GROWTH AND YIELD OF CHERRY TOMATO GROWN WITH DIFFERENT LEVEL OF BORON FOLIAR SPRAY AND MULCHES IN SOILLESS SYSTEM

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*This is to certify that thesis entitled **"GROWTH AND YIELD OF CHERRY TOMATO GROWN WITH DIFFERENT LEVEL OF BORON FOLIAR SPRAY AND MULCHES IN SOILLESS SYSTEM"** submitted to the **Faculty of Agriculture,** Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in HORTICULTURE,** embodies the result of a piece of bona fide research work carried out by **MD. IQBAL HASSAN** Registration No. 14-06276 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged and style of this thesis have been approved and recommended for submission.

Dated: June, 2021
Place: Dhaka, Bangladesh

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DEDICATED
TO
MY BELOVED
PARENTS

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ABSTRACT

A pot experiment was conducted in the semi-greenhouse at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh, during October 2019 to March 2020 to find out the growth and yield of cherry tomato as influenced by boron with mulch materials. The experiment consisted of two factors: Factor A: three types of mulch viz. M_0 = No mulch, M_1 = rice straw and M_2 = Black polythene and Factor B: Four doses of Boron fertilizer viz. B_1= 0.5 ppm, B_2= 1.5 ppm, B_3= 2.5 ppm and B_4= 3.5 ppm. There were 12 treatment combinations and experiment was setup in Completely Randomized Design (CRD) with three replications. In case of mulch materials, the highest plant height at 60 DAT (178.67 cm), maximum branch number per plant (5.25) at 60 DAT, maximum chlorophyll content (85.22 %) at 75 DAT, minimum days required for first flowering (20.25 DAT) and first fruiting (30.50 DAT), maximum flower cluster per plant (38.42), maximum fruit number per plant (241.57), highest single fruit weight (9.06 g), highest amount of TSS (8.96 degrees Brix) and yield per plant (2.44 kg) were obtained from M_2 treatment. Similarly, in case of boron fertilizer, the highest plant height at 60 DAT (180.67 cm), maximum branch number per plant (5.67) at 60 DAT, maximum chlorophyll content (86.75 %) at 50 DAT, minimum days required for first flowering (21.33 DAT) and first fruiting (30.11 DAT), maximum flower cluster per plant (35.56), maximum fruit number per plant (256.76), highest single fruit weight (9.86 g), highest amount of TSS (8.59 degrees Brix) and yield per plant (2.63 kg) were obtained from B_3 treatment. In combined effect, the highest plant height at 60 DAT (191.76 cm), maximum branch number per plant (6.67) at 60 DAT, maximum chlorophyll content (102.33 %) at 50 DAT, minimum days required for first flowering (19.33 DAT) and first fruiting (27.33 DAT), maximum flower cluster per plant (41.33), maximum fruit number per plant (296.00), highest single fruit weight (12.08 g), highest amount of TSS (9.53 degrees Brix), yield per plant (3.31 kg) and highest benefit cost ratio (3.36) were obtained from M_2B_3 treatment. Among the treatment combination, M_2B_3 treatment seemed to be more promising for obtaining higher yield of cherry tomato. In cherry tomato cultivation, application of 2.5 ppm boron with black polythene mulch was more effective for growth, yield and profitable than rest of the treatment combination.

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LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	**Full meaning**
AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
BBS	Bangladesh Bureau of Statistics
BCPC	British Crop Production Council
Cm	Centi-meter
CV	Coefficient of variation
^{o}C	Degree Celsius
Df	Degrees of freedom
DAT	Days After Transplanting
et al.	And others
FAO	Food and Agriculture Organization
G	Gram
Ha	Hectare
CRSP	Collaborative Research Support Program
J.	Journal
kg	Kilogram
LSD	Least Significant Difference
mg	Milligram
MoP	Muriate of Potash
CRD	Completely Randomized Design
SAU	Sher-e-Bangla Agricultural University
TSP	Triple Superphosphate

CHAPTER I

INTRODUCTION

Cherry tomato [*Solanum lycopersicum* L. var. *cerasiforme* (Dunnal) A. Gray] is a cultivated variety of tomato and belongs to the family Solanaceae. It is thought to have originated in Peru and Northern Chile. It is the probable ancestor of all cultivated tomatoes. The variety is generally considered to be similar but not identical to the wild relatives of the domestic tomato (Prema *et al.,* 2011). Cherry tomato is grown for its edible fruits; they are perfect for making processed products like sauce, soup, ketchup, puree, curries, paste, powder, rasam and sandwitch (Charlo *et al.,* 2007). Cherry tomato is small in size, has a sweeter taste and offers several significant nutritional benefits, noted that cherry tomatoes have intense colour and flavour, generally round in shape and weighing 10 to 30g (Anon., 2009a). Its fruits are consumed more as a salad fruit rather than as a vegetable. Cherry tomato often called ‘salad tomato’. The cherry tomato is also beneficial to human health because of its high content of antioxidant and phytochemical compounds including lycopene, β-carotene, flavonoids, Vit C and many essential nutrients (Rosales, 2011). They are a great source of vitamin-C (13 mg/100 g), dietary fibre (2.0 g), vitamin A (25%) and vitamin K and also a good source of vitamin E (Alpha Tocopherol), thiamine, niacin, vitamin B6, foliate, phosphorus, copper, potassium and manganese (Anon., 2009b). This composition explains the high antioxidant capacity in both fresh and processed tomatoes, associating the fruit with lower rates of certain types of cancer and cardiovascular disease (Rao and Aggarwal, 2000).

In Bangladesh, cherry tomato is new type for tomato production and still infancy for farmer field and as well as for consumer market (Udding *et al.,* 2015). Due to the awareness of food consumption and nutritive status of Bangladeshi people, cherry tomato can supply both of demand. Successful cherry tomato cultivation largely depends on the optimum cultural management practices. This includes judicious application of manures and fertilizers, efficient use of available soil moisture, spacing and time of planting. Fertilizer management practices are one of the most important cultural practices particularly in cherry tomato due to the intensive cropping and gradual decline in soil nutrients. This situation can be alleviated by proper fertilizer management practices (Jeanine *et al.*, 2003). So, judicial use of fertilizers may provide us with increased yield of cherry tomato.

In foliar application, nutrients enter through aqueous pores of leaf cuticles, cell wall of the epidermal cells and plasma membrane by active transport (Cheristensen, 2006). Micronutrients have an important role in the plant activities and foliar application can improve the vegetative growth, fruit set and yield of cherry tomato (Adams, 2004) by increasing photosynthesis of green plants. Tomato requires both major and micronutrients for its proper plant growth (Sainju *et al.*, 2003). Balanced fertilization of macro and micro nutrients can increases production but foliar application of micronutrients is the not only efficient but also secured way (Aghtape *et al.*, 2011). Boron is one of the micronutrient; the primary function of B is in plant cell wall structural integrity. Under B deficiency, normal cell wall expansion is disrupted (Havlin *et al.*, 2006). Boron deficiency reduced yield and quality in tomatoes. In spite of the obvious importance of boron, the mechanisms of boron tolerance and toxicity in plants are poorly understood (Cervilla *et al.*, 2007 and Esim *et al.*, 2012). Kaya *et al.* (2009) showed that high B reduced dry matter of tomato plants compared to control. Boron is also required in the translocation of sugars, starches, nitrogen and phosphorus and synthesis of amino acids and proteins (Varma *et al.*, 2005). Lavanya and Bahadur (2021) reported that foliar application with increasing levels of B from

0% to 0.6% exhibited significant increase in morphological characters as well as yield attributes of cherry tomato.

Out of these, efficient use of soil moisture is very important, because rainfall is scanty during Rabi season in Bangladesh when farmers grow this valued crop. Tomatoes are rather sensitive to drought stress (Zayton, 2007). One single most important factor that influences seed yield is soil moisture therefore, tomatoes require frequent irrigations. On the other hand, irrigation feasibilities are not sufficient in all the regions of the country. Sometimes pump cannot lift water in dry season due to lowering of water layer. As a result, the production of tomatoes is hampered to a great extent. Conservation of soil moisture may help in preventing the loss of water through evaporation permitting maximum utilization of moisture by plants. Use of various mulches like black polythene, transparent polythene, rice straw, saw dust, water hyacinth reported to conserve soil moisture efficiently in tomatoes as reported by many workers (Shampa, 2008; Assaduzzaman, 2003). Again, Begum, (2014) reported that different types of mulches including rice straw and polythene significantly increased the growth and yield of tomato.

Mulching associated with proper boron fertilizer is an important factor for successful cherry tomato production. The combined effect of these production practices have not been defined clearly and the information in this respect is meagre in Bangladesh. Considering the above-mentioned facts, the experiment has been undertaken with the following objectives:

- To study the growth and yield of cherry tomato by using different doses of boron foliar spray,
- To find out suitable mulch materials for better growth and higher yield of cherry tomato in soilless system.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter was to review the literatures having relevance to the present study. The review of literature of the past studies and opinions of the researchers pertinent to the present experiment were collected through reviewing of journals, thesis, reports and other form of publications. The information were compiled and presented below:

2.1. Effect of boron (B) on cherry tomato

Lavanya and Bahadur (2021) conducted an experiment to identify the effect of calcium and boron on yield and quality of cherry tomato and to find out suitable method in cherry tomato at VRF SHUATS, Naini (Prayagraj) India, during rabi season 2019-20. It was concluded from the investigation that foliar application with increasing levels of Ca and B from 0% to 0.6% exhibited significant increase in morphological characters as well as yield attributes of cherry tomato. The maximum net returns and (B:C) ratio was obtained in treatment fertilized with 0.6% of calcium + 0.6% of boron which resulted in higher yield and consequently maximum (B:C) ratio (3.45).

Singh *et al.* (2017) conducted an experiment to identify the effect of zinc and boron on yield and quality of cherry tomato. It was concluded from the investigation that the treatment T_9 (B @2.0g/l + Zn @ 2.0g/l) resulted with maximum at all successive stage of growth (30, 60, 90, 120 and 150 DAT), maximum plant height (62.74cm, 94.44cm, 144.29cm, 146.55 and 148.44cm), number of leaves per plant was (19.41, 29.76, 43.05, 46.89 and 54.09), number of cluster per plant (7.00, 12.04, 15.29 and 16.77), number of flower per cluster (22.21, 26.72, 30.15 and 36.65). The maximum number of fruit per cluster (28.22, 30.33 and 32.80), fruit set (%) (57.84, 77.78 and 85.76), fruit weight (14.87g), No. of fruit per plant (244.15), fruit yield per plant (4.98kg), fruit yield per ha (4.98 t ha^{-1}), higher TSS (13.100Brix), vitamin C (14.10mg/100g fruit pulp) were recorded with T_9 (B @2.0g/l + Zn @ 2.0g/l). Based on these results combined foliar application of zinc and boron was more effective than the individual application of zinc or boron on growth, yield and quality for Cherry Tomato.

Islam *et al.* (2016) conducted an experiment to investigate the effects of foliar spraying with boron and calcium on the qualities of light red maturity-stage 'Unicorn' cherry tomato. They observed that B + Ca treatment increases cell -wall compactness, reduces the respiration rate, reduces fresh weight loss, increases shelf life, maintains flesh firmness, and increases vitamin C content in cherry tomato.

Yadav *et al.* (2006) evaluated the effects of boron (0.0, 0.10, 0.15, 0.20, 0.25, 0.30 or 0.35%), applied to foliage after transplanting, on the yield of tomato cv. DVRT-1 in Allahabad, Uttar Pradesh, India, during 2003-04. The highest number of fruits per plant (44.0), number of fruits per plot (704.0), yield per plant (0.79 kg), yield per plot (12.78 kg) and yield/ha (319.50 quintal) were obtained with 0.20% boron, whereas the greatest fruit weight (27.27 g) was recorded for 0.10% boron.

Bhatt and Srivastava (2005) investigated the effects of the foliar application of boron (boric acid), zinc (zinc sulfate), molybdenum (ammonium molybdate), copper (copper sulfate), iron (ferrous sulfate), manganese (manganese sulfate), mixture of these nutrients, and Multiplex (a commercial micronutrient formulation) on the nutrient uptake and yield of tomato (Pusa hybrid-1) in Pantnagar, Uttaranchal, India, during the summer of 2002 and 2003. Zinc, iron, copper, boron and manganese were applied at 1000 ppm each, whereas molybdenum was applied at 50 ppm. Foliar spraying was conducted at 40, 50 and 60 days after transplanting. All treatments significantly enhanced dry matter yield, fruit yield and nutrient uptake over the control. The mixture of the micronutrients was superior in terms of dry matter yield of shoot (53.25 g/ha); dry matter content of shoot (27.25%); nitrogen (152.38 kg/ha), phosphorus (47.49 kg/ha), potassium (157.48 kg/ha), sulfur (64.87 kg/ha), zinc (123.70 g/ha), iron (940.36 g/ha), copper (72.70 g/ha), manganese (359.17 g/ha) and boron (206.58 g/ha) uptake by shoots; total fruit yield (266.60 kg/ha); dry matter yield of fruit (16.98 kg/ha); and nitrogen (78.78 kg/ha), phosphorus (8.51 kg/ha), potassium (34.31 kg/ha), sulfur (16.14 kg/ha), iron (141.81 g/ha), copper (23.13 g/ha), zinc (63.06 g/ha), manganese (34.08 g/ha) and boron (95.23 g/ha) uptake by fruits.

Shoba *et al.* (2005) conducted a field experiment in Tamil Nadu, India, during the 2002 rabi season, to investigate the effects of calcium (Ca) and boron (B) fertilizer and ethrel [ethephon] applications and 45x45 and 65x45 spacings against fruit cracking in the tomato genotypes LCR 1 and LCR 1 x H 24. Between the 2 genotypes, the fruit cracking percentage was low in LCR 1 x H 24. Among the 2 spacings, closer spacing showed less fruit cracking and among the different nutrient treatments, the spraying of B with Ca was effective in controlling fruit cracking.

Smit and Combrink (2004) observed that insufficient fruit set of tomatoes owing to poor pollination in low cost greenhouses is a problem in South Africa, as bumblebee pollinators may not be imported. Since sub-optimum boron (B) levels may also contribute to fruit set problems, this aspect was investigated. Four nutrient solutions with only B at different levels (0.02; 0.16; 0.32 and 0.64 mg L^{-1}) were used. Leaf analyses indicated that the uptake of Ca, Mg, Na, Zn and B increased with higher B levels. At the low B level, leaves were brittle and appeared pale-green and very high flower abscission percentages were found. At the 0.16 mg kg^{-1} B-level, fruit set, fruit development, colour, total soluble solids, firmness and shelf life seemed to be close to optimum. The highest B-level had no detrimental effect on any of the yield and quality related parameters.

Amarchandra and Verma (2003) conducted an experiment during the rabi seasons of 1998 and 1999 at Jabalpur, Madhya Pradesh, India, to evaluate the effects of boron and calcium on the growth and yield of tomato cv. Jawahar Tomato 99. Boron (1, 2, and 3 kg/ha, calcium carbonate), along with phosphorus (60 kg/ha) and potassium (40 kg/ha), were applied before transplanting, whereas nitrogen (100 kg/ha) was applied in split doses at 25 and 50 days after transplanting. Data were recorded for plant height, number of branches per plant, fruit yield and seed yield. Application of 2 kg B/ha + 2 kg Ca/ha recorded the highest yield.

Ben and Shani (2003) stated that Boron is essential to growth at low concentrations and limits growth and yield when in excess. The influences of B and water supply on tomatoes (*Lycopersicon esculentum* Mill.) were investigated in lysimeters. Boron levels in irrigation water were 0.02, 0.37, and 0.74 mol m^{-3}. Conditions of excess boron and of water deficits were found to decrease yield and transpiration of tomatoes. Both irrigation water quantity and boron concentration influenced water use of the plants in the same manner as they influenced yield.

Jeanine *et al.* (2003) stated that Boron application was associated with increased N uptake by tomato in field culture, but not under hydroponic culture. In field culture, foliar and/or soil applied B similarly increased fresh-market tomato plant and root dry weight, uptake, and tissue concentrations of N, Ca, K, and B, and improved fruit set, total yields, marketable yields, fruit shelf life, and fruit firmness. The similar growth and yield responses of tomato to foliar and root B application suggests that B is translocate in the phloem in tomatoes. Fruit from plants receiving foliar or root applied B contained more B, and K than fruit from plants not receiving B, indicating that B was translocate from leaves to fruit and is an important factor in the management of K nutrition in tomato.

Davis *et al.* (2003) carried out an experiment to compare the effects of foliar and soil applied B on plant growth, fruit yield, fruit quality, and tissue nutrient levels. Regardless of the application method, B was associated with increased tomato growth and the concentration of K, Ca, and B in plant tissue. Boron application was associated with increased N uptake by tomato in field culture, but not under hydroponic culture. In field culture, foliar- and/or soil-applied B similarly increased fresh-market tomato plant and root dry weight, uptake, and tissue concentrations of N, Ca, K, and B, and improved fruit set, total yields, marketable yields, fruit shelf life, and fruit firmness. The similar growth and yield responses of tomato to foliar and root B application suggests that B is translocate in the phloem in tomatoes. Fruits from plants receiving foliar- or root-applied B contained more B, and K than fruits from plants not receiving B, indicating that B was translocate from leaves to fruits and is an important factor in the management of K nutrition in tomato.

Naresh (2002) carried out an investigation in Nagaland, India during 1998-2000 to determine the effects of foliar application of boron (50, 100, 150, 200, 250 and 300 ppm) on the growth, yield and quality of tomato cv. Pusa Ruby. Boron improved the yield and quality of the crop. The highest yield (327.18 and 334.58 q/ha) was obtained when the plant was drenched with 250 ppm aqueous solution of boron. B also had positive effects on plant height, number of branches, flowers and number of fruit set per plant, resulting in an increase in the number of fruits per plant and total yield. At lower rates, B improved the chemical composition of tomato fruits and at higher rates increased the total soluble solids, reducing sugar and ascorbic acid contents of the fruits. Acidity of fruits showed a marked increase with increasing levels of B up to 250 ppm. However, the significant effects of B were recorded in the second year only.

Chude *et al.* (2001) reported that plant response to soil and applied boron varies widely among species and among genotypes within a species. This assertion was verified by comparing the differential responses of Roma VF and Dandino tomato (*Lycopersicon lycopersicum and Lycopersicon esculentum*) cultivars to a range of boron levels in field trials at Kadawa (11° 39' N, 8° 2' E) and Samaru (11° 12', 7° 37' E) in Sudan and northern Guinea savanna, respectively, in Nigeria. Boron levels were 0, 0.5, 1.0, 1.50, 2.0 and 2.5 kg/ha replicated three times in a randomized complete block design. Treatment effects were evaluated on fruit yield and nutritional qualities of the two tomato cultivars at harvest. There was a highly significant (P=0.01) interaction between B rates and cultivars, with Dandino producing higher yields than Roma VF in both years and locations.

Yadav *et al.* (2001) conducted an experiment during 1990 and 1991, in Hisar, Haryana, India, to evaluate the effect of different concentrations of zinc and boron on the vegetative growth, flowering and fruiting of tomato. The treatments comprised five levels of zinc (0, 2.5, 5.0, 7.50 and 10.0 ppm) and four levels of boron (0, 0.50, 0.75 and 1.00 ppm) as soil application, as well as 0.5% zinc and 0.3% boron as foliar application. The highest values for secondary branches, leaf area, total chlorophyll content, fresh weight, fruit length, fruit breadth and fruit number were obtained with the application of 7.5 ppm zinc and 1.0 ppm boron.

2.2. Effect of mulching on growth and yield of tomato

Mulches have various effects on the plant growth and yield. Many researchers noted that plants were greatly influenced by mulching.

Cipriani *et al.* (2020) showed that mulch might be an efficient technique to improve the productive indexes of the cherry tomatoes, significantly affecting the growth indicators, which are directly responsible for increasing productivity.

Pinder *et al.* (2016) conducted an experiment on the impact of different mulching materials on the growth and yield of tomato (*Solanum lycopersicum*) in Dehradun region of Uttarakhand to study the effect of mulching on the growth and yield of cherry tomato under two inorganic mulches (black polythene and white polythene) and four organic mulches (FYM, rice straw, dry leaves and sugarcane trash). From the experiment it was observed that among all the treatments black polythene mulch showed significantly higher plant height 89.92 cm and 97.17 cm after 30 and 45 days respectively, number of trusses per plant 109, number of fruits per truss 14.50 and weight of immature and mature fruits 4.59 gm and 42.08 gm in Cherry Tomato varieties. Among all the treatments, black polythene mulch was found to be the best for tomato cultivation in Dehradun (Uttarakhand) region of India.

Kayum *et al.*(2008) conducted an experiment with Three popular tomato varieties namely, Ratan, BARI tomato-3 and BARI tomato-6 were experimentally evaluated to identify the potential mulch on growth and yield, where the experiment consisted of four mulching treatments viz. water hyacinth, straw, am-ada leaf and banana leaf with a control (no mulch). In the experiment, mulching showed significant effect on growth, yield components and thus on the yield of tomato. Yield contributing characters were significantly higher when water hyacinth mulch was used. The combination of water hyacinth and Ratan produced the maximum yield (62.16 t/ha) and thus the experiment revealed that water hyacinth and straw mulches have potentiality to increase the yield of tomato.

Apter (2008) showed that straw-based mulching systems in tomato production would be a more suitable approach to vegetable production. Since the straw could simply be incorporated into the field soil at the end of the season, disposal of the mulching would no longer pose an environmental issue and the added benefit of improving soil structure would also result from incorporation of organic matter into the field soil. The straw mulch also acts as an insulator, preventing the warm-up of soil.

Bender *et al.* (2007) observed that the influence of mulches made of tree leaves, red clover on plant growth height and fruit cracking. They spread the mulches one month after the planting of tomatoes in a 10 cm thick layer. The treatment without mulch over was used as control. The height of the plants was measured once a week and a total of five times before harvesting. To find relationship between treatment and root parameters, soil samples were taken from depth of 0-10 cm and 11-20 cm. From the trial data, they concluded that the share of cracked fruits was significantly (P=0.05) lower only in red clover treatment of one variety among five. Grass mulch caused significantly negative effect on cracking of 4 varieties probably because of lower covering ability of this material. There were bigger differences between varieties than mulch treatments in the height of tomato plants. In all the mulch treatments the roots located more in upper soil layers compared with control. Differences in root parameters were discovered depending on the mulch type. Finally they reported that growth performances of tomato were best in case of tree leaf mulches than grass mulch.

Rahman *et al.* (2006) conducted an experiment to observe the effect of different mulches for production of tomato (*Lycopersicon esculentum* Mill.). Treatments with mulches- rice straw, water hyacinth, and wastage of rice straw significantly increased tomato yield over control (no mulch). Salinity was found to be higher in no mulch treatment than different mulch materials during the experimental period.

Vazquez *et al.,* (2006) reported that high irrigation frequency ensured appropriate soil water content at planting, and reduced both the amount of water applied and lost by drainage to actual needs of dreep irrigated tomato under plastic mulching conditions.

Rastiano *et al.* (2006) observed that straw mulching enhanced microbial biomass, activity and potential N availability by 42, 64 and 30% respectively, relative to none mulched soils via improving C and water availability for soil microbes.

Akintoye *et al.* (2005) reported that the use of mulches in vegetable production is undergoing a radical change away from high input, nonrenewable resources, such as plastic, to the use of high residue organic mulches from cover crops. The purpose of this study was to compare the yield of three tomato varieties when grown under different live mulches.

Dharmesh-gupta *et al.* (2005) studies the efficiency of blue, yellow, white, green and black polythene mulches in tomato leaf curl virus in infecting tomatoes in the field experiment in Himachal Pradesh, India 1997-1998. Mulching with yellow polythene film resulted in the lowest disease incidence and highest crop yield.

Singh *et al.* (2005) conducted an experiment on the effect of transplanting time and mulching on growth and yield of tomato in Abohar, Punjab, In diaduring the winter of (1998-2000) to study the effect of transplanting time (10 and 30 December, and 20 January) and mulching (black and clear polythene, sugarcane trash and rice straw) on the growth and yield of tomato cv. Rupali. Early planting (10 December) resulted in the height vegetative growth, yield attributes, early and total fruit yield, whereas the lowest values for the parameters measured were lowest with 20 January transplanting. Among different mulching materials, black polythene retained higher soil moisture and temperature compared to another mulching materials and the control. Fruit yield was also highest with black polythene mulching. The highest net returns (Rs.52700/ha) were recorded with transplanting 10 December and mulching with black polythene treatment combination, which was significantly superior to all other treatment combinations.

Ghorbani (2004) reported that plastic mulch is an effective way to conserve water in soil reservoir so that it can be taken up gradually by plants. The plastic mulch was used with furrow irrigation on cucumber and tomato yield, in the yield, at flowering and production stage. Using plastic mulch in conjunction with furrow irrigation system increased moisture retention by 75%, whereas no conservation was observed with black polythene mulch. Considerable yield increases (60 and 49%) and (66 and 47%) were achieved for tomato and cucumber crops under both clear and black plastic mulches respectively at flowering and production stage.

Radics and Bongar (2004) observed that mulching provides weed control and reduces evaporation. Eight types of mulches were examined for weed control and their effect on green bean (*Phaseolus vulgaris*) and tomato yields. Plastic sheet, paper mulch and straw mulch showed the best results in weed control and tomato yield. The use of Plastic sheet, paper mulch grass clippings caused the lowest weed cover. However highest yield was found in paper mulched plots. As for green bean, weed control was higher in plastic sheet, paper mulch and straw mulch treated plots but was no significantly different from those in control treatments.

Aydin *et al.* (2003) studied the effects of reflective and black on the yield, quality and pest populations on tomato cv. DR 055 in Turkey during 200. The total yield reflective mulch, black and no mulch treatment were 122.85, 104.99 and 85.68 t/ha respectively. Earliness percentage was higher in the mulch treatments compared to the control. The highest color values were obtained in the reflective mulch treatment. The lowest pest population was observed in reflective mulch treatment.

Sannigrahi and Borath (2002) conducted field experiments in Assam, India to evaluate the effectiveness of different organic mulches including black polythene sheet on tomato production under rain fed conditions. The mulch treatment was black polythene sheet, rice straw, spent straw, water hyacinth (*Eichhornia crasipes*), thatch grass (*Imperata cylindraca*) and no mulch (control mulch). Mulching increase the tomato fruits per plant and had higher yield than the crop yield in both years. Water hyacinth mulch gave the highest increase in tomato yield by (91 %). The rate of weed emergence was low in tomato plots, while black polythene mulch was the most effective treatment for weed control (83.5).

Hudu *et al.* (2002) observed that plant height, number of flowers per plant, fruit sets per plant, number of fruits per plant and harvested total marketable fruit yield/ ha were significantly (0.05) higher in the mulch treated plots than unmulched control treatment. It was also observed that the optimum mulch thickness is at 7.5 t/ ha of grass material in this area in the terms effective weed suppression, better crop growth, optimum root temperatures and ultimate yield of tomato.

Hedau and Mahesh (2002) studied the effect of different mulches (black polythene, silver polythene, silver black polythene, pea straw and no mulch) on the productivity of tomato hybrid. Fruit yield was highest with silver black polythene mulch (76.42 t/ha), followed by black polythene mulch (73.51 t/ha). The highest N uptake was recorded with a silver black polythene mulch (90.38 kg/ha), followed by black polythene mulch (89.82 kg/ha). Soil moisture retention was highest in pea straw mulch plots and lowest in unmulched plots.

CHAPTER III

MATERIALS AND METHODS

3.1. Experimental site and period

The pot experiment was conducted in the semi-greenhouse at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka 1207 in Bangladesh during October 2019 to March 2020.

3.2. Experimental location

The location of the study site was situated in 23°74′N latitude and 90°35′E longitudes. The altitude of the location was 8m from the sea level as per the Bangladesh Metrological Department, Agargaon, Dhaka-1207, which have been shown in the Appendix I.

3.3. Plant and other materials

In this research work, the seeds of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) were used. The name of the variety was Red Star. The seeds were collected from Siddik Bazar, Gulistan, Dhaka. The styrofoam, cocopeat, earthen pot, plastic tray, plastic pipe, polythene sheet, etc. were collected from Town Hall, Mohammadpur, Dhaka. Experimental chemicals were bought from Agargaon Nursery, Dhaka. Different types of daily instruments also used from many purposes to complete the experiment.

3.4. Experimental Design and treatments

The experiment was conducted in a Completely Randomized Design (CRD) with three replications. Two factors were considered as treatments denoted as M (Different Mulches) and B (Different level of Boron).

Factor-A: Different Mulches

M_0= No mulch

M_1= Rice straw

M_2= Black polythene

Factor-B: Different Level of Boron

B_1= 0.5 ppm

B_2= 1.5 ppm

B_3= 2.5 ppm

B_4= 3.5 ppm

There were 12 (3 × 4) treatments combination such as M_0B_1, M_0B_2, M_0B_3, M_0B_4, M_1B_1, M_1B_2, M_1B_3, M_1B_4, M_2B_1, M_2B_2, M_2B_3, and M_2B_4.

3.5. Preparation of growing media

The mixture of coco peat and khoa were used to make the growing media. Coco peat blocks were also soaked a plastic container for overnight. The soaked coco peat was washed well in water and spread in a polythene sheet for three hours. Then three ingredients like, coco peat, khoa and vermicompost @ 60%, 30% and 10% (w/v) were mixed according to mixer ratio.

3.6. Experimental environment

Round eight inch 36 earthen pots were prepared for culturing the plants. Polythene sheet was placed in the surface of the soil. Pots were filled with different substrates mixture according to the ratio. For seedling growing, Styrofoam box filled with media mixture of coco peat, brick broken and vermicompost at the ratio of 6:3:1 (w/v). Two-week-old seedlings were transferred into the earthen pots. The experiment was conducted in a white net house under intensive care. The room was kept clean and tidy during the time of the experiment. Daily supervision was maintained to protect plants. The plants were cultivating and it continued until March 2020.

3.7. Growing media preparation for seedling raising

The mixture of coco peat, broken bricks (khoa) and vermicompost at the ratio of 60:30:10 (w/v). Coconut block was soaked in a big bowl for 24 hours. Then they are mixed with khoa and vermicompost properly. This mixer was placed in a styrofoam sheet box for using seedbed.

3.8. Applicaiton of nutrient solutions

In this experiment two nutrient solutions were used viz. i) Rahman and Inden solution, and ii) Boron solution

3.8.1 Application of Rahman and Inden solution

Rahman and Inden (2012) nutrient solution was applied to the plants for all the treatments until 2 weeks after transplanting until harvest. The constituents of the nutrient solution (meq L^{-1}) were NO_3-N (17.05), P (7.86), K (8.94), Ca (9.95), Mg (6.0), and S (6.0), along with the micronutrients (mg L^{-1}) Fe (3.0), B (0.5), Zn (0.1), Cu (0.03), Mo (0.025), and Mn (1.0). The pH and EC of the solution were ~6.0 and 3 mS cm^{-1}, respectively.

3.8.2 Application of boron solution

In this experiment, boron solution at different concentration (0.5 ppm, 1.5 ppm, 2.5 ppm and 3.5 ppm) were used. To prepare 0.5 ppm B solution, 2.861 mg H_3BO_3 was dissolved in 1L water and prepared the stock solution. Similarly, to prepare, 1.5 ppm, 2.5 ppm and 3.5 ppm B solution, 8.58 mg, 14.30 mg and 20.02 mg H_3BO_3 was dissolved in 1L water and prepared the stock solution.

3.9. Seed sowing

The seeds were soaked in water for 24 hours and then wrapped with piece of thin cloth. The socked seed were then spread over polythene sheet for 2 hours to dry out the surface water. After that, seeds were sown in styrofoam sheet box and covered with newspaper under room temperature for rising seedling.

3.10. Transplanting of cherry tomato seedling

15 days old cherry tomato seedlings were transferred to earthen pot contains the mixture of coco peat, khoa and vermicompost. After four weeks these seedlings were transplanted to the main 12 inch earthen pot. The plants were transplanted carefully so that the roots were not damaged. After transplanting of tomato plant in the plastic pot light watering was done with sprayer so that the plant was got proper moisture.

3.11. Intercultural operations

3.11.1. Pruning

Four weeks after transplanting, the lower yellow leaves were removed, allowing plants to develop an adequate vegetative frame before fruit set.

3.11.2. Irrigation

Immediately after transplanting, light irrigation to the individual pot was provided to overcome water deficit. After establishment of seedlings, each pot was watered in alternate days to keep the soil moist for normal growth and development of the plants. During pre-flowering stage, irrigation was done sincerely.

3.11.3. Weeding

No weeding was done in the experiment.

3.11.4. Stalking

Firstly, a bamboo stick was used for support cherry tomato plant. Secondly, a small plastic pipe was cut roundly different pieces. Then it used as a hook in plant base and plastic rope used for support the plant.

3.11.5. Insect management

Cherry tomato plants were grown in controlled environment. So, no insecticides were applied in the experiment.

3.11.6. Diseases management

Cherry tomato plants were grown in controlled environment in hydroponic system and all nutrients required for plant were supplied artificially to the plants. The growing environment was clean and no disease attacked to the plant.

3.12. Harvesting

The crop was harvested after 120 and 150 DAT. Harvesting of the crop was done according to treatment.

3.13. Data collection

Different data on the growth and physiological traits were recorded during the experiment. Data were collected from each plant described below.

3.13.1. Plant height (cm)

Plant height was measured in centimeter (cm) by a meter scale at 20, 40 and 60 DAT (days after transplanting) from the point of attachment of growing media up to the top of the trunk.

3.13.2. Number of branches per plant

Total number of branches per plant was counted from the plant of each of unit pot. Data recorded at 20 days interval started from the 20 days of planting up to 60 days.

3.13.3. Number of leaves per plant

Total number of leaves per plant was counted from the plant of each of unit pot. Data was recorded at 20 days interval started from the 20 days of planting up to 60 days.

3.13.4. Length of leaflet

The length of leaflet was measured with a scale from the neck of the leaf to the bottom of 10 selected leaves from each plant and their average was taken in cm.

3.13.5. Breadth of leaflet

The breadth of leaflet was measured with a scale from 10 selected leaves from each plant and their average was taken in cm.

3.13.6. Chlorophyll contents (SPAD value)

Leaf chlorophyll content as SPAD values were measured from the youngest fully expanded leaf in the third position from the tip by a portable chlorophyll meter (SPAD-502, Konica Minolta Sensing, Inc., Japan). The SPAD-502 chlorophyll meter can estimate total chlorophyll amounts in the leaves of a variety of species with a high degree of accuracy and is a nondestructive method. Data was recorded at 25 days interval started from the 25 days of planting up to 75 days.

3.13.7. Days to first flowering

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

3.13.8. Number of flower cluster per plant

Total number of flower cluster of individual plant was recorded.

3.13.9. Number of flowers per plant

Total number of flower cluster of individual plant was recorded.

3.13.10. Days of first fruit initiation

The date of fruiting was recorded from the number of days of 1st the date of fruiting after transplanting of cherry tomato.

3.13.11. Number of fruits per plant

Number of fruits per plant were counted at 75 (First harvesting), 120 (Second harvesting) and 180 (Third harvesting) DAT. All the fruits of each plant were counted separately. Only the smallest young fruits at the growing point of the plant were excluded from the counting and the average number was recorded.

3.13.12. Fruit length

The length of fruit was measured with a slide caliper from the neck of the fruit to the bottom of 5 individual fruits from individual plant three times and their average was taken and expressed in cm.

3.12.13. Fruit diameter

Diameter of fruit was measured at middle portion of 5 individual fruits from individual plant three times with a slide caliper. Their average was taken and expressed in cm.

3.12.14. Individual fruit weight

The fresh weight of 5 individual fruits from individual plant was recorded by an electric balance three times and the mean value was calculated by the following formula:

$$\text{Individual fruit weight} = \frac{\text{Total weight of fruits per plants}}{\text{Total number of fruits per plant}}$$

3.13.15. Total soluble solids (% Brix)

Total soluble solid (TSS) content of pineapple pulp was estimated by using Abbe refractometer. A drop of pulp solution squinted from the fruit pulp was placed on the prism of refractometer. Percent TSS was obtained from direct reading of the instrument.

3.13.16. Yield per plant

Yield of cherry tomato per plant was recorded as the whole fruit per plant harvested in different times and was expressed in kilogram.

3.13.17 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of different doses of boron and mulching. All input cost including the cost for lease of land and interests on running capital was computed for the cost of production. The interests were calculated @ 13% in simple interest rate. The market price of tomato was considered for estimating the cost and return. Analyses were done according to the procedure determining by Alam *et al.*, (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ration (BCR)} = \frac{\text{Gross return}}{\text{Total cost of production}}$$

3.14. Statistical analysis

The data in respect of yield, quality and yield components were statistically analyzed to find out the significance of the experimental results. The means of all the treatments were calculated and the analysis of variance for each of the characters under study was performed by "F" test. The difference among the treatment means were evaluated by Least Significant Difference (LSD) test and interpretation of the results were determined by Duncan's Multiple Range Test (DMRT) according to Gomez and Gomes, (1984).

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Plant height

4.1.1 Effect of mulches on plant height

Plant height was recorded at different days after transplanting (DAT). Different mulches showed significant variation on plant height at different days after transplanting (DAT) under the present trail (Appendix II and Figure 1). The maximum (62.25 cm) plant height was recorded from M_2 (Black polythene) which was followed by M_1 (Rice straw) and the minimum plant height (47.67 cm) was obtained from control i.e. no mulches at 20 DAT. On the other hand, at 40 DAT, the maximum plant height (126.96 cm) was recorded from M_2 which was followed by M_1 (107.78 cm), while the minimum plant height (96.08 cm) was obtained from control (M_0). The maximum plant height (178.67 cm) was recorded from M_2 which was closely followed by M_1 treatment, while the minimum plant height (125.68 cm) was found from control at 60 DAT. Plant height is one of the most important parameters, which is positively correlated with the yield of cherry tomato (Asri *et al.*, 2015). The different mulching materials like black polythene retained higher soil moisture and temperature compared to other mulching materials and the control. On the contrary, without mulch, plants suffered from water stress and could not accomplish full vegetative growth. Pinder *et al.* (2016) reported that mulching helped to increase plant height in cherry tomato. They found that plant height of cherry tomato under black polythene was height (74.44 cm), whereas minimum was observed in control (51.78 cm).

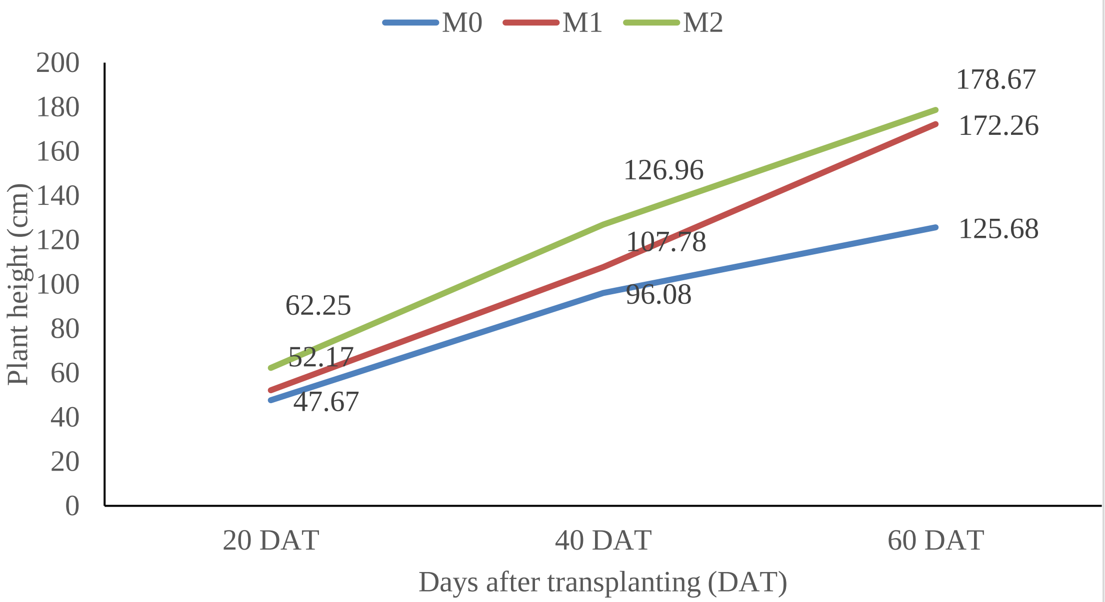

Figure 1. Effect of different mulches on plant height in cherry tomato at different Days After Transplanting (DAT)

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.1.2 Effect of boron on plant height

There was significant variation among different doses of boron in respect of plant height at different stages of growth (Appendix II and Figure 2). The maximum (59.22 cm) plant height was recorded from B_3 (2.5 ppm B) which was followed by B_4 (3.5 ppm B) and the minimum plant height (44.89 cm) was found in control treatment at 20 DAT. On the other hand, at 40 DAT, the maximum plant height (127.78 cm) was recorded from B_3, while the minimum plant height (95.78 cm) was obtained from control (B_1). The maximum plant height (180.67 cm) was recorded from B_3, while the minimum plant height (147.72 cm) was found from control at 60 DAT. It is clear that all boron levels maintained a lead over control with regard to plant height. This corroborates the results of Singh *et al.* (2017) obtained the maximum plant height (62.74 cm, 94.44 cm, 144.29 cm 146.55 cm and 148.44 cm) at (30, 60, 90, 120 and 150 DAT) from T_9 treatment (B @ 2.0 g/l).

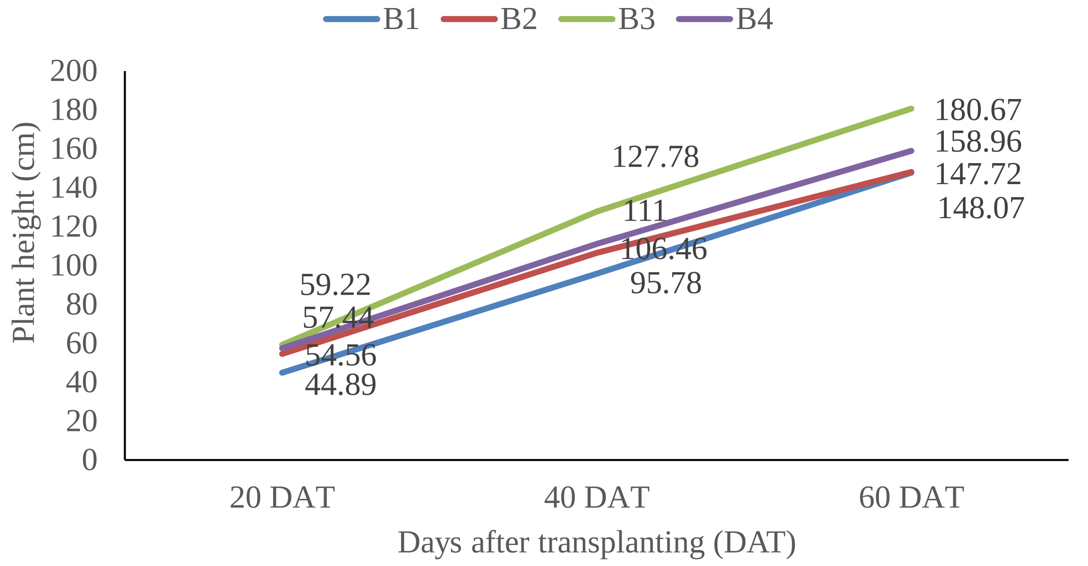

Figure 2. Effect of different levels of boron fertilizer on plant height of cherry tomato at different Days After Transplanting (DAT)

B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.1.3 Combine effect of mulches and boron on plant height

Combine effect of mulches and boron also showed significant differences of the plant height of cherry tomato at 20, 40, 60 DAT and average (Table 1 and Appendix II). At 20 DAT, the longest plant (65.33 cm) was recorded from the M_2B_3 (2.5 ppm Boron with black polythene mulch) treatment while, the shortest plant (33.33 cm) from M_0B_1 treatment. Similarly, at 40 DAT, the longest plant height (138.33 cm) was recorded from the M_2B_3 treatment which was statistically similar with the M_2B_4 (3.5 ppm Boron with black polythene) and M_1B_3 (2.5 ppm Boron with black polythene) treatment while, the shortest plant height (73.33 cm) was recorded from M_0B_1 treatment. At 60 DAT, the tallest plant (191.76 cm) was recorded from M_2B_3 treatment combination and the shortest plant (95.67 cm) was obtained from M_0B_1 treatment combination which was statistically similar with the M_0B_2 (1.5 ppm Boron with no mulch) treatment. In this study boron 2.5 ppm with black polythene mulch possibly maintained higher moisture content and more uniform temperature distribution in soil making more nutrient elements available for increasing plant growth.

Table 1: Interaction effect of different mulches and boron on plant height of cherry tomato at different days after transplanting

Interactions	Plant height (cm) at different days after transplanting (DAT)		
	20 DAT	40 DAT	60 DAT
M_0B_1	33.33 h	73.33 d	95.67 d
M_0B_2	41.67 g	84.67 cd	103.33 d
M_0B_3	56.33 d	115.33 b	172.76 ab
M_0B_4	48.67 e	96.00 c	167.00 b
M_1B_0	55.67 d	110.00 b	170.77 ab
M_1B_2	44.67 f	92.00 c	130.76 c
M_1B_3	62.67 abc	133.33 a	177.33 ab
M_1B_4	59.67 c	118.00 b	173.77 ab
M_2B_1	55.33 d	109.33 b	170.00 ab
M_2B_2	61.33 bc	118.00 b	173.76 ab
M_2B_3	65.33 a	138.33 a	191.76 a
M_2B_4	63.67 ab	134.33 a	179.06 ab
CV (%)	3.29	6.21	7.63
LSD (0.05)	2.95	11.34	20.07

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

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.2 Branch number per plant

4.2.1 Effect of different mulches on branch number per plant

Statistically non-significant variation was recorded for branch number per plant of cherry tomato due to application of various mulch materials at 20, 40 and 60 DAT (Appendix III and Figure 3). Numerically, at different days after transplanting (DAT) the maximum number of branch per plant (2.50, 3.42 and 5.25) was recorded from M_2 (Black polythene) at 20, 40 and 60 DAT, respectively. On the other hand, at the same DAT the minimum number of branch per plant (2.25, 3.42 and 4.75) was recorded from M_0 as mulch control condition. More (2017) reported that mulching helped to increase the primary branches of cherry tomato. They found that branch number of cherry tomato under black polythene was height (5.32), whereas minimum was observed in control (4.07).

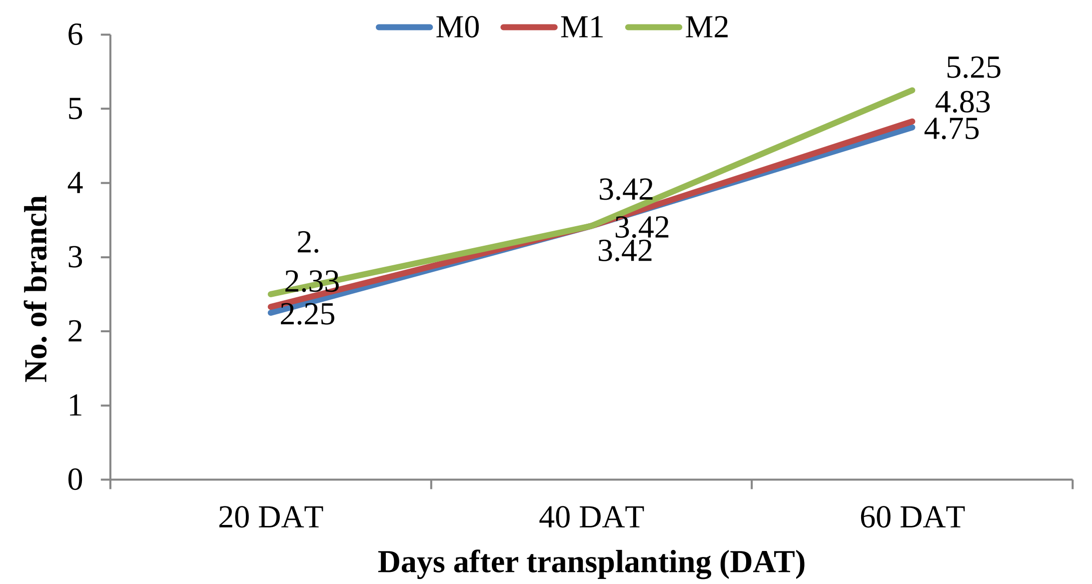

Figure 3. Effect of different mulches on branch number per plant of cherry tomato at different DAT

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.2.2 Effect of boron on branch number per plant

Statistically non-significant variation was recorded for branch number per plant of cherry tomato due to application of different doses of boron at 20 and 40 but at 60 DAT, there was a significant variation was observed due to application of different doses of boron fertilizer (Appendix III and Figure 4). Numerically, at different days after transplanting (DAT) the maximum number of branch per plant (2.44, 3.44 and 5.67) was recorded from B_3 (2.5 ppm B) at 20, 40 and 60 DAT, respectively. On the other hand, at the same DAT the minimum number of branch per plant (2.11, 3.33 and 4.44) was recorded from control (B_1) condition.

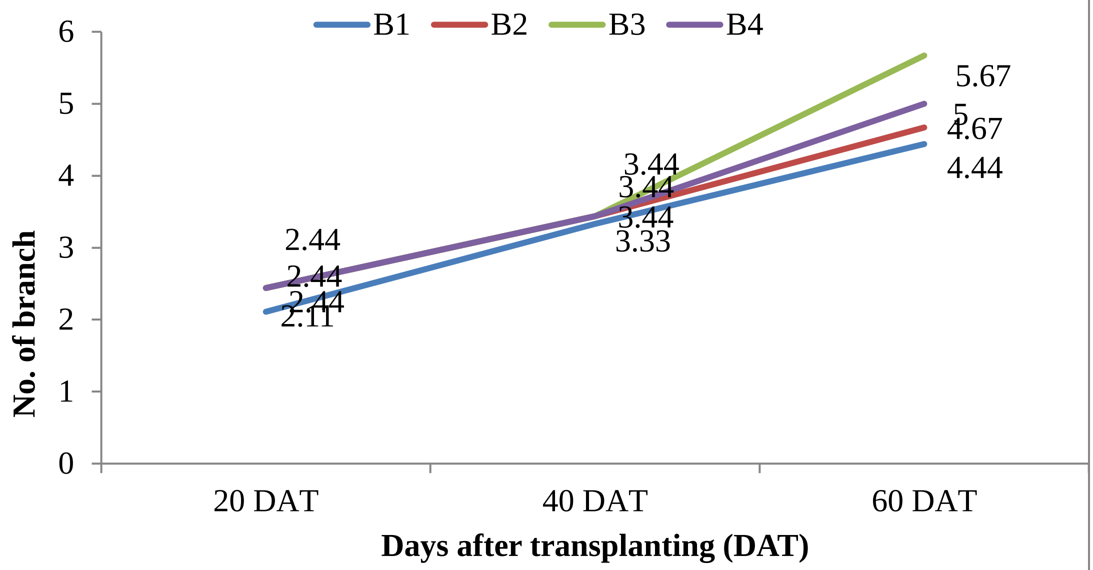

Figure 4. Effect of different level of boron on branch number per plant of cherry tomato at different DAT

B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.2.3 Combine effect of mulches and boron on branch number per plant

Combine effect of mulches and boron also showed significant differences of the branch number per plant of cherry tomato at 60 DAT (Table 2 and appendix III). Numerically, at different days after transplanting (DAT) the maximum number of branch per plant (2.67, 3.67 and 6.67) was recorded from M_2B_3 treatment combination at 20, 40 and 60 DAT, respectively. On the other hand, at the same DAT the minimum number of branch per plant (1.67, 3.33 and 4.33) was recorded from M_0B_1 treatment combination, respectively.

Table 2: Interaction effect of different mulches and boron on branch number per plant of cherry tomato at different days after transplanting

Interactions	Branch number per plant at different days after transplanting (DAT)		
	20 DAT	40 DAT	60 DAT
M_0B_1	1.67	3.33	4.33 c
M_0B_2	2.33	3.33	4.33 c
M_0B_3	2.33	3.33	4.67 bc
M_0B_4	2.33	3.33	4.33 c
M_1B_1	2.33	3.33	4.67 bc
M_1B_2	2.33	3.33	4.33 c
M_1B_3	2.67	3.67	5.67 b
M_1B_4	2.33	3.33	4.67 bc
M_2B_1	2.33	3.33	4.67 bc
M_2B_2	2.33	3.33	5.33 bc
M_2B_3	2.67	3.67	6.67 a
M_2B_4	2.67	3.67	5.67 b
CV (%)	24.45	16.90	11.68
LSD (0.05)	0.96	0.96	0.96

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

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.3 Number of leaves per plant

4.3.1 Effect of mulches on leaves number per plant

Number of leaves per plant of cherry tomato varied significantly due to application of mulching (Table 3 and appendix IV). The maximum number of leaves (53.50) per plant was recorded from M_2 (Black polythene) which was statistically similar with the M_1 (Rice straw) treatment, while the minimum number of leaves (39.92) per plant was recorded from control treatment. It was revealed that number of leaves per plant of cherry tomato increased with the application of mulching especially black polythene. This might be due to that colored polythene was more effective in preservation of moisture and the ultimate results is the longest plant containing higher number of leaves per plant. The present result agreed with the result of Kayum *et al.* (2008). They found that the highest number of leaves (65.73) per plant of cherry tomato was obtained with the application of black polythene.

4.3.2 Effect of boron on leaves number per plant

Number of leaves per plant of cherry tomato varied significantly due to application of different level of boron fertilizer (Table 4 and appendix IV). The maximum number of leaves (53.56) per plant was recorded from B_3 (2.5 ppm B) which was statistically different from all other treatments, while the minimum number of leaves (44.78) per plant was recorded from control treatment which was statistically similar with all other treatments. The present result agreed with the result of Singh *et al.* (2017) obtained the maximum number of leaves (54.09) from T_9 treatment (B @ 2.0 g/l).

4.3.3 Combine effect of mulches and boron on number of leaves per plant

Combine effect of mulches and boron showed statistically significant differences on number of leaves per plant (Table 5 and appendix IV). The maximum number of leaves per plant (61.00) of cherry tomato was recorded from M_2B_3 (2.5 ppm B with black polythene mulch) treatment while, the minimum number of leaves per plant (36.00) was recorded from M_0B_1 treatment which was statistically similar with M_0B_2 treatment.

4.4 Length of leaflet

4.4.1 Effect of mulches on length of leaflet

Leaflet length of cherry tomato varied significantly due to application of mulching (Table 3 and appendix IV). The longest leaflet length (29.42 cm) was recorded from

M_2 (Black polythene) which was statistically similar with the M_1 (Rice straw) treatment, while the shortest leaflet length (22.67 cm) was recorded from control treatment.

4.4.2 Effect of boron on length of leaflet

Leaflet length of cherry tomato varied significantly due to application of different doses of boron fertilizer (Table 4 and appendix IV). The longest leaflet length (29.89 cm) was recorded from B_3 (2.5 ppm B) treatment, while the shortest leaflet length (24.00 cm) was recorded from boron controlled condition.

4.4.3 Combine effect of mulches and boron on length of leaflet

Combine effect of mulches and boron showed statistically significant differences on leaflet length of cherry tomato (Table 5 and appendix IV). The highest leaflet length (31.67 cm) of cherry tomato was recorded from M_2B_3 (2.5 ppm B with black polythene mulch) treatment while, the lowest leaflet length (19.67 cm) was recorded from M_0B_1 treatment.

4.5 Breadth of leaflet

4.5.1 Effect of mulches on breadth of leaflet

Leaflet breadth of cherry tomato varied significantly due to application of mulching (Table 3 and appendix IV). The longest leaflet breadth (20.42 cm) was recorded from M_2 (Black polythene) which was statistically similar with the M_1 (Rice straw) treatment, while the shortest leaflet breadth (14.50 cm) was recorded from mulched controlled condition.

4.5.2 Effect of on breadth of leaflet

Leaflet breadth of cherry tomato varied significantly due to application of different doses of boron fertilizer (Table 4 and appendix IV). The longest leaflet breadth (20.44 cm) was recorded from B_3 (2.5 ppm B) treatment, while the shortest leaflet breadth

(15.22 cm) was recorded from boron controlled condition which was statistically similar with B_2 and B_4 treatment.

4.5.3 Combine effect of mulches and boron on breadth of leaflet

Combine effect of mulches and boron showed statistically significant differences on leaflet breadth of cherry tomato (Table 5 and appendix IV). The highest leaflet breadth (22.00 cm) of cherry tomato was recorded from M_2B_3 (2.5 ppm B with black polythene mulch) treatment while, the lowest leaflet breadth (10.33 cm) was recorded from M_0B_1 treatment.

Table 3: Effect of mulches on leaves number/plant, length of leaflet and breadth of leaflet of cherry tomato

Mulches	Leaves/plant	Length of leaflet	Breadth of leaflet
M_0	39.92 b	22.67 b	14.50 b
M_1	50.75 a	28.25 a	18.00 a
M_2	53.50 a	29.42 a	20.42 a
CV (%)	7.34	9.13	9.01
LSD (0.05)	5.85	4.05	2.64

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.
[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

Table 4: Effect of different boron level on leaves number/plant, length of leaflet and breadth of leaflet of cherry tomato

Boron	Leaves/plant	Length of leaflet	Breadth of leaflet
B_1	44.78 b	24.00 b	15.22 b
B_2	46.67 b	26.22 ab	17.22 b
B_3	53.56 a	29.89 a	20.44 a
B_4	47.22 b	27.00 ab	17.67 b
CV (%)	7.34	9.13	9.01
LSD (0.05)	5.85	4.05	2.64

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.
[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

Table 5: Interaction effect of different mulches and boron on leaves number/plant, length of leaflet and breadth of leaflet of cherry tomato

Interactions	Leaves/plant	Length of leaflet	Breadth of leaflet
M_0B_1	36.00 e	19.67 g	10.33 f
M_0B_2	36.67 e	21.67 fg	14.00 e
M_0B_3	50.33 bc	27.00 bcde	18.67 bcd
M_0B_4	46.00 cd	25.33 def	16.67 de
M_1B_1	50.33 bc	27.00 bcde	17.67 cd
M_1B_2	41.00 de	22.67 efg	14.33 e
M_1B_3	52.00 bc	30.00 abc	20.00 abc
M_1B_4	50.67 bc	29.00 abcd	19.33 abcd
M_2B_1	47.67 bc	26.67 cde	17.67 cd
M_2B_2	51.33 bc	29.33 abcd	20.00 abc
M_2B_3	61.00 a	31.67 a	22.00 a
M_2B_4	53.67 b	31.33 ab	21.00 ab
CV (%)	7.34	9.13	9.01
LSD $_{(0.05)}$	5.85	4.05	2.64

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

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.6 Chlorophyll percentage

4.6.1 Effect of mulches

Different mulches showed significant variation on chlorophyll content (%) at different days after transplanting (DAT) under the present trail (Appendix V and Figure 5). The maximum (55.70 %) chlorophyll content was recorded from M_2 (Black polythene) which was followed by M_1 (Rice straw) and the minimum chlorophyll content (44.83 %) was obtained from control i.e. no mulches at 25 DAT. Similarly, at 50 DAT, the maximum chlorophyll content (75.21 %) was recorded from M_2 which was followed by M_1 (68.50 %), while the chlorophyll content (65.49 %) was obtained from control (M_0). The maximum chlorophyll content (85.22 %) was recorded from M_2 treatment while, the minimum plant height (65.38 %) was found from control at 75 DAT.

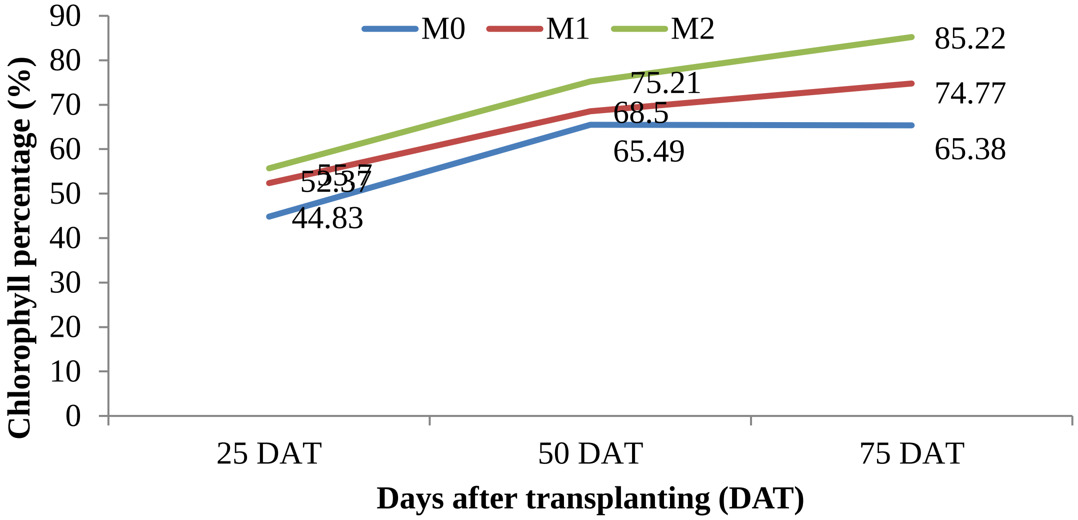

Figure 5. Effect of different mulches on chlorophyll content (%) at different DAT

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.6.2 Effect of boron on chlorophyll content

There was significant variation among different doses of boron in respect of chlorophyll content (%) at different stages of growth (Appendix V and Figure 6). The maximum (53.76 %) chlorophyll content was recorded from B_3 (2.5 ppm B) which was statistically similar with B_4 (3.5 ppm B) treatment and the minimum amount of chlorophyll content (45.98 %) was found in control treatment at 25 DAT. On the other hand, at 50 DAT, the maximum chlorophyll content (86.76 %) was recorded from $B_{3,}$ while the minimum chlorophyll content (57.01 %) was obtained from control (B_1). The maximum chlorophyll content (83.58 %) was recorded from B_3, while the minimum chlorophyll content (68.33 %) was found from control at 75 DAT. It is clear that all boron levels maintained a lead over control with regard to chlorophyll content.

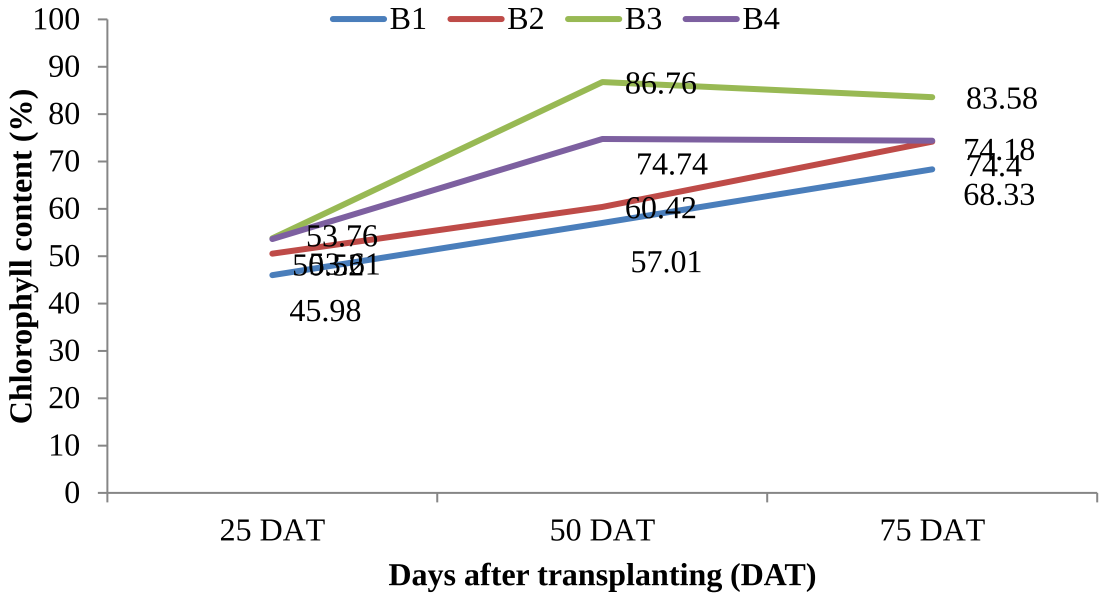

Figure 6. Effect of different level of boron on chlorophyll content (%) at different DAT

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.6.3 Combine effect of mulches and boron on chlorophyll content

Combine effect of mulches and boron also showed significant differences of the chlorophyll content (%) of cherry tomato at 25, 50, 75 DAT and average (Table 6). At 25 DAT, the highest chlorophyll content (63.53 %) was recorded from the M_2B_3 (2.5 ppm B with black polythene mulch) treatment while, the lowest chlorophyll content (40.83 %) from M_0B_1 treatment. Similarly, at 50 DAT, the highest chlorophyll content (102.33 %) was recorded from the M_2B_3 treatment while, the lowest chlorophyll content (47.63 %) was recorded from M_0B_1 treatment. Similarly, at 75 DAT, the highest chlorophyll content (99.43 %) was recorded from M_2B_3 treatment combination and the lowest chlorophyll content (60.53 %) was obtained from M_0B_1 treatment combination. In this study boron 2.5 ppm with black polythene mulch possibly maintained higher chlorophyll content (%).

Table 6: Interaction effect of different mulches and boron on chlorophyll percentage at different days after transplanting

Interactions	Chlorophyll percentage at different days after transplanting		
	25 DAT	50 DAT	75 DAT
M_0B_1	40.83 j	47.63 l	60.53 k
M_0B_2	42.33 i	49.27 k	62.23 j
M_0B_3	51.17 e	67.33 f	70.60 f
M_0B_4	45.23 g	58.67 i	66.67 h
M_1B_1	50.93 e	64.67 g	69.70 g
M_1B_2	44.43 h	50.73 j	64.70 i
M_1B_3	56.43 c	81.37 c	85.43 c
M_1B_4	55.23 d	72.67 e	77.23 e
M_2B_1	46.37 f	62.43 h	69.60 g
M_2B_2	55.50 d	80.43 d	81.70 d
M_2B_3	63.53 a	102.33 a	99.43 a
M_2B_4	59.60 b	99.27 b	93.63 b
CV (%)	0.93	0.33	0.42
LSD $_{(0.05)}$	0.79	0.39	0.52

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

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.7. Days to first flowering

4.7.1 Effect of mulches

Days to first flowering from transplanting showed statistically significant due to the application of different mulching (Appendix VI and Figure 7). It varied from 20.25 to 30.17 days after transplanting. The minimum days (20.25 DAT) required to first flowering in M_2 (Black polythene mulch) and the maximum days (30.17 DAT) required to first flowering in M_0 (No use of mulching), which was statistically similar with M_1 (Rice straw) mulch. Similar result was found by Samsuddin (2008). He found that minimum 32.99 days was required in tomato to first flowering when treated with black polythene and maximum 33.89 days to first flowering in M_0 treatment (No use of mulching).

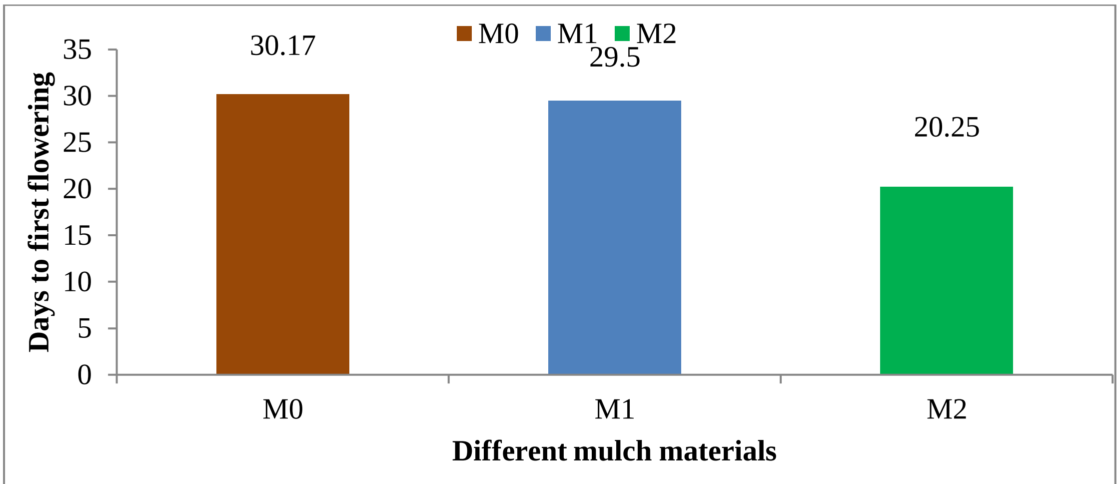

Figure 7. Effect of different mulches on days to first flowering

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.7.2 Effect of boron

The number of days to first flowering was significantly affected by the different levels of boron (Appendix VI and Figure 8). It varied from 21.33 to 35.22 days after transplanting. The minimum days (21.33 DAT) required to first flowering in B_3 (2.5 ppm B) which was followed by B_2 (24.89 DAT) and B_4 (25.11 DAT). On the other hand, the maximum days (35.22 DAT) required to first flowering in B_1 (Boron controlled condition). Similar result was found by Hossain (2008). He found that minimum 29.33 days was required in tomato to first flowering when treated with 10 kg B per hectare and maximum 31.88 days to first flowering in B_0 treatment (No use of boron).

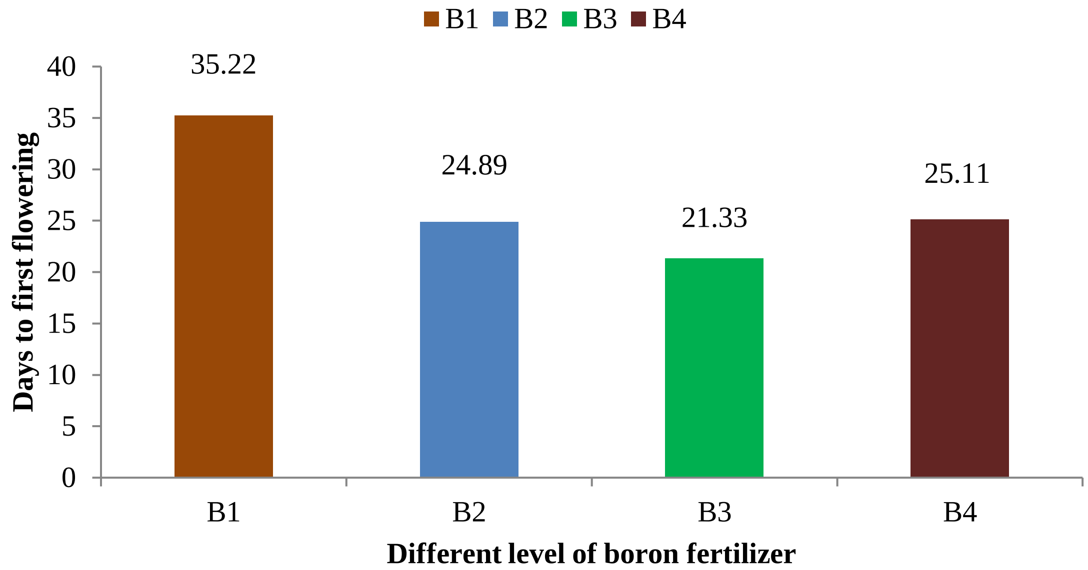

Figure 8. Effect of different boron levels on days to first flowering in cherry tomato

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.7.3 Combine effect of mulches and boron

Statistically significant differences recorded on days to first flowering from transplanting due to the combined effect of different levels of boron and mulching application (Table 7 and Appendix VI). The minimum days (19.33 DAT) required to first flowering in M_2B_3 (2.5 ppm B with black polythene mulch) treatment combination which was statistically similar with M_0B_3, M_1B_3 and M_2B_4 treatment. On the other hand, the maximum days (43.67 DAT) required to first flowering in M_0B_1 treatment combination which was statistically similar with M_1B_1 treatment combination.

4.8. Days to fist fruiting

4.8.1 Effect of mulches

Days to first fruiting from transplanting showed statistically significant due to the application of different mulching (Appendix VI and Figure 9). It varied from 30.50 to 44.67 days after transplanting. The minimum days (30.50 DAT) required to first fruiting in M_2 (Black polythene mulch) and the maximum days (44.67 DAT) required to first flowering in M_0 (No use of mulching). Similar result was found by Samsuddin (2008). He found that minimum 35.47 days was required in tomato to first flowering when treated with black polythene and maximum 49.71 days to first flowering in M_0 treatment (No use of mulching).

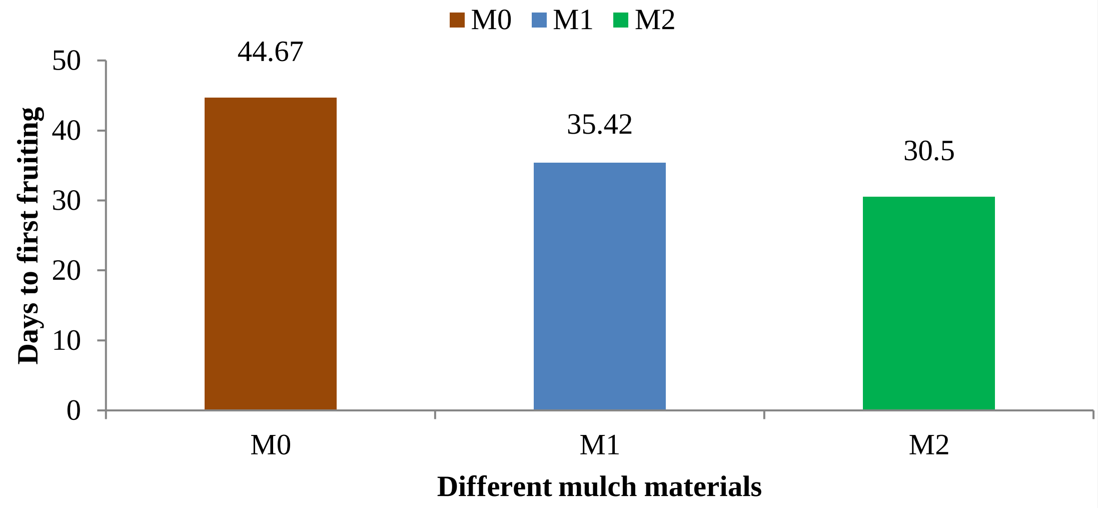

Figure 9. Effect of different mulches on days to first fruiting in cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.8.2 Effect of boron

The number of days to first fruiting was significantly affected by the different levels of boron (Appendix VI and Figure 10). It varied from 30.11 to 46.78 days after transplanting. The minimum days (30.11 DAT) required to first fruiting in B_3 (2.5 ppm B) which was followed by B_2 (33.44 DAT) and B_4 (37.11 DAT). On the other hand, the maximum days (46.78 DAT) required to first fruiting in B_1 (Boron controlled condition). Similar result was found by Hossain (2008). He found that minimum 35.37 days was required in tomato to first fruiting when treated with 1.0 g B per litre and maximum 50.64 days to first flowering in B_0 treatment (No use of boron).

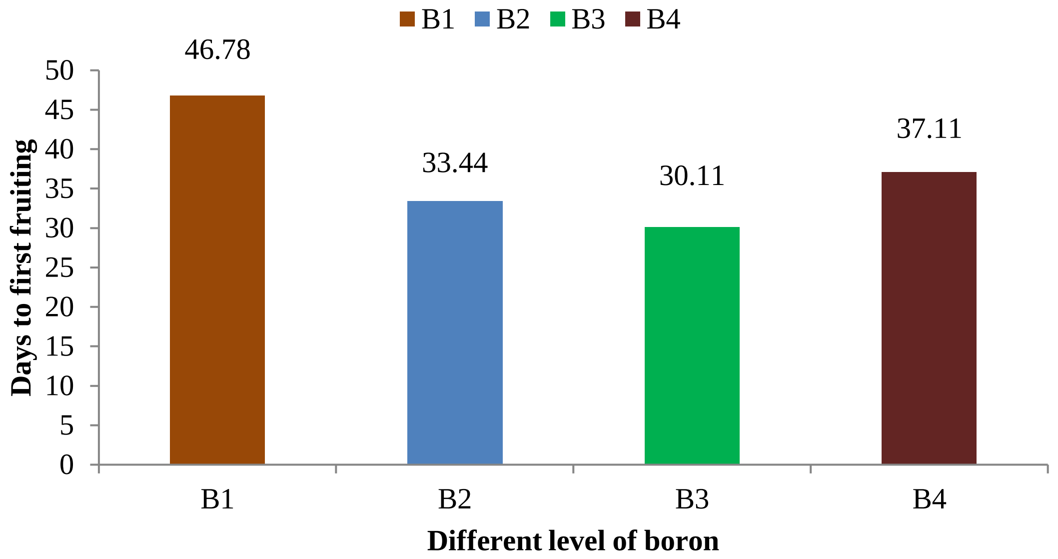

Figure 10. Effect of different levels of boron on days to first fruiting in cherry tomato

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.8.3 Combine effect of mulches and boron

Statistically significant differences recorded on days to first fruiting from transplanting due to the combined effect of different levels of boron and mulching application (Table 7 and Appendix VI). The minimum days (27.33 DAT) required to first flowering in M_2B_3 (2.5 ppm B with black polythene mulch) treatment combination and the maximum days (68.00 DAT) required to first flowering in M_0B_1 treatment combination.

Table 7: Interaction effects of different mulches and boron on days to first flowering and days to first fruiting

Interactions	Days to first flowering	Days to first fruiting
M_0B_1	43.67 a	68.00 a
M_0B_2	29.00 b	42.67 bc
M_0B_3	19.67 c	31.00 de
M_0B_4	22.33 bc	31.33 de
M_1B_1	42.67 a	45.67 b
M_1B_2	24.00 bc	31.67 de
M_1B_3	19.67 c	30.00 de
M_1B_4	26.67 bc	34.67 cde
M_2B_1	24.67 bc	32.67 de
M_2B_2	28.33 bc	37.67 bcd
M_2B_3	19.33 c	27.33 e
M_2B_4	19.67 c	29.67 de
CV (%)	17.75	13.94
LSD (0.05)	7.84	8.52

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

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.9. Number of flower cluster per plant

4.9.1 Effect of mulches

Number of flower cluster per plant differed significantly due to the application of different mulching (Appendix VI and Figure 11). The maximum number of flower cluster per plant (38.42) was recorded in M_2 treatment (Black polythene mulch) and the minimum number of flower cluster per plant (19.92) was recorded from M_0 treatment. Begum (2014) found polythene mulch gave the highest number of flower cluster per plant (10.05) which was similar to the present study.

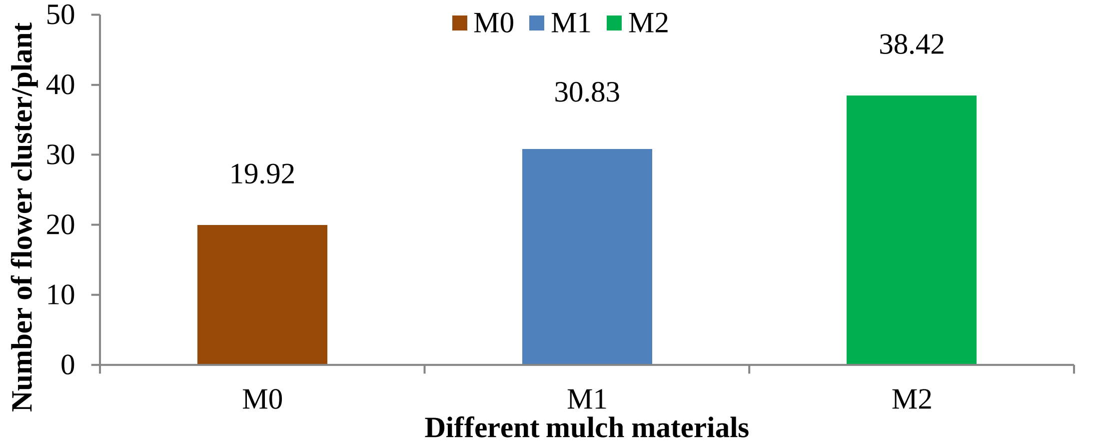

Figure 11. Effect of different mulches on the number of flower cluster per plant

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.9.2 Effect of boron

There were significant variations among the different doses of boron in respect of flower clusters per plant (Appendix VI and Figure 12). The Maximum number of flower clusters per plant (35.56) was found at 2.5 ppm B and the minimum (24.67) was found from the B_1 (0.5 ppm B). The results clearly showed that the number of flower clusters per plant was gradually increased with increasing levels of boron except the highest dose (3.5 ppm B). Azad (2007) found 2.5 ppm B gave the highest number of flower cluster per plant (14.10) which was similar to the present study.

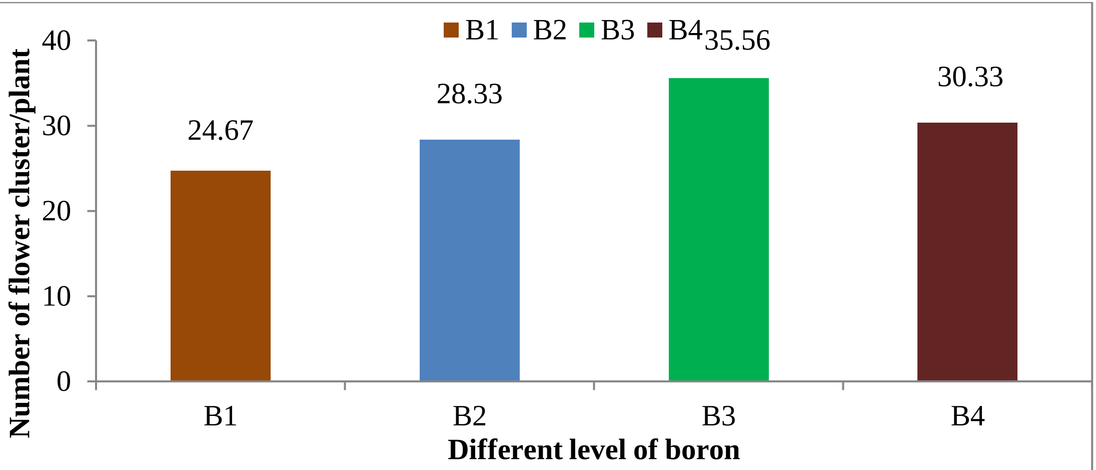

Figure 12. Effect of different levels of boron on the number of flower cluster per plant

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.9.3 Combine effect of mulches and boron

A significant variation was found due to combined effect of boron and mulching in terms of number of cluster per plant (Table 8 and Appendix VI). The maximum number of cluster per plant (41.33) was recorded from M_2B_3 (2.5 ppm B with black polythene mulch) treatment combination, which was statistically identical (39.33) with M_2B_4 (3.5 ppm B with black polythene mulch). While M_0B_1 treatment combination gave the minimum number of cluster (13.67) per plant which was statistically identical (17.00) with M_0B_2 (1.5 ppm B with mulch controlled condition).

4.10. Number of flowers per plant

4.10.1 Effect of mulches

Different mulches showed significant variation with respect to number of flowers per plant under the present trial (Appendix VI and Figure 13). The maximum (382.56) number of flowers per plant was recorded from M_2 (Black polythene) and the minimum (202.56) was found from control condition i.e. no mulch. Kayum *et al.* (2008) observed that all mulches increased and enhanced earlier flowering, more than double over the control.

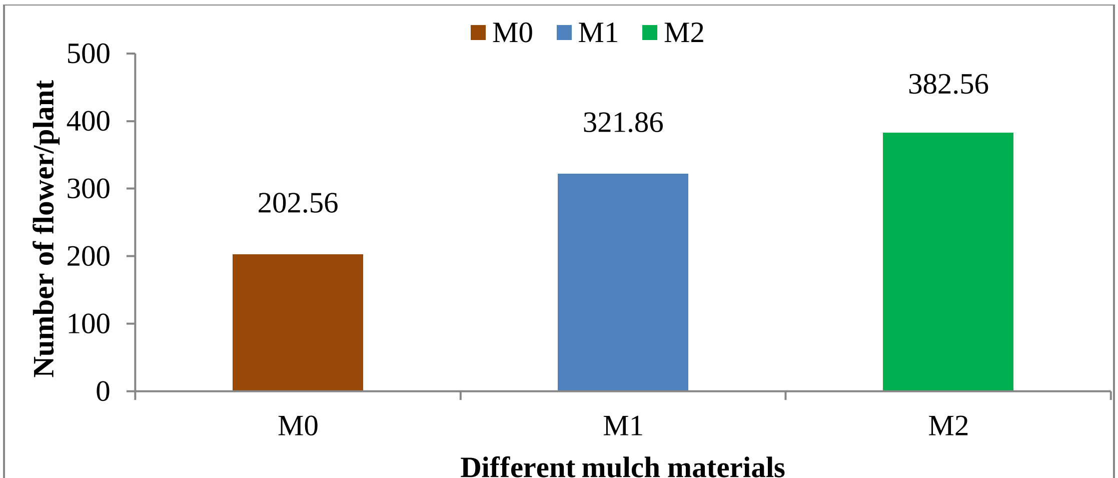

Figure 13. Effect of different mulches on the number of flower per plant in cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.10.2 Effect of boron

Different doses of boron showed significant variation with respect to number of flowers per plant under the present trial (Appendix VI and Figure 14). The maximum (380.00) number of flowers per plant was recorded from B_3 (2.5 ppm B) and the minimum (244.33) was found from B_1 (0.5 ppm B). Singh *et al.* (2017) found 2 g B/l gave the highest number of flower per plant (347) which was similar to the present study.

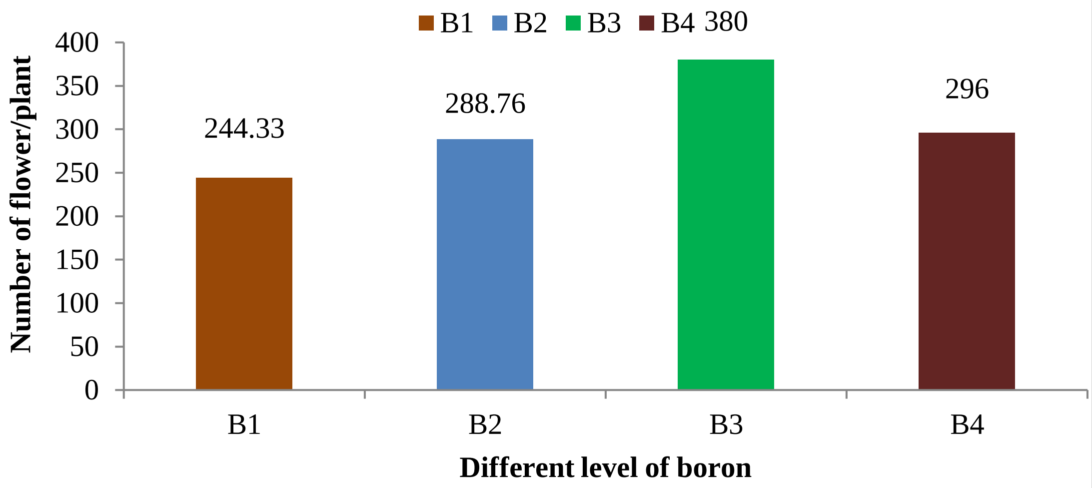

Figure 14. Effect of different levels of boron on the number of flower per plant in cherry tomato

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.10.3 Combine effect of mulches and boron

A significant variation was found due to combined effect of boron and mulching in terms of number of flower per plant (Table 8 and Appendix VI). The maximum number of flower per plant (410.33) was recorded from M_2B_3 (2.5 ppm B with black polythene mulch) treatment combination, which was statistically identical (409.00) with M_2B_4 (3.5 ppm B with black polythene mulch). While M_0B_1 treatment combination gave the minimum number of flower (142.00) per plant which was statistically identical (153.00) with M_0B_2 (1.5 ppm B with mulch controlled condition).

4.11. Number of fruit per plant

4.11.1 Effect of mulches

Different mulches showed significant variation in case of number of fruits per plant under the present trial (Appendix VI and Figure 15). The maximum (241.57) number of fruits per plant was recorded from M_2 (Black polythene) and the minimum (121.00) was observed in control condition i.e. no mulch. Shampa (2008) observed that different mulching materials (black, blue or transparent polyethylene flint paddy straw, sugarcane trash, and poplar leaves) significantly improved the number of fruits per plant compared with the unmulched control on the growth and yield of tomato.

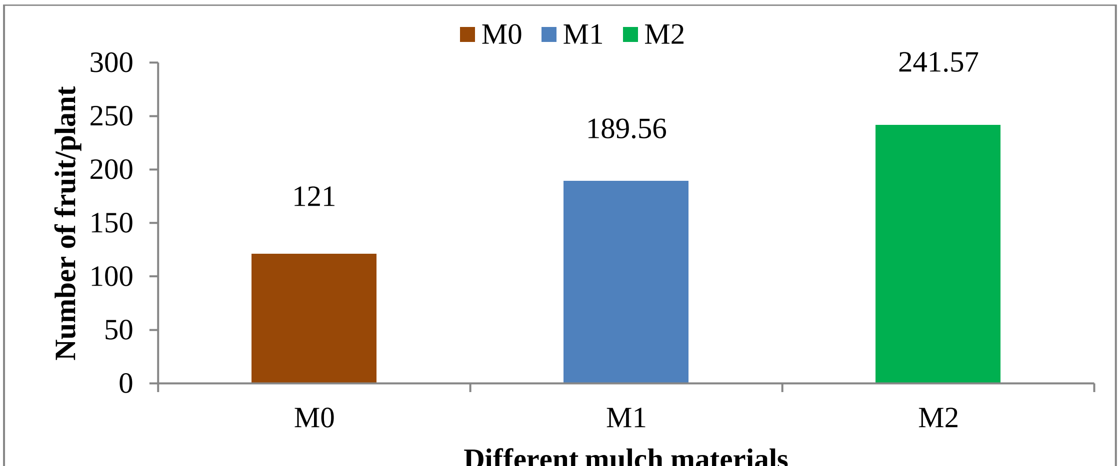

Figure 15. Effect of different mulches on the number of fruit per plant in cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.11.2 Effect of boron

The effect of different levels of boron on the number of fruits per plant was found positive and significant (Appendix VI and Figure 16). Number of fruits per plant gradually increased with increasing level of B up to the highest level of the present trial. The highest number of fruits per plant (256.76) was obtained with the application of 2.5 ppm B, which was statistically similar with 3.5 ppm B application. The lowest number of fruits per plant (117.33) was found in control treatment. Further it was observed that number of fruit per plant was increased with increasing level of boron up to higher level. Singh *et al.* (2017) found 2 g B/l gave the highest number of fruit per plant (244.15) which was similar to the present study.

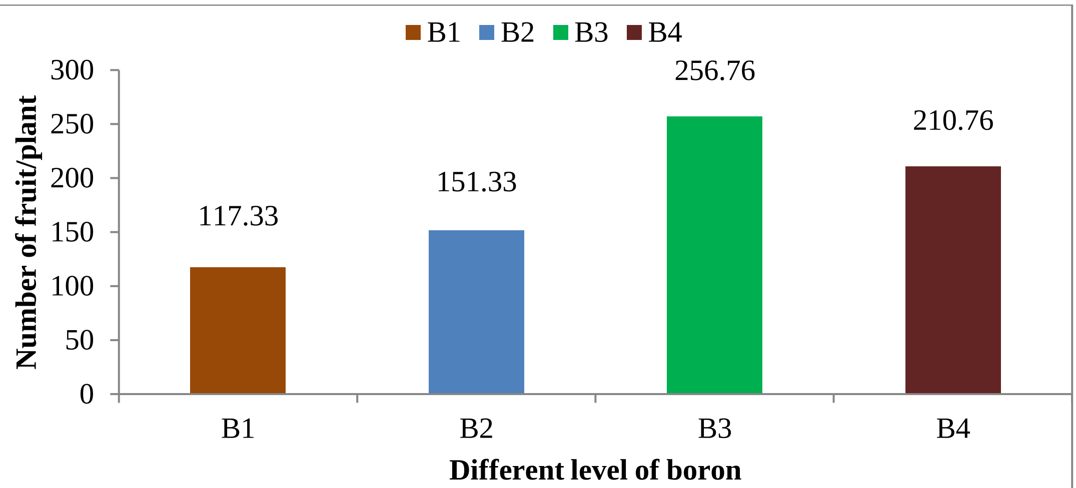

Figure 16. Effect of different level of boron on the number of fruit per plant in cherry tomato

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.11.3 Combine effect of mulches and boron

A significant variation was found due to combined effect of boron and mulching in terms of number of fruit per plant (Table 8 and Appendix VI). The maximum number of fruit per plant (296.00) was recorded from M_2B_3 (2.5 ppm B with black polythene mulch) treatment combination, while M_0B_1 treatment combination gave the minimum number of fruit (46.00) per plant.

Table 8: Interaction effects of different mulches and boron on number of flower cluster per plant, number of flower/plant and number of fruit/plant

Interactions	No. of Flower cluster per plant	No. of Flower/plant	No. of Fruit/plant
M_0B_1	13.67 f	142.00 d	46.00 h
M_0B_2	17.00 f	153.00 d	96.00 gh
M_0B_3	32.00 bc	331.00 b	204.00 cde
M_0B_4	24.33 de	227.00 c	114.00 fg
M_1B_1	37.00 ab	321.00 b	192.00 de
M_1B_2	19.67 ef	194.00 cd	104.00 fg
M_1B_3	31.00 bc	382.00 ab	254.00 abc
M_1B_4	36.00 abc	364.00 ab	236.00 bcd
M_2B_1	29.33 cd	320.00 b	154.00 ef
M_2B_2	36.00 abc	374.00 ab	238.00 bcd
M_2B_3	41.33 a	410.00 a	296.00 a
M_2B_4	39.33 a	409.00 a	274.00 ab
CV (%)	12.66	12.42	16.40
LSD (0.05)	6.24	62.25	50.03

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

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.12. Length of individual fruit (cm)

4.12.1 Effect of mulches

Different mulches showed significant variation on length of individual fruit under the present trial (Appendix VII and Figure 17). The maximum (2.44 cm) length of individual fruit was recorded from M_2 (Black polythene) and the minimum (1.93 cm) was obtained from control condition. Shampa (2008) observed that different mulching materials (black, blue or transparent polyethylene flint paddy straw, sugarcane trash, and poplar leaves) significantly improved the length of individual fruits compared with the unmulched control on the growth and yield of tomato.

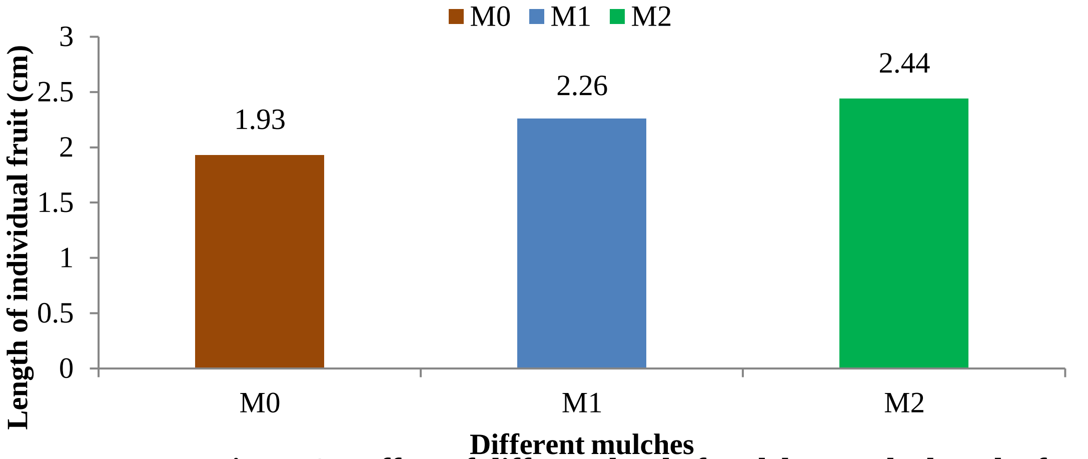

Figure 17. Effect of different level of mulches on the length of individual fruit

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.12.2 Effect of boron

Boron had significant effect on fruit length at harvest (Appendix VII and Figure 18). Fruit length varied from 1.89 cm to 2.49 cm. The longest fruit (2.49 cm) was produced from 2.5 ppm B and the shortest fruit (1.89 cm) was produced from B_1 (0.5 ppm B). This result showed that fruit length was increased gradually with the increasing levels of boron expect the highest level (20 kg B/ha). Azad (2007) found 2.5 ppm B gave the longest fruit (3.74 cm) which was similar to the present study.

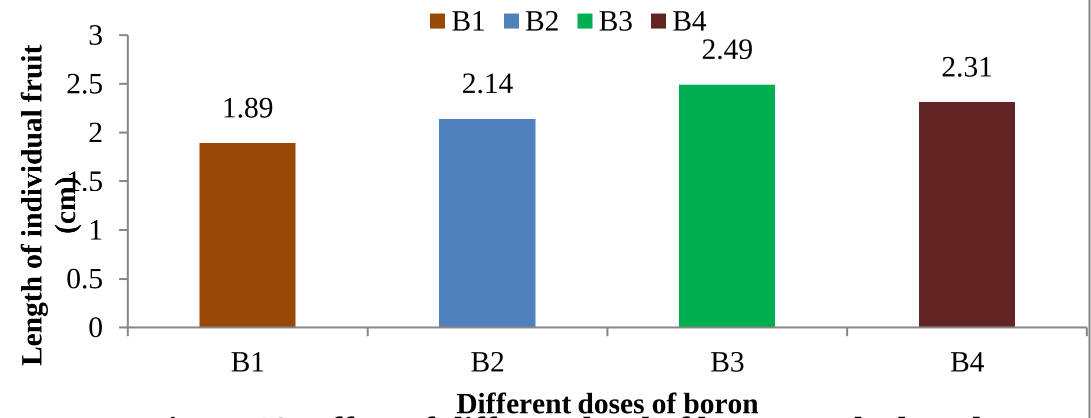

Figure 18. Effect of different level of boron on the length of individula fruit

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.12.3 Combine effect of mulches and boron

The variation was found due to interaction effect of mulches and boron for length of individual fruit under the trial (Table 9 and Appendix VII). The maximum (2.73 cm) length of individual fruit was recorded from treatment combination M_2B_3 (2.5 ppm B with black polythene mulch), while the treatment combination M_0B_1 had minimum (1.37 cm) length of individual fruit.

4.13. Diameter of individual fruit

4.13.1 Effect of mulches

Different mulches showed significant variation on diameter of individual fruit under the present trial (Appendix VII and Figure 19). The maximum (1.94 cm) diameter of individual fruit was recorded from M_2 (Black polythene) and the minimum (1.51 cm) was obtained from control condition. Shampa (2008) observed that black polythene significantly improved the diameter of individual fruits compared with the unmulched control on the growth and yield of tomato.

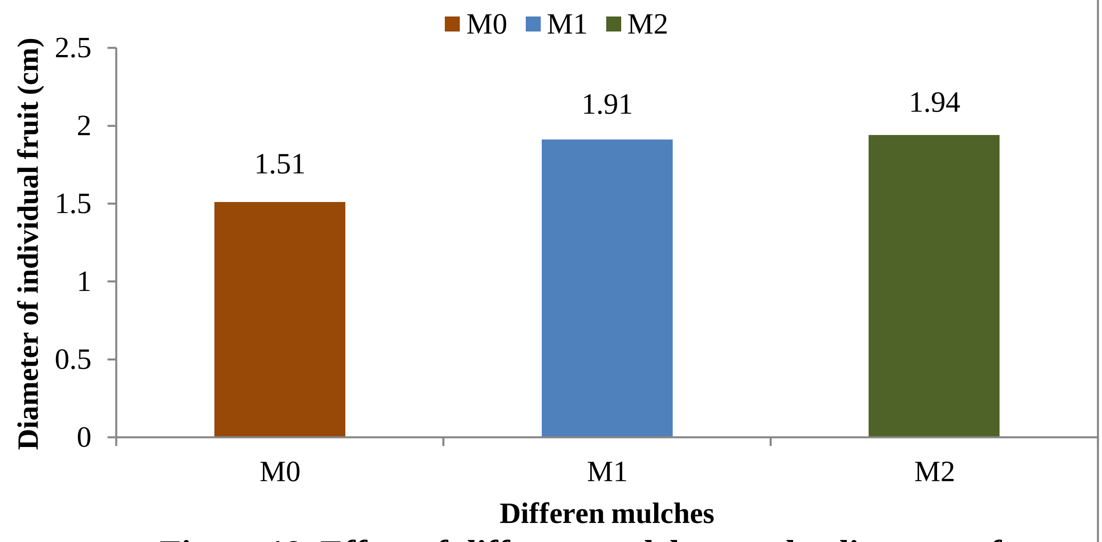

Figure 19. Effect of different mulches on the diameter of individual fruit

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.13.2 Effect of boron

The variation in diameter of fruit among the different doses of boron was found to be statistically significant (Appendix VII and Figure 20). The maximum diameter of fruit (2.03 cm) was found from the plants grown with 2.5 ppm B while the minimum (1.52 cm) was produced from B_1 (0.5 ppm B). Azad (2007) found 2.5 ppm B gave the highest fruit diameter (5.34 cm) which was similar to the present study.

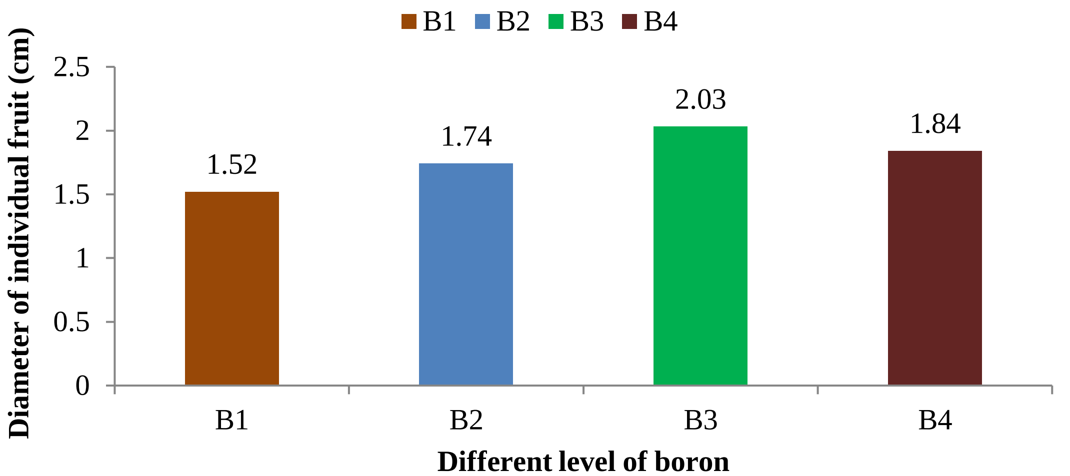

Figure 20. Effect of different doses of boron on the diameter of individual fruit

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.13.3 Combine effect of mulches and boron

Interaction effect varied significantly for boron and mulches for diameter of individual fruit of cherry tomato (Table 9 and Appendix VII). The maximum (2.20 cm) diameter of individual fruit was recorded from treatment combination of M_2B_3 (2.5 ppm B with black polythene mulch) which was statistically identical with M_2B_4 (3.5 ppm B with black polythene mulch), while the treatment combination M_0B_1 had minimum (1.10 cm) diameter of individual fruit.

4.14. Weight of individual fruit

4.14.1 Effect of mulches

A significant variation was recorded for mulches on weight of individual fruit under the present trial (Appendix VII and Figure 21). The maximum weight (9.06 g) weight of individual fruit was recorded from M_2 (Black polythene) and the minimum (5.31 g) was recorded from control condition i.e. no mulch. Shampa (2008) reported that black polythene mulch significantly increased fruit size and total yield of tomato. Kayum *et al.* (2008) observed that different mulching materials (water hyacinth, straw, Am-ada leaf, banana leaf) significantly improved the fresh weight per fruit compared with the unmulched control on the growth and yield of tomato. Begum (2014) observed that all mulches increased fruit size (by weight), more than double over the control.

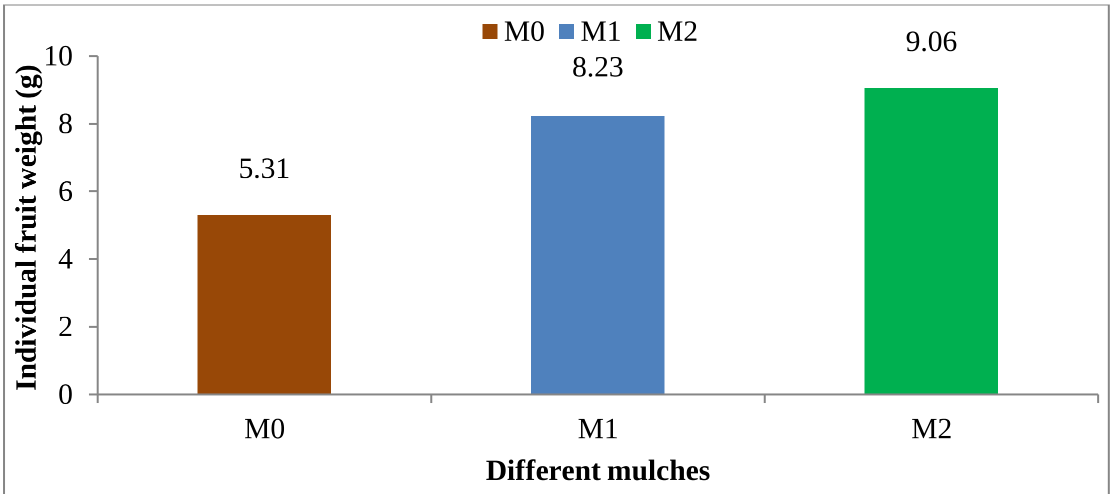

Figure 21. Effect of mulching on individula fruit weight of cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.14.2 Effect of boron

It was noticed that different levels of boron exhibited significant effects on fresh weight of individual fruit (Appendix VII and Figure 22). The weight of individual fruit ranged from 5.28 g to 9.86 g. The maximum fruit weight of 9.86 g was obtained from 2.5 ppm B while the control treatment gave the lowest value (5.28 g). Individual fruit weight was increased gradually with the increasing levels of boron except the highest level (3.5 ppm B). Singh *et al.* (2017) found 2 g B/l gave the highest individual fruit weight of cherry tomato (14.87 g) which was similar to the present study.

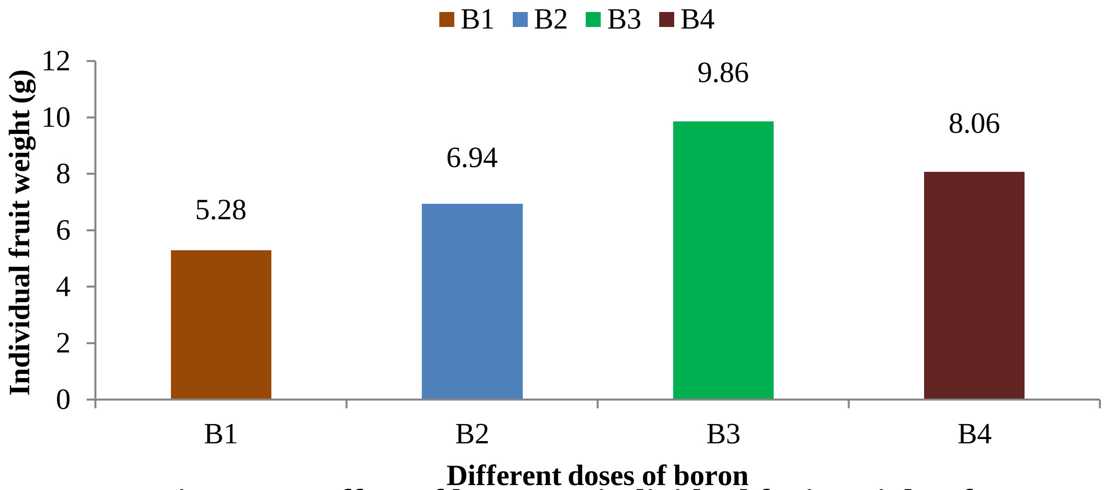

Figure 22. Effect of boron on individual fruit weight of cherry tomato

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.14.3 Combine effect of mulches and boron

The variation was found due to interaction effect of boron and mulches for weight of individual fruit under the trial (Table 9 and Appendix VII). The maximum (12.08 g) weight of individual fruit was recorded from treatment combination of M_2B_3 (2.5 ppm B with black polythene mulch, while the treatment combination M_0B_1 had minimum (3.33 g) weight of individual fruit.

Table 9: Interaction effect of different mulches and boron on yield attributing characteristics of cherry tomato

Interactions	Individual fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)
M_0B_1	1.37 e	1.10 e	3.33 f
M_0B_2	2.00 d	1.57 d	5.42 ef
M_0B_3	2.27 cd	1.77 bcd	7.08 cde
M_0B_4	2.13 cd	1.73 cd	5.83 def
M_1B_1	2.17 cd	1.73 cd	6.67 cde
M_1B_2	2.03 d	1.63 d	5.83 def
M_1B_3	2.43 abc	2.00 ab	9.17 bc
M_1B_4	2.30 bcd	1.83 bcd	8.33 bcd
M_2B_1	2.13 cd	1.73 cd	6.67 cde
M_2B_2	2.33 bcd	1.97 abc	9.17 bc
M_2B_3	2.73 a	2.20 a	12.08 a
M_2B_4	2.60 ab	2.17 a	10.83 ab
CV (%)	7.95	8.08	20.32
LSD $_{(0.05)}$	0.29	0.24	2.54

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

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.15. Total soluble solids (degrees Brix) content

4.15.1 Effect of mulches

TSS is one of the most important quality factors for most of the fruits and for TSS, a TSS of 8.0 to 17.0% indicates the highest quality of fruits to attain the optimum harvesting stage (Morton, 1987). A significant variation was recorded for mulches on total soluble solids of cherry tomato under the present trial (Appendix VII and Figure 23). In the study, highest Total soluble solids (8.96 degrees Brix) was recorded in the fruits treated with black polythene (M_2). Lowest TSS (7.28 degrees Brix) was recorded in control at harvest.

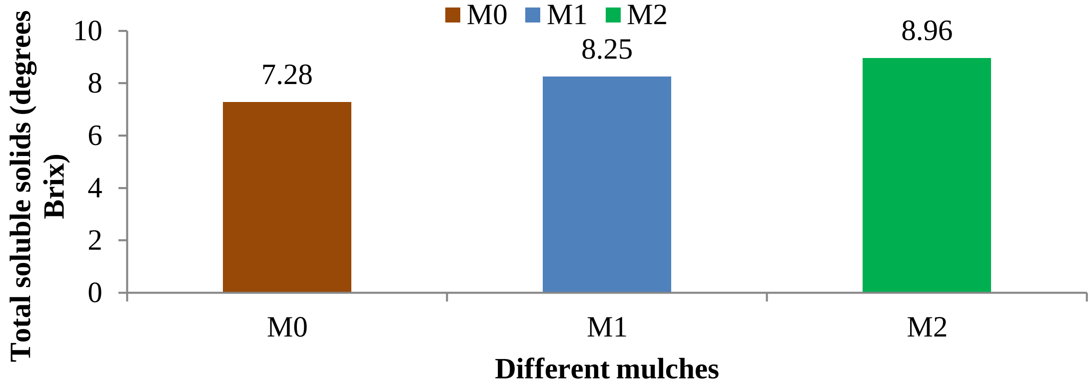

Figure 23. Effect of mulches on total soluble solids content of cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.15.2 Effect of boron

A significant variation was recorded for different doses of boron on total soluble solids of cherry tomato under the present trial (Appendix VII and Figure 24). In the study, highest Total soluble solids (8.59 degrees Brix) was recorded in the fruits treated with 2.5 ppm B (B_3). Lowest TSS (7.36 degrees Brix) was recorded from B_1 at harvest. Similar results were recorded by Singh *et al.* (2017) in cherry tomato, when the fruits treated with found 2 g B/l had highest TSS.

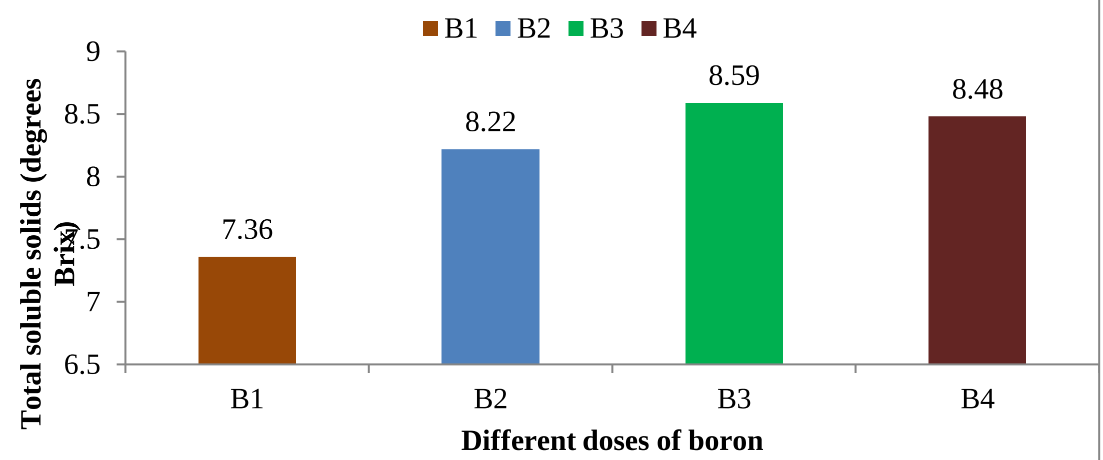

Figure 24. Effect of different doses of boron on total soluble solids content of cherry tomato

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.15.3 Combine effect of mulches and boron

The variation was found due to interaction effect of boron and mulches for the total soluble solids (TSS) of cherry tomato under the trial (Figure 25 and Appendix VII). The highest soluble solids (TSS) 9.53 (degrees Brix) was recorded from treatment combination of M_2B_3 (2.5 ppm B with black polythene mulch, while the treatment combination M_0B_1 had lowest TSS (6.4 degrees Brix).

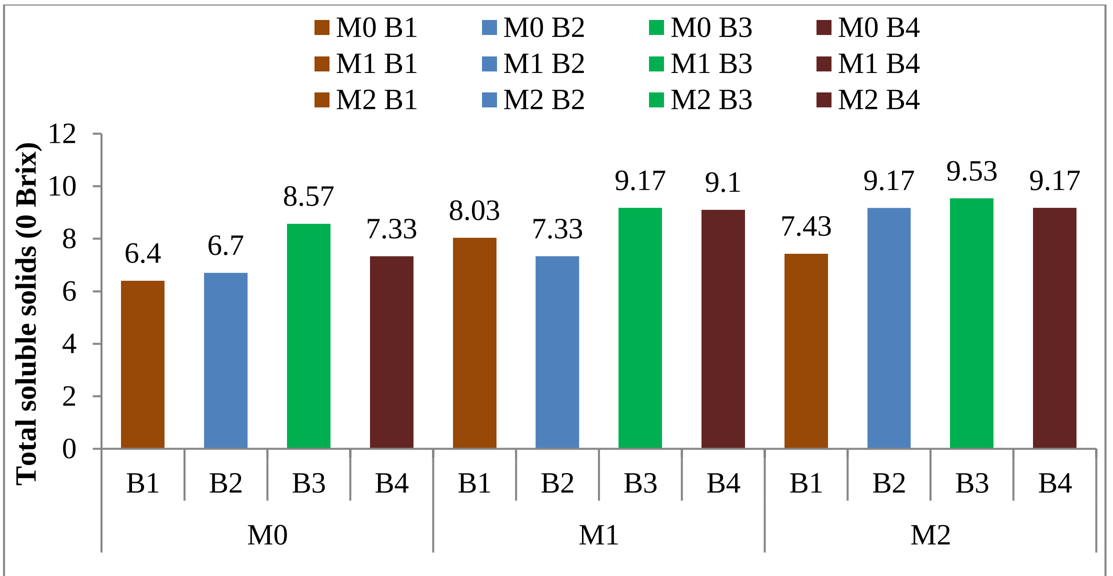

Figure 25. Interaction effect of mulches and boron on total soluble solids content of cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.16. Yield per plant

4.16.1 Effect of mulches

Yield per plant varied significantly due to the application of different mulching (Figure 26 and Appendix VII). The maximum yield per plant (2.44 kg) was recorded from M_2 treatment (Black polythene mulch) which was statistically identical with the treatment M_1 (rice straw) and the minimum yield per plant (1.92 kg) was obtained from M_0 treatment. The higher yield produced with mulch is due to conservation of moisture in the soil, increased microbial activities, hydraulic conductivity etc. and decreased fertilizers leaching and weed population. On the contrary, less vegetative growth as well as low yield was obtained from no mulch treatment. Under polythene mulch, temperature of soil was high and there was almost no weed in contrast with other mulch, resulting higher yield of tomato. Kayum *et al.* (2008) and Shampa (2008) mentioned that, the yield was higher when mulch was used and polythene mulch showed significantly higher yield of tomato.

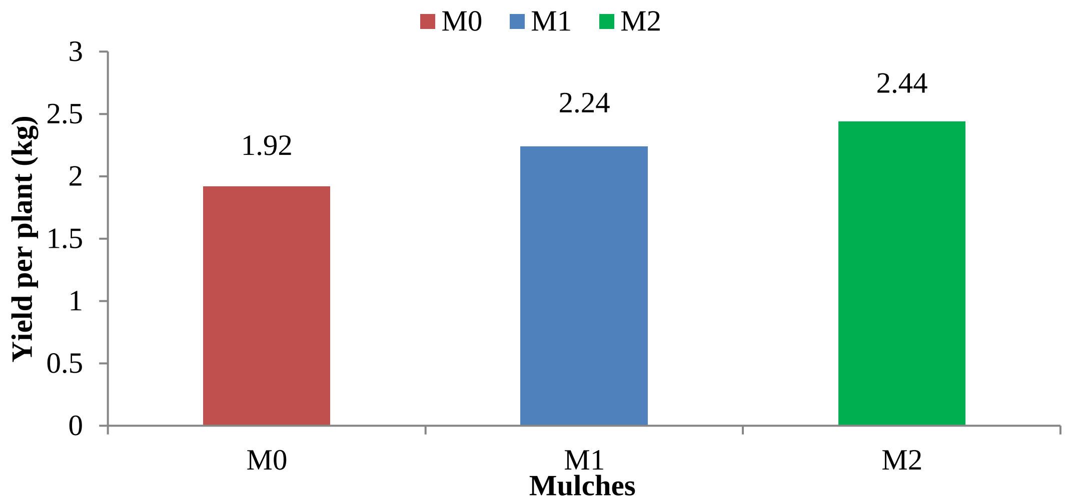

Figure 26. Effect of mulching on yield per plant (kg) in cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene]

4.16.2 Effect of different level of boron

It was observed that different levels of boron exhibited significant effect on the weight of fruits per plant (Figure 27 and Appendix VII). The weight of fruits per plant ranged from 1.60 kg to 2.63 kg. The plant fertilized with 2.5 ppm B produced the highest weight of fruits (2.63 kg) followed by 2.43 kg and 2.13 kg from 3.5 ppm and 1.5 ppm Boron, respectively. The minimum weight (1.60 kg) of fruits per plant was obtained from the B_1 (1.5 ppm B). The result clearly showed that weight of fruits per plant was increased with the increasing levels of boron except the highest level (3.5 ppm B). Azad (2007) found 1.5 kg B/ha gave the highest fruit weight per plant (1.36 kg) which was similar to the present study.

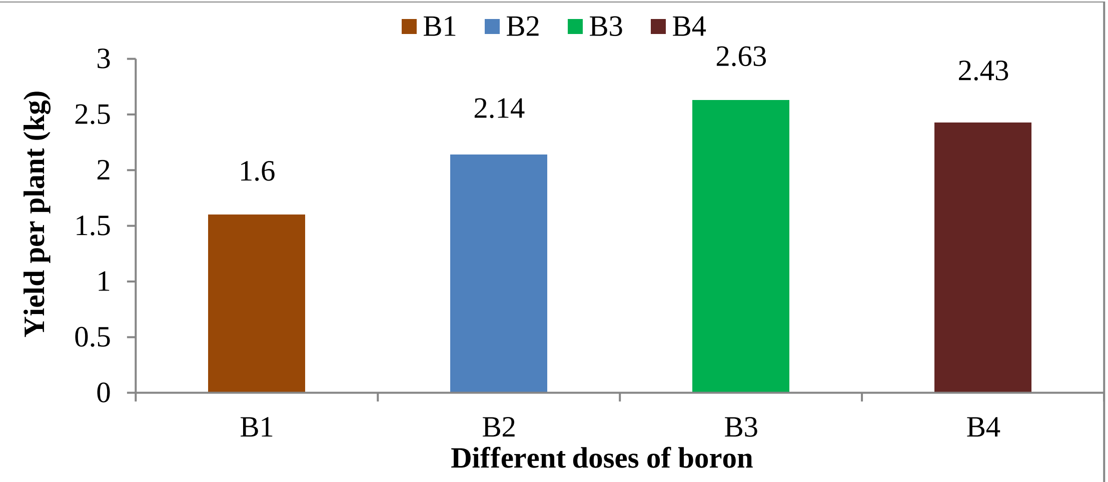

Figure 27. Effect of different level of boron on yield per plant (kg) in cherry tomato

[B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.16.3 Combine effect of mulches and boron

Combine effect of mulches and boron had a significant variation in terms of yield of fruit (Figure 28 and Appendix VII). The maximum yield per plant (3.31 kg) was recorded from M_2B_3 (2.5 ppm B with black polythene mulch), while the treatment combination M_0B_1 gave the minimum (1.27 kg).

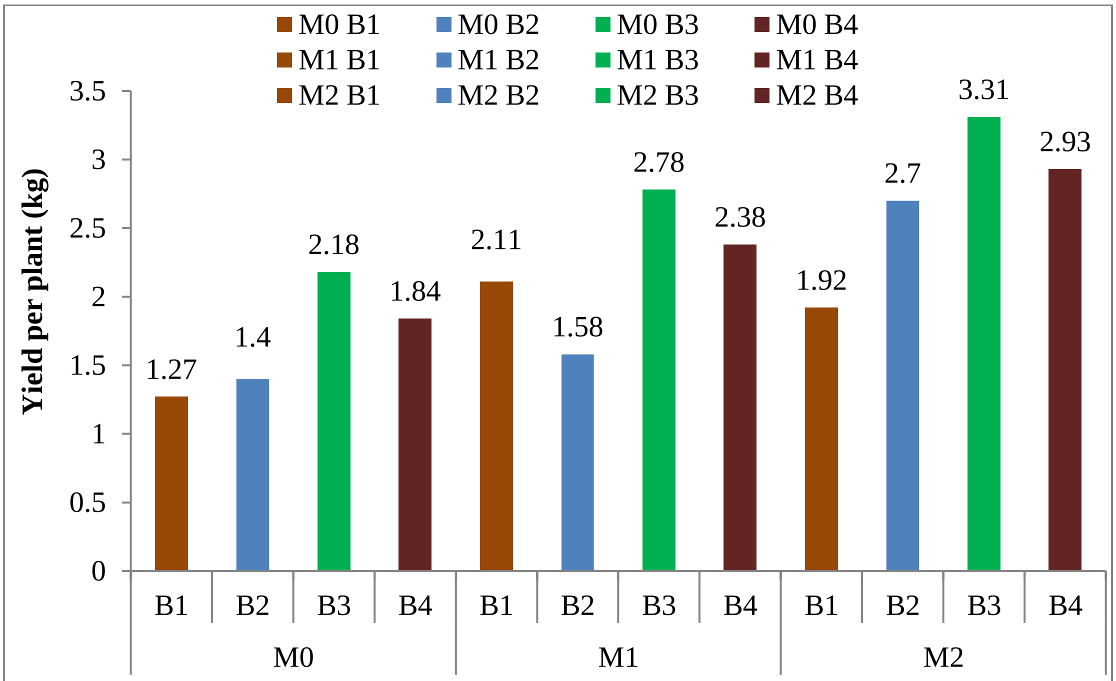

Figure 28. Combine effect of mulching and boron on yield per plant in cherry tomato

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

4.17 Economic analysis

Input costs for pot preparation, cost of seed, pot, fertilizer, pesticide, mulches materials, growing media preparation cost and manpower required for all the operation from sowing to harvesting of cherry tomato were recorded for unit pot and converted into cost per hectare. Fixed cost for all the treatment was almost same except boron and mulch materials cost. The total cost of production was the total cost of input and fixed cost. The economic analysis was done to find out the gross and net return and the benefit cost ratio in the present experiment and presented under the following headings.

4.17.1 Gross return

In the combination of boron and mulches showed different gross return under treatment combination (Table 10). The highest gross return (BDT 5560800) was obtained from the treatment combination of M_2B_3 (2.5 ppm B with black polythene mulch) and the lowest gross return (BDT 2133600) was obtained from the M_0B_1 treatment.

4.17.2 Net return

In case of net return, different treatment combination showed different types of net return. The highest net return (BDT 3907773.78) was obtained from the treatment combination of M_2B_3 (2.5 ppm B with black polythene mulch) and the lowest net return (BDT 610138.69) was obtained from the M_0B_1 treatment.

4.17.3 Benefit cost ratio

The combination of boron and mulches for benefit cost ratio was different in all treatment combination (Table 10). The highest benefit cost ratio (3.36) found in the treatment combination of M_2B_3 and the second highest benefit cost ratio (2.99) was estimated from the treatment combination of M_1B_3. The lowest benefit cost ratio

(1.40) was obtained form M_0B_1. From economic point of view, it was apparent from the above results that the treatment combination of M_2B_3 was more profitable than rest of the treatment combinations.

Table 10. Cost and return of cherry tomato cultivation as influenced by mulching and boron

Treatment combination	Cost of production (tk/ha)	Yield (kg/ha)	Gross return (tk/ha)	Net return (tk/ha	Benefit cost ration
M_0B_1	1523461.31	21336	2133600	610138.69	1.40
M_0B_2	1523938.80	23520	2352000	828061.20	1.54
M_0B_3	1524427.47	36624	3662400	2137972.53	2.40
M_0B_4	1524904.97	30744	3074400	1549495.03	2.02
M_1B_1	1561034.51	35448	3544800	1983765.49	2.27
M_1B_2	1561512.00	26544	2654400	1092888.00	1.70
M_1B_3	1562000.67	46704	4670400	3108399.33	2.99
M_1B_4	1562478.17	39984	3998400	2435921.83	2.56
M_2B_1	1652060.06	32256	3225600	1573539.94	1.95
M_2B_2	1652537.55	45360	4536000	2883462.45	2.74
M_2B_3	1653026.22	55608	5560800	3907773.78	3.36
M_2B_4	1653503.72	49224	4922400	3268896.28	2.98

[M_0= No mulch, M_1= Rice straw, M_2= Black polythene, B_1= 0.5 ppm B, B_2= 1.5 ppm B, B_3= 2.5 ppm B, B_4= 3.5 ppm B]

Market price of cherry tomato @ 100 tk/kg

Net return = Gross return-Total cost of production

Benefit Cost Ratio (BCR) = Gross return/Total cost of production

CHAPTER V

SUMMARY AND CONCLUSION

Different growth and yield parameters of cherry tomato were significantly influenced by the application of different mulch materials. At 20, 40 and 60 DAT the tallest plant (62.25 cm, 126.96 cm and 178.67 cm) was recorded from M_2 (Black polythene) and the shortest plant (47.67 cm, 96.08 cm and 125.68 cm) was found in M_0 (Mulch controlled condition). Numerically, at different days after transplanting (DAT) the maximum number of branch per plant (2.50, 3.42 and 5.25) was recorded from M_2 (Black polythene) at 20, 40 and 60 DAT, respectively and the minimum number of branch per plant (2.25, 3.42 and 4.75) was recorded from M_0 as mulch control condition. The maximum and minimum number of leaves per plant (53.50 and 39.92), highest and lowest leaflet length (29.42 cm and 22.67 cm), highest and lowest leaflet breadth (20.42 cm and 14.50 cm) was recorded in M_2 and M_0 treatment, respectively. At 25, 50 and 75 DAT and at average the maximum chlorophyll content (55.7 %, 75.21 % and 85.22 %) was recorded from M_2 (Black polythene) and the minimum chlorophyll content (44.83 %, 65.49 % and 65.38%) was found in M_0 (Mulch controlled condition). The minimum and maximum days required to first flowering (20.25 DAT and 30.17 DAT) and minimum and maximum days required to first fruiting (30.50 DAT and 44.67 DAT) was recorded in M_2 and M_0 treatment, respectively. The maximum and minimum number of flower cluster per plant (38.42 and 19.22); maximum and minimum number of fruits per plant (241.57 and 121.00); maximum and minimum weight of individual fruit (9.06 g and 5.31 g); highest and lowest amount of TSS (8.96 degrees Brix and 7.28 degrees Brix) and maximum and minimum yield of cherry tomato per plant (2.44 kg and 1.92 kg) was found in M_2 and M_0 treatment, respectively.

Different growth and yield parameters of cherry tomato were significantly influenced by the application of different doses of boron fertilizer. At 20, 40 and 60 DAT the tallest plant (59.22 cm, 127.78 cm and 180.67 cm) was recorded from B_3 (2.5 ppm B) and the shortest plant (44.89 cm, 95.78 cm and 147.72 cm) was found in B_1 (0.5 ppm B). Numerically, at different days after transplanting (DAT) the maximum number of branches per plant (2.44, 3.44 and 5.67) was recorded from B_3 (2.5 ppm B) at 20, 40 and 60 DAT, respectively and the minimum number of branches per plant (2.11, 3.33, 4.44 and 3.29) was recorded from B_1 (0.5 ppm B) condition. The maximum and minimum number of leaves per plant (53.56 and 44.78), highest and lowest leaflet length (29.89 cm and 24.00 cm), highest and lowest leaflet breadth (20.44 cm and 15.22 cm) was recorded in B_3 and B_1 treatment, respectively. At 25, 50 and 75 DAT and at average the maximum chlorophyll content (53.76 %, 86.76 % and 83.58 %) was recorded from B_3 and the minimum chlorophyll content (45.98 %, 57.01 %, and 68.33%) was found in B_1. The minimum and maximum days required to first flowering (21.33 DAT and 35.22 DAT) and minimum and maximum days required to first fruiting (30.11 DAT and 46.78 DAT) was recorded in B_3 and B_1 treatment, respectively. The maximum and minimum number of flower cluster per plant (35.56 and 24.67); maximum and minimum number of fruits per plant (256.76 and 117.33); maximum and minimum weight of individual fruit (9.86 g and 5.28 g); highest and lowest amount of TSS (8.59 degrees Brix and 7.36 degrees Brix) and maximum and minimum yield of cherry tomato per plant (2.63 kg and 1.60 kg) was found in B_3 and B_1 treatment, respectively.

Different growth and yield parameters of cherry tomato were significantly influenced by combined effect of mulches and boron fertilizer. At 20, 40 and 60 DAT the tallest plant (65.33 cm, 138.33 cm and 191.76 cm) was recorded from M_2B_3 (2.5 ppm B with black polythene mulch) treatment combination and the shortest plant (33.33 cm, 73.33 cm and 95.67 cm) was found in M_0B_1 treatment. Numerically, at different days after transplanting (DAT) the maximum number of branch per plant (2.67, 3.67 and 6.67) was recorded from M_2B_3 treatment combination at 20, 40 and 60 DAT, respectively and the minimum number of branch per plant (1.67, 3.33 and 4.33) was recorded from M_0B_1 treatment combination, respectively. The maximum and minimum number of leaves per plant (61.00 and 36.00), highest and lowest leaflet length (31.67 cm and 19.67 cm), highest and lowest leaflet breadth (20.42 cm and 10.33 cm) was recorded in M_2B_3 and M_0B_1 treatment combination, respectively. At 25, 50 and 75 DAT the maximum chlorophyll content (63.53 %, 102.33 % and 99.43 %) was recorded from M_2B_3 treatment combination and the minimum chlorophyll content (40.83 %, 47.63 % and 60.53 %) was found in M_0B_1. The minimum and maximum days required to first flowering (19.33 DAT and 43.67 DAT) and minimum and maximum days required to first fruiting (27.33 DAT and 68.00 DAT) was recorded in M_2B_3 and M_0B_1 treatment, respectively. The maximum and minimum number of flower cluster per plant (41.33 and 13.67); maximum and minimum number of fruit per plant (296.00 and 46.00); maximum and minimum weight of individual fruit (12.08 g and 3.33 g); highest and lowest amount of TSS (9.53 degrees Brix and 6.4 degrees Brix) and maximum and minimum yield of cherry tomato per plant (3.31 kg and 1.27 kg) was found in M_2B_3 and M_0B_1 treatment, respectively.

The highest gross return (BDT 5560800), net return (BDT 3907773.78) and benefit cost ratio (3.36) was obtained from the treatment combination of M_2B_3 (2.5 ppm B with black polythene mulch) and the lowest gross return (BDT 2133600), net return (BDT 610138.69) and benefit cost ratio (1.40) was obtained from the M_0B_1 treatment. Among the treatment combination of M_2B_3 was more effective for growth, yield and profitable than rest of the treatment combination.

Based on the experimental results, it may be concluded that-

i. Mulching had a positive effect on morphological characters, yield contributing characters and yield of cherry tomato. Among the mulch materials, black polythene seemed to be more promising for getting higher yield.

ii. Boron fertilizer had a positive effect on morphological characters, yield contributing characters and yield of cherry tomato. Application of 2.5 ppm of boron seemed to be suitable for higher yield, and

iii. The combined effect of mulching and different doses of boron application had a positive effect on morphological characters, yield contributing characters and yield of cherry tomato. Application of 2.5 ppm B of boron with black polythene mulch seemed to be more suitable for getting higher yield of cherry tomato.

CHAPTER VI

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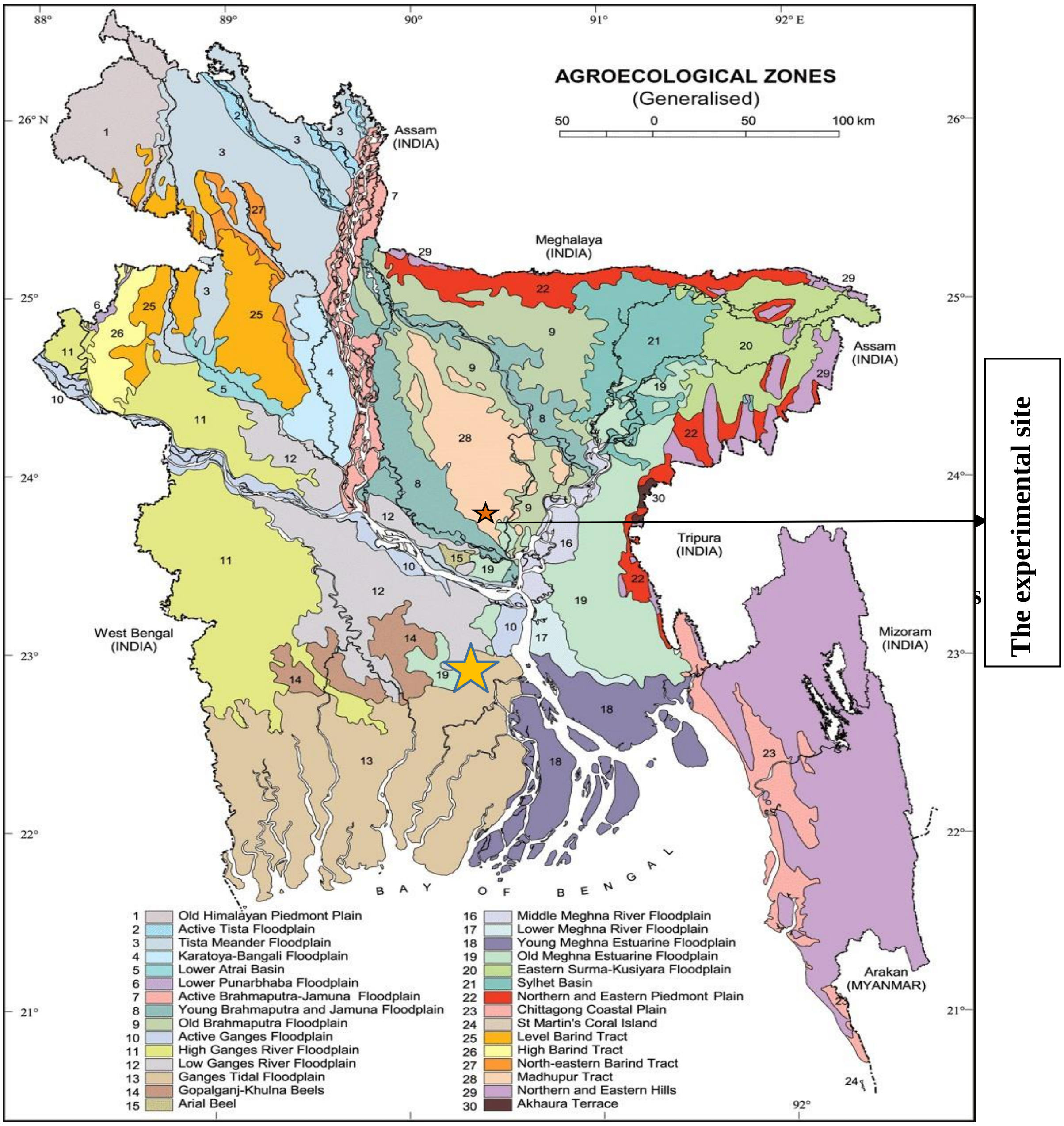
CHAPTER VII

APPENDICES

Appendix I: Map showing the experimental site



Appendix-II. Analysis of variance of data on plant height of cherry tomato at different days after transplanting

Source of variation	Degrees of freedom (df)	Mean Square of plant height (cm)		
		20 DAT	40 DAT	60 DAT
Factor A	2	669.194	2910.861	10040.361
Factor B	3	367.361	1583.481	2141.704
AB	6	137.083	538.898	909.065
Error	24	3.167	46.778	146.667

Appendix-III. Analysis of variance of data on branch per plant of cherry tomato at different days after transplanting

Source of variation	Degrees of freedom (df)	Mean Square of branch per plant		
		20 DAT	40 DAT	60 DAT
Factor A	2	0.194	0.000	0.861
Factor B	3	0.25	0.028	2.556
AB	6	0.194	0.111	1.417
Error	24	0.333	0.333	0.333

Appendix-IV. Analysis of variance of data on Leaves/Plant, Length of Leaflet and Breadth of Leaflet of cherry tomato

Source of variation	Degrees of freedom (df)	Mean Square		
		Leaves/Plant	Length of Leaflet	Breadth of Leaflet
Factor A	2	618.861	156.194	106.194
Factor B	3	130.852	53.259	41.657
AB	6	14.157	2.454	5.713
Error	24	12.444	5.972	2.528

Appendix-V. Analysis of variance of data on chlorophyll percentage of cherry tomato at different days after transplanting

Source of variation	Degrees of freedom (df)	Mean Square of chlorophyll percentage (%)		
		25 DAT	50 DAT	75 DAT
Factor A	2	371.893	296.931	1183.205
Factor B	3	119.573	1690.257	356.997
AB	6	103.785	890.341	290.679
Error	24	0.226	0.054	0.099

Appendix-VI. Analysis of variance of data on days of first flowering, days of first fruiting, flower cluster per plant, flower/plant and fruit/plant of cherry tomato

Source of variation	Degrees of freedom (df)	Mean Square				
		Days of first flowering	Days of first fruiting	Flower cluster per plant	Flower/plant	Fruit/plant
Factor A	2	368.694	620.861	1037.861	100622.25	43833.00
Factor B	3	321.657	466.917	185.667	28868.917	34509.333
AB	6	108.213	252.306	19.083	4602.917	3442.333
Error	24	22.361	26.417	14.167	1410.25	911.00

Appendix-VII. Analysis of variance of data on yield attributing characteristics of cherry tomato

Source of variation	Degrees of freedom (df)	Mean Square				
		Fruit length (cm)	Fruit diameter (cm)	Fruit weight (gm)	BRIX (%)	Yield/plant (kg)
Factor A	2	0.823	0.698	46.528	8.572	827669.444
Factor B	3	0.586	0.408	33.377	2.808	1789736.111
AB	6	0.084	0.037	1.389	2.296	1075613.889
Error	24	0.031	0.021	2.344	0.49	14444.444

Appendix VIII. Production cost of tomato per hectare

- Pot size: 0.1256 sq. m.
- Total land size: 10,000 sq. m.
- Spacing between plot: 50 cm x 100 cm
- Total cultivable area: 5041.3 sq. m.
- Spacing required for each plant: (0.6 x 0.5)=0.3 sq. m.
- Total no. of cherry tomato cultivated: 16800
- Total no. of pot required/ha: 16800
- Pot cost @ 30 tk/pcs = 504000
- Seed 200 g @ 170 tk/0.5 g = 68,000 tk
- Labour cost @ 500 tk/day
- Fertilizer cost @ 4252 tk/ha
- Irrigation cost @ 5500 tk/ha
- Polythene @ 1,15,000 tk/ha
- Rice straw cost @ 33600/ha
- Coco peat cost @ 504000/ha
- Broken bricks @ 22400/ha
- Vermicompost @ 35000/ha
- Boric Acid @ 250 tk/kg
- Rahman and Inden solution cost @ 100 tk/1 L
- Price of cherry tomato @ 100 tk/kg

A. Input cost

Treatment Combination	Pot cost (tk)	Labour cost (tk)	Seed cost (tk)	Growing media preparation (tk)	Mulch materials (tk)	Boron cost (tk)	Rahman and Inden solution cost (tk)	Sticking cost (tk)	Pesticide cost (tk)	Fertilizer cost (tk)	Irrigation cost (tk)	Miscellaneous (tk)	Sub total (tk)
M_0B_1	504000	110000	68000	561400	0	210	20000	9000	10000	4252	5500	10000	1302362
M_0B_2	504000	110000	68000	561400	0	637	20000	9000	10000	4252	5500	10000	1302789
M_0B_3	504000	110000	68000	561400	0	1074	20000	9000	10000	4252	5500	10000	1303226
M_0B_4	504000	110000	68000	561400	0	1501	20000	9000	10000	4252	5500	10000	1303653
M_1B_1	504000	110000	68000	561400	33600	210	20000	9000	10000	4252	5500	10000	1335962
M_1B_2	504000	110000	68000	561400	33600	637	20000	9000	10000	4252	5500	10000	1336389
M_1B_3	504000	110000	68000	561400	33600	1074	20000	9000	10000	4252	5500	10000	1336826
M_1B_4	504000	110000	68000	561400	33600	1501	20000	9000	10000	4252	5500	10000	1337253
M_2B_1	504000	110000	68000	561400	115000	210	20000	9000	10000	4252	5500	10000	1417362
M_2B_2	504000	110000	68000	561400	115000	637	20000	9000	10000	4252	5500	10000	1417789
M_2B_3	504000	110000	68000	561400	115000	1074	20000	9000	10000	4252	5500	10000	1418226
M_2B_4	504000	110000	68000	561400	115000	1501	20000	9000	10000	4252	5500	10000	1418653

B. Grand total cost of production

Treatment Combination	B. Cost of lease of land for 6 months (Tk 120000/year)	Sub-total cost of production (A+B)	Interest on running capital for 6 months (tk. 13% of cost /year)	Total cost (A+B+C) tk	Miscellaneous cost (tk 5% of the input cost)	Grand total cost of production
M_0B_1	60000	1362362	88553.5	1450916	72545.78	1523461.31
M_0B_2	60000	1362789	88581.3	1451370	72568.51	1523938.80
M_0B_3	60000	1363226	88609.7	1451836	72591.78	1524427.47
M_0B_4	60000	1363653	88637.4	1452290	72614.52	1524904.97
M_1B_1	60000	1395962	90737.5	1486700	74334.98	1561034.51
M_1B_2	60000	1396389	90765.3	1487154	74357.71	1561512.00
M_1B_3	60000	1396826	90793.7	1487620	74380.98	1562000.67
M_1B_4	60000	1397253	90821.4	1488074	74403.72	1562478.17
M_2B_1	60000	1477362	96028.5	1573391	78669.53	1652060.06
M_2B_2	60000	1477789	96056.3	1573845	78692.26	1652537.55
M_2B_3	60000	1478226	96084.7	1574311	78715.53	1653026.22
M_2B_4	60000	1478653	96112.4	1574765	78738.27	1653503.72

Plate

Plate 1. Growing media and cherry tomato plant after transplanting

Plate 2. Interculture opearation

Plate 3. Immature and mature fruit cluster

Plate 4. Data collection

Plate 5. Ist harvested cluster of cherry tomato