EFFECTS OF TRANSPLANTING DATE AND SALICYLIC ACID ON MORPHOLOGY AND YIELD OF TOMATO

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DECEMBER, 2015

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Reg. no: 14-06318

A Thesis

Submitted to the Department of Agricultural Botany
Sher-e-Bangla Agricultural University, Dhaka, in partial
fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE
IN
AGRICULTURAL BOTANY

SEMESTER: JULY-DECEMBER, 2015

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CERTIFICATE

This is to certify that thesis entitled, **EFFECTS OF TRANSPLANTING DATE AND SALICYLIC ACID ON MORPHOLOGY AND YIELD OF TOMATO** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **AGRICULTURAL BOTANY,** embodies the result of a piece of bona fide research work carried out by **AHASAN HABIB, Registration No.14-06318** under my supervision and 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 acknowledge.

Dated: December,2016

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DEDICATED TO
MY
BELOVED PARENTS

ACKNOWLEDGEMENT

All praises are due to the Almighty God who kindly enabled the author to complete the research work and the thesis leading to Master of Science.

The author feels proud to express his profound respect, deepest sense of gratitude, heartful appreciation to his supervisor ***Prof. Dr. Shahnaz Sarkar****, Dept. of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, for her constant inspiration, scholastic guidance and invaluable suggestions during the conduct of the research and for her constructive criticism and whole hearted co-operation during preparation of this thesis.*

The author expresses his heartfelt gratitude and indebtness to his co-supervisor ***Prof. Dr. Mohammad Mahbub Islam*** *for his assistance in planning and execution of the study and for his constructive instruction, critical reviews and heartiest co-operation during preparation of the manuscript.*

The author also express his heartfelt thanks to, ***Dr. Md. Ashabul Hoque*** *Associate Professor, Chairman, Dept. of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka.*

The author also express his heartfelt thanks to all the teachers of the Dept. of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for their help, valuable suggestions and encouragement during the period of study.

The Author is also wish to acknowledge is indebtedness to the Farm Division of Sher-e-Bangla Agricultural University, Dhaka for their co-operation in the implementation of research works.The Author is also thankful to senior brothers and friends Lutful Kabir , Rukaiya Rumi, Antora, Jury, Asma, for their constant encouragement.

At last but not the least, the Author feel indebtedness to be beloved father Abdur Rahim, mother Asma Khatun and brother Atikur Rahman, whose sacrifice, inspiration, encouragement and continuous blessing paved the way to is higher education.

The Author

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ABSTRACT

The experiment was conducted in the farm and Laboratory of Agricultural Botany Department, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh, during the period of 10 November 2014 to 15 March 2015 to find out the role of exogenous foliar application of salicylic acid (SA) on the changes of morphology and fruit yield of tomato at different time of transplanting. In this experiment, variety BARI tomato 15 was used as a planting material and the treatments consisted of three different times of transplanting: T_1=First transplanting time, (10December 2014),T_2=Second transplanting time, (20 December 2014), T_3 = Third transplanting time ,(30 December 2014); and four different doses of SA *viz*. C = 0 mM SA, SA_1 = 0.1mM SA, SA_2 = 0.2 mM SA and SA_3 = 0.3 mM SA. Thus, there were 12 treatment combinations. The experiment was laid out in two factors Randomized Complete Block Design (RCBD) with four replications. 48 pots were used to conduct this experiment. Salicylic acid was applied to the plant according to the treatment. The Salicylic acid were sprayed exogenously by a hand sprayer in the morning at 20, 30, and 40 days after transplanting (DAT). Data were recorded on various parameters and statistically analyzed. Most of the results of this experiment showed difference to treatments. The transplanting time (T_1) significantly changed morphological characters such as plant height, number of leaves per plant, number of branches per plant; and yield contributing characters like number of flower clusters per plant, number of flowers per plant , number of fruits per plant fruit length ,fruit breadth ,yield per plant compared to third transplanting time (T_3).The maximum yield per plant (331.22g) was obtained from the first transplanting time (T_1) suggesting that early transplanting time improves fruit yield through promoting the morphological features of tomato. The plant hormone SA showed also significant influence on all the parameters .Plant height, number of leaves per plant, number of branches per plant was increased with the increasing the level of SA but the highest number. of flower clusters (3.08), fruit number per plant.(5.58),fruit length (4.512cm), fruit breadth (4.644cm) ,individual fruit weight (55.86g), total yield per plant (295.9g) recorded from the SA_2 (0.2 mM SA).The combined effect of transplanting date and SA also had significant influence on different growth and yield parameters and yield. The highest yield of fruit (417.23g) was recorded from the T_1SA_2 (10 December,2014 and 0.2mM SA).Therefore, the treatment combination T_1SA_2 increased fruit yield and suggest, that early transplanting (T_1) with 0.2 mM SA improves morphological characters along with fruit yield of tomato under SAU environmental condition.

CONTENTS

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS AND SYMBOLS

ANOVA	Analysis of Variance
BBS	Bangladesh Bureau of Statistics
BARI	Bangladesh Agricultural Research Institute
CIMMYT	International Wheat and Maize Improvement Center
CT	Canopy Temperature
CV	Co-efficient of Variation
Cm	Centimeter
DAS	Days After Sowing
df	Degrees of freedom
FAO	Food and Agriculture Organization
g_m	Gram
ha	Hectare
SAU	Sher-e-Bangla Agricultural University
J	Journal
K	Selection intensity
Kg	Kilogram
MSS	Mean Sum Square
MSE	Error Mean Square
No.	Number
CRBD	Completely Randomized Block Design
Sci.	Science
WRC	Wheat Research Centre
∑	Sum
^oC	Degree Celsius
i.e.	That is
@	At the rate of

CHAPTER I

INTRODUCTION

Tomato *(Solanum lycopersicum*) belonging to the family Solanaceae, is one of the most important vegetable crop grown in Bangladesh. It might be the worlds largest vegetables crops after potato and a common canned vegetable. Specialists considered that tomato has originated in the new world (The America) i.e. the Andean region which includes part of Bolivia, Chili, Colombia, Ecuador and Peru and grown throughout the world including Bangladesh. It is evident that tomato was originally domesticated in Mexico (Jenkins, 1948) because ofits diversity ofcultivated type. Tomato gradually spread from its native land to European countries and rest ofthe world .So, it is clear that tomato is an introduced crop in Bangladesh.It is most popular for its taste, nutritional status and various uses. It is cultivated all over the country due to its adaptability to wide range of soil and climate (Ahmad, 1976). The crop is adapted to a wide variety of climates ranging from the tropics to a few degree of the Arctic Circle. The present leading tomato producing countries of the world are China, United States of America, India, Egypt, Turkey, Iran, Italy, Mexico, Brazil and Indonesia (FAO 2008). In Bangladesh tomato has great demand throughout the year but its production is mainly concentrated during the winter season. Recent statistics showed that tomato was grown in 17.790 hectares of land and the total production was approximately 202 metric tons in Bangladesh during the year 2004-2005. Thus the average yield of tomato was 11.35 tons/ha (BBS. 2011).While it was 69.41 t/ha in USA, 21.27 t/ha in India, 31.13 t/ha in China and 65.45 t/ha in Japan (FAO 2008).

The popularity of tomato and different products produced from tomato processing is increasing day by day. It is a nutritious and delicious vegetable used in salads, soups and processed into stable products like ketchup, sauce, marmalade, chutney and juice. Nutritive value of the fruit is an important aspect of quality tomato and public demand. Food value of tomato is very rich because of higher contents of vitamins A, B and C including calcium

and carotene (Bose and Som, 1990). Tomato adds flavor to the foods and it is also rich in medicinal value.

The low yield of tomato in Bangladesh is not the induction of low yield potentially of this crop but the fact this may attribute due to the several reason like availability of improved variety, conventional management practices, inappropriate time of transplanting ,different abiotic and biotic stress including temperature , salinity ,insects , pathogen and residual effect of pesticides, proper application of plant nutrients and plant growth regulators (PGRs) along with nutrients are believed to the effective and modern agricultural techniques to improve the fruit yield of tomato under the existing climate condition. Among them transplanting time is a vital factor that influences the growth and yield of tomato. Proper planting date reduce the production cost by reducing the crop time and also produce elite flowers with increased market value. (Adil et al. 2013) It is well known that climate change is a frightening issue on reduction of crop yield not only Bangladesh but also all over the world. Presently drought changes of temperature, salinity, heavy metal contamination etc affects the growth, development and yield of agricultural crops. It was reported that fruit set was abundant only when night temperature was between 15ºC and 20 ºC. (went,1984).Curme (1992) also showed that fruit set varies with temperature as low (7.2º C) and with temperature as high (26.6º C). Tremendous decline in fruit set due to high as well as low temperature which disturb mechanisms involved in the development of male and female parts of the flower. (Lawhori *et al.,*1963). In some areas of our country particularly in the northwestern part the night temperature fall even sometimes go below 5^0 to 6^oC which results remarkable yield loss of tomato. These findings suggest that late transplanting induces cold injury which exhibits a significant reduction on both growth and yield of tomato.

Presently tomato cultivators are also commercially producing tomato both and higher and lower temperature with foliar application of Plant growth

regulators. Batlang (2008) reported that the fruit yield of tomato is influenced by number of fruits in each cluster, fruit size which are improved with plant growth regulators and become popular to tomato growers. Among the different plant growth regulators that were required for tomato cultivation GA_3 and Salicylic acid is most important. (Riley, 2012)

Salicylic acid (from Latin *salix*, *willow tree*) is a monohydroxybenzoic acid, a type of phenolic acid and a beta hydroxy acid. It has the formula $C_7H_6O_3$. This colorless crystalline organic acid is widely used in organic synthesis and functions as a plant growth regulators (Grimes, 1999). It is derived from the metabolism of salicin. Salicylic acid(SA) is a phenolic phytohormone and is found in plants with roles in plant morphology and development, photosynthesis, transpiration, ion uptake and transport.

Salicylic acid also induces specific changes in leaf anatomy and chloroplast structure. SA is involved in endogenous signaling, mediating in plant defense against pathogens. It plays a role in the resistance to pathogens by inducing the production of pathogenesis-related proteins. It is involved in the systemic acquired resistance (SAR) in which a pathogenic attack on one part of the plant induces resistance in other parts.

Salicylic acid is considered to be the potent plant hormone (Raskin 1992) because of its diverse regulatory roles in plant metabolism.(Popova *et al*, 1990).It is synthesized in cells , can move freely in an out of cells, tissues and organ.(Kawano *et al*., 2004) and this movement is finely regulated by reactive oxygen species (ROS) (Chen and Kuc1999.)

Fariduddin *et al.,* 2003 reported that lower concentration of salicylic acids were found to be beneficial enhancing the photosynthesis, growth and various other physiological and bio chemical characteristics of plant. On the other hand at higher concentrations salicylic acid itself may cause a high level of stress of plant. The exogenous salicylic acid application enhances the activities of antioxidant enzyme activity as well as the enzyme of nitrate metabolism under stressful environment. Therefore it is suggest that salicylic

acid alters various physiological functions and biochemical process in plant for regulating their morphology and productivity in relation to change and plant environment. As we know that tomato production in Bangladesh is largely affected due to environmental conditions. To minimize the effect of these adverse conditions and to fulfill the current need of tomato for over population of our country. The yield of tomato needs to be increased through proper use of alleviating agent to alleviate the low temperature injury with late transplanting to increase the cropping intensity.

Research on the effect of different transplanting time in association with application of Salicylic acid in different doses on the growth and yield of tomato under Bangladesh conditions is limited. The present piece of research was undertaken with the following objectives:

- To find out the effect of transplanting time on the morphology and yield of tomato,
- To determine the effect of salicylic acid on the morphology and yield of tomato and
- To find out the suitable combination of transplanting time and salicylic acid for ensuring the maximum growth and yield of tomato.

CHAPTER II

REVIEW OF LITERATURE

Throughout the world Tomato *(Solanum lycopersicum*) is one of the most important and popular vegetable crops. It has received much attention to the researcher and a large number of research works have been done on various aspects to improve both quality and quantity of tomato. Several research works have been done to find out to effect on growth, yield and other characters for screening, selection and development of better varieties in different developing countries of the world. Some of the available research works in this connection have been reviewed with the hope that these may contribute useful information to the present study. Most of the works related to the present study are reviewed here.

2.1 Morphological and yield contributing parameters

Plant height is an important morphological character. It has been found to vary from variety to variety and also among different groups such as determinate,intermediate and indeterminate type.An experiment "Response of tomato cultivars to partial shade" was carried out at Peshawar on two tomato cultivars (Roma, Rio Grande).Bibi*et al*. (2012) observed that maximum increase in plant height (101cm) was recorded in partial shade applied from April. Plant height in control (74.5cm), partial shade from May (74.1cm) and partial shade from June (75.4cm) was almost same.

Islam (2009) conducted a field experiment with thirty one tomato genotypes and he reported that the tallest plant was 217.30 cm and the shortest plant was 83.27 cm. Narayan *et al*. (2007) conducted a field experiment in India during the kharif season to assess the effect of micronutrients on the growth and yield of the tomato hybrid Vijeta, and the maximum plant height 69.55 cm was obtained.

Narayan*et al.* (2007) conducted an experiment in Kanpur, Uttar Pradesh, India to assess the genetic variability of tomato cultivars KS-16, Azad T-3, Angoorlata, KS-29 and KS-7 and reported that the highest genotypic coefficient of variation was observed for plant height. The tallest plant (102 cm) was produced by the plant poultry manure, but the lowest (88 cm) was in the control in Raton (Hossen, 2007). .

Ahmed *et al.* (2005) conducted a study in Pakistan, during 2003-2004 to evaluate the seed production potential of 7 improved cultivars of tomato, i.e. Nemadina Roma, Red blast, Shalkot, Reograde, Nigeria and Modired, where the founded Shalkot showed the highest plant height (97.47 cm).

An experiment was conducted by Ghorbani *et al.* (2013) on 13 genotypes in Karaj region of Iran during year 2012. Based on results from factor analysis among the genotypes a highest proportion (39.619%) of data variation was found in fruit diameter.

Kabir (2005) conducted an experiment in Bangladesh Agricultural Research institute, Gazipur during summer season with fourteen genotypes of tomato. He reported fruit length differ significantly. The longest fruit was observed in P-71 (6.64 cm) and shortest fruit was observed in P-51 (3.67 cm). In another study with 49 genotypes of tomato in summer season and the reported fruit length ranged from 1.94 cm to 5.46 cm (Ahmed, 2002).

Jamwal *et al.* (1984) conducted an experiment in Solan, Himachal Pradesh, India, during 2000-01 on 37 tomato genotypes. They reported that the genotype FT-13 produced the highest fruit length. Singh *et al.* (2002) studied the variation among 92 tomato genotypes with regard to 13 characters were evaluated in Pantnagar, Uttaranchal and reported that the greatest phenotypic variation was recorded for fruit length.

2.2 Effect of transplanting time on the growth and yield of tomato

Zhao *et al. (*2014) carried out a experiment to extend the growing season and protect high-value horticultural crops. High tunnels have been used for many years worldwide and their popularity has increased in Mississippi. A planting date study of 'Roma' tomato (*Solanumlycopersicum* L.),Legend' tomato, 'Ichiban' eggplant (*Solanummelongena* L.), 'Sweet Banana' pepper (*Capsicum annuum*L.), 'Benary's Giant' zinnia (*Zinnia elegans* L.), and 'Potomac Red' snapdragon (*Antirrhinum majus* L.) was conducted in 2010 in three high tunnels in Starkville, Mississippi. There were two planting dates for all the cultivars: 12 March 2010 and 2 April 2010. Only for zinnias, yield (272 stem/plot) of first planting date was higher than planting date two (106 stem/plot). Harvesting of tomato, eggplant, and pepper from high tunnels was a month earlier than the field-grown crops.

Adil *et al*. (2013) carried out a study was to elucidate the effect of different sowing dates and temperature on growth, yield and quality of two important cultivars of *Gladiolus grandiflorus* L. Rose supreme and White prosperity .The results showed that different planting dates have significant effect on number of days taken by gladiolus corm to germinate. Maximum sprouting percentage was recorded in T2 with 94.66 % followed by T3 82.19 % on all the treatments. The maximum plant height (115.33cm) was recorded in T2 followed by T3 with 111.04cm. The maximum number of florets (17.16) was recorded in T2 followed by T3 with 15.83 florets. Among the treatments maximum corm diameter (6.19 cm) was recorded on T2 and T6 showed maximum number of cormels (5.96 cm). It is suggested that proper planting date reduce the production cost by reducing the crop time and also produce elite flowers with increased market value.

Bevacqua and Vanleeuwen (2003) reported that Chile pepper *(Capsicum annuum*L.) yields were highly variable and were strongly influenced by disease and weather. Chile pepper was direct seeded on six planting dates, 13, 20, 27 March and 3, 10, 17, April.2001, with or without an application of phosphorus fertilizer, Pat 29.4 kg.ha'1, banded beneath the seed row. During the growing season, this experimental planting suffered, as did commercial plantings in New Mexico, from high mortality and stunting due to beet curly top virus, a disease transmitted by the beet leafhopper. The results indicated that planting date had a significant effect on crop performance. The best stand establishment and the highest yield were associated with the earliest planting date, 13 March.

Hossain *et al*. 2013 was conducted experiment at Agricultural Research Station, Thakurgaon, Bangladesh during October 2009 to March 2010 to observe the effect of sowing dates on yield of tomato genotypes. Three sowing dates viz. October 1, October 15 and October 30 were considered as factor A and tomato variety viz., BARItomato-2, BARI Tomato-3, BARI Tomato-4, BARI Tomato-9 and BARI Hybrid Tomato-4 considered as factor B. The experiment was laid out in RCBD (Factorial) with three replications. Early flowering (52.40 days) as well as early fruit harvesting (119.13 days) was occurred in October 1 sowing, where as sowing on October 30 resulted in delayed flowering (71.73 days) and fruit harvesting (140.67 days), respectively. Number of fruits per plant was also the highest (27.40) in October 1 sowing and the lowest (13.73) was in October 30 sowing. Seed sowing of October 1 was found better in respect of yield (74.75 tha-1) compared to October 15 (58.55 tha-1) and October 30 (24.60 tha- 1) sowing. Among the variety, BARI Tomat-2 produced the highest (68.12 tha-1) marketable yield followed by BARI Tomato-9 (56.16 tha-1) and BARI Tomato-3 while BARI Tomato-4 gave the lowest (36.91 tha-1) marketable yield

Alam *et al.* 2011 carried out an experiment at the Olericulture field of Horticulture Research Centre of BARJ, Joydebpur,Gazipur during September 2006 to April 2007 to investigate yield and yield attributes of sweet pepper as influenced by plant spacing and sowing time. The number of branches per plant, number of fruits per plant, fruit length, individual fruit weight, yield per plant were found significantly increased with the increasing plant spacings but other parameters were found to be significantly increased with the decreasing plant spacing. The combined effect of sowing date and plant spacing also had significant effect on different growth and yield parameters and yield. The highest yield (19.36 t/ha) of fruit was recorded from the earlier sowing (1 October) with the closest spacing (50 × 30 cm).

Russo (1996) found that planting date, fertilizer rate, and timing of harvest can affect yield of Jalapeno and banana peppers *(Capsicum annuum*L.). Seedlings of the Jalapeno 'Mitla' and Long yellow wax 'Sweet Banana #504' were transplanted in April and July 1995 into beds fertilized with either a recommended or a higher rate. Fruits were harvested either three times or once, the latter corresponding to the last of several harvests. Significantly higher yields were produced from the July planting of both cultivars and with once over harvesting. The recommended rate of fertilizer increased yield of 'Sweet banana #504' and decreased that of' Mitla' compared to the higher rate.

Cebula (1995) conducted a field experiment in plastic tunnels near NowySacz in 1993 and 1994 using six *Capsicum* cultivars. Plants were set out in late April or early May in each year. Good light conditions in this area promoted early fruiting. Cultivars Oasis FI and Spartacus F (gave the highest marketable yields of 7.66 and 7.20 kg/m2, respectively. Average fruit weights were also high (310 and 255 g, respectively). Yields were higher from planting in late April.

2.3 Effect of Growth regulators on the growth and yield of tomato

Ong and Cruz (2016) conduct a study to know the effect of SA treatment on the severity of leaf curl disease of tomato (*Solanum lycopersicum* L.) was evaluated under screen house conditions in two experimental trials at the Crop Protection Cluster, University of the Philippines Los Baños from 2012 to 2013. The study sought to determine the concentration of SA applied at different time of induction which can effectively reduce the severity of the disease. Healthy seedlings of susceptible tomato variety, Apollo White were treated by spraying with 50, 250 or 500µM SA at 5, 10 or 15 days before inoculation (dbi). At induction time of 5 dbi, treatment with 250µM SA had lowest leaf curl infection compared with the untreated control, while at 10 and 15 dbi, leaf curl infection was lowest with treatment of 50µM SA.

Rahman *et al*. (2015) conducted an experiment at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh to test the impact of plant growth regulators on growth and yield of summer tomato. The experiment consisted of two tomato varieties *viz*. BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 and four types of plant growth regulator GR)*viz*.,(i) control (without PGR), (ii) 4-CPA (4-chlorophenoxy acetic acid), GA_3 (gibberellic acid) and 4-CPA +GA_3.At 75 DAT the maximum plant height (87.90 cm), number of flowers and fruits (49.04 and 21.9, respectively) plant^{-1}, individual fruit weight (61.16 g), and fruit yield (27.28 tha^{-1}) were found when 4-CPA + GA_3 applied together.

El-Alwany (2014) carried out an experiment on Salicylic acid (SA) and 2,6-dichloroisonicotinic acid (INA), which have the ability to induce systemic acquired resistance in plants were used in this study to test their

effect on radial growth of (*F.o.l*) and (*F.o.c*) in Petri dishes. Results showed that 500 ppm of SA and INA had the greatest radial growth of *F.o.l*and *F.o.c* compared to other concentrations 1000 and 2000 ppm significantly. Inhibition percentage measurements showed also SA and INA 500 ppm had the lowest inhibition percentage (6.8%), (28%) for *F.o.l*and (8.8%), (24.8) for *F.o.c*. respectively. Results of this study and many of other studies conducted for the induction of systemic acquired resistance by these two compounds proved that concentrations less than 500 ppm able to induce the systemic acquired resistance in plants, also their inhibitory influence on radial growth are very few or non-existent in many cases.

Javaheri *et al.* (2012) carried out an experiment to study the effects of salicylic acid on yield quantity and quality of tomato at research center of Shirvan Agricultural Faculty in 2011. Foliar application of five concentrations of salicylic acid (0, 10^{-2}, 10^{-4}, 10^{-6}, 10^{-8} M) were used. Results showed that application of salicylic acid treated with 10^{-6} M significantly had higher fruit yield (3059.5 g per bush) compared to non-treated plants (2220 g per bush). Results also indicated that application of salicylic acid significantly improved the fruit quality of tomato. Application of salicylic acid increased the amount of vitamin C, lycopene, diameter of fruit skin and also increased rate of pressure tolerance of fruits.

Rahmawati *et al.* (2014) conduced an experiment to determine compound from *Clerodendrum japonicum* and *Catharan tusroseus* leaf extract, which were potential as bio activator and to evaluate the concentration of salicylic acid in tomato cultivars (*Lycopersicon esculentum*cv. Intan and cv. CL 6064) infected by CMV virus after application of plant extracts. The results showed that leaf extract of *C. japonicum* and *C. roseus* contained glyoxylic

acid, phytol, and 1, 2-benzenedicarboxylic acid which might be potential as plant activator. In tomato plant cv. Intan, leaf extract of *C. japonicum* was more potential to increase salicylic acid production averagely 36.91%, while in cv. CL 6064, leaf extract of *C. roseus* was more potential to increase salicylic acid production (averagely 27.47%)

Mehraj *et al.* (2014) carried out an experiment at Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to assess the response of foliar application of GA3 with different concentrations to cherry tomato plants. The assessment expressed that the foliar application of 200-ppm gibberellic acid solution provided maximum number of leaves (16.7), tallest plant (70.0 cm), early flower bud initiation (13.0 days), early flowering (16.0 days) and early fruiting (20.3 days); utmost fruit diameter (25.9 mm) and number of fruits (105.0 fruits) per plant; maximum single fruit weight (11.1 g) and total fruit weight (1.2 kg) per plant, whereas the control was lowest.

Mohammadi *et al*. (2014). carried out an experiment at the University of Thessaly during the summer season of 2011, the effect of foliar application of gibberellic acid (GA3) to okra at an early stage of plant growth (3-4 leaves) on plant growth, pod and seed characteristics was studied in relation to harvest time. GA3 was applied at concentrations of 0 (Control), 50, and 100 mg L-1 to four okra cultivars (‘Boyiatiou’, ‘Veloudo’, ‘Clemson’ and ‘Pylaias’) and pods were harvested 30, 35, 40 and 50 days after anthesis (DAA) from the lower part of the plant. From the results it was found that GA3 application increased plant height irrespective of cultivar and GA3 concentration (50 and 100 mg L-1), but without increasing flower induction or pod set, increase the number of seeds per pod.

Kumar *et al*.,(1999) observed that foliar application of Salicylic acid to Soybean to enhance the flowering and pod formation.

Hussein *et al.*(2007) conducted a pot experiment where they sprayed salicylic acid to the foliar of wheat plants., irrigated with Mediterranean sea water and reported and enhance productivity due to improvement in all growth characteristics including plant height , number and area of green leaf.

Yahaya and Gaya, 2012 conducted a field trials on dry seasons to assess the efficacy of various rates of giberrellic acid on the growth and yield of tomato (Lycopersicon lycopersicum (L) karst. The treatments consisted of seven rates (0, 50, 100, 150, 200, 250 and 300 ppm) of giberrellic acid. Data were recorded on plant height, number of leaves, number of branches, number of flowers and fresh fruit weight. Results of the study showed that giberrellic acid concentration had significantly ($P \leq 0.05$) enhanced the growth, yield components as well as total yield of tomato. Best results were recorded from plants treated with 300 ppm giberrellic acid compared to all other rates applied

Sahu *et al*. (2007) investigated the effect of various concentration of salicylic acid on the growth pigment content and the activity of antioxidant in the laboratory grown wheat plants.

Kumar *et al.(*2000) in a comparative studies analysis studied the cumulative effect of salicylic acid with that of GA, kinetin, NAA, ethral and chloro chloro chloride (CCC) and founded synergistic effect of SA and GA on flowering compare to other combination of hormone.

Zahra, 2010 conducted a research on tomato seeds which planted in pots containing perlite were put in a growth chamber under controlled conditions of 27 ± 2 and 23 ± 2°C temperature, 16 h lightness and 8 h darkness, 15 Klux light intensity and 75% humidity; NaCl concentration of 0, 25, 50, 75 and 100 mM and salicylic acid concentration of 0, 0.5, 1 and 1.5 mM were used in the form of factorial experiment in. Salinity increases the soluble sugar in leaf and root tissues, and salicylic acid decreases it. The leaf protein level decreased because of salinity effect, but salicylic acid could increase it. In the root, salinity increases protein, but salicylic acid with 1.5 mM concentration decreases it.

Roy and Nasiruddin, (2011) conducted an experiment to study the effect of GA3 on growth and yield of cabbage. Single factor experiment consisted of four concentrations of GA3, viz., 0, 25, 50 and 75 ppm. Significantly the minimum number of days to head formation (43.54 days) and maturity (69.95 days) was recorded with 50 ppm GA3 and 50 ppm GA3 gave the highest diameter (23.81 cm) of cabbage head while the lowest diameter (17.89 cm) of cabbage head was found in control (0 ppm GA3) treatment. The application of different concentrations of GA3 as influenced independently on the growth and yield of cabbage. Significantly the highest yield (45.22 kg/plot and 104.66 t/ha) was found from 50 ppm GA3.

Khan *et al.* (2006) conducted a pot experiment was performed according to a factorial randomized design at Aligarh to study the effect of 4 levels of gibberellic acid spray (0, 10-8, 10-6 and 10-4 M GA3) on the growth, leaf-NPK content, yield and quality parameters of 2 tomato cultivars (Lycopersiconesculentum Mill.), namely Hyb-SC-3 and Hyb-Himalata. Irrespective of its concentration, spray of gibberellic acid proved beneficial for most parameters, especially in the case of Hyb-SC-3.

Sakirova (2007) recorded enhanced germination and seedling growth in wheat when the grains were subjected to pre sowing seed soaking treatment in Salicylic acid.

Salim *et al.* (2013) held three experiment (laboratory field and pots) those were conducted at Giza agric. Res, station, ARC Egypt during the to successive summer season 2012 and 2013. Seed of tiosintee variety local were primed in five concentration of Salicylic acid (0.4, 0.6, 0.8, 1.0 and 1.2 g/l) for twenty four hours, as well as control with non priming. The aims of these study was to determine the best level of salicylic acid of pre sowing treatment for tiosentine seed to improve to germination performance, germination speed, seedling character, antioxident enzyme activity and forage yield.

Shittu and Adeleke (1999) investigated the effects of foliar application of GA3 (0, 10, 250 or 500 ppm) on growth and development of tomatoes cv, 158-3 grown on pots. Plant height and number of leaves were significantly enhanced by GA3 treatment. Plants treated With GA3 with 250 ppm were the tallest plant the highest number of leaves

Tomar and Ramgiry (1997) studied that tomato plant treated with GA3 showed significantly greater number of branches plant-1 than untreated controls.

Sanyal *et al.*(1995) studied that the effects of plant growth regulators (IAA or NAA at 15, 25 or 50 ppm or GA3 at 50, 75 or 100 ppm) and methods of plant growth regulator application on the quality of tomato fruits. Plant growth regulators had profound effects on fruit length, weight and sugar : acid ratio. The effects of presoaking seeds and foliar application of plant growth regulators were more profound than presoaking alone.

EI- Habbasha *et al.*(1999) carried out a field experiment with tomato cv. castel rock over two growing seasons (1993-94). The effects of GA3 and 4-CPA on fruit yield and quality were investigated. Many of the treatments significantly increased fruit set percentage and total fruit yield, but also the percentages of puffy and parthenocarpic fruits compared to the controls.

Application of GA3 at 50 and 100 ppm in french bean increased leaf number over control (Cato *et al.* 2013). The increased leaf number could intercept most of the incident radiation and result in higher dry matter production in faba bean (Takano *et. al.* 1995).

Gain in dry matter per unit assimilatory area per unit time is the NAR. It was established that NAR become higher during vegetative stage and then decline rapidly as season progressed possibly due to mutual leaf shading and increase of old leaves which could have lower photosynthetic efficiency (Majumder *et al.,* 1980).

Leonard *et al.* (1983) reported that inflorescence development in tomato plants grown under low light regimes was promoted by GA3 application directly on the inflorescence.

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Chern *et al.* (1983) presented that one month old transplanted tomato plants were sprayed with 1, 10 or 100 ppm GA3 and observed that GA3 at 100 ppm increased leaf area, plant height and stem fresh and dry weight but 10 ppm inhibited growth.

Wu *et al.* (1983) sprayed one-month old transplanted tomato plants with GA3 at 1, 10 or 100 ppm and reported that GA3 100 ppm increased plant height and leaf area.

Hathout *et al.* (1993) found that application of 10 ppm IAA as foliar sprays or to the growing media of tomato plants had a stimulatory effect on plant growth, development and fruit which was accompanied by increases in endogenous auxin, gibberellins and cytokinin contents. However, IAA at 80 ppm had an inhibitory effect on plant growth and development, which was accompanied by increase in the level and activity of indigenous inhibitors and by low levels of auxins, cytokinins and gibberellins

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 Experimental site

The experiment was conducted at the farm and Lab Dept.of Agricultural Botany, of Sher-e-Bangla Agricultural University, Dhaka. The location of the site was $23^{o}74'$ N latitude and 90^{o} 35′ longitude with an elevation of 8.2 meter from sea level.

3.2 Experimental period

The experiment was carried out during the Rabi season from November 2014 to March 2015. Seedlings were sown on pot in three times at November, 2014 and were harvested up to 15 March, 2015.

3.3 Soil type

The experimental site was situated in the subtropical zone. The soil of the experimental site lies in agro-ecological regions of "Madhupur Tract" (AEZ NO. 28). Its top soil is clay loam in texture and olive grey with common fine to medium distinct dark yellowish brown mottles. The pH 4.47 to 5.63 and organic carbon contents is 0.82 (Appendix-I).

3.4 Weather

The monthly mean of daily maximum, minimum and average temperature, relative humidity, monthly total rainfall and sunshine hours received at the experimental site during the period of the study have been collected from Bangladesh Meteorological Department, Agargaon, Dhaka (Appendix III)

3.5 Materials used for experiment

The tomato, variety BARI Tomato-15 was used for the experiment. Seeds were collected from Bangladesh Agricultural Research Institute, Joydevpur Gazipur and no of pot is 48.

3. 6 Treatments

The two factor experiment consisted of 3 times of transplanting (Factor A) and 3 levels of hormone Salicylic acid with control (Factor B).

Factor: A: Different days of Transplanting

T_1	First transplanting date	10 December 2014 (The temperature 19.43^0c)
T_2	Second transplanting date	20 December 2014 (The temperature 19.75^0c)
T_3	Third transplanting date	30 December 2014 (The temperature 17.88^0c)

Factor B: Different doses of plant growth regulators with control

Treatment	**Plant growth regulator**	**Concentration**
C	Control	No plant growth regulators
SA_1	Salicylic Acid	o.1mM
SA_2	Salicylic Acid	0.2mM
SA_3	Salicylic acid	0.3mM

Treatment combinations are as follows

First Transplanting Treatments	Second Transplanting Date	Third Transplanting Treatments
T_1CR_1	T_2CR_1	T_3CR_1
T_1CR_2	T_2CR_2	T_3CR_2
T_1CR_3	T_2CR_3	T_3CR_3
T_1CR_4	T_2CR_4	T_3CR_4
$T_1SA_1R_1$	$T_2SA_1R_1$	$T_3SA_1R_1$
$T_1SA_1R_2$	$T_2SA_1R_2$	$T_3SA_1R_2$
$T_1SA_1R_3$	$T_2SA_1R_3$	$T_3SA_1R_3$
$T_1SA_1R_4$	$T_2SA_1R_4$	$T_3SA_1R_4$
$T_1SA_2R_1$	$T_2SA_2R_1$	$T_3SA_2R_1$
$T_1SA_2R_2$	$T_2SA_2R_2$	$T_3SA_2R_2$
$T_1SA_2R_3$	$T_2SA_2R_3$	$T_3SA_2R_3$
$T_1SA_2R_4$	$T_2SA_2R_4$	$T_3SA_2R_4$
$T_1 SA_3R_1$	$T_2SA_3R_1$	$T_3SA_3R_1$
$T_1 SA_3R_2$	$T_2SA_3R_2$	$T_3SA_3R_2$
$T_1 SA_3R_3$	$T_2SA_3R_3$	$T_3SA_3R_3$
$T_1 SA_3R_4$	$T_2SA_3R_4$	$T_3SA_3R_4$

T_1= First Transplanting, T_2= Second Transplanting and T_3= Third Transplanting.

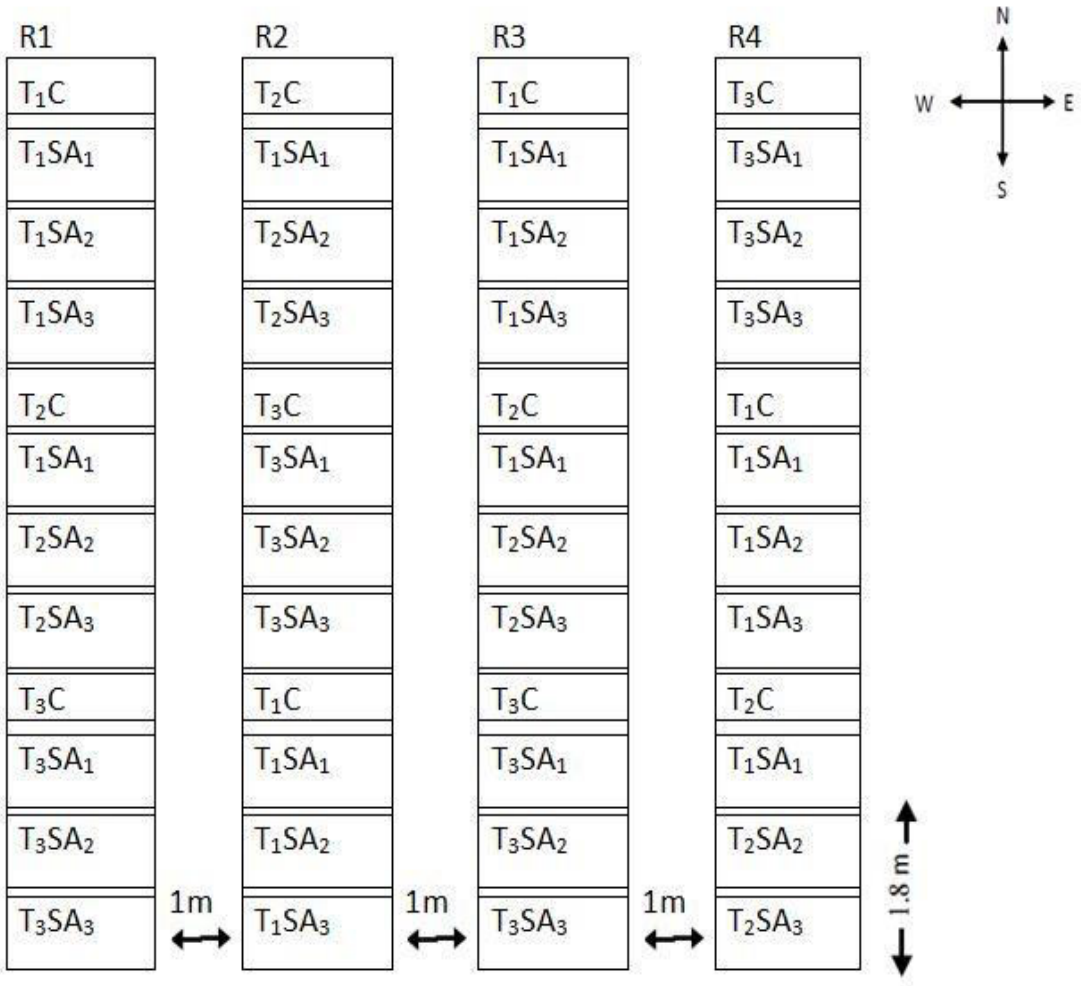
R= Replication.

C= Control =No Salicylic acid

SA_1= Salicylic Acid 0.1mM

SA_2= Salicylic Acid 0.2mM

SA_3= Salicylic Acid 0.3mM



$T_{1=}1^{st}$ Transplanting Date
$T_{2=}2^{nd}$ TransplantingDate
$T_{3=}3^{rd}$ Transplanting Date

C= Control
SA_1= Salicylic acid 0.1mM
SA_2= Salicylic acid 0.2mM
SA_3= Salicylic acid 0.3mM

Fig. 1: Layout of the experimental plot

3.7 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications.

3.8 Raising of seedling

Tomato seedlings were raised in two seed beds of 2m X 1m size. The soil was well prepared and converted into loose friable condition in obtaining good tilth. All weeds, stubbles and dead roots were removed. Twenty grams of seeds were sown in each seedbed. The seeds were sown in the seedbed on three times at October, 2014. Seeds were then covered with finished light soil and shading was provided by bamboo mat (chatai) to protect young seedlings from scorching sunshine and rainfall. Light watering, weeding and mulching were done as and when necessary to provide seedlings with a good condition for growth.

3.9 Pot preparation

Sandy loam soil, well dried cow dung and proper amount of fertilizer were mixed as per tub recommendation and then tub was filled with that. Then pots were placed into laboratory and arranged through experimental design. The tubs were ready for transplanting seedling.

3. 10 Application of manure and fertilizers

The sources of N, P_2O_5 and K_2O as urea, TSP and MP were applied, respectively. The entire amounts of TSP and MP were applied during the final Tub preparation. Urea was applied in three equal installments at 20, 30 and 40 days after seedling transplanting. Well-rotten cow dung 800g/pot also applied during pot preparation.

Table 1:Rate of manures and fertilizers used in the experiment

Name of the fertilizer	Amount g/pot
Urea	25g
TSP	12g
MP	2g
Cow dung	800g

3.11 Application of Salicylic acid

The stock solution of 1000 mm of SA with small amount of ethanol to dilute and then mixed in 1 litre of water turn as per requirement of 0.1 mM SA and Similarly prepared 0.2mM and o.3 mM. Application of hormone at 10 day interval were done at 20, 30 and 40 days after transplanting.

3.12 Transplanting of seedlings

Healthy and uniform 20 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental pot in the afternoon of 05 November, 2014maintaining experimental design. Each tub contain one healthy plant .Similarly second transplanting was done 10 days interval after first sowing and third transplanting was done 10 days interval after second sowing.The seedbed was watered before uprooting the seedlings from the seedbed so as to minimize damage of the roots. The seedlings were watered after transplanting.

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3.13 Intercultural operation

After transplanting of seedlings, various intercultural operations such as irrigation, weeding, staking and top dressing etc. were accomplished for better growth and development of the tomato seedlings.

3.13.1 Irrigation

Over-head irrigation was provided with a watering cane to the tubs once immediately after transplanting seedlings in every alternate day in the evening up to seedling establishment. Further irrigation was provided when needed.

3.13.2 Staking

When the plants were well established, staking was given to each plant by Dhaincha *(Sesbania*sp.) sticks to keep them erect. Within a few days of staking, as the plants grew up, the plants were pruned as per the treatments.

3.13.3 Weeding

Weeding was done to keep the plots clean and easy aeration of soil which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully. Mulching for breaking the crust of the soil was done when needed.

3.13.4 Top dressing

After basal dose, the remaining doses of urea were used as top-dressed in 3 equal installments at 15, 30 and 45 DAT. The fertilizers were applied on both sides of plant rows and mixed well with the soil. Earthening up operation was done immediately after top-dressing with nitrogen fertilizer.

3.13.5 Control of pest and disease

Malathion 57 EC was applied @ 2 ml/L 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. During foggy weather precautionary measured against disease infection of tomato was taken by spraying Dithane M-45 fortnightly @ 2 g/L, at the early vegetative stage. Ridomil gold was also applied @ 2 g/L against blight disease of tomato.

3.14 Harvesting

Fruits were harvested at 3 day intervals during early ripe stage when they attained slightly red color. Harvesting was started from 26 February, 2015 and continued up to 25 March, 2015.

3.15 Collection of data

Plant from each pot was selected and was tagged for the data collection. Some data were collected from sowing to harvesting with 10 days interval and some data were collected at harvesting stage. Data were collected on the following parameters:

A. **Morphological characters**

1. Plant height (cm) at different growth stages (from 30 DAT , 40 DAT and 50 DAT.

2. No. of leaves per plant at different growth stages (from 30 DAT, 40 DAT and 50 DAT.)

3. No. of brunch /plant

4. Number of cluster/ plant

5. No. of flower/plant from (30 DAS , 40 DAS and 50 DAS.)

6. Length of fruit (cm)

7. Breadth of Fruit (cm)

8. No. of fruits/plant

9. Individual fruit weight (g)

10. Total Yield/plant

3.15.1 Plant height

Plant height was measured from the sample plants in centimeter from the ground level to the tip of the longest stem and means value was calculated. Plant height was recorded 30, 40, and 50 days after transplanting to observe the growth rate.

3.15.2 Number of leaves

Number of leaves was counted from the ground level to the tip of the longest stem and mean value was calculated. Number of leaves was recorded from 30, 40 and 50 days of planting to observe the growth rate of the plants.

3.15.3 Number of branch /plant

Number of Branch was counted from the ground level to the tip of the longest stem and mean value was calculated. Number of branch was recorded from 50 DAT to observe the growth rate of the plants.

3.15.4 Number of flower clusters per plant

The number of flower clusters was counted from the sample plants at 50 DAT and the average number of flower clusters produced per plants was calculated.

3.15.5 Number of flowers per plant

The number of flowers per cluster was counted 50 DAT and mean value was calculated.

3.15.6 Number of fruit in clusters per plant

The number of fruit was recorded from each plant, and the total number of fruit was produced per plant was recorded.

3.15.7 Fruit Length

The length of fruit was measured with a slide calipers from the neck of the fruit to the bottom of 10 selected marketable fruits from each plant and their average was calculated in centimeter.

3.15.8 Fruit breadth

Breadth of fruit was measured at the middle portion of 10 selected marketable fruits from each tub with a slide calipers and their average was calculated in centimeter.

3.15.9 Single fruit weight

The weight of fruit was measured with an electric balance from 10 selected marketable fruits from each plant and their average was calculated in gram.

3.15.10 Fruit yield per plant

An electric balance was used to take the weight of fruits per plant. It was measured by totaling of fruit yield from each unit tub during the period from first to final harvest and was recorded in gram.

Analysis of data

The data in respect of growth, yield contributing characters and yield were statistically analyzed to find out the statistical significance. The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and the mean differences were adjusted by Least Significance Difference (LSD) test (Gomez & Gomez, 1986).

i.General mean (X) $= \frac{\text{Sum of observation of all the plants for each genotype}}{\text{Number of plants}}$

ii. Range = The minimum and maximum values for each trait within population

Coefficient of variation (CV%) $= \frac{\sigma_p}{\bar{x}}$ x 100

Where, σ_p = Phenotypic standrad deviation

X = General mean of the character

CHAPER IV
RESULTS AND DISCUSSION

The present experiment was carried out with a view to determine the effect of transplanting time and effect of salicylic acid on tomato in respect morphological, yield and yield contributing and characters. The results have been described and discussed under the following headings.

4.1 Plant height

In this study, the effect of transplanting date of tomato in relation to delay of transplanting reduced the plant height. The main effect of transplanting date indicated that the plant height gradually increased when recorded at different growth period; observed at 30, 40 and 50 days after transplanting (DAT) (Table 1 and Appendix III).At 30DAT, the highest plant height (33.13cm) was recorded fromT_1 (10 December,2014) and the lowest (26.58cm) was recorded from T_3(30December,2014). At 40 DAT, the highest plant height (55.88cm) was recorded from the T_1 (10 December, 2014) and the lowest (38.69cm) was recorded fromT_3 (30 December, 2014). At 50DAT, the highest plant height (73.88cm) was recorded from the T_1 (10December, 2014) and lowest value (69.44cm) was recorded fromT_3 (30December, 2014).These data showed that early transplanting shows maximum plant height than late transplanting. Previous result showed that late transplanting induce cold induction which reduced the plant height (Chen *et al.1999).*

In this study, different concentration of Salicylic Acid (SA) as 0.1 mM, 0.2 mM and 0.3 mM were used to show the effect of SA on plant height (Table 2and Appendix III). The higher concentration of SA, the higher plant height was found. At 30 DAT, the highest plant height (31.56cm) was recorded from SA_2 (0.2mM SA) and the lowest (26.60 cm) was recorded from C (no SA). At 40DAT, the highest plant height (51.25cm) was recorded from SA_2 (0.2mM SA

) and the lowest(46.67cm)was recorded from C (no SA). At 50DAT, the highest plant height (74.83 cm) was recorded from the SA_2 (0.2mM SA) and lowest value (69.83cm) was recorded from C (no hormone).

The combined effect of sowing date and SA were statistically significant on plant height (Table 3and Appendix III). At 30 DAT, the highest plant height 37.50cm) was recorded fromT_1SA_2 (10December, 2014 and 0.2mM SA) and the lowest (24.30cm) was recorded from T_1C (10December, 2014 and no plant growth regulator). At 40 DAT, the highest plant height (57.75cm) was recorded from the T_2SA_2 (20 December, 2014 and 0.3mM SA) the lowest (36.7cm) was recorded from T_1C (10 December, 2014 and no hormone). At 50 DAT, the highest plant height (78.25cm) was recorded from theT_1SA_3 (10 December, 2014 and 0.3 mM SA) lowest value (64.00cm) was recorded fromT_3C (30 December, 2014 and no SA). The results of the present study for this character are in agreement with the findings of Shittu and Adeleke (1999) who stated that, plant height of tomato was significantly increased with close application hormone. Roy and Nasiruddin 2011 also expressed similar opinion on plant height of tomato.

Table1. Effect of transplanting time on plant height of tomato at different days after transplanting

Transplanting time	Plant height (cm) at different days after transplanting (DAT)		
	30 DAT	**40 DAT**	**50 DAT**
T_1	33.13 a	55.88 a	73.88 a
T_2	29.13 b	52.38 b	73.50 a
T_3	26.58 c	38.69 c	69.44 b
$LSD_{(0.05)}$	1.816	3.168	3.463
Significant level	**	**	*
CV (%)	8.56	7.025	6.65

$T_{1=}$ First transplanting , 10 December 2014,

$T_{2=}$ Second transplanting , 20 December 2014

T_3= Third transplanting, 30 December 2014

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table2. Effect of different doses of SA on plant height of tomato at different days after transplanting

Plant growth regulator	Plant height (cm) at different days after transplanting (DAT)		
	30 DAT	**40 DAT**	**50 DAT**
Control	26.60 c	46.67ab	69.83 b
SA_1	31.02ab	49.75ab	71.08 ab
SA_2	31.56 a	51.25 a	74.67 a
SA_3	29.25 b	47.25 b	74.83 a
$LSD_{(0.05)}$	2.097	3.658	3.999
Significant level	**	NS	*
CV (%)	7.56	6.02	6.65

C= Control= No SA

SA_1= Salicylic acid (0.1mM)

SA_2= Salicylic acid (0.2 mM)

SA_3= Salicylic acid (0.3 mM)

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table3. Combined effect of transplanting time and different doses of SA on Plant height of tomato at different days after transplanting

Treatment combination	Plant height (cm) at different days after transplanting (DAT)		
	30 DAT	**40 DAT**	**50 DAT**
T_1C	24.30 c	36.70 d	70.00ab
T_1SA_1	28.00 bc	39.50 d	74.50ab
T_1SA_2	37.50 a	55.25abc	76.25ab
T_1SA_3	30.00 b	56.75ab	78.25 a
T_2C	26.08 bc	37.75 d	67.25bc
T_2SA_1	28.50 b	49.00 c	70.25 abc
T_2SA_2	29.50 b	50.50bc	71.00abc
T_2SA_3	29.25 b	57.75 a	72.50ab
T_3C	27.92 bc	40.75 d	64.00 c
T_3SA_1	30.25 b	51.75abc	73.25ab
T_3SA_2	27.00 bc	57.25ab	75.25ab
T_3SA_3	37.00 a	54.75abc	70.00bc
LSD (0.05)	3.633	6.336	6.926
Significant level	**	*	*
CV (%)	5.56	6.02	6.65

$T_{1=}$First transplanting , 10 December 2014 C= Control = No SA

$T_{2=}$ Second transplanting , 20 December 2014 SA_1= Salicylic acid(0.1mM)

T_3 = Third transplanting, 30 December 2014 SA_2= Salicylic acid(0.2mM)

LSD= Least significance difference SA_3= Salicylic acid(0.3mM)

CV= Co-efficient of variance

* = Significant at 5% level

4.2 Number of leaves per plant

It is known to all that leaf is the main photosynthetic organ of plant along with the leaf number is a fundamental morphological character for plant growth and development. The number of leaves was counted to investigate the effect of different transplanting time on changes in the leaf number per plant of tomato at 30 DAT, 40 DAT and 50 DAT (Table 4, Appendix III). At 30 DAT, the maximum number of leaves per plant (9.13) was recorded from T_1 (10 December, 2014) and the minimum (7.00) was recorded from T_3 (30 December, 2014).At 40 DAT, the maximum number of leaves per plant (15.50) was recorded from the T_1 (10 December, 2014) and the minimum (10.50) was recorded from T_3 (30 December, 2014) which was statistically similar to theT_2 (20 December,2014). At 50 DAT, the maximum number of leaves per plant (21.50) was recorded from the T_1 (10 December, 2014) and lowest value (16.44) was recorded fromT_3 (30 December, 2014).These data showed that early transplanting shows maximum plant. These results indicate that highest number of leaves per plant found from early transplanting whereas minimum number of leaves per plant was produced from late transplanting. Adil *et al* 2013 support this experiment.

SA also showed significant influence on number of leaves per plant of tomato (Table 5 and Appendix III).Number of leaves per plant increased significantly with higher concentration of SA. At 30 DAT, the highest number of leaves per plant (8.75) was recorded fromSA_2 (0.2 mM SA) and the lowest was (7.17) was recorded from C (no SA). At 40 DAT, the highest number of leaves per plant (13.75) was recorded from SA_2 (0.2 mM SA) and the lowest (12.25) was recorded from C (control). At 50 DAT, the highest number of leaves per plant (18.58) was recorded from the SA_3 (0.3mM SA) solution which was statistically similar to SA_2 (0.2 mM SA) and SA_1 (0.1 mM SA)

The combined effect of transplanting date and different doses of SA on number of leaves per plant was also significant (Table 6 and Appendix III.). At 30 DAT, the highest number of leaves per plant (9.75) was recorded fromT_1SA_2

(10 December, 2014 and 0.2 mM SA) and the lowest (6.50) was recorded from T_1SA_1 (10 December, 2014 and 0.1mM SA).At 40 DAT, the maximum number of leaves per plant (17) was recorded from the T_1SA_3 (10 December, 2014 and 0.3 mM SA) the lowest (10.75) was recorded from T_1C (10 December, 2014 and no plant growth regulators). At 50 DAT, the highest number of leaves per plant (21.75) was recorded from the T_1SA_3 (10 December, 2014 and 0.3 mM SA) lowest value (64.00cm) was recorded from T_3C (30December, 2014 and no SA) Which is statistically similar to T_2C (20 December, 2014 and no SA).

Table4. Effect transplanting time on leaf of tomato at different days after transplanting

Transplanting time	Number of leaves per plant at different days after transplanting (DAT)		
	30 DAT	**40 DAT**	**50 DAT**
T_1	9.13 a	15.50 a	21.50 a
T_2	7.25 c	13.60 b	19.63 a
T_3	7.00 b	10.50 b	16.44 b
LSD(0.05)	0.5210	1.145	1.440
Significant level	**	**	**
CV(%)	6.94	4.07	7.85

$T_{1=}$ First transplanting , 10 December 2014,

$T_{2=}$ Second transplanting , 20 December 2014

T_3 = Third transplanting, 30 December 2014

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table5. Effect different doses of Salicylic acid (SA) on leaf of tomato at different days after transplanting

Plant growth regulator	Number of leaves per plant at different days after transplanting (DAT)		
	30 DAT	**40 DAT**	**50 DAT**
Control	7.17 b	12.25 b	16.58 b
SA_1	8.42 a	13.58 ab	18.50 a
SA_2	8.75 a	13.75 a	18.42 a
SA_3	8.17 a	13.33 ab	18.58 a
$LSD_{(0.05)}$	0.6016	1.322	1.663
Significant level	**	*	**
CV (%)	8.94	12.07	10.85

C= Control= No SA

SA_1 = Salicylic acid (0.1mM)

SA_2 = Salicylic acid (0.2 mM)

SA_3 = Salicylic acid (0.3 mM)

LSD= Least significance difference

CV= Co-efficient of varianc

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table6. Combined effect of transplanting time and different doses of Salicylic acid (SA) on leaf of tomato

Treatment combination	Number of leaves per plant at different days after transplanting (DAT)		
	30 DAT	**40 DAT**	**50 DAT**
T_1C	8.25 c	10.75 ef	17.50 cde
T_1SA_1	6.50 e	13.75 cd	19.00 a-d
T_1SA_2	9.75 a	16.00 ab	21.75 a
T_1SA_3	7.00 de	17.00 a	19.25 abc
T_2C	7.50 cde	11.00 def	16.25 de
T_2SA_1	7.50 cde	13.00 cde	20.75 ab
T_2SA_2	8.50 bc	14.50 bc	19.75 abc
T_2SA_3	9.75 a	16.00 ab	19.50 abc
T_3C	8.00 cd	10.75 def	16.50 de
T_3SA_1	8.25 c	14.25 bc	17.25 cde
T_3SA_2	7.00 de	13.25 cd	19.75 abc
T_3SA_3	9.50 ab	15.50 ab	19.25 abc
$LSD_{(0.05)}$	1.042	2.290	2.881
Significant level	*	*	**
CV(%)	8.94	9.07	10.85

T_1 = First transplanting , 10 December 2014

T_2 = Second transplanting , 20 December 2014

T_3 =Third transplanting, 30 December 2014

LSD = Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

C= Control =No SA

SA_1= Salicylic Acid (0.1mM)

SA_2= Salicylic acid(0.2mM)

SA_3= Salicylic acid(0.3mM)

4.3 Number of branches per plant

The effect of sowing date on the number of branches per plant of tomato was significant (Table 7 and Appendix IV).The highest number of branch per plant (2.18) was observed from the T_1 (10 December, 2014) and the lowest value (1.87) was observed from T_2 (20December, 2014). Among dates of transplanting early transplanting recorded the highest vegetative growth in tomato which was reported by Sing *et. al.* (2005)

Application of different doses of SA showed statistically significant effect on branches number of tomato plant (Table 8 and Appendix IV).The highest number braches per plant (2.18) was observed from the SA_3 (0.3 mM SA) and the lowest (1.833) was observed from C (no SA). Kazemi (2012) and Yildirim et al (2009) observed significant effect of SA and Ca^{2+} in increasing the number of branches in plant.

The combined effect of transplanting date and SA on number of branches per plant was significant (Table 9 and Appendix IV). The maximum number of branches per plant (2.60) was found from T_3SA_3 (30December, 2014 and 0.3 mM) which was statistically similar to T_2SA_2 (20 December, 2014 and 0.2 mM SA). The minimum value (1.80) was recorded from T_2C (20 December, 2014 and no SA).

4.4 Number of flower clusters per plant

In this experiment, there was a significant difference in number of flower clusters per plant at different transplanting date (Table 7 and Appendix IV). The highest number of flower cluster per plant (3.00) was found from T_1 (10 December, 2014) which is statistically similar to T_2 (20 December, 2014) and the lowest number of cluster (2.50) was recorded from T_3 (30 December, 2014). These results indicate that lower temperature reduces the formation of number of flower clusters per plant.Therefore, it is suggesting that low

temperature stress significantly affect the both vegetative and reproductive development in tomato. The maximum number of cluster per plant (3.08) was recorded from application of SA_2 (0.2 mM SA) which was statistically similar to SA_3 (0.3 mM SA).The minimum number of cluster per plant of tomato (2.58) was recorded from C (no SA) in 50.The combined effect of sowing date and SA on number of cluster per plant was also significant (Table 9, Appendix IV).The maximum number of cluster per plant (3.70) was obtained from T_1SA_2 (10 December, 2014 and 0.2 mM SA)

The lowest value (1.43) was recorded from T_2C (20 December, 2014 and no SA) which is statistically similar to T_1SA_3 and T_2SA_1.The application of 50 ppm SA by root soaking had significantly increased the number of flowers, fruits and fruit yield per plant but similar results were achieved when only. 25 Mm SA was applied at the flowering stage.(Friduddin *et al* 2013 .*)*

Table7. Effect of transplanting on number 0f branches per plant and number of flower clusters per plant of tomato

Transplanting time	No. of branches per plant	No. of cluster per plant
T_1	2.18 a	3.00 a
T_2	1.87 c	2.93 a
T_3	2.00 b	2.50 b
$LSD_{(0.05)}$	0.1156	0.2991
Significant level	**	**
CV(%)	8	11.81

$T_{1=}$First transplanting, 10 December 2014,

$T_{2=}$ Second transplanting, 20 December 2014

T_3= Third transplanting, 30 December 2014

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table8. Effect of SA on number of branches per plant and number of clusters per plant of tomato

Plant growth regulator	No. of branches per plant	No. of clusters per plant
Control	1.83 c	2.58 b
SA_1	2.00 b	2.67 b
SA_2	2.06 ab	3.08 a
SA_3	2.18 a	2.92 ab
$LSD_{(0.05)}$	0.1335	0.3454
Significant level	**	**
CV(%)	8	12.81

C= Control= No SA

SA_1= Salicylic acid (0.1mM)

SA_2= Salicylic acid (0.2 mM)

SA_3= Salicylic acid (0.3 mM)

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table9. Combined effect of transplanting time and different doses of SA on number branches per plant and number of clusters per plant of tomato

Treatment combination	No. of branches per plant	No. of clusters per plant
T_1C	2.00 c	2.50 c
T_1SA_1	2.25 b	3.25 ab
T_1SA_2	2.25 c	3.70 a
T_1SA_3	2.50 a	2.50 c
T_2C	2.00 c	1.43 d
T_2SA_1	2.25 b	2.43 c
T_2SA_2	2.50 a	3.30 ab
T_2SA_3	2.25 b	3.00 bc
T_3C	1.80 d	1.75 d
T_3SA_1	2.00 c	3.00 bc
T_3SA_2	2.50 c	3.50 ab
T_3SA_3	2.60 a	2.50 c
$LSD_{(0.05)}$	0.2312	0.5982
Significant level	**	**
CV(%)	8.5	11.81

$T_{1=}$First transplanting , 10 December 2014
$T_{2=}$ Second transplanting , 20 December 2014
T_3 = Third transplanting, 30 December 2014

LSD= Least significance difference

CV= Co-efficient of variance
* = Significant at 5% level
** =Significant at 1%level

C= Control
SA_1= Salicylic acid(0.1mM)
SA_2= Salicylic acid(0.2mM)
SA_3= Salicylic acid(0.3mM)

4.5 Number of flowers /plant

Among the yield contributing characters, number of flower per plant is one of the important characters. Transplanting time had significant effect on number of flowers per plant of tomato (Table 10 and Appendix V). The highest number of flower per plant (10.50) was observed fromT (10 December, 2014) and the lowest (8.25) was observed from T_3 (30 December, 2014).The number of flowers per plant varied significantly under different plant growth regulators (Table 11 and appendix V).From the table 11 it is easily understand that the highest no of flower was (10) found from SA_2 (0.2 mM SA) and lowest value (8.00) was found from C (no SA).A significant combined effect of transplanting date and plant growth regulator was also observed on number of flowers per plant (Table 12 and appendix V). The highest number of flower (12.00) per plant was found from T_1SA_2 (10 December, 2014 and 0.2 mM SA) which was significantly different from of other sowings and SA concentration. The minimum number of fruits (7.00) per plant being noticed in plants of third transplanting with closer control condition. Gabal *et al.* (1990) found that 100 ppm of SA was more effective treatment in increasing flower number per plant compared to control.

Table10. Effect of transplanting time on flower no per plant of tomato

Transplanting Time	Number of flowers per plant
T_1	10.50 a
T_2	8.50 b
T_3	8.25 b
Significant level	*
LSD $_{(0.05)}$	1.20
CV(%)	7.5

$T_{1=}$First transplanting , 10 December 2014,

$T_{2=}$ Second transplanting , 20 December 2014

T_3= Third transplanting, 30 December 2014

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

NS= Non significant

Table11. Effect of SA on number of flower per plant of tomato

Plant hormone	**No. of flower per plant**
Control	8.00 b
SA_1	8.50 b
SA_2	10.00 a
SA_3	9.40 ab
LSD $_{(0.05)}$	0.6908
Significant level	**
CV(%)	12.81

C= Control= No SA

SA_1= Salicylic acid (0.1mM)

SA_2= Salicylic acid (0.2 mM)

SA_3= Salicylic acid (0.3 mM)

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table12. Combined effect of transplanting time and different doses of SA on flowers per plant of tomato

Treatment combination	Flower number per plant
T_1C	8.50 cd
T_1SA_1	10.00 ab
T_1SA_2	12.00 a
T_1SA_3	7.50 cd
T_2C	7.00 d
T_2SA_1	8.50 cd
T_2SA_2	9.50 ab
T_2SA_3	11.50 ab
T_3C	7.00 d
T_3SA_1	9.00 bcd
T_3SA_2	10.00 abc
T_3SA_3	8.00 cd
$LSD_{(0.05)}$	2.402
Significant level	**
CV (%)	9.10

$T_{1=}$First transplanting , 10 December 2014 C= Control

$T_{2=}$ Second transplanting , 20 December 2014 SA_1= Salicylic acid(0.1mM)

T_3 =Third transplanting, 30 December 2014 SA_2= Salicylic acid(0.2mM)

LSD= Least significance difference SA_3= Salicylic acid(0.3mM)

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

4.6 Fruit length (cm)

A significant variation in length of fruit was observed due to transplanting date (Table 13 and Appendix V).The highest fruit length (4.48 cm) was observed from the T_1 (10 December,2014) and the lowest (4.05 cm) was observed from T_3 (30 December, 2014).These data resulted that early transplanting time increased fruit length in contrast to late transplanting. Madhumati and Sadarunnisa (2013) had reported that early transplanting showed the maximum fruit length of tomato.

There was no significant variation in fruit length of tomato due to plant hormone SA. (Table 14 and Appendix V).Longest fruit (4.51 cm) was obtained from the SA_2 (0.2 mM SA) and shortest was recorded (4.08 cm) in C (no SA).The result is in agreement with the report of Mohamma*di et al*. (2014). who reported that the number of fruits per plant and fruit length increased with application plant hormone.

The combined effect of transplanting date and SA had no significant variation in fruit length of Tomato (Table 15 and Appendix V). The longest fruits (4.48 cm) were recorded from T_1SA_2 (10 December, 2014 and 0.2 mM SA) and the lowest one (4.05 cm), was obtained fromT_1 C (10 December, 2014 and no SA).

4.7 Fruit breadth (cm)

Fruit breadth was significantly influenced by transplanting date (Table 13 and Appendix VI). The highest fruit breadth (4.60 cm) was found at the T_1 (10 December, 2014).The lowest fruit breadth (4.20 cm) was found fromT_3 (30 December, 2014) .

There was no significant variation in fruit breadth of tomato due to plant hormone SA (Table 14 and Appendix VI). The highest fruit breadth (4.64 cm) was obtained From SA_2 (0.2 mM SA) and the lowest fruit breadth (4.24 cm) was recorded in C (no SA). The results of the present experiment showed

disagreement with the report of Sanyal *et al.* (1995who stated that planting systems and distances did not significantly alter plant height, main stem length, fruit length, fruit diameter or thickness.

Fruit breadth (cm) showed no significant variation due to the interaction between the different transplanting time and application of different doses SA on tomato (Table 15 and Appendix V).The highest fruit breadth (4.680 cm) was observed from T_1SA_2 (10 December, 2014 and 0.2 mM SA) and the lowest value (4.05cm) was observed from T_2C (20 December, 2014 and no SA).

4.8 Number of fruits per plant

Significant effect of Transplanting date was found on the number of fruits per plant (Table 13 and Appendix V). The highest number (6.44) of fruits per plant was obtained T_1 (10 December, 2014). The lowest number (4.13) of fruits per plant was obtained from the T_3 (30 December, 2014). Number of fruits per plant was also the highest (27.40) in October 1 sowing and the lowest (13.73) was in October 30 sowing. Hossain *et al*. (2013)

The number of fruits per plant differed significantly among the different plant hormone SA level (Table 14 and Appendix V). The highest number (5.58) of fruits per plant was observed from SA_2 (0.2mM SA).The lowest number (4.13) of fruits was recorded from C (no SA). Significant increase in fruit size and weight due to 2,4-D and increased fruit number due to SA spray contributed to increased fruit yield. The (Selim *et al* 2013).

The combined effect of sowing date and plant hormone on the number of fruits per plant was found significant (Table 15 and Appendix V). The highest number (7.25) of fruits per plant was obtained from T_1SA_2 (10 December, 2014 and 0.2 mM SA) which is statistically similar to T_1SA_1 (6.75), T_2SA_2 (6.50), T_2SA_3 (6.00).The lowest number (4.00) of fruits per plant was obtained T_1C (10 December, 2014 and no SA)

4.9 Individual fruit weight (g)

Individual fruit weight of tomato was significantly influenced by transplanting date (Table 13 and appendix V).The heaviest fruit (52.29 g) was obtained from T_1 (10 December, 20140. The lowest fruit (49.87 g) weight was produced fromT_3 (30 December, 2014).

SA also influenced the individual fruit weight (Table 14 and Appendix V).The maximum fruit weight (55.86 g) was obtained from SA_2 (0.2 mM SA).The lowest weight (46.53) was found C (control).The result is in agreement with the report of (Alam *et al.* 2011) who reported that the he individual fruit weight declined with increased plant hormone. Individual fruit weight, yield per plant were found significantly increased with the increasing plant growth regulator.

The combined effect of sowing dates and hormone on individual fruit weight was significant (Table 15 and Appendix V). The highest single fruit weight was recorded (58.40 g) from T_2SA_2 (20 December, 2014 and 0.2 mM SA). The lowest (46.00g) was found from T_1SA_1 (10 December, 2014 and 0.1 mM SA)

4.10 Yield per plant (g)

Sowing date imposed significant difference in respect of yield per plant (Table 13 and Figure no 2 Appendix VI).The maximum yield (336.74.20 g) per plant recorded in T_1 (10December, 2014) which was significantly higher than all other treatments. The lowest value (205.00g) was recorded from T_3 (30 December, 2014) .The result of the present experiment is in agreement with the findings of g Russo (1996).

Table13. Effect of transplanting time on fruit length, fruit breadth, fruit number, individual fruit weight and total fruit wt. of tomato

Transplanting time	Fruit Length(cm)	Fruit Breadth(cm)	Fruit Number	Individual Fruit weight (g)	Yield per plant (g)
T_1	4.48 a	4.60 a	6.44 a	52.29 a	336.74 a
T_2	4.46 a	4.57 a	4.31 b	50.16 a	226.18 b
T_3	4.05 b	4.20 b	4.13 b	49.87 a	205.24b
LSD $_{(0.05)}$	0.2389	0.2692	0.3684	5.042	26.40
Significant level	**	*	*	*	*
CV(%)	5.14	9.74	10.00	9.14	8.47

$T_{1=}$ First transplanting , 10 December 2014

$T_{2=}$ Second transplanting, 20 December 2014

T_3= Third transplanting, 30 December 2014

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table14. Effect of different doses of SA on fruit length, fruit breadth, fruit number, individual fruit weight and total fruit wt. of tomato.

Plant growth regulator	Fruit Length (cm)	Fruit Breadth (cm)	Fruit Number	Individual Fruit weight (g)	Yield per plant (g)
Control	4.08	4.24	4.13 b	46.53 b	226.00 b
SA_1	4.48	4.45	5.00ab	52.50 ab	263.00 ab
SA_2	4.51	4.64	5.58 a	55.86 a	295.90 a
SA_3	4.28	4.42	4.92ab	50.95 ab	246.5 0b
$LSD_{(0.05)}$	0.2759	0.3109	0.4254	5.822	30.48
Significant level	NS	NS	*	**	**
CV(%)	10.14	9.74	8.00	11.14	12.47

C= Control

SA_1= Salicylic acid (0.1mM)

SA_2= Salicylic acid (0.2 mM)

SA_3= Salicylic acid (0.3 mM)

LSD= Least significance difference

CV= Co-efficient of variance

* = Significant at 5% level

** =Significant at 1%level

NS= Non significant

Table15. Combined effect of transplanting time and different doses of SA on fruit length, fruit breadth, fruit number, individual fruit weight, and total fruit wt. of tomato

Treatment combination	Fruit Length (cm)	Fruit Breadth (cm)	Fruit Number	Individual Fruit weight (g)	Yield per plant (g)
T_1C	4.00	4.19	4.00 cd	52.69 abc	203.50 d-g
T_1SA_1	4.25	4.54	6.75 a	46.00 bc	309.50 b
T_1SA_2	4.48	4.68	7.25 a	57.55 ab	417.23 a
T_1SA_3	4.44	4.63	5.75 b	54.13 abc	310.00 b
T_2C	4.03	4.11	4.25 cd	49.84 abc	187.20 fg
T_2SA_1	4.35	4.48	4.00 cd	46.97 abc	212.30 c-g
T_2SA_2	4.46	4.50	6.50 a	58.40 a	381.20 a
T_2SA_3	4.23	4.41	6.00 a	57.54 a	342.00 ab
T_3C	4.02	4.05	4.00 cd	47.93 abc	172.90 g
T_3SA_1	4.13	4.22	4.50 cd	48.31 abc	240.30 cde
T_3SA_2	4.57	4.55	5.50 ab	53.06 abc	265.90 bc
T_3SA_3	4.57	4.61	4.90 c	55.08 abc	259.5 bcd
LSD $_{(0.05)}$	0.9126	0.4988	2.452	5.237	52.790
Significant level	NS	NS	*	*	**
CV(%)	15.14	9.74	15.00	12.14	14.47

$T_{1=}$First transplanting , 10 December 2014
$T_{2=}$ Second transplanting , 20 December 2014
T_3 = Third transplanting, 30 December 2014
LSD= Least significance difference
CV= Co-efficient of variance
* = Significant at 5% level
** =Significant at 1%level

C= control
SA_1= Salicylic acid(0.1mM)
SA_2= Salicylic acid(0.2mM)
SA_3= Salicylic acid(0.3mM)

Yield per plant was significantly influenced by application plant hormone (Table 14 and Appendix VI). The maximum yield (295.9 g) was recorded from the application SA_2 (0.2mM SA) and differed significantly from that of the other doses. The application of 50 ppm SA by root soaking had significantly increased the number of flowers, fruits and fruit yield per plant but similar results were achieved when only 25 ppm SA was applied at the flowering stage. (El-Alwany2014)

The combined effect of sowing date and hormone on yield per plant was significant (Table 15 and Appendix VI). The highest yield (417.23 g) per plant was obtained from T_1SA_2 (20 December, 2014 and0.2 mM SA) different from other treatment combinations. The lowest yield (172.9 g) per plant was found from the T_3C (30 December, 2014 and no SA).

CHAPTER V
SUMMARY AND CONCLUSION

The experiment was conducted in the farm and Laboratory of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during the period of 10 November 2014 to 15 March 2015 to find out the role of exogenous foliar application of salicylic acid (SA) on the changes of morphology and fruit yield of tomato under low temperature injury owing to late transplanting. In this experiment, variety BARI tomato 15 was used as a planting material and the treatments consisted of three different times of transplanting:T_1=First transplanting time (10December 2014), T_2 =Second transplanting time (20 December 2014), T_3 = Third transplanting time (30 December 2014); and four different doses of SA *viz*. C = 0 mM SA, SA_1 = 0.1mM SA, SA_2 = 0.2 mM SA and SA_3 = 0.3 mM SA. Thus, there were 12 combinations treatment. The experiment was laid out in two factors Randomized Complete Block Design (RCBD) with four replications. 48 pots are needed to conduct these experiment. SA was applied to the plant according to the treatment. SA were sprayed exogenously by a hand sprayer in the morning at 20, 30, and 40 DAT. Data were recorded on various parameters and statistically analyzed. Data on different growth parameter, physiological parameters and yield with contributing characters of tomato were recorded.

There was significant difference among the different time of transplanting in respect of almost all parameters. Plant, transplanted on T_1=first transplanting time, showed the maximum height more or less over the growth period whereas the lowest height was recorded from late transplanted plants. At 30, 40 and 50 DAT, The tallest plant height were respectively 33.13, 55.88 and 73.88 cm which were recorded from T_1= first transplanting whereas the lowest height

were respectively 26.58, 38.69 and 69.44 cm which were recorded from T_3= third transplanting time.At 30,40 and50 DAT,the maximum number leaves per plant were respectively 9.13,15.50 and 21.50 which were recorded from T_1 whereas the minimum number of leaves per plant were respectively 7.00,10.50 and 16.44 recorded from T_3. Maximum number of branches per plant was 2.18 recorded from T_1 and minimum number of branches per plant was 1.87 recorded from T_3 The maximum number of flower cluster, flowers and fruits per plant 3.00, 10.50, 6.44 respectively obtained from T_1.The highest fruit length and diameter 4.48and 4.60 cm respectively were obtained from T_1=first transplanting. The maximum yield (336.74g) was observed from theT_1. Plant growth regulator Salicylic acid (SA) showed also significant influence on all the parameters .Plant height, number of leaves per plant, number of branches per plant was increased with the increasing the level of SA. The heighest plant height (74.83 cm), number of leaves (18.58) and Number of branch (2.18) was recorded in SA_3 (0.3 mM SA) where as lowest value was found in C (control condition). However the highest no. of cluster (3.08), Fruit no.(5.58), fruit length (4.51 cm) , fruit breadth(4.64cm), a individual fruit weight (55.86g), total yield per plant (295.9g) recorded from the SA_2 while the minimum no. of cluster (2.58),Fruit No. (4.13), fruit length (4.07 cm), fruit breadth (4.20 cm, individual fruit weight (46.33g), total yield per plant (226.00g) was recorded in control condition.

The combinations of transplanting time and salicylic acid had significant effect on almost all growth and yield contributing parameters. At 30, 40 and 50 DAT, the tallest plant height 37.50, 57.75, 78.25 cm respectively were recorded from T_1SA_2, T_2SA_2, and T_1SA_3. At 30, 40 and 50 DAT, the maximum number leaves per plant were respectively 9.75,17 and 21.75 which were recorded fromT_1SA_2, T_1SA_3 and T_1SA_3.Maximum number of branches per plant was 2.60 recorded from T_3SA_3 The maximum number of flower clusters, flowers and fruits per plant 3.70, 6.00 and7.25 respectively obtained from T_1SA_2 .The highest fruit

length and breadth 4.48 and 4.68 cm respectively were obtained from T_1SA_2. The maximum yield (417.23g) was observed from T_1SA_2

Conclusion:

Taking into account the above results, it may be concluded that morphological parameter, yield contributing characters and yield of tomato consistent with time of transplanting and exogenous foliar application of salicylic acid (SA).Considering the yield T_1= first transplanting with 0.2 mM SA was best for production of tomato under the farm of Dept.of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Recommendation:

- Need repeated trial for the accuracy of the experiment.
- Further studies are needed in different AEZ to find out optimum transplanting date for tomato production.
- Advanced study is needed to know how Salicylic acid works.

CHAPTER VI

REFERENCES

Adil, M., W. ahmad , K. S. Ahmad, J. Shafi, M. A. Shehzad, M. A. Sarwar, M. Salman, M. I. Ghani, M. Iqabal. 2013.Effect of Different Planting Dates on Growth and Development of *Gladiolus grandiflorus*under the Ecological Conditions of Faisalabad, Pakistan.*Universal Journal of Agricultural Research* 1(3):110-117.

Ahmed, K.U. 1976. "PhulPhal and ShakSabjee", 3rdEdn.AlhajKaniisuddin Ahmed, Bungalow No. 2, Farmgate, Dhaka- 15, Bangladesh. p.12.

Ahmed, K.U. 2005. "PhulPhal and ShakSabjee", 6thEdn.AlhajKaniisuddin Ahmed, Bungalow No. 2, Farmgate, Dhaka- 15, Bangladesh. p.20.

Ahmed, S. 2002. Genetics of fruit set and related traits in tomato under hot-humid conditions. Ph.D. Thesis, Department of Horticulture, Bangabandhu Sheikh MujibarRahman Agriculture University, Gazipur, Bangladesh.19-22.

Alam , M. S., S. R. Saha , M. A. Salam, M. S. Alam a nd M. K. Alam. 2011. Effect of sowing time and plant spacing on the yield and yield attributes of sweet pepper (Capsicum Annuum). *Bangladesh J. Agril*. Res. 36(1) : 271-278

Ali , M. B. , H. I. Lakun , W. Abubakar1 , and Y. Mohammed. 2014. Performance of tomato as influenced by organic manure and sowing date in Samaru, Zaria. *International Journal of Agronomy and Agricultural Research (IJAAR),*5(5): 104-110.

Anonymous, 2011.Food and Agriculture Organization of the United Nations. Available online with updates at http://faostat.fao.org/site/567 /default.aspx.

Bandok, A. M. and H. G. A. 2008. Response of Tomato plants to salicylic acid and chitosan under infection mosaic virus. *American – Eurasian J.ofAgric and Environ. Sci*.15(8)1520-1529

Barickman, T. C. 2014.The Effect of Abscisic Acid on Tomato Calcium Partitioning and Fruit Quality.PhD diss., University of Tennessee, 2014.

BBS, 2011.Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka. p. 108.

Bevacqua, R.F.andVanleeuwen, D.M.2003.Planting date effects on stand establishment and yield of chile pepper. *American Society for Horticultural Science.*38: 357-360.

Bibi B., Sajid M., Rab A., Shah S.T., Ali N., Jan I., Haq I., Wahid F.I., Haleema B. and Ali I. 2012. Effect of partial shade on growth and yield of tomato cultivars.*Global Journal of Biology, Agriculture & Health Sciences,* 1(1): 22-26

.

Bose T. K. and N.G. Som. 1986.Fruits of India Tropical and Subtropical.NayaProkashBidhansarani, Calcutta 700000. India. p. 1249

Camara, M. C.2015. General Aspects and Applications of Gibberelins and Gibberellic Acid in Plants.*In: Hardy, J. (*Org.). Gibberellins and Gibberellic Acid: Biosynthesis, Regulation and Physiological Effects. 1ed.Hauppauge: Nova Science Publishers, 1-21

Cato **S. C.**,W. R. Macedo**,** L. E. P. Peres**,** P. R. C. Castro**. 2013.**Sinergism among auxins, gibberellins and cytokinins in tomato cv. Micro-Tom.*HorticulturaBrasileira*31: 549-553.

Cebula, S. 1992.The effect of sowing and planting dates on the growth and yields of sweet pepper in greenhouse conditions.*Folia Horticulturae.*4(2): 15-23.

Cebula, S. 1995. Effect of cultivar and planting date on the growth and yield of sweet pepper grown in plastic tunnels in a sub-montane region.MaterialyogolnopolskiejkonferencjinaukowejNaukaPraktyceOgrodniczejokazjiXXVleciaWydzialuOgrodniczegoAkademiiRolniczejLublinie.545-548.

Chen, H. J., J. Kuc. 1999. Calcium dependent excretion of salicylic acid in tobacco cell Suspension culture. *J. Exp. Bot.,* 52:1219-1226

Chern, J. K, C. W., Wu, J. K. Lin, and, S. F. Tarng.1983.Effect of plant growth regulators on the growth and development of tomato *J. Agnc. Assoc. China.,* 124: 31-42.

Crume, J. H. 1992. Effect of low temperature on fruit set. *Pro.plant Sci. Symp.,*Cambell Soup. Pp.99-108

EI-Habbasha. K.M.;Gomaa, H.M, EI-Gizawy, A.M and S.S.Mohamed.1999. Response of tomato plants to foliar spray with some growth regulators under later summer conditions. *Egyptian J. Hort*., 26: 3546.

El-Alwany, A. M. 2014. Efficacy of Salicylic Acid & 2, 6-Dichloroisonicotinic Acid as Systemic Acquired Resistance Activators *In vitro* on *Fusariumoxysporum*f. sp. *lycopersici*and *Fusariumoxysporum*f. sp. *Radiciscucumerinum*Radial Growth. *Nat Sci*, 12(9):92-96.

FAO (Food and Agriculture Organization). 2008. FAO Production Yearbook. Basic Data Unit, Statistics Division, FAO, Rome, Italy. 57:140-141.

Fariduddin Q., S. Hayat, A. Ahmed. 2003.Salicylic acid influences net photosynthesis rate , carbooxidation efficiency, nitrate reeducates and seed yield in *Brassica Juncea*.*Photosynthetica*. 41:281

Gelmesa , D., B. Abebie and L. Desalegn. 2010. Effects of Gibberellic acid and 2,4- dichlorophenoxyacetic acid spray on fruit yield and quality of tomato (*Lycopersiconesculentum*Mill*.) Journal of Plant Breeding and Crop Science,* 2(10) : 316-324.

Ghorbani B.D., Zaefizadeh M., Abadi A.A.J. and Karimi F. 2013. Study on the most important agronomical traits of 13 tomato cultivars through factor analysis.*International Journal of Farming and Allied Sciences*, 2 (17): 631-633.

Gomez, K. A. and Gomez, A. A. 1984.Statistical Procedures for Agricultural Resserch (2nd Edn.) John Willey and Sons, Singapore. Pp. 28-92.

Grimes, P. E. 1999."The Safety and Efficacy of Salicylic Acid Chemical Peels in Darker Racial-ethnic Groups". *Dermatologic Surgery*. **25** (1): 18–22.

Hathout, T.A., S.A ,Sheteawi, and S.M. Khallal. 1993. Effect of mode of application of some hormonal contents. *Egyptian J. Physiol, Sci.* Botany Department.Women's College.Ain Shams University, Cairo, Egypt, **17** (1): 45-62.

Hayat, S. & A. Ahmad. 2007 . Salicylic acid A Plant Hormone. *Springer*. *ISBN 1-4020-5183-2*

Hossain, M., M. Karim, M. M. Haque and A. M. A. Hossain. 1986. Performance tof different tomato lines planted different dates .*Bangladesh Horti.,* 14(1):25-28.

Hossain, M.F, N. Ara, M.R. Islam, J. Hossain and B. Akhter. 2013. Effect Of Different Sowing Dates On Yield Of Tomato Genotypes. *Int. J. Agril. Res. Innov. & Tech*. 4 (1): 40-43.

Hussein, M.M.M., L. K. Bablaand.S. M. Gabllah.2007. Salicylic acid and salinity effects on growth of maize plants. Res. *J. Agri. Bio. Sci*.,3(4):321-328.

Islam, M. 2009. Influence of Sowing Date And Spacing on Growth and Yield off Sweet Pepper. A Thesis.*Dept, on Horticulture & Postharvest Technology Sher-E-Bangla Agricultural University, Dhaka.*

Jamwal R. S., Pattan R.S. and Saini S.S. 1984.Hybrid vigour and combining ability in tomato.*South Indian Horticulture.*32(2): 69-74.

Javaheri , M., K. Mashayekhi, A. Dadkhah, F. Z. Tavallaee. 2012. Effects of salicylic acid on yield and quality characters of tomato fruit (Lycopersicumesculentum Mill.). *International Journal of Agriculture and Crop Sciences*. 4(16): 1184-1187

Jenkins J. A. 1948.The Origin of Cultivated Tomato.*Econonomics of Botany*, 2: 379.

Kabir M.E. 2005. Performance of heat tolerant tomato hybrids *(Lyropersiconesculentum*Mill.) varieties of Bangladesh. MS Thesis. Department of Horticulture, Bangabandhu Sheikh MujiburRahman Agriculture University, Gazipur, Bangladesh.p. 28.

Kalloo. 1985. Tomato (*Lycopersiconesculentum* Miller). Allied Publishers Private.Limitade, India, p. 407.

Kawano, T., T. Fruichi, S. Mutto. 2004. Control free Salicylic acid levels and corresponding signaling mechanism I plants. *Plant Bio. Tech*., 21:319-335.

Khan M. M. A., C. Gautam, F. Mohammad, M. H. Siddiqui, M. Naeem, M. N. Khan. 2006. Effect of Gibberellic Acid Spray on Performance of Tomato.*Turk J Biol.* 30 : 11-16.

Kumar, J. 1999. The Salicylic acid in signal plants.Plant.*Mol.Bio.,* 6:1439-1458.

Kumar, P. ,Lakshami, N. J. Mani.V .P.2 000.Interactive effects of salicylic acid and performance on age

Leonard, M., K. M Kinet, M. Bodsonand, ,G. Bernier1983. Enhanced Inflorescence development in tomato by growth substance treatments in relation to Cassimilate distribution.*Physiologia plant arun.***57** (1): 85-89

Lwahori, S. R. ,Sakiyana and Takahashi. 1963. High temperature injures in tomato. Effect of different temperature of fruit setting and yield seedling treated at different stage of growth. *J. Japan. Soc. Hort.Sci.* 32:197-204.

Majumder, M.K., S.D. Chanergee, S. Malik, and S. P. Banergee. 1980. Use of growth parameters in genetic screening for low temperature tolerance in rice under boro culture. *SABRAOJ*.,**12**(1):1-9.

Matin, M. A. 2001. Study on the variability, interrelationship of agro-morphological and some qualitative characters of tomato. MS Thesis, Genetics and Plant Breeding, Bangladcsh Agriculture University, Mymenshing, Bangladesh.

Mehraj, H., A. A. Sadia, T. Taufique1, M. Rashid and A.F.M. Jamal Uddin*.2014 .Influence Of Foliar Application Of Gibberellic Acid On Cherry Tomato. *J. Expt. Biosci.* 5(2):27- 30.

Mohammadi, G., E. M. Khah, S. A. Petropoulos1, D.B. Chachalis, F. Akbari&G.Yarsi., 2014. Effect of Gibberellic Acid and Harvesting Time on the Seed Quality of Four Okra Cultivars. *Journal of Agricultural Science*, 6 (7)

Narayan S., Ahmed N., Shahnaz-Mufti, Narayan R. and Chattoo M.A. 2007.Response of foliar application of micronutrients on tomato hybrid.Vijeta Environmental Ecological, 25(1): 86-88

Ong , S. and F. C. S. Cruz. 2016.Effect Of Exogenous Application Of Salicylic Acid On The Severity Of Tomato Leaf Curl Disease. *J. ISSAAS.* 22(1):137-145 .

Popova, L., T. Pancheva, A. Uznova. 1990. Salicylic acid properties ,Boisynthesis and physiological role . *Bulg. J. Plant.* Physiol.23:85-93.

Rahman, M ., M. A .Nahar, M. S. Sahariar, M. R. Karim. 2015.Plant growth regulators promote growth and yield of summer tomato (*Lycopersiconesculentum*Mill.) Progressive Agriculture 26: 32-37.

Rahman , M. S. , M. A. Haque and M. G. Mostofa. 2015. Effect of GA3 on Biochemical Attributes and Yield of Summer Tomato.*Journal of Bioscience and Agriculture Research.*3 (2): 73-78

Rahmawati, S. L., R. Esyanti, and N. Gunaeni.2014 .The Role of Leaf Extracts as Plant-activator to Enhance Salicylic Acid Production on Tomato Plant (*Lycopersiconesculentum*Mill.)Infected by CMV (Cucumber Mosaic Virus).*International Journal of Chemical, Environmental & Biological Sciences (IJCEBS)* , 2:2

Rashidi M.,GholamiM.andB.G.Khabbaz. 2009. Response of yield and yield components of tomato (*Lycopersiconesculentum*) to different tillage

methods.*International Journal of Agriculture & Biology*,11(5): 626–630.

Raskin, I. 1992. Role of Salicylic acid acid in plants. Plant Physiol. *Mol.Bio.* 43:39-63.

Riley, John M. *2012.*"Gibberellic Acid for Fruit Set and Seed Germination".

Roy, R. and K. M. Nasiruddin. 2011. Effect of Different Level of GA3 on Growth and Yield of Cabbage. *J. Environ. Sci. & Natural Resources,* 4(2): 79-82 .

Russo V. M. 1996. Planting date, fertilizer rate, and harvest timing affect yield of Jalapeno and Banana peppers. *American Society for Horticultural Science,* 31(7): 1097-1118.

Sahu. G. K. C.S. Sabat. 2007.Change in the growth potential and antioxidants in the root and leaf tissues of what plants under the influence of of exogenous salicylic acid. *Brazilian journal of plant Physiology*, 23(3).

Salem , M. A. A. 2013. Improved growth , productivity and quality of tomato plans through application of salicylic acid . *Saudi. J. Bio. Sci.* , 20(4):339-345.

Sanyal, D.; Kar, P.L. and M. ,Longkumar. 1995. Effect of growth regulators on the physicochemical composition of tomato *(Lycopersiconesculetum*Mill.) *Advances in Hort. And Forestry.,***4**:67-71.

Shakirova, F. M., A. R. Shakhabutdinova, A. R. Bezrukova, M. V. Fatkhudinova. 2003. Changes in the hormonal status of wheet seedling induced by Salicylic acid on salinity. *Plant Science.* 164: 317-322.

Shittu, G.A. and , A. Adeleke. 1999. Effect of gibberellic acid on the growth and development of tomato *(Lycopersiconesculetum*Mill.) cultivar 158-163 *Global J. Pure Apply Sci.,* **5** (1): 27-30.

Singh A.K., Bhalla S.K. and Verma S. 2002.A note on the variability in tomato (*Lycopersiconesculentum*Mill.).*Himachal Journal of Agricultural Research*, 19(I&2): 98-100.

Takano, K.P.; Bialek, K. and Cohen, J.D. 1995. The effect of growth regulators on two spring legumes, protein peas and french beans Mekedelingen Jan de facutiedlandbouwwetenschapenRijksunversiffeit Gent, **52**:1259-1266.

Thompson H.C. and W.C. Kelly. 1983. Vegetable crops, 5th edition. *Tata McGraw Hill Publishing Company Limited*, New Delhi. p. 611.

Tomar, J.S. and S. R. Ramgiry. 1997. Effect of growth regulator on yield and yield attributes 10 tomato*(Lycopersiconesculetum*Mill.) *Advan. Plant Sci.,***10**(2) 29-31.

Wu, C.W. J.Y Lin, S.F.Tarug and J. L.Cheru.1983. Effect of plants growth regulators on the growth and development of tomato..*J. Agric. China.,* **124**:31-42

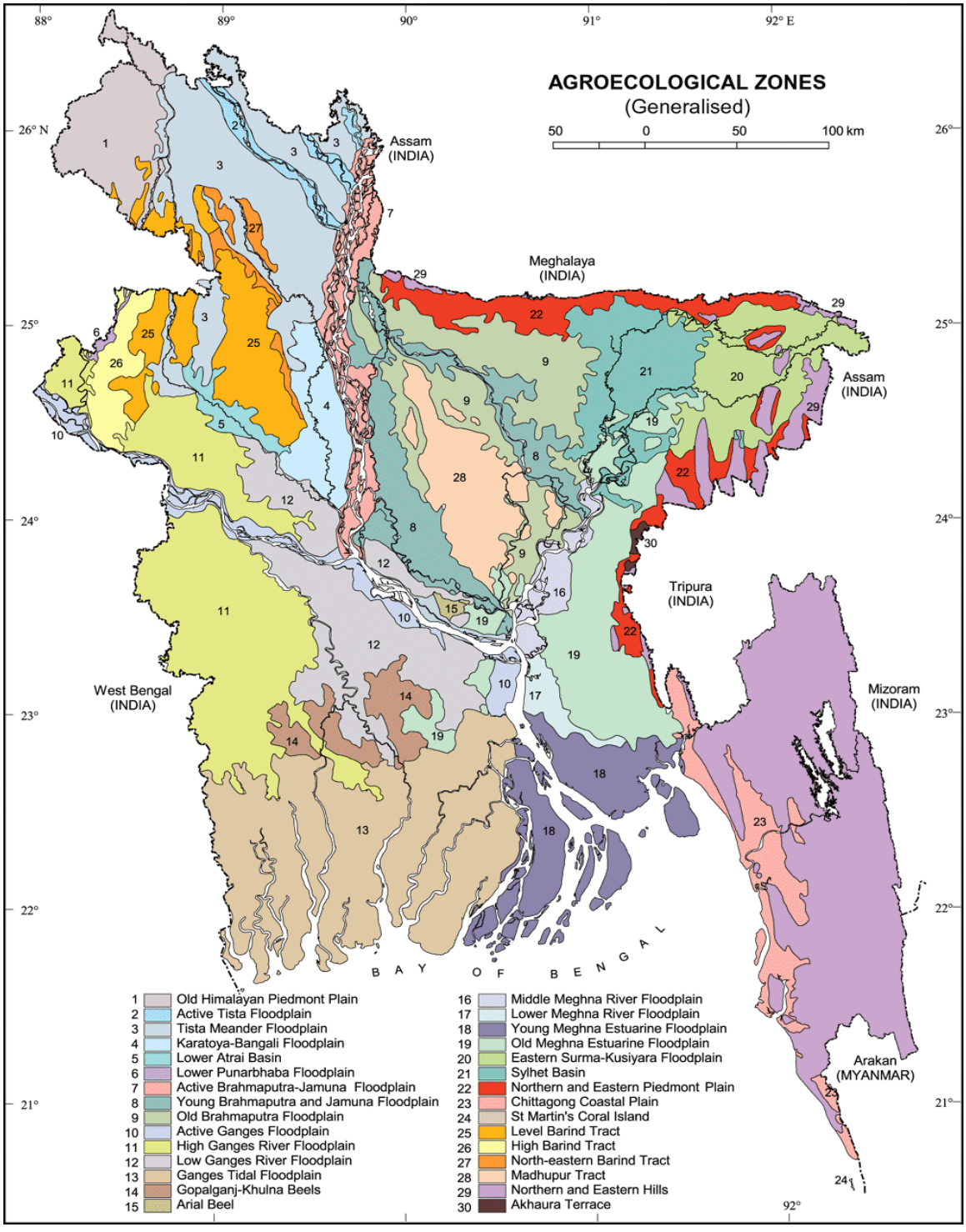
Yahaya, S. U. and , U. H. Gaya. 2012. Response of Tomato (LycoperisconLycopersicum (L) Karst) t o Various Rates of Giberrellic Acid.*Bayero Journal of Pure and Applied Sciences*, 5(1): 33 – 37

Zahra, S., B.Amin, V .S. M. Ali, Y. Ali and Y.Mehdi. 2010.The salicylic acid effect on the tomato (*Lycopersicumesculentum*Mill.) sugar, protein and proline contents under salinity stress (NaCl).*Journal of Biophysics and Structural Biology* 2(3): 35-41

Zhao,Y. ,M. Gu,G.Bi, B. Evans, and R. Harkess. 2014.Planting Date Effect on Yield of Tomato, Eggplant, Pepper, Zinnia, and Snapdragon in High Tunnel in Mississippi. *Journal of Crop Improvement* , 28

APPENDICES

Appendix I: Experimental location on the map of agro-ecological zones Of Bangladesh



Appendix II: **Soil characteristics of Sher-e-Bangla Agricultural University Farm, Dhakaare analyzed by Soil Resources Development Institute (SRDI), Farmgate, Dhaka.**

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy farm, SAU, Dhaka
AEZ	Modhupur tract (28)
General soil type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	**N/A**

Source: Soil Resources Development Institute(SRDI)

B. Physical and Chemical properties of the Initial soil

Characteristics	Value
Practical size analysis	
Sand (%)	16
Silt (%)	56
Clay (%)	28
Silt + Clay (%)	84
Textural class	Silty clay loam
Ph	5.56
Organic matter (%)	0.25
Total N (%)	0.02
Available P (µgm/gm soil)	53.64
Available K (me/100g soil)	0.13
Available S (µgm/gm soil)	9.40
Available B (µgm/gm soil)	0.13
Available Zn (µgm/gm soil)	0.94
Available Cu (µgm/gm soil)	1.93
Available Fe (µgm/gm soil)	240.9
Available Mn (µgm/gm soil)	50.6

Source: Soil Resources Development Institute (SRDI)

Appendix III: Analysis of variance of data on plant height, Number of leaves of tomato influenced by different transplanting time and different concentration of SA

Source	DF	Mean square					
		Plant Height			Number of Leaves		
		30 DAT	40 DAT	50 DAT	30 DAT	40 DAT	50 DAT
Sowing time (A)	2	174.41**	1320.02**	56.89*	14.25**	102.52**	52.14**
Hormone (B)	3	59.95**	41.85ns	76.85*	5.58**	5.46 ns	76**
Interaction (AB)	6	26.37**	20.10*	37.228	1.33*	5.21 ns	12.03**
Error	36	6.41	19.52	23.32	0.528	2.54	4.03

** = 1% level of significance, * = 5% level of significance, NS = Not significant

Appendix IV: Analysis of variance of data on Number of branches per plantand Number of clusters per plant of tomato influenced by different transplanting time and different concentration of SA

Source	DF	Mean square	
		Number of Branches	Number of Clusters
		50 DAT	50 DAT
Sowing time (A)	2	0.396**	1.18**
Hormone (B)	3	0.243**	0.632**
Interaction (AB)	6	0.118**	0.465**
Error	36	0.026	0.174

* = 1% level of significance, * = 5% level of significance, NS = Not significant

Appendix V: Analysis of variance of data on Flower number ,Fruit length, fruit breadth, and fruit number, ,Individual and fruit weight of tomato influenced by different transplanting time and different concentration of SA

Source	DF	Mean square				
		Number of flowers per plant 50 DAT	Fruit Length(cm)	Fruit Breadth (cm)	Number of fruits per plant	Individual Fruit wt.
Sowing time (A)	2	6.52**	0.069**	0.092^{ns}	38.34*	38.34*
Hormone (B)	3	0.132*	0.137*	0.106*	141.62**	141.62**
Interaction (AB)	6	3.13**	0.064**	0.044*	75.98*	75.98*
Error	36	0.701	0.111	0.141	49.44	49.44

* = 1% level of significance, * = 5% level of significance, NS = Not significant

Appendix VI: Analysis of variance of data on plant height, Number of leaves of tomato influenced by different transplanting time and different concentration of SA

Source	DF	Mean square
		Yield
Sowing time (A)	2	72445.64**
Hormone (B)	3	9884.82**
Interaction (AB)	6	5007.93**
Error	36	1355.12

* = 1% level of significance, * = 5% level of significance, NS = Not significant

Appendix VII: Records of meteorological information (monthly) during the period from November 2014 to March 2015

Name of the month	Temperature			% Humidity	Day length	
	Max Tem(®C)	Min Tem(®C)	Average tem (®C)		Shortest Day	Longest Day
November	23	14	31	81	10’47’’	12’17’’
December	26	13	31	87	10’32	10.59’’
January	27	12	18	84	10’37	11’6’’
February	27	12	18	82	11’6’’	11’29’’
March	33	20	27	66	12’8’’	12’20’’

Source: Bangladesh Meteorological Department (Climate and weather division) Agargaon, Dhaka