2007	BARI Tomato-2	24cd	4.94d	3.17 de	52.07d	64.08b	90.47b	5.00a	0.93
	BARI Tomato-3	26bc	4.803d	2.8e	31.27f	59.39b	88.03c	4.33ab	1.06
	BARI Tomato-4	24.67cd	6.287bc	4.56ab	65bc	73.16a	85.42d	4.50ab	0.99
	BARI Tomato-9	26.33bc	6.86ab	3.68cd	71.67b	53.57de	81.49f	4.33ab	1.17
	BARI hybridTomato-4	20d	6.887ab	5.21a	53.13d	75.78a	47.27i	4.33ab	0.92
November 15, 2007	BARI Tomato-2	24.33cd	5.203cd	2.88e	42.33e	55.6cd	88.47c	4.17b	1.06
	BARI Tomato-3	32a	4.963d	2.61e	38.87e	52.29de	93.22a	4.33ab	1.14
	BARI Tomato-4	21.67cd	7.72a	4.10bc	57.67cd	53.79de	84.12e	4.50ab	1.12
	BARI Tomato-9	30.33ab	7.04ab	2.98de	63.47c	42.25f	77.72g	4.33ab	1.13
	BARI hybridTomato-4	22cd	7.83a	3.39cde	91.27a	49.74e	56.4h	4.50ab	0.99
LSD (0.05)		4.187	1.13	0.6989	7.579	3.933	0.6303	0.6372	0.217
Level of significance		*	*	*	*	*	*	*	NS
CV (%)		9.71	10.53	11.50	7.8	3.96	5.2	8.38	12.10

Means bearing the common letter (s) in a column do not differ significantly at 5% level

*significant at 5% level of probability, NS- non significant

The analysis of variance (Appendix IV) indicated a significant variation among the treatment combinations in number of flowers per cluster. The maximum number of flowers per cluster (7.83) was found in BARI hybrid Tomato-4 planted on November 15, 2007, which was statistically similar to BARI Tomato-4 planted on November 15, 2007. Whereas the minimum number of flowers per cluster (4.80) was found in BARI Tomato-3 planted on November 01, 2007 (Table 6). Hossain M. M. (2001) also reported similar influence of planting time and variety on the number of flowers per cluster.

4.8 Pollen viability

The different time of planting showed no significantly variation in the percent of pollen viability (Appendix IV). The maximum percent of pollen viability (79.99) was produced by November 01, 2007 planting and the minimum percent of pollen viability (78.54) was found in November 15, 2007 planting (Table 4).

Percent of pollen viability due to the influence of different varieties was significant (Appendix IV). The variety BARI Tomato-3 had the highest percent of pollen viability (90.63). However, the lowest percent of pollen viability (51.83) was obtained from the variety BARI hybrid Tomato-4 (Table 5).

The variation among the treatment combinations of date of planting and variety was found statistically significant (Appendix IV). The maximum percent of pollen viability (93.22) was found in BARI Tomato-3 planted on November 15, 2007 and the minimum percent of pollen viability (47.27) was found in BARI hybrid Tomato-4 planted on November 01, 2007 (Table 6).

4.9 Total soluble solid (TSS) content

The variation in the total soluble solid content two different date of planting was exhibited no significant variation (Appendix IV). The maximum total soluble solid content (4.58%) was produced by November 01, 2007 planting and November 15, 2007 planting produced the shortest total soluble solid content (4.33%) (Table4).

No significant variation in the total soluble solid content was found among the varieties (Appendix IV). The maximum total soluble solid content (4.58%) was obtained from BARI Tomato-2 and the minimum total soluble solid content (4.33 %) was obtained from BARI Tomato-3 and BARI Tomato-9 (Table 5).

The variation in total soluble solid content due to combined effect of date of planting and variety was found statistically not significant (Appendix IV). The maximum total soluble solid content (5%) was found in BARI Tomato-2 planted on November 01, 2007. Whereas the minimum total soluble solid content (4.17%) was found in BARI Tomato-2 planted on November 15, 2007 (Table 6). BARI (1989) also reported that earlier planting produces tomato with higher TSS.

4.10 Firmness

The variation in the firmness two different date of planting was exhibited no significant variation (Appendix IV). However, the maximum firmness (1.10 kg) was produced by November 15, 2007 planting and November 01, 2007 planting produced the minimum firmness (.99 kg) (Table 4).

No significant variation in the firmness was found among the varieties (Appendix IV). However, the maximum firmness (1.15 kg) was obtained from BARI Tomato-9 and the minimum firmness (0.96 kg) was obtained from BARI hybrid Tomato-4 (Table 5).

The variation in firmness due to combined effect of date of planting and variety was found statistically not significant (Appendix IV). However the maximum firmness (1.14 kg) was found in BARI Tomato-3 planted on November 15, 2007. Whereas the minimum firmness (0.92 kg) was found in BARI hybrid Tomato-4 planted on November 01, 2007 (Table 6).

4.11 Number of fruits per cluster

The different time of planting showed no significant variation in the number of fruits per cluster (Appendix IV). The maximum number of fruits per cluster (3.88) was produced by November 01, 2007 planting and November 15, 2007 planting produced the minimum number of fruits per cluster (3.19) (Table 4). Generally, earlier planting should have produced maximum number of fruits per cluster. Similar results were reported by Hossain (2001).

Number of fruits per cluster due to the influence of different varieties was significant (Appendix IV). The variety BARI Tomato-4 had the highest number of fruits per cluster (4.32) which was statistically similar BARI hybridTomato-4. However, the lowest number of fruits per cluster (2.70) was obtained from the variety BARI Tomato-3, BARI Tomato-2 and BARI Tomato-9 is statistically similar (Table 5). This result partially agreed with the findings of Hossain (2001).

The variation among the treatment combinations of date of planting and variety was found statistically significant (Appendix IV). The maximum number of fruits per cluster (5.21) was found in BARI hybrid Tomato-4 planted on November 01, 2007, which was statistically similar to BARI Tomato-4 planted on November 15, 2007. Whereas the minimum number of fruits per cluster (2.61) was found in BARI Tomato-3 planted on November 15, 2007 (Table 6).

4.12 Number of fruits per plant

The different time of planting showed no significant variation in the number of fruit per plant (Appendix IV). The maximum number of fruit per plant (47.2) was produced by November 01, 2007 planting November 15, 2007 planting produced the minimum number of fruit per plant (35.07) (Table 4).The number fruits per plant decreased gradually with delay in planting. This result partially agreed with the findings of other workers (Hoque and Rahman, 1988; BARI, 1989; Meher *et al.*, (1994)

Number of fruit per plant due to the influence of different varieties was no significant (Appendix IV). The variety BARI hybrid Tomato-4 had the highest number of fruit per plant (72.2) and the lowest number of fruit per plant (35.07) was obtained from the variety BARI Tomato-3 (Table 5).This variation among varieties was due to the genetically potentiality of the varieties and is supported by Hossain *et al.*(1986).

The interaction between different time planting and variety was found significant on the number of fruits per plant (Appendix IV). The maximum number of fruits per plant (91.27) was found in BARI hybrid Tomato-4 planted on November 15, 2007

planting, whereas the lowest number of fruits per plant (31.27) was found in BARI Tomato-3 planted on November 01, 2007 (Table 6).

4.13 Percent of fruit set

The different time of planting showed no significant variation in the percent of fruit set (Appendix IV). The maximum percent of fruit set (65.2) was produced by November 01, 2007 planting and the minimum percent of fruit set November 15, 2007 planting (50.74) (Table 4).This results partially agreed with the findings of Sharma and Tiwari (1996)

Percent of fruit set due to the influence of different varieties was significant (Appendix IV). The variety BARI Tomato-4 had the highest percent of fruit set (63.47). However, the lowest percent of fruit set (47.91) was obtained from the variety BARI Tomato-9 (Table 5).

The variation among the treatment combinations of date of planting and variety was found statistically significant (Appendix IV). The maximum percent of fruit set (75.78) was found in BARI hybrid Tomato-4 planted on November 01, 2007, which was statistically similar to BARI Tomato-4 planted on November 01, 2007. Whereas the minimum percent of fruit set (42.25) was found in BARI Tomato-9 planted on November 15, 2007 (Table 6). Similar results were reported by Pokhan *et al.* (1977).

4.14 Length of fruit

The date of planting exhibited no significant variation in the length of fruit (Appendix V). However, The longest fruit length (5.34 cm) was produced by November 01,

2007 planting and November15, 2007 planting produced the shortest fruit length (5.27 cm) (Table 7).This result is supported by Hossain (2001)

A significant variation in the length of fruit was found among the varieties (Appendix V). The longest fruit length (6.66 cm) was obtained from BARI Tomato-9 and the shortest fruit length (4.70 cm) was obtained from BARI hybrid Tomato-4 (Table 8). Hossain (2001), Sing and Sahu (1998) also reported varietal influence on the length of fruit.

The variation in fruit length due to combined effect of date of planting and variety was found statistically significant (Appendix V). The longest fruit length (6.84 cm) was found in BARI Tomato-9 planted on November 01, 2007, which was statistically similar to BARI Tomato-9 planted on November 15, 2007. Whereas the shortest fruit length (4.57 cm) was found in BARI hybrid Tomato-4 planted on November 01, 2007 (Table 9). Similar influence of planting time and variety on the length of fruit was reported by Sing and Tripathy (1995); and Sukhu *et al.* (1990).

4.15 Breadth of fruit

The variation in the breadth of fruit two different date of planting was exhibited no significant (Appendix V). The largest fruit breadth (5.46 cm) was produced by November 15, 2007 planting and November 01, 2007 planting produced the shortest fruit breadth (5.09 cm) (Table 7). Earlier planting produce largest fruit breadth is reported by Hossain (2001), Sharma and Tiwari (1996) was not similar with this result.

Table 7 Main effects of date of transplanting on the yield components and yield of tomato

Treatment	Days to first harvest	Days to final harvest	Fruit length(cm)	Fruit breadth(cm)	Weight of fruit(gm)	Yield per plant(kg)	Yield per plot(kg)	Yield per hectare (t/ha)
November 01, 2007	84.8	132.2	5.34	5.09	96.17	1.18	28.42	59.20
November 15, 2007	90.27	117.2	5.27	5.46	93.51	1.15	27.60	87.42
LSD(0.05)	59.01	17.93	3.90	6.23	59.248	2.31	32.78	50.59
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	6.50	1.39	7.11	11.41	6.02	19.29	11.28	8.37

NS- non significant

Table 8 Main effects of the variety on the yield components and yield of tomato

Treatment	Days to first harvest	Days to final harvest	Fruit length(cm)	Fruit breadth(cm)	Weight of fruit(gm)	Yield per plant(kg)	Yield per plot(kg)
BARI Tomato-2	79.33b	123.5	5.11b	5.75a	108.5a	1.25ab	29.91b
BARI Tomato-3	99.5a	126.5	5.19b	6.16a	121.3a	0.90b	21.66c
BARI Tomato-4	78.67b	123.5	4.86b	4.17b	65.53c	1.21ab	29.02b
BARI Tomato-9	105.5a	126.5	6.66a	5.02ab	94.26b	0.813b	19.4c
BARI hybridTomato-4	74.67b	123.5	4.70b	5.27ab	84.53b	1.67a	40.04a
$LSD_{(0.05)}$	12.9	3.92	0.8543	1.364	12.95	0.5069	7.165
Level of significance	*	NS	*	*	*	*	*
CV (%)	6.50	1.39	7.11	1.411	6.02	19.29	11.28

Means bearing the common letter (s) in a column do not differ significantly at 5% level

*significant at 5% level of probability, NS- non significant

Table 9 combined effects of date of planting and variety on the yield components and yield of tomato

Treatment combination		days to first harvest	days to final harvest	fruit length(cm)	fruit breadth(cm)	weight of fruit(gm)	yield per plant(kg)	yield per plot(kg)
Planting time	Variety							
November 01, 2007	BARI Tomato-2	72.67de	131a	5.48b	5.967ab	122.2a	1.25bcd	30.04c
	BARI Tomato-3	97b	134a	4.98bc	6ab	118.5a	0.97cde	23.4de
	BARI Tomato-4	74.33de	131a	4.83bc	3.547d	61f	1.15bcd	27.65cd
	BARI Tomato-9	109a	134a	6.83a	4.93bc	99.61b	1.03cd	24.67cde
	BARI hybridTomato-4	71e	131a	4.57c	5.02bc	79.5de	1.51ab	36.33b
November 15, 2007	BARI Tomato-2	86c	116b	4.75bc	5.54abc	94.86bc	1.24bcd	29.78c
	BARI Tomato-3	102ab	119b	5.39b	6.3a	124.2a	0.83de	19.92e
	BARI Tomato-4	83cd	116b	4.9bc	4.793c	70.06ef	1.26bc	30.4c
	BARI Tomato-9	102ab	119b	6.48a	5.113bc	88.91cd	0.59e	14.13f
	BARI hybridTomato-4	78.33cde	116b	4.83bc	5.51abc	89.56bcd	1.82a	43.75a
$LSD_{(0.05)}$		9.759	2.966	0.6464	1.032	9.798	0.3836	5.422
Level of significance		*	*	*	*	*	*	*
CV (%)		6.50	1.39	7.11	11.41	6.02	19.29	11.28

Means bearing the common letter (s) in a column do not differ significantly at 5% level

*significant at 5% level of probability

A significant variation in the breadth of fruit was found among the varieties (Appendix V). The largest fruit breadth (6.16 cm) was obtained from BARI Tomato-3, which is statistically similar to BARI tomato- 2 and the shortest fruit breadth (4.17 cm) was obtained from BARI Tomato-4 (Table 8). Hossain (2001), Sing and Sahu (1998) also reported varietal influence on the breadth of fruit.

The variation in fruit breadth due to combined effect of date of planting and variety was found statistically significant (Appendix V). The largest fruit breadth (6.32 cm) was found in BARI Tomato-3 planted on November 15, 2007. Whereas the shortest fruit breadth (4.79 cm) was found in BARI Tomato-4 planted on November 15, 2007 (Table 9). Similar influence of planting time and variety on the length of fruit was reported by Sing and Tripathy (1995).

4.16 Days to first harvesting

A significant variation was observed in days to first harvesting due to date of transplanting (Appendix V). The seedling transplanted on November 01, 2007 required the earliest of days of first harvesting (84.8 days). Seedlings transplanted on November 15, 2007 were the longest time of first harvesting (90.27 days) (Table 7).The present result agrees with the report of BARI (1983).

There was a marked difference among the varieties in the days to first harvesting (Appendix V). Delayed first harvesting (105.5 days) was found in BARI Tomato-9, which was statistically similar to BARI Tomato-3 and first harvesting was earliest (74.67 days) in BARI hybrid Tomato-4 (Table 8). Varietal influence on the days to first harvesting was also reported by Hossain (2001) and Kallo (1989).

The combined effect of different varieties and dates of planting on days of first harvesting was found to be significant (Appendix V). Data in table 9 Shows that, the days of first harvesting was minimum (71 days) in BARI hybrid Tomato-4 planted on November 01, 2007, while it was maximum (109 days) in BARI Tomato-9 planted on November 01, 2007. This result is also supported by Hossain (2001).

4.17 Days to final harvesting

A significant variation was observed in days to final harvesting due to date of transplanting (Appendix V). The seedling transplanted on November 15, 2007 required the earliest of days to final harvesting (117.20 days). Seedlings transplanted on November 01, 2007 were the longest time of days to final harvesting (132.20 days) (Table 7).The days to final harvesting decreased gradually with delay planting and this statement agrees with Hossain (2001).

There was a marked difference among the varieties in the days to final harvesting (Appendix V). Delayed final harvesting (126.5 days) was found in BARI Tomato-9, which was statistically similar to BARI Tomato-3 and final harvesting was earliest (123.5 days) in BARI hybrid Tomato-4 (Table 8). Varietal influence on the days to final harvesting was also reported by Hossain (2001).

The combined effect of different varieties and dates of planting in days to final harvesting was found to be significant (Appendix V). Data in Table 9 Shows that,

the days to final harvesting was minimum (116 days) in BARI hybrid Tomato-4 planted on November 15, 2007, while it was maximum (134 days) in BARI Tomato-9 planted on November 01, 2007.

4.18 Fruit picking period

The difference between days to first harvesting indicates the duration of picking period. A significant variation was observed in respect of fruit picking period (Appendix IV). The longest fruit picking period (47.17 days) was produced by November 01, 2007 planting and November 15, 2007 planting produced the shortest fruit picking period (27.17 days) (Table 4). It was also observed that, the crop duration as well as picking period decreased gradually with delay on planting and this result is partially similar with the result reported by Hossain (2001).

Different tomato varieties had significant influence on fruit picking period (Appendix IV). The longest fruit picking period (48.83 days) was found in BARI hybrid Tomato-4, which was those statistically similar to which was statistically similar to BARI Tomato-4 and BARI Tomato-2. The shortest fruit picking period (21 days) was found in BARI Tomato-9 (Table5). Varietal influence on the fruit picking period was also reported by Thomas *et al.* (1979).

The combined effect of different varieties and dates of planting on fruit picking period was found to be significant (Appendix IV). The fruit picking period of tomato as influenced by the treatment combinations has been presented graphically (Fig 3).

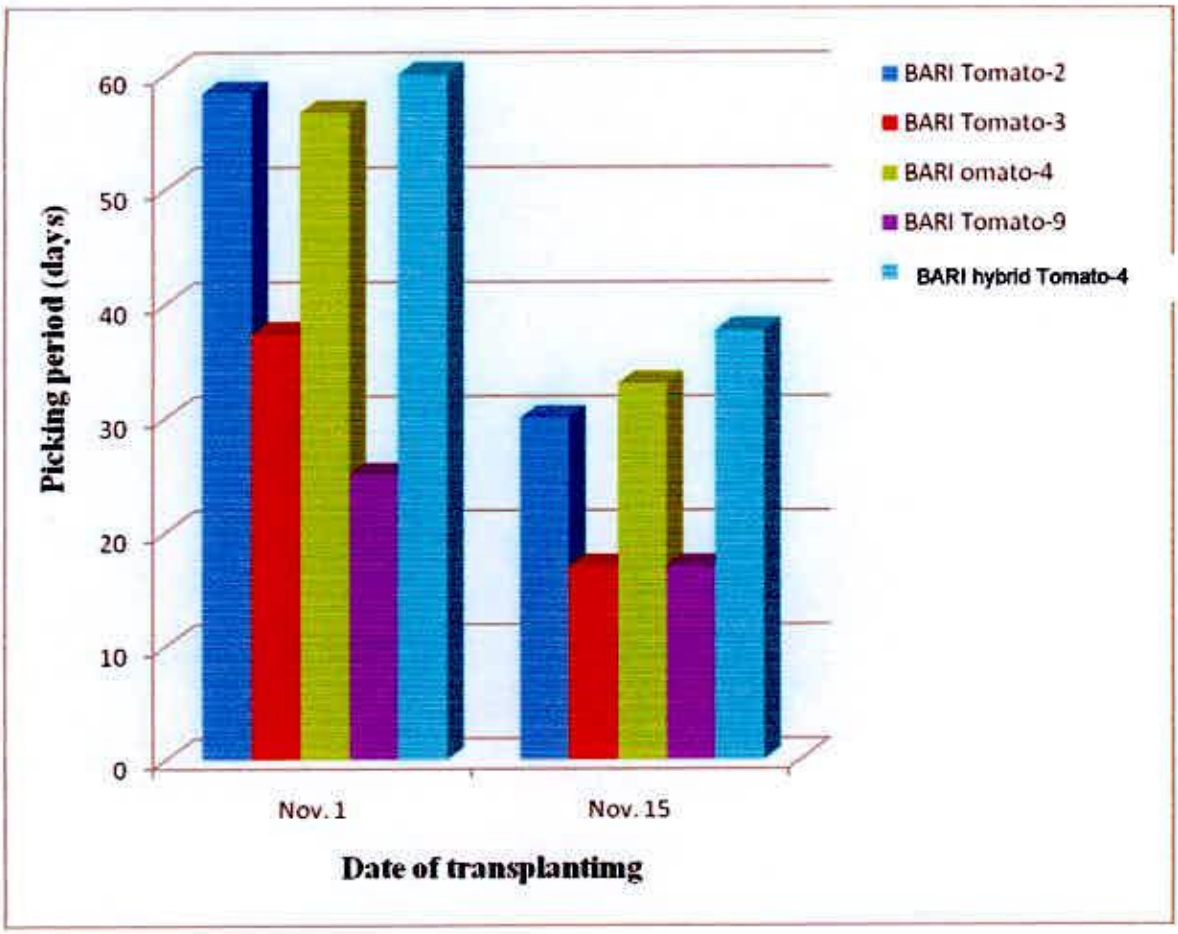

Figure 3. Combined effects of date of planting and variety on the fruit picking period.

The fruit picking period was maximum (60 days) in BARI hybrid Tomato-4 planted on November 01, 2007, which was statistically similar to BARI Tomato-4 and BARI Tomato-2 planted on November 01, 2007. The minimum fruit picking period (17 days) was found in BARI Tomato-3 planted on November 15, 2007 and statistically identical in BARI Tomato-9 planted on November 15, 2007. As evident from the graph, it can be deduced that the picking period decreased gradually with delay in planting irrespective of variety, which might have happened possibly due to the exposure of plants to high temperatures in the later planting. Islam (2000) also reported that the crop duration as well as picking period decreased gradually with delay in planting according to variety.

4.19 Individual fruit weight

Time of planting did not influence significantly on the average weight of individual fruit weight (Appendix V). The largest individual fruit weight (96.17 g) was produced by November 01, 2007 planting and November 15, 2007 planting produced the shortest individual fruit weight (93.51 g) (Table 7).Similar results were also reported by Hossain *et al.* (1986) and BARI (1989).

The weight of individual fruit weight was significantly influenced by different varieties (Appendix V). The largest individual fruit weight (121.3 g) was obtained from BARI Tomato-3, which was statistically similar to BARI Tomato-2. The shortest fruit weight (65.53 g) was obtained from BARI Tomato-4 (Table 8). The wide variation among the varieties in respect of individual fruit weight was due to the varietal characteristics. Varietal influence on individual fruit weight was also reported by Hossain *et al.* (1986) and Meher *et al.* (1994).

As evident from Appendix-V, individual fruit weight was significantly affected by both planting times and different varieties. The highest individual fruit weight (124.2 g) was found in BARI Tomato-3 planted on November 15, 2007, which was statistically similar to BARI Tomato-2 planted on November 01, 2007. Whereas the lowest fruit length (61 g) was found in BARI Tomato-4 planted on November 01, 2007 (Table 9). Sing and Tripathy (1995) also reported similar influence of planting time and variety on individual fruit weight.

4.20 Yield of fruit per plant

The higher yield of fruit per plant was associated with the number of fruits per plant and size of fruit. The different time of planting had no significant effect on the yield of fruits per plant (Appendix V). The maximum yield of fruits per plant (1.18 kg) was produced by November 01, 2007 planting and November 15, 2007 planting produced the minimum yield of fruits per plant (1.14 kg) (Table 7). Similar results were also reported by Taleb (1994).

The different varieties of tomato significantly influenced on the yield of fruits per plant (Appendix V). The maximum yield of fruits per plant (1.67 kg) was obtained from BARI hybrid Tomato-4 and the minimum yield of fruits per plant (0.81 kg) was obtained from BARI Tomato-9 (Table 8). Varietal influence on the yield of fruits per plant is also reported by Hossain (2001), Sing and Sahu (1998).

As evident from Appendix V, yield of fruit per plant was significantly affected by both planting times and different varieties. The highest yield of fruits per plant (1.82 kg) was found in BARI hybrid Tomato-4 planted on November 15, 2007. Whereas

lowest yield of fruits per plant (0.59 kg) was found in BARI Tomato-9 planted on November 15, 2007 (Table 9). It appears from the result that, earlier plant produced maximum yield of fruit per plant in all of the varieties and this might have happened possibly due to earlier plant received favorable temperature for fruit setting.

4.21 Yield of fruit per plot

The different time of planting had no significant effect on the yield of fruits per plot (Appendix V). The maximum yield of fruits per plot (28.42 kg) was produced by November 01, 2007 planting and November 15, 2007 planting produced the minimum yield of fruits per plant (27.60 kg) (Table 7).

The different varieties of tomato significantly influenced on the yield of fruits per plot (Appendix V). The maximum yield of fruits per plot (40.04 kg) was obtained from BARI hybrid Tomato-4 and the minimum yield of fruits per plot (19.4 kg) was obtained from BARI Tomato-9, which was statistically similar to BARI Tomato-3 (Table 8).

The combined effect of planting time and variety was significant on yield of fruit per plot. The highest yield of fruits per plot (43.75 kg) was obtained from BARI hybrid Tomato-4 planted on November15, 2007.The lowest yield of fruits per plot (14.13 kg) was obtained from BARI Tomato-9 planted on November 15, 2007 (Table 9).

4.22 Total fruit yield per hectare

The yield of tomato per plot was converted into per hectare, and has been expressed in metric tons. The different time of planting had no significant effect on the yield of fruits per hectare (Appendix V). The maximum yield of fruits per hectare (59.20 tones) was obtained from November 01, 2007 planting and November 15, 2007 planting obtained the minimum yield of fruits per hectare (57.42 tones) (Table 7). The profound influence of time of planting on the yield of tomato has also been reported by Hoque and Rahman (1988) and Hossain *et al.* (1986).

When per plot yield of tomato varieties was converted into yield of fruits per hectare (Appendix V). The maximum yield of fruits per hectare (83.42 tones) was obtained from BARI hybrid Tomato-4 and the minimum yield of fruits per hectare (40.25 tones) was obtained from BARI Tomato-9, which was statistically similar to BARI Tomato-3 (Fig 4). Hossain (2001) and Ahmed *et al.* (1986) also reported varietal influence on the yield of fruit per hectare.

The combined effect of planting time and variety was significant on yield of fruits per hectare. The highest yield of fruits per hectare (91.15 tones) was obtained from BARI hybrid Tomato-4 planted on November 15, 2007. The lowest yield of fruits per hectare (41.47 tones) was obtained from BARI Tomato-9 planted on November 15, 2007 (Fig 5). Taleb (1994) also reported that, earlier planting gave relatively higher yield than later planting.

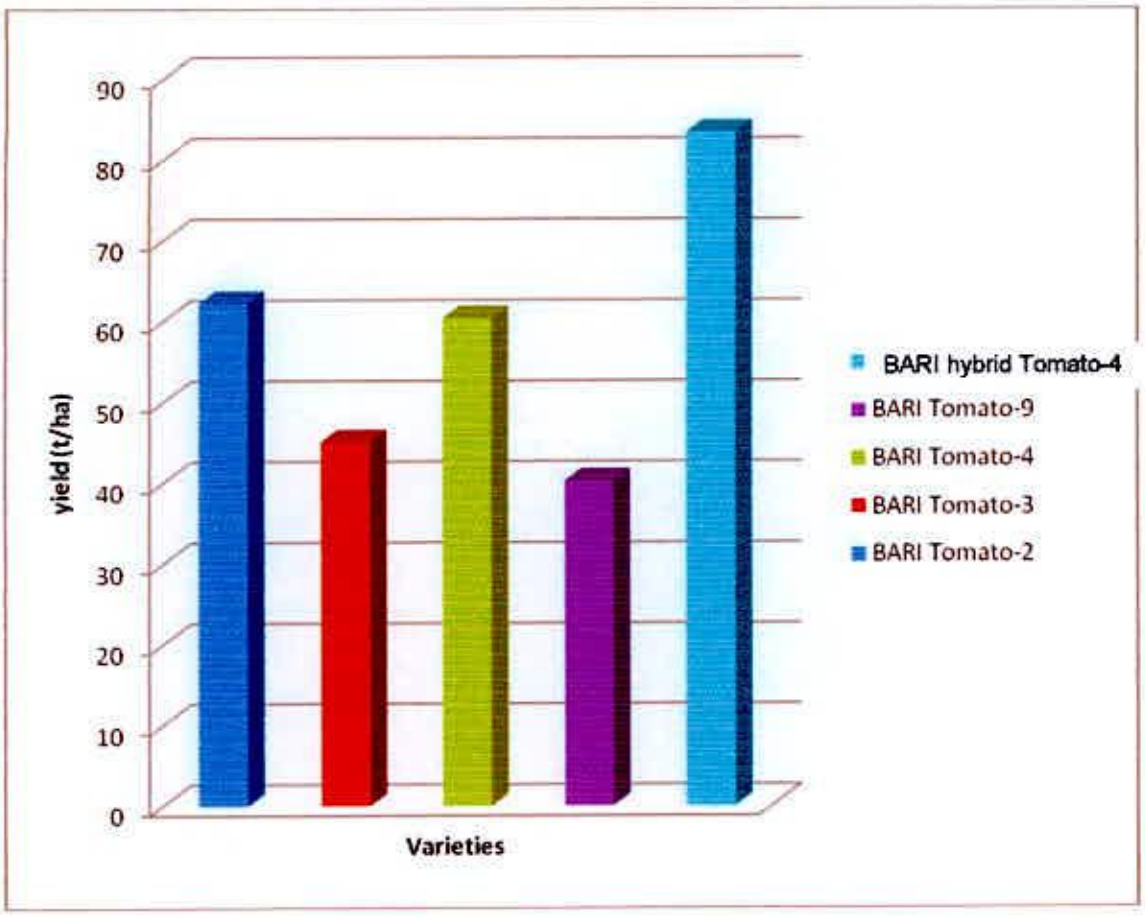

Figure 4. Effect of variety on the yield of tomato

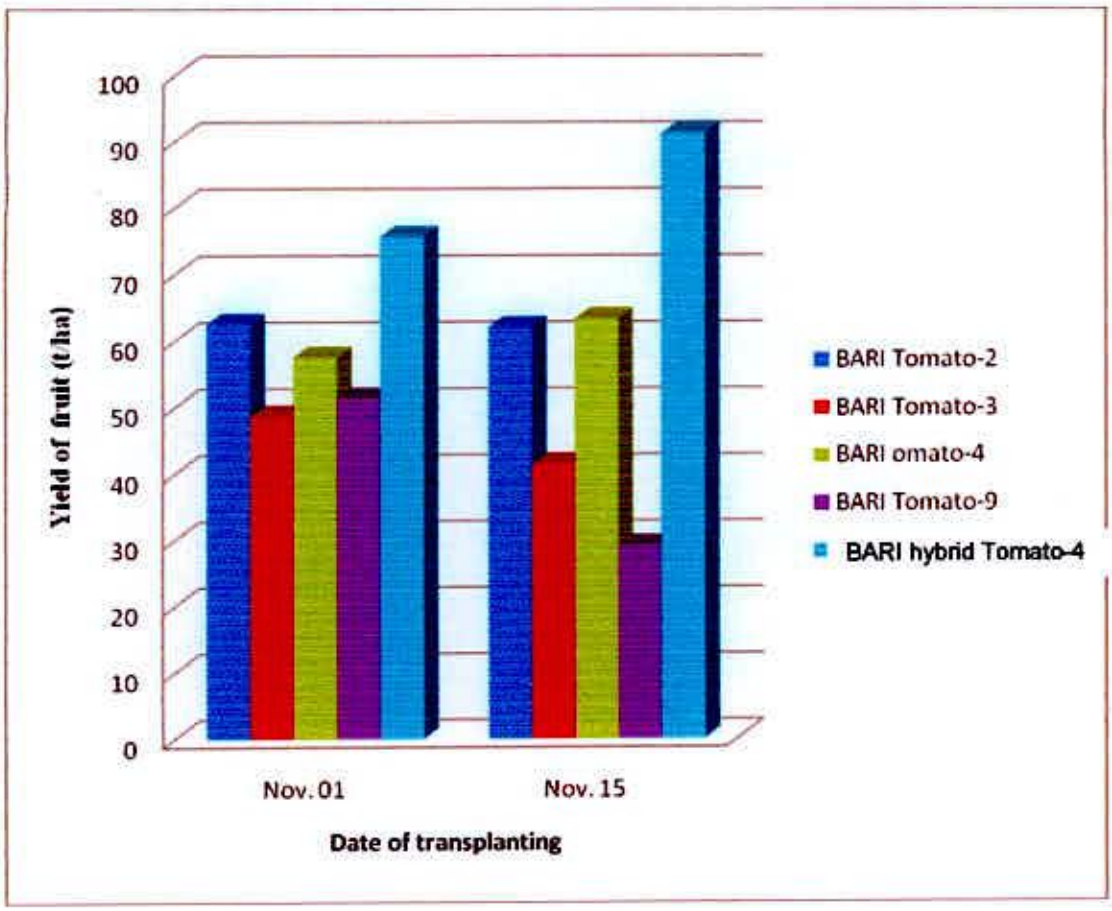

Figure 5. Combined effects of date of planting and variety on the yield of tomato per hectare.

Chapter 5

Summary and Conclusion

CHAPTER V

Summary and Conclusion

The research was conducted at the Horticulture Research Center farm of Bangladesh Agricultural Research Institute, Joydebpur, Gazipure during October 2007 to March 2008. The experiment included two different planting times, viz., 01 November and 15 November, and five varieties, viz., BARI Tomato-2, BARI Tomato-3, BARI Tomato-4, BARI Tomato-9 and BARI hybrid Tomato-4. The factorial experiment was laid out in Randomized complete Block Design (RCBD) having two factors with three replications.

Data were taken on growth, yield contributing characters, yield and picking period, and the collected data were statistically analyzed for evaluation of the treatment effects. The summary of the results has been described in this chapter.

The main effect of date of planting indicated that, the plant height was not influenced significantly by the date of planting. However, earlier planting (November 01) produced taller plant than delayed planting (November 15). The days required for 50% flower initiation were longer in November15, 2007 planting. The number of branch, leaves, and fruit per plant, and flowers, fruit per cluster were significantly influenced by different dates of planting. The maximum values of these parameters were found from November15, 2007 planting. The fruit picking period was longest (44.17 days) in November 01, 2007 planting, while it was shortest (27.17 days) in November 15, 2007 planting. The maximum weight and breath of individual fruit were obtained from November 15 and length from November 01, 2007 planting.

General yield levels were much higher in earlier (59.201 tones) than later (57.42 tons) planting. The time of planting exhibited marked influence on tomato fruit yield.

The main effect of variety demonstrated that, the variety BARI Tomato-3 produced the tallest plant (144.1cm). Significant variation in number of leaves was observed due to variety. The maximum value of the parameter was produces from the variety BARI Tomato-3 (234.5). Significant variation in number of flowers per cluster, number of fruits per cluster and number of fruit per plant was observed due to variety. The maximum values of the parameters were produces from the variety BARI hybrid Tomato-4 (7.36, 4.30 and 72.20). Significant variation in length of the leaf and leaf breadth was observed due to variety. The maximum values of the parameters were produces from the variety BARI Tomato-3 (38.07cm and 32.40cm). The length of fruit and fruit breadth were significantly influence by the variety. The variety BARI Tomato-9 produced largest fruit length (6.66 cm) and the variety BARI Tomato-3 produced largest fruit breadth (6.16 cm). The highest percent of fruit set (63.47) was found in BARI Tomato-4 which is statistically similar to BARI hybrid Tomato-4(62.76). The highest percent of pollen viability (90.63) was found in BARI Tomato-3. No Significant variation in total soluble solid content and firmness was observed due to variety. The maximum value of total soluble solid content (4.58%) was obtained from the variety BARI Tomato-3. The maximum value of firmness (1.15kg) was obtained from the variety BARI Tomato-9. The 50% flowering was earlier (21days) in BARI hybrid Tomato-4, while it was later (29days) in BARI Tomato-3. Days to first harvesting and final harvesting were significantly influence by the variety. The variety BARI hybrid Tomato-4 matured earlier (74.67 days), while the

maturity was delayed in BARI Tomato-9 (105.5 days) from the dates of transplanting. The days to last harvesting was shorter in variety BARI hybrid Tomato-4 (123.5 days), while it was longer in BARI Tomato-9 (126.5 days) from the dates of transplanting. The longest picking period of fruit (48.83 days) was found in BARI hybrid Tomato-4, while the lowest picking period of fruit was found in BARI Tomato-9 (21 days). The variety BARI Tomato-3 produced largest fruit (121.3gm) compared to other four varieties. The different varieties exhibited marked influence on fruit yield of tomato. The highest fruit yield per plant (1 .61kg), fruit yield per plot (40.04 kg) and fruit yield per hectare (83.42 tones) were produced by BARI hybrid Tomato-4.

The interaction between variety and date of planting was found to be significant in several parameters. The tallest plant (146.6cm) was produced by BARI Tomato-3 planted on November 15, 2007. The maximum number of branch (3.33)was observed from BARI Tomato-9 planted on November 01, 2007. The maximum number of leaves (271.3) was produced from BARI Tomato-3 planted on November 01, 2007. The maximum number of flowers per cluster (7.83) was observed from BARI hybrid Tomato-4 planted on November 15, 2007. The maximum number of fruits per cluster (5.21) and number of fruit per plant (91.27) was observed from BARI hybrid Tomato-4 planted on November 01, 2007. The largest length of the leaf (40.73cm) and leaf breadth (33.8cm) was found in BARI Tomato-3 planted on November 15, 2007. The variety BARI Tomato-9 produced largest fruit length (6.84cm) planted on November 01, 2007 and the variety BARI Tomato-3 produced largest fruit breadth (6.3cm) planted on November 15, 2007. The highest percent of fruit set (75.78) was

found in BARI hybrid Tomato-4 planted on November 01, 2007 which is statistically similar to BARI Tomato-4. The highest percent of pollen viability (93.22) was found in BARI Tomato-3 planted on November 15, 2007. The maximum value of total soluble solid content was obtained from the variety BARI Tomato-2 planted on November 01, 2007. The maximum value of firmness (1.17kg) was obtained from the variety BARI Tomato-9 planted on November 01, 2007.The longest picking period of fruit (60 days) was found in BARI hybrid Tomato-4 planted on November 01, 2007, while the lowest picking period of fruit (17 days) was found in BARI Tomato-3 planted on November 15, 2007 which is statistically similar to BARI Tomato-9 planted on November 15, 2007. In generally, the crop duration as well as picking period decreased gradually with delay

Time of planting and variety exhibited marked influence on tomato fruit yield. The different varieties exhibited marked influence on fruit yield of tomato. The highest fruit yield per plant (1.82 kg) fruit yield per plot (43.75 kg) and fruit yield per hectare (91.15 tones) was found in BARI hybrid Tomato-4 planted on November 15, 2007.

Conclusion

Considering the stated findings, it may be concluded that yield and yield contributing parameters are positively correlated with planting dates and variety. However, BARI hybrid Tomato-4 planted on November 15 would be beneficial for the farmers, BARI Tomato-3 and BARI Tomato-9 would be suitable at planting date November 01,where BARI Tomato-2 and BARI Tomato-4 would be suitable for planting throughout the entire period of the study (November 01-15) under Gazipur condition.

Recommendation

BARI hybrid Tomato-4 planted on November 15 can be adapted at the farmer level due to higher yield (91.15 t/ha). However, in this experiment performance of only five BARI released tomato varieties were observed only at two planting dates (November 01 and 15). So, the response of other varieties to different planting dates should be studied in order to make a clear recommendation on the subject. This experiment was conducted only at Gazipur condition. So it should be conducted in other Agro-Ecological Zones of Bangladesh.

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Appendices

Appendix I: Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from October 2007 to March 2008

Month	Air temperature (^{0}C)			Average RH (%)	Total rainfall (mm)
	Maximum	Minimum	Mean		
October 07	35.6	19.5	27.55	64.5	320
November 07	31.8	16.8	24.3	67.0	111
December 07	28.2	11.3	19.75	63.0	0
January 08	29.0	10.5	19.75	61.5	23
February 08	30.6	10.8	27.0	54.5	56
March 08	34.6	16.5	30.5	61.5	45

Source: Bangladesh Meteorological Department (Climate division)

Agargaon, Dhaka-1207

Appendix II: The chemical analysis of the soil of the experimental field

Soil property	Analytical data	Critical point
PH	6.0	-
Organic matter	1.76	-
Ca	4.7 meq / 100ml	2.0
Mg	1.6 meq / 100ml	0.8
K	0.11 meq / 100ml	0.2
Total N %	0.080	0.12
P	13 µg/ml	14
S	17 µg/ml	14
B	0.36 µg/ml	0.2
Cu	1.3 µg/ml	1.0
Fe	114 µg/ml	10
Mn	13 µg/ml	5.0
Zn	1.6 µg/ml	2.0

Appendix III: Analysis of variance of the data on plant height, Number of branches per plant, number of leaves per plant, leaf length and leaf breadth of five varieties of tomato as influenced at two dates of transplanting

sources of Variation	Degrees of freedom	Plant height				Number of branches per plant	Number of leaves per plant	leaf length	leaf breadth
		65 DAT	80 DAT	95DAT	Final harvest				
Replication	2	2.04	13.39	5.65	3.56	0.69	11.63	1.62	1.95
Factor A (Planting time)	1	467.29^{NS}	111.36^{NS}	32.87^{NS}	0.01^{NS}	0.3^{NS}	224.13^{NS}	23.94^{NS}	27.84^{NS}
Factor B (Variety)	4	1833.46*	2049.61*	2403.3*	2632.44*	0.833^{NS}	20888.97*	40.99*	38.55*
AB	4	53.09*	35.57*	40.79*	89.43*	0.165*	3751.63*	7.27*	5.10*
Error	18	5.85	11.02	12.76	10.35	0.18	34.56	2.7	17.81

*significant at 5% level of probability,

NS- non significant

Appendix IV: Analysis of variance of the data on Days to 50% flowering, Number of flower per cluster, Number of fruits per cluster, Number of fruit per plant, Percent of Fruit set, Percent of Pollen viability, Fruit picking period, TSS (%) and Firmness (kg) of five varieties of tomato as influenced at two dates of transplanting

Sources of variation	Degrees of freedom	Days to 50% flowering	Number of flower per cluster	Number of fruits per cluster	Number of fruit per plant	Percent of Fruit set	Percent of Pollen viability	Fruit picking period	TSS (%)	Firmness (kg)
Replication	2	5.03	0.03	0.15	5.39	3.48	36.32	2.50	0.01	0.04
Factor A (planting time)	1	26.13^{NS}	2.67^{NS}	3.58^{NS}	125.67^{NS}	1568.62^{NS}	15.78^{NS}	3162.13^{NS}	0.13^{NS}	0.04^{NS}
Factor B (Variety)	4	70.62*	8.32*	3.30*	1407.08*	243.66*	1524.00*	907.87*	0.07^{NS}	0.04^{NS}
AB	4	17.88*	0.49*	0.65*	616.46*	96.85*	44.88*	86.63*	0.24^{NS}	0.01^{NS}
Error	18	5.96	0.43	0.17	19.52	5.26	0.14	4.54	0.14	0.02

*significant at 5% level of probability,

NS- non significant

Appendix V: Analysis of variance of the data on days to first harvest, days to final harvest, fruit length, fruit breadth, weight of fruit, yield per plant, yield per plot and yield per hectare of five varieties of tomato as influenced at two dates of transplanting

Sources of variation	Degrees of freedom	Days to first harvest	Days to final harvest	Fruit length(cm)	Fruit breadth(cm)	Weight of fruit(gm)	Yield per plant(kg)	Yield per plot(kg)	Yield per hectare (t/ha)
Replication	2	424.90	0.00	0.09	0.37	30.00	0.05	1.37	7.28
Factor A (planting time)	1	4.80^{NS}	1687.50^{NS}	0.04^{NS}	0.99^{NS}	52.99^{NS}	0.01^{NS}	5.07^{NS}	23.76^{NS}
Factor B (Variety)	4	908.55*	16.20*	3.68*	3.45*	2783.79*	0.69*	395.83*	1727.4*
AB	4	353.88*	0.01*	0.33*	0.55*	390.69*	0.12*	68.38*	301.91*
Error	18	264.27	0.01	0.14	0.36	32.62	0.05	9.99	23.80

*significant at 5% level of probability,

NS- non significant