EFFECTS OF POTASSIUM ON GROWTH, YIELD AND QUALITY CHARACTERS IN TOMATO

A THESIS

BY

MD. ABDULLAH

DEPARTMENT OF AGRICULTURAL BOTANY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA -1207

December, 2015

EFFECTS OF POTASSIUM ON GROWTH, YIELD AND QUALITY CHARACTERS IN TOMATO

BY

MD. ABDULLAH

Registration No. : 10-04075

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: January-June, 2015

Approved by:

_____	_____
Prof. Dr. Md. Ashabul Hoque	**Prof. Dr. Shahnaz Sarkar**
Supervisor	**Co-Supervisor**

_____

Prof. Dr. Md. Ashabul Hoque
Chairman
Examination Committee

Prof. Dr. Md. Ashabul Hoque
Department of Agricultural Botany
Sher-e-Bangla Agricultural University
Dhaka, Bangladesh

Ref:

Date:

CERTIFICATE

This is to certify that thesis entitled, "EFFECTS OF POTASSIUM ON GROWTH, YIELD AND QUALITY CHARACTERS IN 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 inAGRICULTURAL BOTANY, embodies the result of a piece of bonafide research work carried out by MD. ABDULLAH, Registration No.10-04075under 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 acknowledged.

Dated: December, 2015
Dhaka, Bangladesh

Dated:December, 2015

Prof. Dr.

Department of Agricultural Botany
Sher-e- Bangla Agricultural University
Supervisor

DEDICATED TO
MY
BELOVED PARENTS

ACKNOWLEDGEMENTS

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

I would like to express my heartiest respect, my deep sense of gratitude and sincere, profound appreciation to my supervisor, Associate Prof. Md. Ashabul Hoque, Chairman, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for his sincere guidance, scholastic supervision, constructive criticism and constant inspiration throughout the course and in preparation of the manuscript of the thesis.

I would like to express my heartiest respect and profound appreciation to my Co-supervisor, Prof. Dr. Shahnaz Sarkar Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for her utmost cooperation and constructive suggestions to conduct the research work as well as preparation of the thesis.

I express my sincere respect to all the teachers of Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for providing the facilities to conduct the experiment and for their valuable advice and sympathetic consideration in connection with the study.

I would like to thank all of friends especially and senior brother Arif to help me in my research work.

Mere diction is not enough to express my profound gratitude and deepest appreciation to my father, mother, brothers, sisters, husband and relatives for their ever ending prayer, encouragement, sacrifice and dedicated efforts to educate me to this level.

December, 2015 *The Author*

SAU, Dhaka

ABSTRACT

The growth, yield contributing characters and yield of tomato largely depend on soil and climatic conditions and also on variety. Among these, proper doses of potassium and variety play a vital role. The field experiment was conducted at Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh during October 2015 to April, 2016 to evaluate the effect of potassium on yield and quality of tomato. Two different varieties, viz., BARI Tomato-2, Minto hybrid Tomato and five doses of potassium viz. P_0=0 kg/ha, P_1= 140 kg/ha, P_2= 150 kg/ha, P_3= 160 kg/ha, P_4= 170 kg/ha were used to conduct this experiment. The experiment was laid out in Randomized complete Block Design (RCBD) having two factors and replicated three times. Data were collected on plant height, number of branches per plant, length of branch, number flowers cluster per pant, number of fruit per plant, yield per plot, yield per hectare, TSS, β-Carotene content and Vit C content. A statistically significant variation was recorded in terms of all the characters related to growth and yield of tomato. The maximum plant height, number of branches per plant, length of branch was produced by Minto hybrid. The maximum number flowers cluster per plant and number of fruit per plant was produced by Minto hybrid. The maximum yield of fruits per hectare (41.60 tones) was obtained from Minto hybrid. The maximum plant height, number of branches per plant, length of branch was observed in doses of potassium 160 kg/ha. The maximum number flowers cluster per plant and number of fruit per plant was produced by doses of potassium 160 kg/ha. The maximum yield of fruits per hectare (35.24 tones) was obtained from doses of potassium 160 kg/ha treatment. The highest yield of fruits per hectare (49.01 tones) was obtained from Mintro hybrid Tomato with 160 kg K/ha. The lowest yield of fruits per hectare (12.22 tones) was obtained from BARI Tomato-2 with 0 kg K/ha.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATION AND ACRONYMS

AEZ Agro-Ecological Zone

BARI Bangladesh Agricultural Research Institute

BBS Bangladesh Bureau of Statistics

FAO Food and Agriculture Organization

N Nitrogen

B Boron

GA_3 Gibberellic Acid

et al. And others

TSP = Triple Super Phosphate

MOP = Muirate of Potash

RCBD = Randomized Complete Block Design

DAT = Days after Transplanting

ha^{-1} = Per hectare

g = gram (s)

kg	**=**	**Kilogram**
SAU	**=**	**Sher-e-Bangla Agricultural University**
SRDI	**=**	**Soil Resources and Development Institute**
wt	**=**	**Weight**
LSD	**=**	**Least Significant Difference**
^{0}C	**=**	**Degree Celsius**
NS	**=**	**Not significant**
Max	**=**	**Maximum**
Min	**=**	**Minimum**
%	**=**	**Percent**
NPK	**=**	**Nitrogen, Phosphorus and Potassium**
CV%	**=**	**Percentage of Coefficient of Variance**

CHAPTER I

INTRODUCTION

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

Tomato is widely used as salad as well as for cooking purposes. It is well known for its nutritional importance as it is the rich source of nutrients Na, K, Fe, vitamin A and C and antioxidants especially lycopene and salicylate (Afzal *et al.* 2013). Lycopene is an antioxidant which protects the cells from oxidative damage, so it decreases the risk of chronic diseases such as coronary heart diseases and cancer diseases (Giovannucci 2002, Taber *et al*. 2008). The mode of action is tentative, but they are believed to reduce cancer risk by successfully trapping oxygen and intermediates of free oxygen radical. Lycopene is soluble in fat and it is the precursor of β-carotene. It has at least two folds antioxidant capacity of β-carotene (Taber *et al*. 2008). Lycopene concentration in tomato fruit depends upon maturity, genetics, environmental conditions, cultivation techniques and production methods. The environmental conditions like

temperature, light, fertility and others affect fruit lycopene (Robertson, 1995; Kanai *et al*. 2007).

In Bangladesh, it is cultivated as winter vegetable, which occupied on area of 59000 acres of land, and The total production of tomatoes were 255 thousands metric tons in Bangladesh in the year of 2011-2012 (BBS, 2014). Thus the Average yield of tomato is 14.35 tons/ha, while it was 41.81 t/ha in the world (FAO, 2007). Which is very low in comparison with that of other countries, namely India (15.67 t/ha), Japan (52.82 t/ha) and USA (63.66 t/ha).The yield of tomato in our country is not satisfactory enough in comparison to requirement (Aditya *et al.*, 1999). There are many reasons such as lack of appropriate time of sowing dates, lack of improved varieties, lack of proper cultural and management practices is the barrier to increase the tomato production in Bangladesh. Meanwhile, the scientists have developed some varieties to increase the growth and yield of tomato. In addition, several researchers are still working for improving the growth and yield of tomato both in winter and summer season with proper management practices.

It has been reported that variety is an important factor, which is greatly influenced on the growth and yield of tomato. Previous many reports stated that variety effects on growth, yield contributing characters and yield of tomato (Thomas *et al.* (1979).They reported that dwarf money maker was the highest yielder (50 t /ha) having the longest fruiting period. The cultivar V. 687 and Parc-5 also gave higher yields that Gaamed, Punjab Chhuhara and Roma.

Kalloo (1989) and Ahmed *et al.* (1986) also found that different varieties influenced on growth and yield of tomato.

Potassium (K) is a key nutrient for enhancing productivity of vegetable crops and its content in vegetables has significant positive relationship with quality attributes (Bidari and Hebsur, 2011). Potassium has significant contribution in photosynthesis, enzyme activation, cell turgor maintenance and ion homeostasis (Marschner 1995). Additionally, it is also involved in the enrichment of lycopene contents of tomato fruit through synthesis of pigments or carotenoids (Bedari and Hebsur, 2011). Inside plant, K is found in ionic form only; it is co-factor of many enzymes. Major role of K in plant is osmotic adjustment. Under K deficient conditions, the fruit will be small in size, lack in red color and at early stage. Red color of fruit and ripening disorders closely related with K content of fruit (Perkins-Veazie and Robert 2003). It is reported that the K application above the optimum level reduces the tomato fruit color disorders (Hartz *et al.* 1999).

Fruit quality is directly affected by potassium supply (Windsor, 1979; Janse, 1985; Martin-Prével, 1989). Intensive research has been done to investigate the effects of K on fruit quality of vegetables grown in hydroponics, showing the significance of K in the nutrition of the crop (Sonneveld and Voogt, 1985; Voogt, 1987; Sonneveld and Vanden Burg, 1991; Bakker *et al.*, 1989; Kreij, 1996 and Kreij, 1999). However, a complication with increasing K supply is that enlargement of the total ion concentration (EC level). At the same time the osmotic pressure is increased, which in itself has a clear effect on yield and

quality (Sonneveld and van den Burg, 1991). The effect of K nutrition should be studied by taking into consideration the total ion concentration (EC). Fruit cracking in sweet pepper was reduced by increasing K levels (Kreij *et al.*, 1999). Lin *et al.* (2004) found that increasing potassium levels significantly increased the concentration of total sugar, total soluble solids, glutamic acid, aspartic acid, alanine, and volatile acetate of muskmelon. In tomato, it has been reported that acid and reducing sugar contents, often correlated with K application, influence not only sweet and sour taste attributes, but also different flavor traits (Auerswald *et al.*, 1999; Chapagain and Wiesman, 2004; Petersen, *et al.*, 1998).

Considering the above mentioned issues, the present experiment was conducted with the following objectives.

i. To investigate the response of tomato varieties to potassium on growth, yield and quality of tomato.
ii. To insight in the relationship of K nutrition and quality of tomato cultivar.
iii. To find out the optimum dose of potassium on growth, yield and quality of tomato.

CHAPTER II

REVIEW OF LITERATURE

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

2.1 Effect of potassium on growth and yield of tomato

A field experiment was conducted by Ahmad *et al.* (2015) to investigate the effect of potassium and its time of application on yield and quality of tomato variety, Nagina. Treatments included three potassium levels i.e. 60, 90 and 120 kg ha^{-1} and two application timings: at transplanting as single dose, and half at transplanting + half at 40 days after transplanting in two splits, were applied along with a control (0 kg ha^{-1} K). Potassium application @ 60 kg ha^{-1} either applied in single or in two splits, significantly increased the yield and improved the quality parameters of tomato over control while higher levels of K (90 and 120 kg ha^{-1}) did not show further significant increase in the yield and quality subsequently. Ascorbic acid remained unaffected. Results revealed that time of application/splitting of K did not affect the yield and

quality. The highest yield (23.3 t ha^{-1}), firmness (8.32 kg), fruit weight (83.24 g $fruit^{-1}$), total invert sugars (4.11 %), dry matter (6.33 %) and mineral matter (1.95 %) were recorded with the application of 120 kg ha^{-1} potassium at transplanting while the highest values of acidity (0.81%) , TSS (7.03 %) and ascorbic acid (30.33 mg 100 g^{-1}) were observed in treatment where potassium was applied @ 60 kg ha^{-1} in two splits. Minimum yield (17.2 t ha^{-1}), firmness (6.35 kg), fruit weight (68.11 g/fruit), mineral matter (1.80 %), dry matter (5.26 %), acidity (0.61 %), ascorbic acid (21.79 mg $100g^{-1}$), TSS (6.60 %) and total invert sugars (3.85 %) were found in control.

Javari *et al.* (2012) conducted a pot experiment to investigation effect of different rates of potassium fertilizer on chemical and sensory attributes of tomato during crop season of 2009. The pots were treated with K_2O @ 0, 75, 150, 225, 300, 375, 450 Kg K_2O ha-1 along with basal doses of N and P (100 Kg N and 80 Kg P_2O_5 ha^{-1}, respectively). Treatments were arranged in complete randomized design. The result showed that total solids, sugars & titratible acidity increased significantly with increasing rates of potassium but contrary to above attributes the pH decreased. Similarly, lycopene, vitamin C and total soluble solids increased significantly with increased application of K_2O up to 375 kg but thereafter decreased when K_2O was applied @ 450 Kg K_2O ha^{-1}. Significant relationships were apparent between fertilizer rates and surface redness, tissue redness, firmness, crispness, mealinss, sweetness, sourness and flavor. Moreover, several masking effects were observed between taste active components and chemical components of tomato fruit. A positive linear correlation of flavor with

sugar, total solids, titratible acidity; surface redness with lycopene & firmness with total solids while negative correlation between flavor and pH was observed. It was concluded that increasing K concentration resulted in improved quality parameters of tomato fruit and application of K_2O @ 375 Kg K_2O ha^{-1} along with recommended doses of N and P was found to be the best dose for high quality tomato fruit.

El-Nemr *et al.* (2012) conducted to study the effect of different concentrations of potassium (K) on the vegetative growth, yield and important quality traits of different tomato cultivars, including TSS, titratable acidity, vitamin C content and pH of fruit juice. Three K levels of 200, 300, and 350 ppm in the nutrient solution were used and two cultivars (Floridat and Super Strain B) were compared. Floridat cultivars showed 23% higher total soluble solids (TSS) than Super Strain B and also showed a total vitamin C content (4.65 $mg \cdot kg^{-1}$), markedly higher than Super Strain B. Increased K levels in the nutrient solution resulted in increased contents of TSS, Vitamin C contents, titratable acidity and juice pH in tomato fruits. Higher yield was recorded with Floridat cultivar and high level of K concentration (350 ppm).

Iqbal *et al.* (2011) were undertaken to study the effect of N and K doses (60, 90 and 120kg ha^{-1} N and 90kg, 110kg, 130kg ha^{-1} of K) on growth, economical yield and yield components of tomato under the agro-climatic conditions of Swat. The parameters selected under study i.e plant height at flowering stage, days to flowering, days to maturity, number of primary branches per plant, fruit length,

fruit width, number of fruits per plant and total yield were significantly affected by the applications of N and K. The maximum days to flowering (52) in 00kg N and 110kg of K, maximum days to maturity (85.67) were taken when was obtained with the application of 120kg N and 130kg ha^{-1} of K was applied. Maximum fruit length (5.96cm) was noted in 00kg of N and 130kg of K, while maximum fruit diameter (5.08cm) was noted when plants received 120kg N and 90kg K. in treatment 14 (120kg N and 90kg ha^{-1} of K), Economical yield (19 ton ha^{-1}) was obtained with 60kgN and 130kg ha^{-1} of K.

Akhtar *et al*. (2010) conducted to evaluate comparative effects of sulphate and muriate of potash (SOP and MOP) application on yield, chemical composition and quality of tomato (*Lycopersicon esculentum*, M. cultivar Roma*)* at National Agricultural Research Centre Islamabad, Pakistan. Potassium from two sources i.e., MOP and SOP was applied @ 0, 100 and 200 kg K ha^{-1} with constant dose of 200 kg N ha^{-1} and 65 kg P ha^{-1}. A significant increase in tomato yield with K application was observed. Potassium applied @ 100 kg K ha^{-1} as MOP produced significantly higher marketable tomatoes as compared to SOP and control. Levels and sources of potassium showed no effect on acidity of tomato fruits. Potash application decreased sugar content of tomato fruits as compared to control. This effect of K on reducing sugar content was more pronounced in K treated fruits as SOP than those of MOP. Vitamin C contents in tomato fruits increased with K application in the form of MOP. The K use as MOP significantly reduced incidence of leaf blight disease and insect pest attack in tomato plant as compared to SOP and control treatments.

Field experiments were conducted by Singh *et al.* (2004) on a Mollisol in Pantnagar, Uttaranchal, India, to determine the effects of integrated nutrient management on crop nutrient uptake and yield under okra-pea-tomato cropping sequence. In the sequence, treatments were given to okra crop, while in the succeeding crops (pea and tomato), only recommended dose of fertilizers were applied on the basis of soil test. The treatments consisted of NPK recommended dose of 80:30:30 kg/ha with biofertilizer. The treatments were applied in the first crop and their effect was observed on instant as well as succeeding crops. The integrated use of organic and inorganic sources of nutrients and biofertilizers increased the N, P and K concentrations in the plants including fruits of tomato. The integrated nutrient management also significantly increased shoot dry matter and fruit yields of tomato.

An experiment was conducted by Chapagain *et al.* (2003) to find out the effects of potassium chloride (KCl) as potassium (K) in fertilizer solution on growth, yield and quality of tomato (cv. Durinta) in a controlled greenhouses were compared with potassium nitrate (KNO3), the conventional K source for vegetable fertilization. Ammoniurn nitrate (NH_4NO_3), calcium nitrate [$Ca(NO_3)_2$] and nitric acid (HNO_3) were used as nitrogen (N) sources in KCl treatments. Plant height, time to anthesis, time to harvest, and leaf nutrient content were monitored. No significant differences in yield components and plant growth were recorded among the treatments. It was concluded that KNO_3 can be replaced

fully or partially (depending on water quality) by KCI in tomato production while improving the quality of fruits.

Results are given of several studies in different regions by Johnston *et al.* (2003) in Iran on the effects of different rates of K fertilizer application on crop yield and water use efficiency. All the soils used in these experiments were calcareous soils. On farms growing wheat in the Karaj and Darab regions, different rates and sources of K were tested in 1999. In a tomato plantation in Marand region, muriate of potash at 2 rates (100 and 150 kg K_20/ha) with 8000 m3/ha of irrigation water was tested in 1999 and found that 150 kg K_20/ha superior than 100 kg K_20/ha regarding yield and yield contributing characters.

The study on the effect of organic and inorganic fertilizers on yield and quality of tomato (cv. Parhhani 'Yashashri") conducted in Parbhani, Maharashtra, India, by Mohd *et al.* (2002) to revealed that application of 50% recommended dose of farmyard manure (FYM) @ 12.5 t ha^{-1} along with reduced levels of recommended doses of fertilizers (50% of the recommended dose of fertilizers of 100:50:50 NPK kg ha^{-1}) resulted in the highest yield with high quality. The study also revealed that the readymade organic manures of commercial companies used in this study were inferior to traditional organic manures, viz. FYM and vermicompost.

Tomato cv. House Momotaro plants growing in perlite with a nutrient solution were supplemented with 10, 20, 30 or 40 mM KCI or NaCl on various dates after

anthesis, to determine the optimum salt concentration and application time for the improvement of fruit quality in tomatoes by Rhee *et al.* (2001). The number of fruit binds was limited and planting density was increased to minimize yield loss. Fruit quality improved as the salt concentration increased and improved with earlier applications. However, the improvements were accompanied by proportional yield reductions. KCI at 20 mM and NaCl at 25 mM improved fruit quality without significantly reducing yield. Application at 20 days alter anthesis of the first truss flowers gave the best results.

A long-tenn field experiment was conducted by Wijewardena and Amarasiri (1997) at Bandarawela (Sri Lanka) on a Red Yellow Podzolic soil during the ten cropping seasons commencing Maha 1986/87. Four levels of potassium fertilizers at rates of 0. 25, *50* and 100 kg K_2O/ha were applied for each crop. Potato. cabbage. tomato, pole bean, cabbage, potato, cabbage, tomato, pole bean and cabbage were cultivated in this sequence. Alier cultivation of low K removal crops such as potato and pole bean, soil exchangeable K increased when 100 kg K_2O/ha was applied. Soil K increased when potassium was continuously applied to soil at 100 kg K_2O/ha but the cropping sequence was an important factor to he considered. High yields of vegetables e.g. tomato could be obtained with 100 kg K_2O/ha per season without any accumulation of K in the soil.

2.2 Effect of variety on growth and yield of tomato

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

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

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

In Nepal, an experiment was conducted by Lohar and Peat (1998) to study the floral characteristics of heat-tolerant and heat sensitive tomato cultivars at high temperature. They observed that, flowering was earliest in Pusa Ruby at 23-28° C (day/night) and latest in CL-1131 at 15/10° C. They also indicated that, cv. CL-1131 was suitable for cultivating at high temperature and producing an earlier crop. Cultivar Pusa Ruby produced fewer flowers and fruits at high temperature than CL-1131, but not in 15/10° C regime.

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

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

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

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

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

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

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

An investigation was carried out by Sarker and Haque (1980) to compare the yielding ability and to assess the distinguishing external morphological characters of seven varieties of tomato during the period from October, 1977 to March 1978. The varieties were Master No. 2, Ramulas, Roma, Rambo, Marmande, Bigo and World Champion. They reported that, the Rambo produced the highest yield (28.28 t/ha), followed by Bigo (24.63 t/ha), World Champion (23.38 t/ha),Master No. 2 (21.98 t/ha), Roma (21.03 t/ha) and Ramuas (20.21 t/ ha).

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

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

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

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

2.3 Combined effect of potassium and variety on growth and yield of tomato

Afzal *et al*. (2015) conducted on two tomato cultivars, Nagina and Roma. Foliar application with varying levels (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0%) of potassium solutions was applied to the plants and compared with control (without K). Exogenous application of 0.6% K significantly improved plant height, lycopene content, potassium, fruit weight and diameter. Exogenous application of 0.5, 0.6 and 0.7% K maximally improved ascorbic acid contents of both tomato cultivars whereas 0.4 and 0.8% did not improve ascorbic acid

contents. Due to positive correlation between K nutrition and fruit quality attributes, exogenous application of an appropriate K level can contribute to higher yield and better quality of tomato fruits. Among all potassium levels, 0.5–0.7% K maximally improved performance of tomato plants of both cultivars.

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

CHAPTER III

MATERIALS AND METHODS

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

3.1 Location of the experiment field

The field experiment was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh from October 2015 to April, 2016 to evaluate the effect of potassium on yield and quality of tomato.

3.2 Climate of the experimental area

The area is characterized by hot and humid climate. The average rainfall of the locality of the experimental area is 89.06 mm, the minimum and maximum temperature is 11.10 °C and 34.80 ºC respectively. The average relative humidity was 75.8 % during October 2015 to April, 2016 (Appendix I).

3.3. Soil of the experimental field

Initial soil samples from 0-15 cm depth were collected from experimental field. The collected samples were analyzed at Soil Resources Development Institute (SRDI), Dhaka, Bangladesh. The physio-chemical properties of the soil are presented in Appendix II. The soil of the experimental plots belonged to the agro-ecological zone of Madhupur Tract (AEZ-28), which is shown in Appendix II .

3.4 Plant materials used

In this research work, the seeds of four tomato varieties were used as planting materials. The tomato varieties used in the experiments were BARI Tomato-2 and Minto hybrid. All varieties are semi-indeterminate type. BARI Tomato-2 was collected from the Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI) at Joydebpur, Gazipur and Minto hybrid variety from Siddique Bazar , Dhaka.

3.5. Raising of seedlings

Tomato seedlings were raised in two seedbeds of 3 m x 1m size. A distance of 50 cm was maintained between the beds. The soil was well prepared and converted into loose friable and dried mass by spading. All weeds and stubbles were removed and 10 kg well rotten cowdung was mixed with the soil. Four gram of seeds was sown on each seedbed. The seeds were sown in the seedbeds 1 october, 2015. Sevin 85SP was applied around each seedbed as precautionary measure against ants, worm and other harmful insects. The emergence of the seedlings took place with 6 to 8 days after sowing. Shading by polythene with bamboo structure was provided over the seedbed to protect the young seedlings from the scorching sunshine or rain. After 10 days emergence, the seedlings were transferred into a second bed to obtain healthy and vigorous seedlings. Diathane M-45 was sprayed in the seedbeds @ 2 g/l, to protect the seedlings from damping off and other diseases. Weeding, Mulching and Irrigation were done as and when required.

3.6 Treatments and layout of the experiment

The experiment consisted of two factors; (A) Two variety of tomato and (B) five different level of potassium. The levels of the two factors were as follows:

Factor A: variety of tomato

a) V_1= BARI Tomato-2

b) V_2 = Minto hybrid

Factor B: level of potassium fertilizer (MoP)

a) P_0=0 kg/ha

b) P_1= 140 kg/ha

c) P_2= 150 kg/ha

d) P_3= 160 kg/ha

e) P_4= 170 kg/ha

3.7 Design and layout of the experiment

The experiment was laid out in Randomized complete Block Design (RCBD) having two factors and replicated three times. An area was divided into three equal blocks. Each block was consists of 10 plots where 10 treatments were allotted randomly. These there were 30 unit plots altogether in the experiment. The size of each plot was 2m × 1.8m. The distance between two blocks and two plots were kept 0.5m and 0.50 m respectively (Appendix III).

3.8 Cultivation procedure

3.8.1. Land preparation

The land for growing the crop was first opened with a tractor. Later on the land was ploughed three times followed by laddering to obtain desirable tilth. The corners of the land were spaded and larger clods were broken into smaller pieces. After ploughing and laddering, all the stubbles and uprooted weeds were removed and then the land was ready. Finally, the unit plots were prepared as 15 cm raised beds. Ten pits were made in each plot in two rows maintaining a recommended spacing of row to row distance was 60 cm and plant to plant distance was 40 cm (BARI, 2000).The field layout and design or the experiment was followed immediately after land preparation.

3.8.2. Manure and fertilizers and its methods of application

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

Manure/ fertilizer	Total amount per hectare	Applied during land preparation	Applied in pit a week before transplanting	Applied as top dressing in rows	
				1st installment after 3 weeks of transplanting	2nd installment after 5 weeks of transplanting
Cowdung (Decompost)	10 t	5 t/ha	5 t/ha	-	-
Urea	550 kg	-	200 kg/ha	175 kg/ha	175 kg/ha
TSP	450 kg	-	450 kg/ha	-	-
MP	As per treatment				

3.8.3 Transplanting of seedlings

Healthy and uniform 30 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots in the afternoon of 30

october 2015 planting. The seedbed was watered before uprooting the seedlings from the seedbed so as to minimize damage to the roots. The seedlings were watered after transplanting. Shading was provided using polythene with bamboo structure from seed sowing to harvesting to protect the tomato seedlings from the adverse weather conditions in summer season. Seedlings were also planted around the border area of the experimental plots for gap filling.

3.8.4 Intercultural operations

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

a) Shading

Shading was provided by using polythene with bamboo structure from seed sowing to harvesting of tomato plants thus create a favorable environment for the growth ,development and yield of tomato during summer season.

b) **Gap filling**

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

c) Weeding and Mulching

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

d) **Staking and Pruning**

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

e) **Irrigation**

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

f) **Plant protection**

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

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

3.9 Harvesting

Fruits were harvested at 5-day intervals during early ripe stage when they attained slightly red color. Harvesting was started from 16 January, 2016 and was continued up to 10 April 2016.

3.10 Data collection

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

3.10.1 Plant height (cm)

Plant height at final harvest was measured from sample plants in centimeter from the ground level to the tip of the longest stem and mean value was calculated. Plant height was also recorded at 10days interval starting from 40 days of planting up to 60 days to observe the growth rate of plants. Lastly, the height was recorded at final harvest.

3.10.2 Number of branches per plant

It was measured by the following formula :

Number of branches per plant = $\frac{\text{Total number of bra}}{}$

3.10.3 Length of branches

The length of branch was measured with a measuring tape from the stem of the branch to the top of 10 randomly selected branches from each plot and their average was taken in centimeter (cm) as the length branch.

3.10.4 Number of flowers cluster per plant

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

Number of flower cluster per plant =

$$\frac{\text{Total number of flowers cluster from}}{\text{Total number of flowers clusters fro}}$$

3.10.5. Number of fruits per plant

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

Number of fruits per plant =

$$\frac{\text{Total number of fruits f}}{\text{ten samp}}$$

3.10.6 Yield of fruits per plot (kg)

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

3.10.7 Yield of fruits per hectare (t/ha)

It was measured by the following formula

Fruit yield per hectare (t/ha) $= \frac{}{A}$

3.10.8 Total soluble solid content (TSS)

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

3.10. 9 β- carotene content

At first 15-20g flesh of ripen tomato was taken and crushed by mortar and pastel. Then 5g paste was taken in a plastic container having airtight lid. There after 50ml mixture (Acetone: n-Hexane = 2:3) was poured in the container by a measuring cylinder and the container was placed in a vertical shaker for 10 minutes. Then the solution was centrifuged at 5000-6000 rpm. After centrifuge, the supernatant (clear transparent) was taken in a glass vial. Then spectrophotometer reading was recorded at four different nanometer length viz. 663nm, 645nm, 505nm and 453nm.

Finally, β- carotene was calculated by the following formula:

β- carotene (mg)= 0.216 (reading of 664nm) + 0.452 (reading of 453nm)-1.22 (reading of 645nm)-0.304(reading of 505nm)

3.10.10 Vitamin C content

Vitamin C content of green and dry fruits were determined by 2, 6-dichlorophenol indophenols visual titration method. The following reagents were used for the estimation of vitamin C contains.

Reagents

i. **3% Metaphosphoric acid (HPO_3)** Is was prepared by dissolving 30 g of HPO_3 and 80 ml glacial acetic acid in distilled water and volumes made up to one liter.

ii. **Standard ascorbic acid solution** 10 % of L- ascorbic acid solvent was made by dissolving ascorbic acid in 3 metaphosphoric acid solution.

iii. **Dry solution** It was prepared by dissolving 260 mg of sodium salt of 2, 6-dicholophenol indophenols in one liter of distilled water.

Procedure

Standardization of dye solution

Dilute 5 ml of standard ascorbic acid solution with 5 ml of Meta phosphoric acid. A micro burette was loaded with dye solution and the mixed solution was titrated with dye solution using phenolphthalein as indicator to a the pink colored end point which insisted for at least 15 sec.

Dye factor was enumerated using the following formula:

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

Preparation of sample

Five grams of fresh fruit and dry fruits was taken in a 100ml beaker with 50 ml 3% metaphosphoric acid and then it was transferred to blender and homogenized with same concentration of metaphosphoric acid. First blending then it was filtered and centrifuged at 2000 rpm for 5 minutes. The homogenized

liquid was transferred to a 100 ml volumetric flask and was made up to the mark with 3 % metaphosphoric acid.

Titration

Five ml of the aliquot was taken in conical flask and titrated with 2, 6-dicholophenol indophenols dye, phenolphthalein was used as indicator to a ping colored end point, which persisted at least 15 seconds. The ascorbic acid content (Vitamin C) of the sample was calculated by using the following formula:

$$\text{Ascorbic acid (mg/100g)} = \frac{T \times d \times V_1}{V_2 \times W} \times 100$$

Where,

T = Titre value (ml)

D = Dye factor

V_1 = Volume to be made (ml)

V_2 = Volume of extract taken for titration (ml)

W = Weight of sample taken for estimation (gm)

3.11 Statistical analysis

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

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results from the experiment. The experiment was conducted to determine the effects of potassium on growth and yield of tomato. Some of the data have been presented and expressed in table (s) and others in figures for ease of discussion, comparison and understanding. A summary of all the parameters have been shown in possible interpretation wherever necessary have given under the following headings.

4.1 Plant height (cm)

Plant height is one of the important parameter, which is positively correlated with the yield of tomato (Taleb, 1994). Plant height was recorded at 40, 50 and 60 DAT (days after transplanting). At 40 DAT, the variety Minto hybrid (V_2) had the highest plant height (44.39 cm). The lowest plant height (41.35 cm) was obtained from the BARI Tomato-2 (V_1) (Fig. 1). The variety Minto hybrid (V_2) had the highest plant height (60.93 cm) at 50 DAT. The lowest plant height (56.27 cm) was obtained from the BARI Tomato-2 (V_1). At 60 DAT, the variety Minto hybrid (V_2) had the highest plant height (99.09 cm). However, the lowest plant height (85.78 cm 60 DAT) was obtained from the BARI Tomato-2 (V_1). Varietal influence on plant height was also reported by Hossain *et al.* (1986).

The effect of different doses of potassium on plant height at 40, 50 and 60 DAT was significant (Fig. 2). At 40 DAT, the doses of potassium 160 kg/ha (P_3) produced the tallest plant (45.02 cm) and the shortest plant (41.20 cm) was produced by control treatment. The doses of potassium 160 kg/ha (P_3) produced the tallest plant (60.27 cm) at 40 DAT and the shortest plant (57.03 cm) was obtained from control treatment. At 60 DAT, the doses of potassium 160 kg/ha (P_3) produced the tallest plant (100.40 cm) and the shortest plant (86.83 cm) was observed in control treatment.

The combined effect of varieties and different doses of potassium indicated a significant variation in plant height at 40, 50 and 60 DAT (table 1). At harvest, the tallest plant height (49.57 cm,) was found in V_2P_3 (Minto hybrid Tomato with potassium 160 kg/ha) and the smallest plant height (38.07 cm) was found in V_1P_0 (BARI hybrid Tomato-2 with control treatment). The tallest plant height (64.23) was obtained from in V_2P_3 at 50 DAT. The smallest plant height (51.40 cm) was found in V_1P_0. At 60 DAT, the tallest plant height (108.30 cm) was found in V_2P_3 and the smallest plant height (75.87 cm) was found in V_1P_0. The variation among the treatment combination was characteristics of different varieties and variation under different doses of potassium.

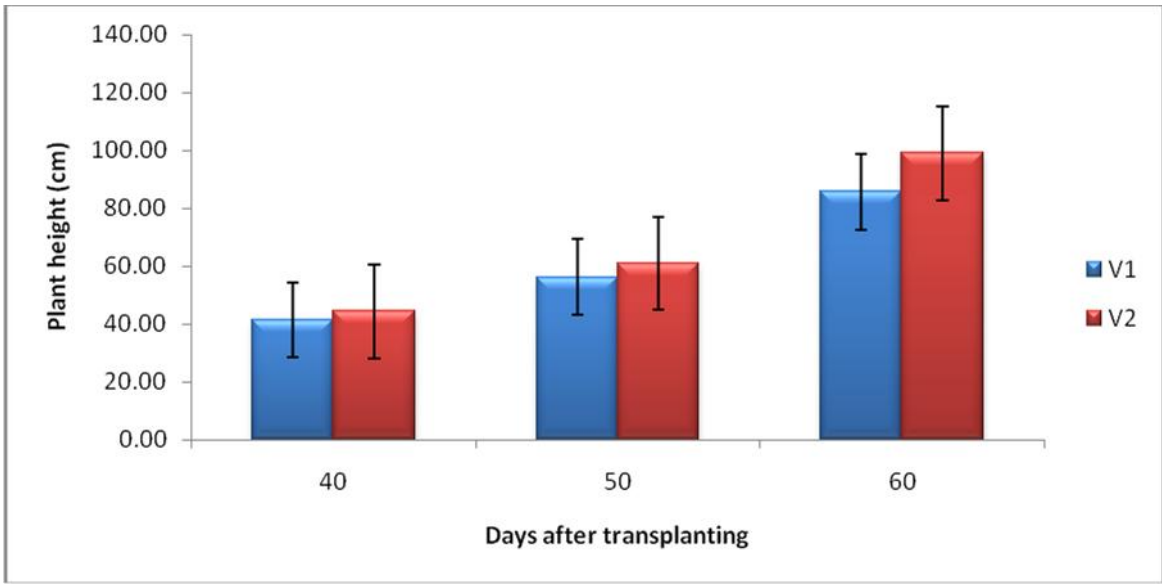


Fig. 1. Effect of variety on the plant height of tomato

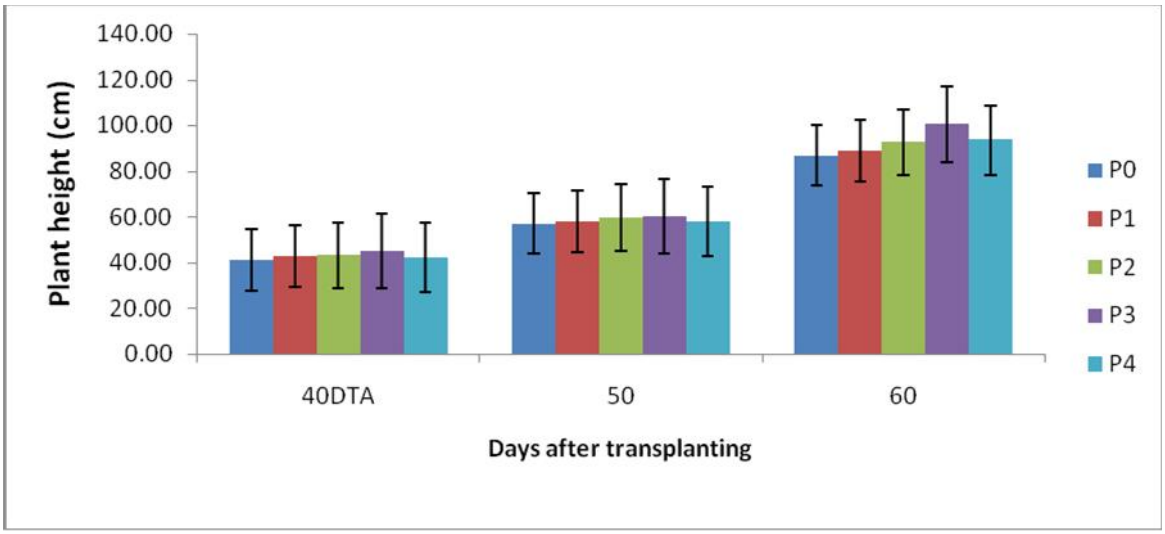


Fig. 2. Effect of doses of potassium on the plant height of tomato

Table 1. Interaction of doses of potassium and variety on plant height of tomato

Treatment	Plant height 40DAT		50DAT		60DAT	
V_1P_0	38.07	d	51.40	c	75.87	g
V_1P_1	43.93	bc	61.23	ab	85.13	f
V_1P_2	41.03	bcd	56.30	bc	89.03	e
V_1P_3	40.47	cd	55.90	bc	92.63	d
V_1P_4	43.27	bc	56.50	bc	86.23	ef
V_2P_0	44.33	bc	62.67	a	101.60	b
V_2P_1	41.37	bcd	54.97	bc	88.53	e
V_2P_2	45.23	b	63.50	a	96.00	c
V_2P_3	49.57	a	64.23	a	108.30	a
V_2P_4	41.43	bcd	59.30	ab	101.10	b
LSD (0.05)	4.05		5.63		2.87	
CV (%)	9.21		8.80		7.86	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications

4.2 Number of branches per plant

The effect of different variety was influenced on number of branch per plant at 40, 50 and 60 DAT. At 30 DAT, The variety Minto hybrid tomato had the highest number of branches per plant (8.40) and the lowest number of branches per plant (7.93) was obtained from the variety BARI tomato-2 (Fig. 3). The treatment V_2 had the highest number of branches per plant (9.27) at 50 DAT and the lowest number of branches per plant (8.13) was obtained from V_1 treatment. At 60 DAT, the variety Minto hybrid tomato had the highest number of branches per plant (9.73) and the lowest number of branches per plant (8.73) was obtained from the variety BARI tomato-2.

The different doses of potassium showed significant variation in the number of branches per plant at 40, 50 and 60 DAT. At 40 DAT, the maximum number of branches per plant (9.17) was produced by P_3 treatment. The control treatment (P_0) produced the minimum number of branches per plant (6.67) (Fig. 4). The maximum number of branches per plant (9.67) was observed in P_3 treatment at 50 DAT. The control treatment (P_0) produced the minimum number of branches per plant (7.33). at 60 DAT, the maximum number of branches per plant (10.50) was

obtained from P_3 treatment. The control treatment (P_0) produced the minimum number of branches per plant (8.00).

The interaction between different variety and doses of potassium was found significant on the number of branches per plant at 40, 50 and 60 DAT. At 40 DAT, the maximum number of branches per plant (10.33) was found in V_2P_3 treatment, whereas the lowest number of branches per plant (5.33) was found in V_1P_0 treatment (Table 2). The maximum number of branches per plant (11.00) was observed in V_2P_3 treatment at 50 DAT. The lowest number of branches per plant (6.33) was found in V_1P_0 treatment. At 60 DAT, the maximum number of branches per plant (12.33) was obtained from V_2P_3 treatment, whereas the lowest number of branches per plant (7.33) was found in V_1P_0 treatment

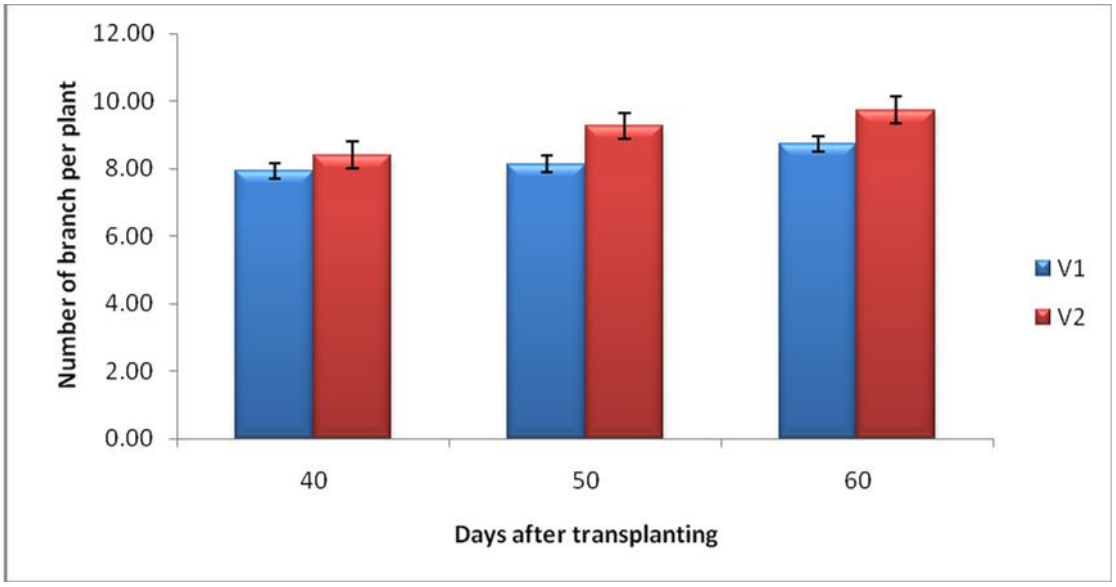


Fig. 3. Effect of variety on number of branches on tomato

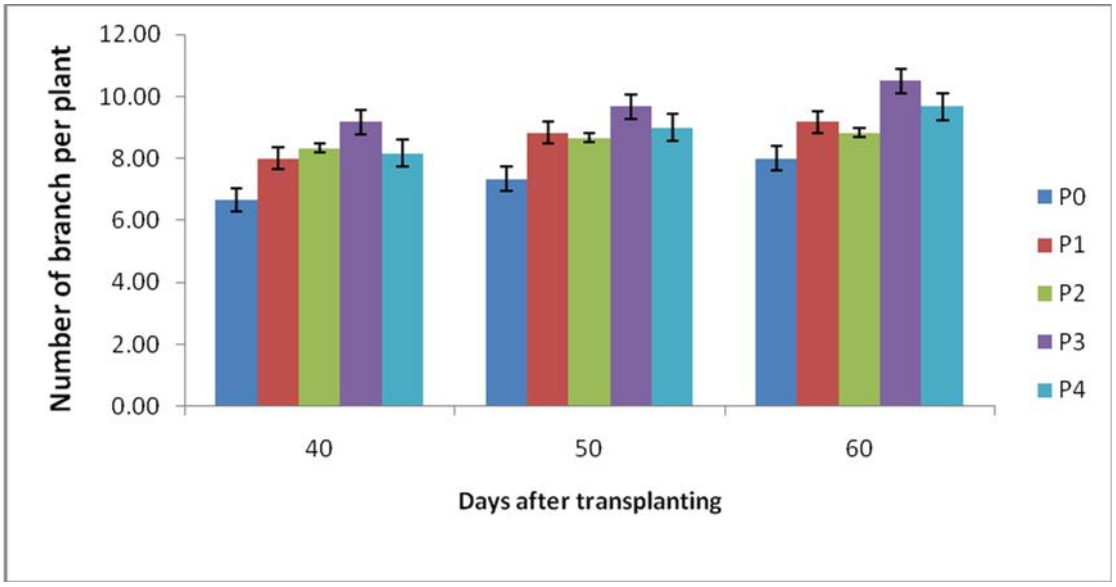


Fig. 4. Effect of doses of potassium on number of branches on tomato

Table 2. Interaction of doses of potassium and variety on number of and branches per plant of tomato

Treatment	Number of branch per plant					
	40DAT		50DAT		60DAT	
V_1P_0	5.33	e	6.33	e	7.33	e
V_1P_1	8.33	bcd	9.33	b	10.00	b
V_1P_2	8.67	bc	8.00	d	8.00	d
V_1P_3	9.00	b	8.33	cd	8.67	c
V_1P_4	8.33	bcd	8.67	c	9.67	b
V_2P_0	8.00	cd	8.33	cd	8.67	c
V_2P_1	7.67	d	8.33	cd	8.33	cd
V_2P_2	8.00	cd	9.33	b	9.67	b
V_2P_3	10.33	a	11.00	a	12.33	a
V_2P_4	8.00	cd	9.33	b	9.67	b
LSD (0.05)	0.86		0.54		0.61	
CV (%)	9.89		9.12		9.23	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications

4.3 Length of branch

Length of branch was influenced by variety at 40, 50 and 60 DAT. The variety Minto hybrid tomato had the highest length of branches (25.05, 37.63 and 50.80 cm at 40, 50 and 60 DAT, respectively) and the lowest length of branches (24.83, 35.29 and 43.62 cm at 40, 50 and 60 DAT, respectively) was obtained from BARI tomato-2 (Fig. 5).

The different doses of potassium showed significant variation in the length of branch (Fig. 6). The maximum length of branch (27.18, 39.08 and 49.97 cm at 40, 50 and 60 DAT, respectively) was produced by P_3 treatment. The control treatment (P_0) produced the minimum length of branch (22.07, 33.25 and 43.75 cm at 40, 50 and 60 DAT, respectively).

The combined effect of variety and doses of potassium was found significant on the length of branches at 40, 50 and 60 DAT. At 40 DAT, the maximum length of branches (30.07 cm) was found in V_2P_3 treatment, whereas the lowest length of branch (19.43 cm) was found in V_1P_0 treatment (Table 3). The maximum length of branches (41.67 cm) was observed in V_2P_3 treatment at 50 DAT. The lowest length of branch (30.33 cm) was found in V_1P_0 treatment. At 60 DAT, the maximum length of branches (56.33 cm) was obtained from V_2P_3 treatment, whereas the lowest length of branch (36.50 cm) was found in V_1P_0 treatment.

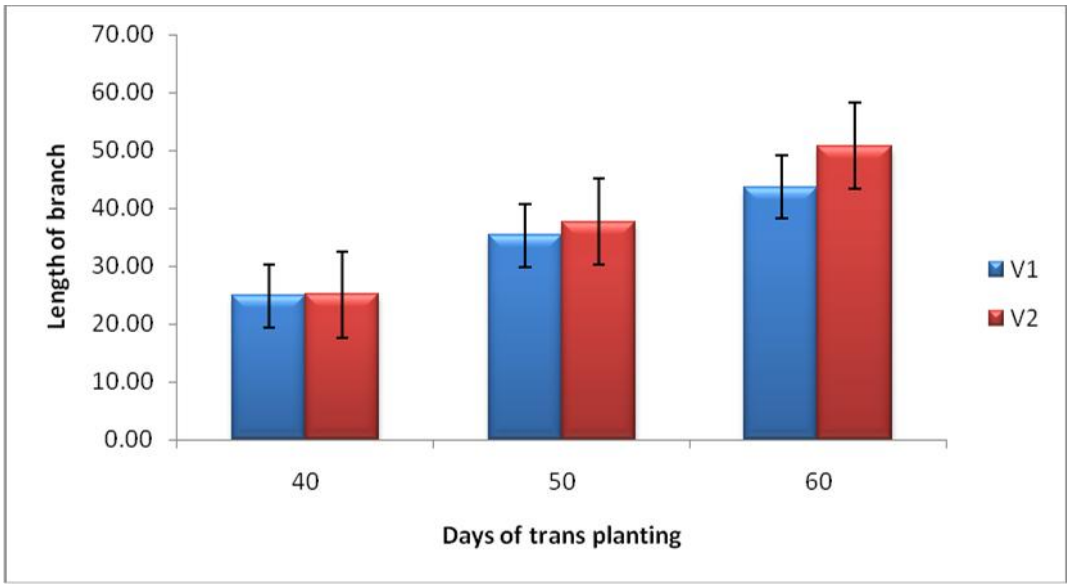


Fig. 5. Effect of variety on length of branches on tomato

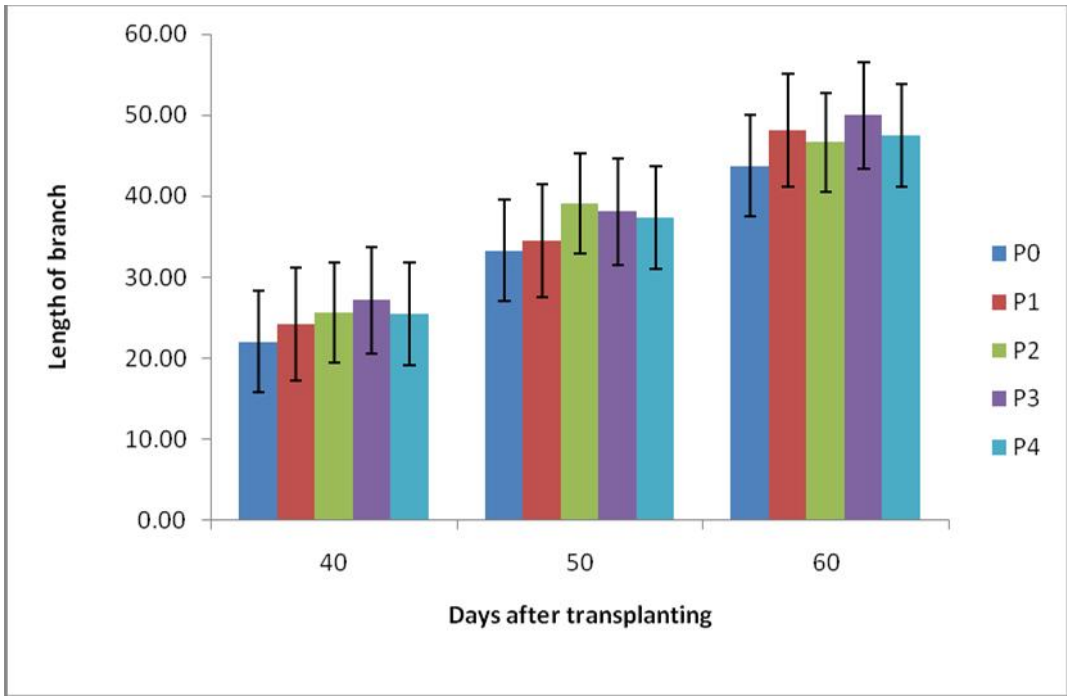


Fig. 6. Effect of doses of potassium on length of branch on tomato

Table 3. Interaction of doses of potassium and variety on length of branch of tomato

Treatment	Length of branch		
	40DAT	50DAT	60DAT
V_1P_0	19.43 e	30.33 d	36.50 c
V_1P_1	26.80 bc	35.30 bc	47.67 ab
V_1P_2	26.03 bc	39.67 ab	47.00 b
V_1P_3	24.30 bcd	34.50 cd	43.60 bc
V_1P_4	27.57 ab	36.67 bc	43.33 bc
V_2P_0	24.70 bcd	36.17 bc	51.00 ab
V_2P_1	21.63 de	33.67 cd	48.67 ab
V_2P_2	25.30 bc	38.50 abc	46.33 b
V_2P_3	30.07 a	41.67 a	56.33 a
V_2P_4	23.53 cd	38.17 abc	51.67 ab
LSD (0.05)	2.96	4.51	7.96
CV (%)	6.92	7.21	9.83

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications

4.4 Number of flowers cluster per plant

There was a significant difference among the varieties in the number of flower cluster per plant. As evident from figure 7, the maximum number of flower cluster (6.00) was produced in Minto hybrid Tomato. The minimum number of flower cluster per plant (4.00) was produced in BARI Tomato-2.

The different doses of potassium showed significant variation in the number of flowers cluster per plant. The maximum number of flower cluster per plant (5.67) was produced from P_3 treatment and treatment P_0 planting produced the minimum number of flowers per cluster (4.33) (fig 8). The number of flowers per cluster decreased gradually as the temperature increased later. Similar result was reported by Hossain (2001).

A significant variation among the treatment combinations in number of flowers cluster per plant. The maximum number of flowers cluster per (7.68) was found in Minto hybrid Tomato with 160 Kg K/ha, which was followed by V_2P_1, V_2P_2, V_2P_4, and V_2P_0. Whereas the minimum number of flowers cluster per plant (3.33) was found in BARI Tomato-2 with 0 kg K/ha (Table 4).

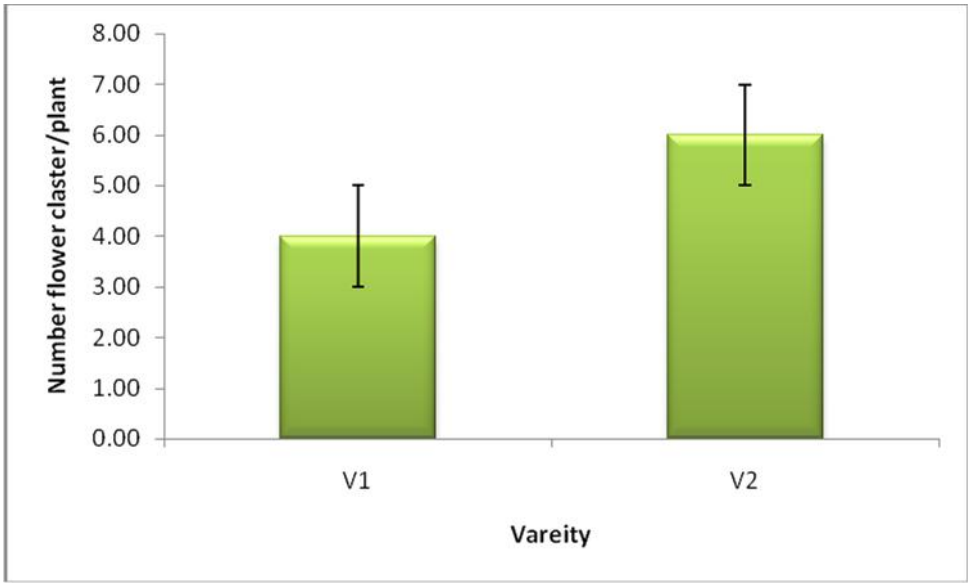


Fig. 7. Effect of variety on number of flower cluster per plant on tomato

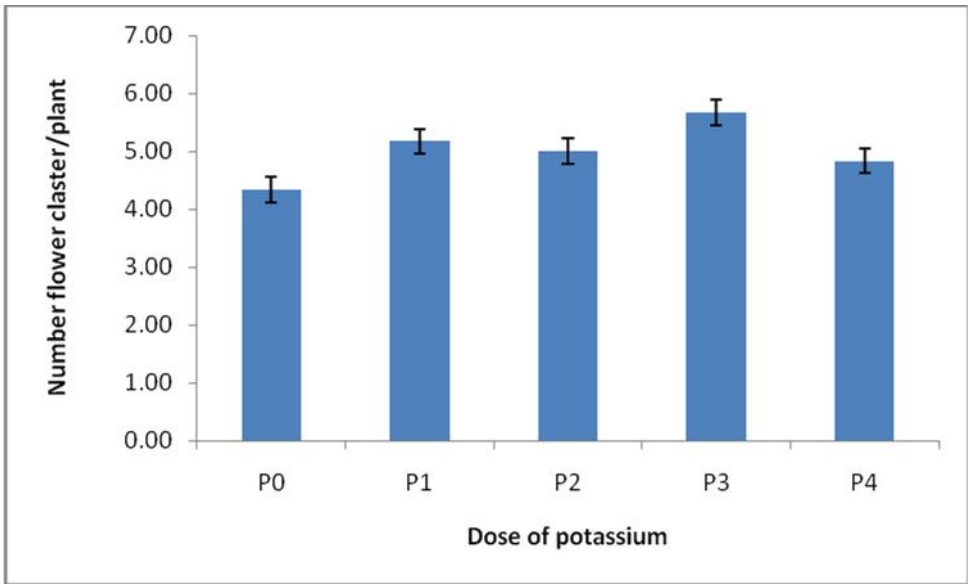


Fig. 8. Effect of doses of potassium on number of flower cluster per plant on

tomato

Table 4. Interaction of doses of potassium and variety on yield and yield contributing character of tomato

Treatment	Number flower cluster/plant	Number of fruit per plant	Yield per plot (kg)	Yield per ha (ton)
V_1P_0	3.33 d	12.33 d	4.40 d	12.22 f
V_1P_1	4.33 cd	16.00 cd	7.53 cd	20.92 e
V_1P_2	4.33 cd	15.67 cd	7.42 cd	20.60 e
V_1P_3	3.67 d	13.33 d	7.73 cd	21.48 e
V_1P_4	4.33 cd	15.67 cd	11.70 bc	32.50 d
V_2P_0	5.33 bc	19.67 bc	13.30 ab	36.94 bcd
V_2P_1	6.00 b	22.00 b	15.33 ab	42.59 abc
V_2P_2	5.67 bc	21.00 bc	15.79 ab	43.87 ab
V_2P_3	7.67 a	28.33 a	17.64 a	49.01 a
V_2P_4	5.33 bc	19.67 bc	12.82 ab	35.60 cd
$LSD_{(0.05)}$	1.24	5.18	4.79	7.42
CV (%)	5.45	6.43	7.31	8.8

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications

4.5 Number of fruit per plant

There was a significant difference among the varieties in the number of fruit per plant. As evident from table 5, the maximum number of fruit (22.13) was produced in Minto hybrid Tomato. The minimum number of fruit per plant (14.60) was produced in BARI Tomato-2.

The different doses of potassium showed significant variation in the number of fruit per plant. The maximum number of fruit per plant (20.83) was produced from P_3 treatment and treatment P_0 planting produced the minimum number of fruit (16.00) (table 5).

A significant variation was observed among the treatment combinations in number of fruits per plant. The maximum number of fruit per (28.33) was found in Minto hybrid Tomato with 160 Kg K/ha, whereas the minimum number of fruit per plant (12.33) was found in BARI Tomato-2 with 0 kg K/ha (Table 4).

Table 5. effect of variety on yield and yield contributing character of tomato

Treatment	Number of fruit per plant	Yield per plot (kg)	Yield per ha (ton)
V_1	14.60	7.76	21.55
V_2	22.13	14.98	41.60
CV (%)	6.43	7.31	8.8

Table 6. Effect of potassium on yield and yield contributing character of tomato

Treatment	Number of fruit per plant	Yield per plot (kg)	Yield per ha (ton)
P_0	16.00 c	8.85 b	24.58 d
P_1	18.33 bc	11.43 ab	31.76 c
P_2	19.00 ab	11.60 ab	32.24 bc
P_3	20.83 a	12.69 a	35.24 a
P_4	17.67 bc	12.26 a	34.05 ab
LSD(0.05)	2.38	3.04	1.93
CV (%)	6.43	7.31	8.8

4.6 Yield of fruits (kg) per plot

The different varieties of tomato significantly influenced on the yield of fruits per plot. The maximum yield of fruits per plot (14.98 kg) was obtained from Minto hybrid Tomato and the minimum yield of fruits per plot (7.76 kg) was obtained from BARI tomato-2 (Table 5).

The different time of doses of potassium had significant effect on the yield of fruits per plot. The maximum yield of fruits per plot (12.69 kg) was produced by P_3 treatment and control treatment produced the minimum yield of fruits per plot (8.85 kg) (Table 6).

The combined effect of variety and doses of potassium was significant on yield of fruit per plot. The highest yield of fruits per plot (17.64 kg) was obtained from Mintro hybrid Tomato with 160 kg K/ha, which was statistically similar with other treatment except P_0. The lowest yield of fruits per plot (4.40 kg) was obtained from BARI Tomato-2 with 0 kg K/ha (Table 4).

4.7 Total fruit yield per hectare (t/ha)

When per plot yield of tomato varieties was converted into yield of fruits per hectare. The maximum yield of fruits per hectare (41.60 tones) was obtained from Minto hybrid Tomato and the minimum yield of fruits per hectare (41.87 tones) was obtained from BARI Tomato-2 (Table 5). Hossain M. M. (2001) and Ahmed *et al*. (1986) also reported varietal influence on the yield of fruit per hectare.

The yield of tomato per plot was converted into per hectare, and has been expressed in metric tons. The different doses of potassium had significant effect on the yield of fruits per hectare. The maximum yield of fruits per hectare (35.24 tones) was obtained from P_3 treatment and control obtained the minimum yield of fruits per hectare (24.58 tones) (Table 6).

The combined effect of variety and doses of potassium was significant on yield of fruits per hectare. The highest yield of fruits per hectare (49.01 tones) was obtained from Mintro hybrid Tomato with 160 kg K/ha. The lowest yield of fruits per hectare (12.22 tones) was obtained from BARI Tomato-2 with 0 kg K/ha (Table 4).

4.8 Total soluble solid content (TSS)

No significant variation in the total soluble solid content was found among the varieties. The maximum total soluble solid content (8.28%) was obtained from BARI Tomato-2 and the minimum total soluble solid content (7.92 %) was obtained from Minto hybrid tomato (Table 7). The variation in the total soluble solid content different doses of potassium were exhibited significant variation. The maximum total soluble solid content (8.97%) was produced by P_3 treatment and control treatment produced the minimum total soluble solid content (7.77%) (Table 8). The variation in total soluble solid content due to combined effect of variety and potassium was found statistically significant. The maximum total soluble solid content (9.50%) was found in Minto hybrid Tomato with 160 kg K/ha. The minimum total soluble solid content (6. 9%) was found in BARI Tomato-2 with 0 kg K/ha (Table 9).

4.9 β-Carotene content

β-Carotene was influenced by variety. The highest β-Carotene (0.469 mg/100g) was obtained from V_2 (Mintro hybrid Tomato) and whereas the lowest (0.073 mg/100g) was observed in V_1 (BARI Tomato-2) treatment. (Table 7)

Different dosess of potassium significantly influenced on β-Carotene amount. It was evident from the highest β-Carotene (0.5125 mg/100g) was

recorded from P_3 (160 kg K/ha) and the lowest β-Carotene was (0.0655 mg/100g) from P_0 (control). (Table 8)

Combination effect of variety and different levels of potassium showed statistically significant variation on β-Carotene amount. The highest β-Carotene (0.994 mg/100g) was found from V_2P_3, while the lowest β-Carotene (0.0310 mg/100g) was recorded from V_1P_0 (Table 9).

4.10 Vitamin C content

The variety of tomato show significant variation in case of Vit C content in tomato fruit which is examined by sampling it in proper way. The higher amount Vit C (102.60 mg/100 g) found in V_2 treatment and lower amount Vit C (87. 46 mg/100 g) found in V_1 treatment. (Table 7)

The variation in Vit C content of tomato fruit due to different doses of potassium is significant. The higher amount Vit C (99.00 mg/100 g) found in P_3 treatment which is statistically identical with all other treatments. The lower amount Vit C (90.68 mg/100 g) found in P_0 treatment. (Table 8)

Due to combined effect of variety and different doses of potassium performed significant effect on Vit C content. The treatment combination of V_2P_3 gave the maximum Vit C content (113.10 mg/100 g) and the minimum Vit C content (79.77 mg/100 g) was found from the treatment combination on V_1P_0 treatment (Table 9).

Table 7. Effect of variety on quality characters of tomato

Treatment	TSS (%)	β-Carotene(mg/100g)	Vitamin C (mg/100g)
V_1	8.28	0.073	87.46
V_2	7.92	0.469	102.60
CV (%)	9.4	5.60	6.70

Table 8. Effect of potassium on quality characters of tomato

Treatment	TSS (%)	β-Carotene(mg/100g)	Vitamin C(mg/100g)
P_0	7.70 c	0.0655 c	90.68 d
P_1	7.35 c	0.0705 c	93.88 c
P_2	7.90 bc	0.5060 a	97.72 b
P_3	8.97 a	0.5125 a	99.00 a
P_4	8.58 ab	0.2013 b	93.87 c
LSD(0.05)	0.73	0.0227	0.07169
CV (%)	9.44	5.6	6.70

Table 9. Combined effect of variety and potassium on quality characters of tomato

Treatment	TSS (%)		β-Carotene(mg/100g)		Vitamin C(mg/100g)	
V_1P_0	6.90	c	0.031	f	79.77	i
V_1P_1	7.80	bc	0.076	e	84.90	h
V_1P_2	7.80	bc	0.062	e	88.75	g
V_1P_3	8.60	ab	0.061	e	90.03	f
V_1P_4	8.57	ab	0.136	d	93.87	e
V_2P_0	7.70	bc	0.070	e	97.72	d
V_2P_1	7.70	bc	0.267	c	101.60	c
V_2P_2	8.00	bc	0.950	b	106.70	b
V_2P_3	9.50	a	0.994	a	113.10	a
V_2P_4	8.43	ab	0.065	e	93.87	e
LSD (0.05)	1.31		0.017		0.05	
CV (%)	9.44		5.6		6.70	

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

CHAPTER V

SUMMARY AND CONCLUSION

The growth, yield contributing characters and yield of tomato largely depend on soil and climatic conditions and also on variety. Among these, proper doses of potassium and variety play a vital role. The field experiment was conducted at Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh during October 2015 to April, 2016 to evaluate the effect of potassium on yield and quality of tomato. Two different varieties, viz., BARI Tomato-2, Minto hybrid Tomato and five doses of potassium viz. P_0=0 kg/ha, P_1= 140 kg/ha, P_2= 150 kg/ha, P_3= 160 kg/ha, P_4= 170 kg/ha were used to conduct this experiment. The experiment was laid out in Randomized complete Block Design (RCBD) having two factors and replicated three times. Data were taken on growth, yield contributing characters, yield and the collected data were statistically analyzed for evaluation of the treatment effects. The summary of the results has been described in this chapter.

Plant height at 40, 50 and 60 DAT due to the influence of different varieties was significant. The variety Minto hybrid (V_2) had the highest plant height (44.39, 60.93 and 99.09 cm at 40, 50 and 60 DAT respectively). The variety Minto hybrid tomato had the highest number of branches per plant (8.40, 9.27 and 9.73 at 40, 50 and 60 DAT, respectively) and length of branches (25.05, 37.63 and 50.80 cm at 40, 50 and 60 DAT, respectively). The maximum number of flower cluster (4.00) was produced in Minto hybrid Tomato. The maximum total soluble solid content (8.28%) was obtained from BARI Tomato-2. The maximum yield of

fruits per plot (14.98 kg) was obtained from Minto hybrid Tomato. The maximum yield of fruits per hectare (41.60 tones) was obtained from Minto hybrid. The highest β-Carotene (0.469 mg/100g) was obtained from V_2 (Mintro hybrid Tomato). The higher amount Vit C (102.60 mg/100 g) found in V_2 treatment

The effect of different doses of potassium on plant height at 40, 50 and 60 DAT was significant. The doses of potassium 160 kg/ha (P_3) produced the tallest plant (45.02, 60.27 and 100.40 cm at 40, 50 and 60 DAT, respectively). The different doses of potassium showed significant variation in the number of branches per plant. The maximum number of branches per plant (9.17, 9.67 and 10.50 at 40, 50 and 60 DAT, respectively) was produced by P_3 treatment. The different doses of potassium showed significant variation in the length of branch. The maximum length of branch (27.18, 39.08 and 49.97 at 40, 50 and 60 DAT, respectively) was produced by P_3 treatment. The maximum number of flower cluster per plant (5.67) was produced from P_3 treatment. The maximum total soluble solid content (8.97%) was produced by P_3 treatment. The maximum yield of fruits per plot (12.69 kg) was produced by P_3 treatment. The different doses of potassium had significant effect on the yield of fruits per hectare. The maximum yield of fruits per hectare (35.24 tones) was obtained from P_3 treatment. The highest β-Carotene (0.5125 mg/100g) was recorded from P_3 The higher amount Vit C (99.00 mg/100 g) found in P_3 treatment

The effect of varieties and different doses of potassium indicated a significant variation in all parameter. The tallest plant height (49.57, 64.23 and 108.30 cm,

at 40, 50 and 60 DAT, respectively) was found in V_2P_3 (Minto hybrid Tomato with potassium 160 kg/ha). The maximum number of branches per plant (9.17, 9.67 and 10.50 at 40, 50 and 60 DAT, respectively) was produced by P_3 treatment. The maximum length of branches (30.07, 41.67 and 56.33 cm at 40, 50 and 60 DAT, respectively) was found in V_2P_3 treatment. The maximum number of flowers cluster per (7.68) was found in Minto hybrid Tomato with 160 Kg K/ha. The maximum total soluble solid content (9.50%) was found in Minto hybrid Tomato with 160 kg K/ha. The combined effect of variety and doses of potassium was significant on yield of fruit per plot. The highest yield of fruits per plot (17.64 kg) was obtained from Mintro hybrid Tomato with 160 kg K/ha. The combined effect of variety and doses of potassium was significant on yield of fruits per hectare. The highest yield of fruits per hectare (49.01 tones) was obtained from Mintro hybrid Tomato with 160 kg K/ha. The lowest yield of fruits per hectare (12.22 tones) was obtained from BARI Tomato-2 with 0 kg K/ha. The highest β-Carotene (0.994 mg/100g) was found from V_2P_3. The treatment combination of V_2P_3 gave the maximum Vit C content (113.10 mg/100 g).

Considering the stated findings, it may be concluded that growth and yield contributing parameters are positively correlated with variety and doses of potassium. However, Minto hybrid Tomato applied on 160 kg K/ha would be recommended for the Sher-e-Bangla Agricultural University, Dhaka. Researchers may conduct further trial to verify present results for increasing the accuracy of the experiment at different locations of Bangladesh.

REFERENCES

Aditya, T. L., Rahman, L., Shah-E-Alam, M. and Ghosh, A. K. 1999. Correlanou and path co-efficient analysis in tomato. *Bangladesh Agril. Sci.* 26 (1): 119-122.

Afzal, I., Hussain, B., Basra, s.M.A., Ullah, S.H., Shakeel, Q. and Kamran, M. 2015. Foliar application of potassium improves fruit quality and yield of tomato plants . *Acta Sci. Pol., Hortorum Cultus* 14(1) : 3-13.

Afzal, I., Munir, F., Ayub, C.M., Basra, S.M.A., Hameed, A., Shah, F. 2013. Ethanol priming: an effective approach to enhance germination and seedling development by improving antioxidant system in tomato seeds. *Acta Sci. Pol., Hortorum Cultus*, 12: 129–137.

Ahmad, N., Sarfraz, M., Farooq, U., Arfan-ul-Haq, M., Mushtaq, M.Z. and Ali, M.Z. 2015. Effect of potassium and its time of application on yield and quality of tomato. *Intel. J. Scientific and Res. Publications* 5 (9): 1-4.

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

Ajlouni, M.M., Shibli, R.A., Hussein, A. and Ereifej K.I. 1996. Seasonal distribution of yield of tomato (*lycopersicon esculentum* Mill) cultivars grown in Jordan. *J. Agric. Sci.*, **66** (9): 541-545.

Akhtar, M.E., Khan, M. Z., Rashid, M.T. Ahsan, Z. and Ahmad, S. 2010. Effect of potash application on yield and quality of tomato (*Lycopersicon esculentum* Mill.). *Pak. J. Bot*., 42(3): 1695-1702.

Auerswald, H., D. Schwarz, C. Kornelson, A. Krumbein and B. Brückner, 1999. Sensory analysis, sugar and acid content of tomato at different EC values of the nutrient solution. Sci. Hort., 82: 227-242.

Bakker, J.C., G.W.H. Welles, J. Janse, C. de Kreij and K. Buitelaar, 1989. The effects of air humidity in combination with the composition of the nutrient solution on yield, the incidence of blossom-end rot and keeping quality of aubergine. Annual Report, Glasshouse Crops Research Station, Naaldwijk, The Netherlands, pp: 42.

BARI. 1996. Summer Tomato (Booklet in Bengali).Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur. Gazipur. P.12.

BBS. 2014. Year Book of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Govt. of the Peoples Republic of Bangladesh, Dhaka. p. 144.

Berry, S. Z., Wiese, K.L. and Aldriel, T.S. 1995. 'Ohio 8556' hybrid processing tomato. *Hort. Sci.,* **30** (1):159-161.

Bhangu, J.S. and Singh, S. 1993. Comparative performance of tomato cultivars under rainfed conditions of kandi area (Panjab). *Panjab Hort. J.,* **33** (1/4): 123-126.

Bidari, B.I. and Hebsur, N.S. 2011. Potassium in relation to yield and quality of selected vegetable crops. *Karnataka J. Agric. Sci.,* 24(1), 55–59.

Chapagain, B. P., Wiesman. Z., Zaccai, M., Imas, P. and Magen, H. 2003. Potassium chloride enhances fruit appearance and improves quality of fertigated greenhouse tomato compared to potassium nitrate. *.1. P1. NuirL,* 26(3): 643-658.

Chapagain, B.P. and Z. Wiesman, 2004. Effect of potassium magnesium chloride in the fertigation solution as partial source of potassium on growth, yield and quality of greenhouse tomato. Sci. Hort., 99: 279-288.

El-Nemr, M.A., Abd El-Baky, M.M.H. Salman, S.R. and El-Tohamy, W.A. 2012. Effect of Different Potassium Levels on the Growth, Yield and Quality of Tomato Grown In Sand-Ponic Culture. *Australian J. Basic and Applied Sci.,* 6(3): 779-784.

FAO. 1999. FAO production yearbook. Basic data unit, statistics division, FAO, Rome, Italy, 53: 135-136.

FAO. 2002. FAO Production Yearbook. Basic Data Unit, Statistics l)i FAO, Rome, Italy, **56**: 142-144.

FAO. 2007. FAO Production Year Book. Food and Agricultural Organization, Rome, Italy

Giovannucci, E. 2002. A review of epidemiologic studies of tomatoes, lycopene, and prostate cancer. *Exp. Biol. Med*., 227: 852–859.

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

Hamid, A., Ahmed, M., Kayani, F., Farooq, A. 2005. Performance of tomato varieties for growth and yield under Rawalakot conditions. University Coll. of Agriculture, Rawalakot (Pakistan). *Sarhad J.Agric*. (Pakistan). (2005). v. **21** (2) p. 201-203.

Haque, M. S., Islam, M. T. and Rahman, M. 1999. Studies on the presentation of semi-concentrated tomato juice. *Bangladesh J. Agril. Sci.*, 26 (1): 25.29

Hartz, T.K., Miyao, G., Mullen, R.J., Cahn, M.D., Valencia, J. and Brittan, K.L. 1999. Potassium requirements for maximum yield and fruit quality of processing tomato. *J. Amer. Soc. Hort. Sci.*, 124: 199–204.

Hoque, M.M. and Ali, C.M.1975. A study on the performance of different varieties of tomato. *Bangladesh Hort.*,3(1):37-40

Hossain, A.K.M.A. and Ahmad, K.U. 1973. A comparative study on the performance of different varieties of tomato. *Bangladesh Hort.*, **1** (1): 39-45.

Hossain, M.M., Karim, M.A., Haque, M.M. and Hossain, A.K.M.A. 1986. Performance of some tomato lines planted at different dates. *Bangladesh Hort.*, 14 (1): 25-28.

Hossain, S.M.M., and Haque, M.M.. 1984. A study on the feasibility of growing tomatoes during summer in Bangladesh. *Bangladesh J. Agric.*, **9** (2): 77-79.

Iqbal, M., M. Niamatullah, I. Yousaf, M. Munir and M. Z. Khan. 2011. Effect of nitrogen and potassium on growth, economical yield and yield components of tomato. *Sarhad J. Agric*. 27(4): 545-548.

Janse, J., 1985. Bemesting zeer bepalend voor kwaliteit bij komkommers en tomaten. Tuinderij, 65: 14-15.

Javaria, S., Khan, M. Q. and I. Bakhsh. 2012. Effect of potassium on chemical and sensory attributes of tomato fruit. *J.Animal & Plant Sci*., 22(4): 1081-1085.

Johnston, A. E., Vaziri, J., Noun, A. A., Ramazanpoor, M. It, Mahdavi, M. and Rastegbar. H. 2003. Crop yield and water use efficiency as affected by potassium fertilization. ***Proceedings of the Regional Workshop of the International Potash Institute, Amman, Jordan, 5-6.*** **76- 82.**

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

Kanai, S., Ohkura, K., Adu-Gyamfi, J.J., Mohapatra, P.K., Nguyen, N.T., Saneoka, H. and Fujita, K. 2007. Depression of sink activity precedes the inhibition of biomass production in tomato plants subjected to potassium deficiency stress. ***J. Exp. Bot.*** **58: 2917–2928.**

Khalid, A.N.M. 1999. Floral abscission and reproductive efficiency in summer and winter tomato (*lycopersicon esculentum* Mill) varieties. MS thesis, Dept. of Hort, BAU, Mymensingh. p: 50.

Kreij, C. de., 1996. Interactive effects of air humidity, calcium and phosphate on blossom-end rot, leaf deformation, production and nutrient contents of tomato. Journal of Plant Nutrition, 19: 361-377.

Kreij, C. de., 1999. Production, blossom-end rot, and cation uptake of sweet pepper as affected by sodium, cation ratio, and EC of the nutrient solution. Gartenbauwissenschaft, 64: 158-164.

Lin Duo., H. Danfeng and W. Shiping, 2004. Effects of potassium levels on fruit quality of muskmelon in soiless medium culture. Scientia Horticulturae, 102: 53-60.

Lohar, D,P. and peat, W.E. 1998. Floral characters of heat-tolerent and heat sensitive tomato (*lycopersicon esculentum* Mill) cultivars at high temperature. *Scientia Hort*., **73** (1): 53-60.

Marschner, H. 1995. Functions of mineral nutrients: macronutirents. In: Mineral nutrition of higher plants 2nd edition, Marschner, H. (ed.). Academic Press, N.Y., 299–312.

Martin-Prével, 1989. Physiological processes related to handling and storage quality of crop, pp: 225-284. Proceedings of 21st Colloq. International Potash Institute, Bern, Switzerland.

Mohd, R., Narwadkar. P. R., Prabu, T. and Sajindranath, A. K. 2002. Effect of organic and inorganic fertilizers on yield and quality of tomato *(Lycopersicon esculentum* Mill.). *J. Soils and t'rops.* 12(2): 167-169.

Perkins-Veazie, P. and Roberts, W. 2003. Can potassium application affect the mineral and antioxidant content of horticultural crops. Amer. Soc. Agron., Proc. Symposium on Fertilizing Crops for Functional Foods, 21–26.

Petersen, K.K., J. Willumsen and K. Kaack, 1998. Composition and taste of tomatoes as affected by increased salinity and different salinity source. J. Hort. Sci., 3: 205-215.

Prassad, A. and Prasad, R. 1977. Studies on varietal performance of tomato. *Progress. Agric*., 9 (2): 57-61.

Rashid, M.A. Rahman, M.A. Rahman, A.K.M. and Hossain, M.M. 2000. Screening of wild rootstocks brinjal lines and tomato varieties against bacterial wilt. Review of progress. Activity-II. IPM-CRSP (Intrgrsted Pest Management_Collaborative Research Support Program), HRC, BARI, Gazipur, 17p.

Rhee, H. C., Lee, B. Y. and Choi, Y. 2001. Effects of concentration and treatment time of KCI or NaCl on the growth and fruit quality of 2nd truss-limited tomatoes in peniLe nutrient culture. *J. Korean Soc. Hon. Sci.,* 42(1): 2 1-24.

Robertson, G.H., Mahoney, N.E., Goodman, N. and Pavlath, A.E. 1995. Regulation of lycopene formation in cell suspension culture of VFNT tomato (*Lycopersicon esculentum*) by CPTA, growth regulators, sucrose, and temperature. *J. Expt. Bot*., 46: 667–673.

Salunkhe, D.K., Desai, B.B., and Bhat, N.R. 1987. Vegetable and flower seed production. 1st, Edn., Agricole pub. Acad., New Delhi, India. P. 135.

Sarker, A. and Haque, M.M. 1980. Studies on the comparative characters and yield of seven varieties of tomato. Proc. 4th and 5th Bangladesh Sci. Con., 2-5 march, BAAS, Dhaka. P.18.

Singh, D.N. and Sahu, A.A. 1998. Performance of tomato cultivars in winter season on entisol of Orissa. Environ. And Ecol., 16 (4): 766-762.

Singh. T. R., Singh, S., Singh, S. K. Singh, M. P. and Stivastava, B. K. 2004. Effect of integrated nutrient management on crop nutrient uptake and yield under okra-pea-tomato cropping system in a Mollisol. *Indian J. Hart.*. 61(4): 3 12-314.

Sonneveld, C. and. Van den Burg, A.M.M. 1991. Sodium chloride salinity in fruit vegetable crops in soilless culture. Netherlands Journal of Agricultural Science, 39: 115-122.

Sonneveld, C. and W. Voogt, 1985. Growth and cation absorption of some fruit-vegetable crops grown on rockwool as affected by different cation ratios in the nutrient solution. Journal of Plant Nutrition, 8: 585-602.

Taber, H., Perkins-Veazie, P., Li, S., White, W., Rodermel, S. and Xu, Y. 2008. Enhancement of tomato fruit Lycopene by potassium is cultivar dependent. *Hort Sci*., 43: 159–165.

Taleb, M.A. 1994. Effect of planting time, 2, 4- Dichlophenoxy acetic acid and kinetin on growth and yield of tomato. MS thesis, Dept. of Hort., BAU, Mymensingh. 124p.

Thomas,T.A., Sarker,R.K. and Handas, M.W. 1979. A new pear shaped tomato.Indian Hort., 23(4):9-10

Voogt, W., 1987. The growth of beefsteak tomatoes as affected by K/Ca ratios in the nutrient solution. Acta Horticulture, 222: 155-165.

Wijewardena, J. D. H. and Amarasiri. S. L. 1997. Long term use of potassium fertilizer for vegetable crops in the upcountry intermediate zone. *J. National Sci. Coun. Sri Lanka.* 25(1): 59-68.

Windsor, G.W., 1979. Some factors affecting the quality and composition of tomatoes. Acta Horticulture, 93: 335-346.

APPENDICES

Appendix I Monthly Average Air Temperature, Total Rainfall, Relative Humidity and Sunshine Hours of the experimental site during the period from September 2015 to March 2016

Year	Month	Average Air temperature (^{0}C)			Total rainfall (mm)	Average RH (%)	Total Sun shine hours
		Maximum	Minimum	Mean			
2015	**October**	**34.8**	**18.0**	**77**	**227**	**80**	**34.8**
	November	**32.3**	**16.3**	**69**	**0**	**65**	**32.3**
	December	**29.0**	**13.0**	**79**	**0**	**68**	**29.0**
2016	**January**	**28.1**	**11.1**	**72**	**1**	**66**	**28.1**
	February	**33.9**	**12.2**	**55**	**1**	**66**	**33.9**
	March	**34.6**	**16.5**	**67**	**45**	**68**	**34.6**
	April	**35.7**	**17.8**	**68**	**65**	**67**	**35.1**

Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix II. The physical and chemical characteristics of soil of the experimental site as observed prior to experimentation
(0- 15 cm depth)

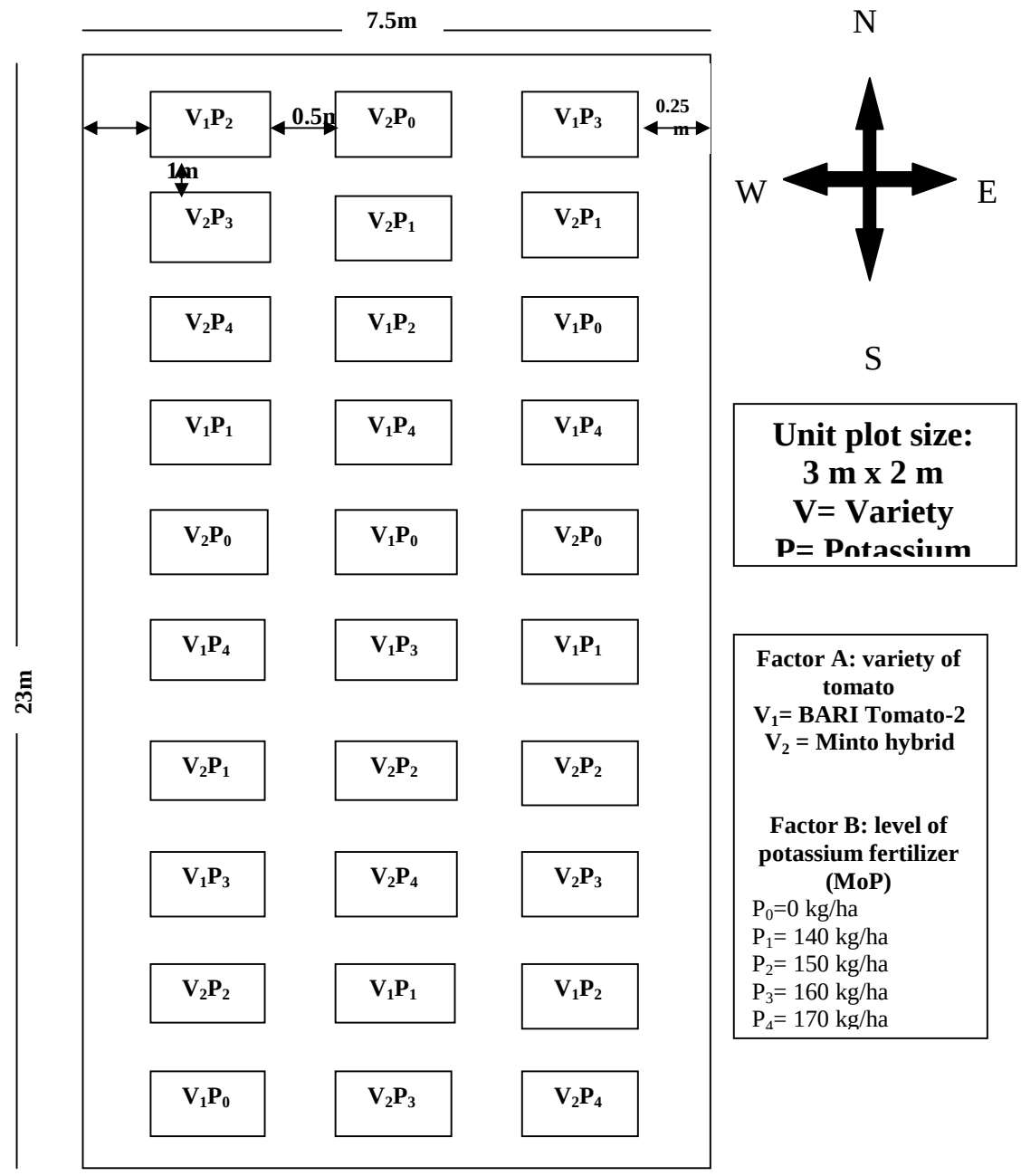
Constituents	Percent
Sand	**26**
Silt	**45**
Clay	**29**
Textural class	**Silty clay**

Chemical composition:

Soil characters	Value
Organic carbon (%)	**0.45**
Organic matter (%)	**0.78**
Total nitrogen (%)	**0.07**
Phosphorus	**22.08 µg/g soil**
Sulphur	**25.98 µg/g soil**
Magnesium	**1.00 meq/100 g soil**
Boron	**0.48 µg/g soil**
Copper	**3.54 µg/g soil**
Zinc	**3.32 µg/g soil**
Potassium	**0.30 µg/g soil**

Source: Soil Resources Development Institute (SRDI), Khamarbari, Dhaka

Appendix III. Layout and design of the experimental plot



Appendix IV. Analysis of variance of the data on plant height of tomato as influenced by variety and potassium

Sources of Variation	Degrees of	Mean Square
		Plant height

	freedom	40DAT	50DAT	60DAT
Replication	**2**	**15.799**	**42.588**	**47.334**
Factor A	**1**	**69.008**	**163.33**	**1328**
Factor B	**4**	**11.678***	**10.773***	**166.39***
AB	**4**	**38.874***	**69.697***	**112.38***
Error	**18**	**15.585**	**27.048**	**52.804**

*** = Significant at 5% level of probability**

Appendix V. Analysis of variance of the data on number of branch per plant of tomato as influenced by variety and potassium

Sources of Variation	Degrees of freedom	Mean Square		
		Number of branch per plant		
		40DAT	50DAT	60DAT
Replication	**2**	**0.133**	**0**	**0.133**
Factor A	**1**	**1.633**	**9.633**	**7.5**
Factor B	**4**	**6.833***	**4.367***	**5.217***
AB	**4**	**3.3***	**2.967***	**5.917***
Error	**18**	**0.652**	**0.63**	**0.726**

*** = Significant at 5% level of probability**

Appendix VI. Analysis of variance of the data on length of branch plant of tomato as influenced by variety and potassium

Sources of Variation	Degrees of freedom	Mean Square		
		Length of branch		
		40DAT	50DAT	60DAT
Replication	**2**	**0.73**	**22.725**	**78.273**
Factor A	**1**	**0.363**	**41.067**	**386.64**
Factor B	**4**	**22.068***	**36.965***	**31.298***
AB	**4**	**39.094***	**24.109***	**69.568***
Error	**18**	**2.976**	**6.914**	**21.529**

*** = Significant at 5% level of probability**

Appendix VII. Analysis of variance of the data on yield and yield contributing of tomato as influenced by variety and potassium

Sources of Variation	Degrees of freedom	Mean Square			
		Number flower cluster	Number fruit per plant	Yield per plot	Yield per ha

		per plant			
Replication	**2**	**0.3**	**104.43**	**18.284**	**141.11**
Factor A	**1**	**30**	**425.63**	**391.04**	**3017.2**
Factor B	**4**	**1.417***	**18.867***	**13.405***	**103.46***
AB	**4**	**2.083***	**28.3***	**18.369***	**141.77***
Error	**18**	**0.522**	**9.1**	**12.797**	**98.727**

*** = Significant at 5% level of probability**

Appendix VIII. Analysis of variance of the data on quality characters of tomato as influenced by variety and potassium

Sources of Variation	Degrees of freedom	Mean Square		
		TSS	β-Carotene (mg/100g)	Vitamin C(mg/100g)
Replication	**2**	**48.4**	**1**	**130**
Factor A	**1**	**0.972**	**1.176**	**1717.8**
Factor B	**4**	**2.621***	**0.301***	**66.874***
AB	**4**	**0.503***	**0.356***	**190.48***
Error	**18**	**0.585**	**0.001**	**0.002**

*** = Significant at 5% level of probability**

Plate 1. Photograph showing the plot

Plate 2. Photograph showing the flowering stage

Plate 3.

Photograph showing the fruit setting stage

Plate 4.

Photograph showing the laboratory work