EFFECT OF STEM PRUNING AND ELECTRICAL CONDUCTIVITY ON GROWTH AND YIELD OF HYDROPONIC CAPSICUM

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CERTIFICATE

This is to certify that the thesis entitled ***"EFFECT OF STEM PRUNING AND ELECTRICAL CONDUCTIVITY ON GROWTH AND YIELD OF HYDROPONIC CAPSICUM "*** *submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in HORTICULTURE****, embodies the result of a piece of bona fide research work carried out by* ***MOST. ZANNAT ZAKIA,*** *Registration No.* **11-04396** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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ABSTRACT

Stem pruning of the plants and electrical conductivity (EC) of the nutrient solution are the most important factors for producing high quality fruit of capsicum in hydroponic system. Therefore, the present research work was aimed to identify a suitable stem pruning system and optimum level of EC in the nutrient solution for capsicum production in hydroponic system. Treatments considered two factors, viz., three types of stem pruning (S_1: No pruning; S_2: Two branches present and S_3: Four branches present) and four EC levels (EC_1: 2.0 dS/m; EC_2: 3.0 dS/m; EC_3: 4.0 dS/m and EC_4: 5.0 dS/m). The experiment was conducted in a Randomized Completely Block Design with three replications. Growth, yield and physiological parameters of capsicum were measured. In case of stem pruning, the highest plant height, number of fruit per plant, individual fruit weight, fruit length, fruit diameter, fruit yield (1406.59 g/plant), ascorbic acid and physiological traits (net assimilation ratio and relative growth rate) were found in S_2 while the lowest in S_1. In case of EC, the highest plant height, number of fruit per plant, individual fruit weight, fruit length, fruit diameter, fruit yield (1395.39 g/plant), ascorbic acid and physiological traits (net assimilation ratio and relative growth rate) were found in EC_3 while the lowest in EC_1. In case of Interaction effect, the highest plant height (104.83 cm), number of fruit per plant (12), individual fruit weight (190.83 g), fruit yield (2113.17 g/plant), fruit length (9.47 cm), fruit diameter (8.03 cm), fruit volume (220.70 CC), ascorbic acid content (202.03 mg/100g FW) were found in S_2EC_3 while the lowest in S_1EC_1. Therefore, it can be concluded that remain two stem and electrical conductivity of 4.0 dS/m can be used for producing higher yield and high quality of capsicum in hydroponic system.

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LIST OF ABBREVIATED TERMS

DAT	=	Days after transplanting
DAF	=	Days after flowering
DAS	=	Days after sowing
SAU	=	Sher-e-Bangla Agricultural University
EC	=	Electrical conductivity
LA	=	Leaf area
LAR	=	Leaf area ratio
LDW	=	Leaf dry weight
LMR	=	Leaf mass ratio
RDW	=	Root dry weight
RWR	=	Root weight ratio
df	=	Degree of freedom
ANOVA	=	Analysis of Variance
FW	=	Fresh weight
BCSIR	=	Bangladesh Council of Scientific and Industrial Research

CHAPTER I

INTRODUCTION

Capsicum (*Capsicum annuum* L.) is an economically important crop belonging to the family solanaceae and is self-crossing annual crop. Capsicum has high demand both in local and export market. The fruits contain capsaicinoids that give them the characteristic pungent taste. Capsaicin and dihydrocapsaicin, the two major capsaicinoids, are responsible for up to 90% of the total pungency of pepper fruits. Capsaicinoids are currently used in the food industry, for medical purposes as pharmaceuticals, and in defensive sprays. At immature stage, capsicum is green and turn into red, gold, purple, orange as they ripen. Because, sugar content increases as they ripen, colored peppers tend to be sweeter than green peppers. Capsicum are rich sources of antioxidants and vitamin C. Capsicum is a high value crop and rich in vitamins, particularly provitamin A, vitamin B, vitamin C and minerals such Ca, P, K and Fe (*Malik et al., 2011*). The level of carotene, like lycopene, is nine times higher in red peppers. Red peppers have twice the vitamin C content than green peppers. Red bell peppers are a great source of vitamin B6 and folate. Vitamins B6 and folate can help prevent anemia. Red bell pepper is high in vitamin A, which helps to support healthy eyesight, especially night vision. (University of the District of Columbia, Center for Nutrition, Diet and Health, 2013.)

If capsicum grow in the open field need more (extensive) labor and a high cost of agrochemicals to assure good yield and quality. Again, capsicum attack more pests diseases such as viral disease is more common for capsicum crop in the field. For theses reason fruit production and fruit quality hampered. Cultivation of plant without soil gives more production in less time, allows growing plant more densely with balanced supply of proper water and nutrient where the products are more resistant to diseases and natural or biological control can be easily employed to it. Moreover, soil born pests and diseases can be easily eliminated easily through the soil less cultivation. Troublesome weeds can be avoided by this cultivation (Munoz *et al.*, 2010). Soilless growing is becoming an attractive option because of the unpredictable problems of soil due to fluctuating temperatures, moisture holding capacity, obtain ability of nutrients, salinity, root aeration, undesirable microbial activities and nematode, disease and pest to overcome these problems with soilless.

Hydroponic crop production has significantly increased in recent years worldwide is the growing of plants in a soilless medium or an aquatic based environment. Hydroponic growing uses mineral nutrient solutions to feed the plants in water without soil. Hydroponics has proved to be an excellent alternative crop production system (Savvas, 2003). Furthermore, hydroponic production increases crop quality and productivity, which results in higher competitiveness and economic incomes. Hydroponics is a suitable system of growing crops in which space, fertilizer and labor are efficiently used. A hydroponic system enables a considerable reduction of fertilizer application and a drastic restriction or even a complete elimination of nutrient leaching from greenhouses to the environment (Avidan, 2000).

Yield variation may be occurred due to variation in cultural practices. Stem pruning is one of the most important factors. Yield per unit area appears to increase to certain maximum as plant density increases and then declines (Akintoye *et al.*, 2009). Researchers have reported an increase in yield of sweet peppers with increase in plant population (Stoffella and Bryan, 1988; Lorenzo and Castilla, 1995; Cebula, 1995; Jovicich *et al.*, 1999). Optimum plant spacing may help in proper utilization of land and for obtaining good quality fruits. Deleafing and stem pruning are sometimes performed only twice a month. On capsicum plants, a decrease in height, leaf area and yield were also observed when plants were submitted to frequent mechanical measurements on leaves and fruits (length, diameter) in comparison with plants which were never measured (Klaering, 1998). On the other hand, stem pruning also may influence on the production of yield. Capsicum has a shallow root system (Ikiz et al., 2009) and according to Jovicich *et al.* (2004) removal of the first two flowers and stem enhances root development which subsequently improves vegetative growth before fruit set. It is further stated that a well-developed root system with improved vegetative growth will improve fruit bearing and fruit size. Poor root development may lead to insufficient nutrient and water uptake, which, subsequently, will affect yield and quality of sweet pepper. Pruning to two or three stems was reported to be effective in increasing yield and reducing fruit size of cherry tomatoes to a more acceptable marketable size (Maboko and Du Plooy, 2008).

In hydroponics, nutrient solution is one of the important factors. The three main things are important as the alkalinity, the electrical conductivity (EC) and the concentration specific elements in the nutrient solution for success of hydroponic system.

Pepper has been considered to be a salt sensitive species (Maas and Hoffman, 1977) with a threshold of 1.5 dS m^{-1} and a slope of 14% per dS m^{-l} in the statured extract of soils. Post and Klein-Buitendijk (1996) found a reduction of 5% in total yield with 11 mM NaCl. However, Chartzoulakis and Klapaki, (2000) observed that salt tolerance of pepper was cultivar dependent. In this experiment, we found reductions of 23% (sulphate treatment) and 15% (chloride treatment) with 3 dS m^{-1}, which could indicate that new commercial varieties are more sensitive to salinity than older ones. Salinity decreased total yield by reducing fruit size. Similar results were found with cultivars of Lamuyo and Sonar (Chartzoulakis and Klapaki, 2000), where a reduction in size was observed when the EC of irrigation water was above 4.1 dS m^{-1}; the number of fruits was reduced only with water above 7.1 dS m^{-l}. However, with respect to marketable fruit, sulphate treatments produced higher yield than chloride treatments at 3, 4 and 6 dS m^{-l}.

The main cause of the salinity-induced increase in unmarketable fruits was the increased incidence of blossom-end rot (BER). Blossom-end rot in pepper is the symptom of a physiological disorder caused by local calcium deficiency during the initial stage of fruit development (Morley, 1996).

Again, hydroponic is new technology for our country. Nowadays population is increasing day by day in our country for this reason cultivable land reduced.

So, hydroponic or soilless culture is the best technology for our country for successful pepper production. Furthermore, increasing salt in coastal area for global warming in our country and hydroponic can be a suitable climate smart agriculture technology for the coastal and hoar areas. Despite the considerable advantages of commercial hydroponics, there are still some disadvantages, which restrict the further expansion of soilless cultivation. Nowadays principal disadvantages of hydroponics relative to conventional open-field agriculture are the high costs of capital and energy inputs and the high degree of management skills required for successful production. Therefore, development a simple a low cost hydroponic system with a suitable stem pruning and electric conductivity for capsicum are needed to produce high quality fruits in Bangladesh.

Considering the above mentioned facts, the present research work was aimed to study with the following objectives:

- To identify a suitable stem pruning system in capsicum and
- To determine a suitable electrical conductivity value for capsicum production in hydroponic system in Bangladesh.

CHAPTER II

REVIEW OF LITERATURE

Very few studies on the growth and yield of capsicum in hydroponic system have been carried out in our country. Therefore, the research work so far done in Bangladesh is not adequate and conclusive. Nowadays, a wide variety of capsicum and leafy vegetables can be successfully grown in hydroponic systems. An appropriate stem pruning system and electrical conductivity are necessary to produce a high-quality crop.

Some of the research findings related to the growth and yield of hydroponic capsicum as influenced by stem pruning and electrical conductivity far have been reviewed here.

Malik *et al.* (2011) reported that the growth, yield and fruit quality of sweet pepper hybrid SH-SP-5 (*Capsicum annuum L.*) was affected by integration of inorganic fertilizers and organic manures (FYM) which carried out at two locations of Experimental Farm of the Division of Olericulture, SKUAST-K, Shalimar and Regional Research Station, Faculty of Agriculture, Wadura (Sopore), during Kharif 2007. Observations were recorded on growth, yield, and fruit quality. Under both locations, Treatment 9 (N=150 kg ha-1; P_2O_5 = 120 kg ha^{-1}; K_2O = 60 kg ha-1; FYM = 40 t/ha) proved better to improve the growth and yield attributing traits than other treatment combinations. Maximum plant height (55.65 cm), number of branches (6.61), plant spread (44.50 cm), fruit length (8.30 cm), fruit diameter (8.00 cm) were recorded in treatment T9. The highest fruit yield (686.39 kg/ha) was recorded in treatment T9, and followed by T8 (670.26 kg/ha). The treatment T9 also exhibited the highest fruit quality in terms of vitamin-C (243.34 mg/100g), total chlorophyll content (732.66 mg/100 g), dry matter content (9.93 g/100 g), nitrogen (4.38%), phosphorus (0.46%) and potassium (3.65%) in fruit.

Samarakoon *et al*. (2006) reported that the EC values for hydroponic systems range from 1.5 to 2.5 d/ms. Higher EC hinders nutrient uptake by increasing osmotic pressure, whereas lower EC may severely affect plant health and yield.

Jovicich *et al*. (1999) reported that the greenhouse crops, fruit yield and quality can be increased by managing shoot pruning and plant density. The effect of plant population density (2, 3 and 4 plant·m^{-2}, as function of in-row plant spacing: 66.5, 44.3 and 33.3 cm, respectively), and shoot pruning (1, 2 and 4 main stems) was studied for effects on fruit yield, fruit quality and plant growth of greenhouse grown sweet pepper (*Capsicum annuum L*. cv. Robusta) during Summer 1998 in Gainesville, Florida. Plants were grown in perlite bags and irrigated with a nutrient solution. Red fruits were harvested 84 and118 days after transplanting (Apr. 14th). Additional fruit set was inhibited due to the high temperatures. Marketable yield (number and weight) per m2 increased linearly with plant density and was greater on plants with four stems than in those with two or one stem. Extra-large fruit yield per m^2 was not affected by plant density but was higher in four-stem plants. Total marketable yield and extra-large fruit yields per plant were greatest in the four-stem plants at 2 plant·m^{-2}. The stem length and the number of nodes per stem increased linearly with the decrease in plant spacing. Stem length and number of nodes per stem were greater in single-stem than in four-stem plants. Number and dry weight of leaves, stem diameter, and total plant dry weight were higher in four and two than in single-stem plants. Total stem weight in four-stem plants increased linearly with the decrease of plant density. Results indicated that 4 plant•m^{-2} pruned to four stems increased marketable and extra-large fruit yield in a short harvest period of a summer greenhouse sweet pepper crop in North central Florida.

Lorenzo and Castilla (1995) studied that two-bell pepper (*Capsium amnuum* cv. Clovis) plant densities (2.0 and 3.2 plants.m-2) were compared in unheated plastic greenhouse in a sand mulched soil, along the autumn-winter cycle in Almeria (Spain). The higher values of leaf area index (LAI) in the high-density treatment generated better radiation interception, inducing significantly higher total (6.13 vs. 4.78 kg.m^{-2}), commercial (5.68 vs. 4.39 kg. m^{-2})abd first quality (3.82 vs. 3.04 kg. m^{-2}) yields. The differences in radiation, around the winter solstice, between different zones of the greenhouse (quantified in a complementary trial) induced differences in pepper yields.

Maboko and Du Plooy (2008) studied that the commercial importance of cherry tomatoes is continuously increasing in the South African retail market, with fruit size playing an important role. The effect of pruning on yield and quality of two cherry tomato cultivars (Naomi and Josefina) with an indeterminate growth habit were investigated in an open bag hydroponic system at ARC-VOPI (25° 59'S ; 28° 35'E) Pretoria. The plants were subjected to three pruning treatments (one, two and three stems) in a complete randomized block design with three replications. Fruit were harvested at the full ripe stage and the fruit number, size and mass, marketable yield and total yield, as well as the total soluble solids (%Brix), were determined for all treatments. An increase in fruit size was evident in plants pruned to a single stem compared to plants pruned to two or three stems in both cultivars. The yield of plants increased with an increase in the number of stems. Cultivar Josefina had a significantly higher marketable yield compared to cultivar Naomi. Regardless of cultivar, pruning to two or three stems was effective in increasing yield and reducing fruit size to a size which is currently more acceptable to the market.

Stoffella *and Bryan.* (1988) studied that bell pepper (*Capsicum annuum* L. cv. Early Calwonder) were plug-mix seeded at 13-, 25-, 38-, and 51-cm within-row spacing in two rows on raised beds and thinned to one, two, or three plants per hill upon emergence. The experiments were conducted on commercial pepper fields located in southern Florida during the Winter 1983 and Spring 1984 seasons. Populations ranged from 21,527 to 258,328 plants/ha. Plant growth characteristics were measured at anthesis and just before the final harvest in each experiment. Root and shoot weights, shoot: root ratios, and stem diameters generally decreased and plant heights generally increased in response to higher plant populations. The lower shoot: root ratios at higher plant populations indicated that plants were producing more root mass in proportion to shoot mass than plants at lower populations. Numbers of primary and secondary branches per plant in the two experiments averaged 2.7 and 5.3, respectively, and were generally not influenced by plant populations. Marketable fruit yields/ha increased linearly in response to higher plant populations. Marketable fruit number and weight per plant decreased with higher plant populations, whereas fruit size (g/fruit) was unaffected. This observation suggested that the higher marketable yields/ha at higher plant populations were attributed to more plants with a lower number of similarly sized fruits per plant. The 25-cm within-row spacing with two plants per hill resulted in 81

Maboko *et.al* (2012) was conducted in 2009/2010 and 2010/2011 to investigate the effect of plant population, flower and stem pruning of hydroponically grown peppers in a 40% (black and white) shade net structure at the ARC-Roodeplaat VOPI. The research was done in an open bag hydroponic system with sawdust as growing medium. Pepper plants were subjected to three plant populations (2, 2.5 and 3 plant/m^2), three stem pruning treatments (2, 3 and 4 stems) and three flower pruning treatments (removal of first two or first four flowers or zero flower removal). Experimental layout was a randomized block design with two replicates. Sweet pepper fruits were harvested at a mature green stage. Data was collected on ten plants determining fruit number, fruit mass, unmarketable yield, marketable yield and total yield for all treatments. Stem pruning to four stems without removing any flowers at a plant population of 3 plants/m^2 resulted in the highest yield and quality. Pruning the first two or four fruits seemed to have no significant influence on yield. Results showed that sweet pepper yield and quality can be effectively manipulated by plant population and stem pruning, while flower pruning had insignificant ($p<0.05$) effect.

Aminifard *et al.* (2010) was conducted to determine the effects of different plant densities (20x50 cm, 30x50 cm, 20x100 cm, 30x100 cm) on plant growth characteristics and fruit yield of paprika pepper (*Capsicum annum L.*) in open field. Plant height, leaf chlorophyll content, flower number, yield, fruit seed number, 1000 seed weight and vitamin C were assessed at immature and mature. The results indicated that vegetative growth characteristics (plant height, lateral stem length and leaf chlorophyll content) reduced as plant density increased. The highest lateral stem number and leaf number were obtained in plants density 30x100 cm. Plant density affected on flowering factors (node number to first flower, days to 1st flowering and flower number). The days to 1st flowering increased as plant density increased. It was observed that fruit volume, fruit average weight, plant yield and seed number decreased with increasing plant density, but total yield/ha increased with increasing plant density. The highest and lowest of yield/ha were obtained by 20x50 cm and 30x100 cm spacing, respectively. Also plant density significantly affected on Vitamin C. The highest and lowest vitamin C were observed in 30x100 cm and 30x50 cm spacing, respectively.

Cebula (1995) reported that the aim of the experiment effectuated at the company SC Cristal Lux SRL from Bălan commune, Sălaj County, Romania, was to establish the best plant density and plant directing method for bell peppers cultivated in plastic tunnel. A bifactorial experience has been organized: Factor A = plant density, with: a 1 – 30000 plants/ha; a 2 – 40000 plants/ha; Factor B = shoots pruning method, with: b 1 – pruned with 2 shoots; b 2 – pruned with 3 shoots. By factors combination 4 experimental variants resulted. Plants density has affected both the early and the total yield. A density of 40000 plants/ha assured a significant yield increase comparative with 30000 plants/ha. The pruning method has influenced neither early nor total yield. Under the combined influenced of both factors the best results have been obtained by variant III (40000 plants/ha, 2 shoots) and variant IV (40000 plants/ha, 3 shoots) for both the early and the total yield.

Akintoye *et al*. (2009) reported that there is an increase in demand for watermelon (*Citrullus lanatus L.*) in Nigeria. Information is needed on how to maximize yield. Field trials were conducted in 2006 and 2007 to evaluate the performance of watermelon cvs. Sugarbaby and Kaolack at four planting densities in Ilesha, Ibadan, and Dogondawa representing the forest, derived Savanna (transitional zone between the forest and Guinea savanna), and the Guinea Savanna ecological zones of Nigeria, respectively. Cultivars responded differently to planting density with respect to fruit yield, with ‘Sugarbaby’ producing higher yields, 6.35 and 12.93 $Mt \cdot ha^{-1}$ in Ilesha and Ibadan, respectively, whereas ‘Kaolack’ produced higher yields (23.85 $Mt \cdot ha^{-1}$) in Dogondawa. Generally, the forest ecology had the lowest fruit yield when compared with Savanna ecologies. Differences in fruit yield existed among the ecologies due to planting density, with llesha having the highest yield at 11,111 $plants \cdot ha^{-1}$. Highest yield was at 14,815 $plants \cdot ha^{-1}$ in Ibadan and Dogondawa. Average fruit weight decreased with increased planting density. Density response appears to be location dependent and producers should plant watermelon at optimum plant population density as determined by experimental results in each ecological zone of Nigeria.

Navarrete and Jeannequin (2000) reported that greenhouse tomato crops, several manual operations are performed each week to keep the plants in optimal growth conditions. But growers are trying to reduce labour costs by spacing out the manual operations. An experimental study was conducted on one particular operation, axillary bud deshooting. The aim is to determine the effect of the deshooting frequency on vegetative growth and fruit yield, in order to help growers to determine the optimal frequency. The trials were conducted in an experimental station in AleÂnya (south France). Four deshooting frequencies were compared on two cultivars: every 7 (control), 10, 14 and 21 days. Deshooting frequency affected both vegetative growth and yield: when deshooting was performed seldom (every 21 days), the stem diameter and the vigour scored by experts were decreased; the number of fruits per m^2 was also reduced, leading to a signi®cantly lower yield. Moreover, the harvest started later than on the control. When the axillary buds were eliminated frequently (7 days), even those located near the apex, it reduced vegetative growth, but not yield. Therefore, from a biological point of view, the optimal deshooting frequency lies between 7 and 14 days, probably depending on climate, season and cultivar vigour.

Hell *et al.* (2013) reported that the temperature of the nutrient solution influenced the behavior of sweet pepper changing the electrical conductivity (EC). They found that the increased in EC did not reduce sweet pepper productivity when the maximum temperature of the nutrient solution was limited at 26^{o}C. They also found that cooling of the nutrient solution provided greater accumulation of biomass and higher water content in plants, increasing the productivity of hydroponic sweet pepper in the tropics.

Dyśko *et al.* (2008) studied that in the root zone this element can be found as PO_4^{3-}, HPO_4^{2-}, and $H_2PO_4^-$ ions; the last two ions are the main forms of P taken by plants. On inert substrates, the largest amount of P available in a nutrient solution is presented when its pH is slightly acidic (pH 5). In alkaline and highly acidic solutions the concentration of P decreases in a significant way.

Urrestarazu and Mazuela (2005) studied that the pH value determines the nutrient availability for plants. Accordingly, its adjustment must be done daily due to the lower buffering capacity of soilless systems.

Tyson *et al.* (2007) in a study to determine the nitrification rate response in a perlite trickling biofilter (root growth medium) exposed to hydroponic nutrient solution, varying NO_3^- concentrations and two pH levels (6.5 and 8.5), founded that nitrification was significantly impacted by water pH. The increased ammonia oxidation rate (1.75) compared to nitrite oxidation rate (1.3) at pH 8.5 resulted in accumulation of NO_2^- to levels near those harmful to plants (observed peak of 4.2 mg L^{-1} NO_2^-). The potential for increased levels of unionized ammonia, which reduced plant nutrient uptake from micronutrient precipitation, are additional problems associated with pH 8.5.

Marschner (1995) concluded that an important feature of the nutrient solutions is that they must contain the ions in solution and in chemical forms that can be absorbed by plants, so in hydroponic systems the plant productivity is closely related with to nutrient uptake and the pH regulation.

Alasadon *et al.* (2013) Pruning system plays a key role in efficient use of production area inside protected structures. Cultivars were grown under greenhouse conditions in drip fertigated soil culture and plants were pruned leading to one main branch, two and four side branches. Vegetative growth, yield and quality traits were affected by cultivars or pruning systems and their interactions. Pepper plants pruned to one branch resulted in a significant increase in early yield, fruit size and internal fruit quality with a decrease in total fruit yield followed by plants pruned to two branches. However, plants pruned to four branches produced the highest yield, due to higher number of fruits plant-1. The best fruit number and total yield were obtained by pruning 'Pasodoble' F1 plants to 4 branches. On the other hand, pruning 'Lirica' F1 plants to one branch improved fruit weight, fruit size and gave thicker flesh width. Regarding to fruit quality traits; 'Sondela' F1 red pepper, especially under one branch pruning system represented a vital source of vitamin C.

Bergquist *et al.* (2007) reported that the nutrient composition determines electrical conductivity and osmotic potential of the solution.

Garceäs-Claver *et al.* (2006) produced sweet pepper in stationary (trough) culture of hydroponics successfully under tropical greenhouse conditions (38.5^{o}C). A solution concentration of 0.5 g/L of Albert’s solution (having an EC of l.4 dS/m) with renewal at 2-weeks intervals could be identified as the best fertigation strategy under hot and humid conditions. Increasing solution concentrations above that level up to 2dS/m increased the plant uptake of N, P, K and Ca but, without a significant increase in leaf growth and yield.

Fanasca *et al.* (2006) reported that Iron, copper, zinc, boron, and manganese, become unavailable at pH higher than 6.5 in nutrient solution of Hydroponic system.

De Rijck and Schrevens (1998a) studied that the pH is a parameter that measures the acidity or alkalinity of a solution. This value indicates the relationship between the concentration of free ions H^+ and OH^- present in a solution and ranges between 0 and 14. Changing the pH of a nutrient solution affects its composition, elemental speciation and bioavailability. The term “speciation” indicates the distribution of elements among their various chemical and physical forms like: free ions, soluble complexes, chelates, ion pairs, solid and gaseous phases and different oxidation states.

De Rijck and Schrevens (1998b) conveyed that the pH is a parameter that measures the acidity or alkalinity of a solution. This value indicates the relationship between the concentration of free ions H^+ and OH^- present in a solution and ranges between 0 and 14 exchanges the pH of a nutrient solution affects its composition, elemental speciation and bioavailability. The term “speciation” indicates the allocation of elements among their various chemical and physical forms like: free ions, soluble complexes, chelates, ion pairs, solid and gaseous phases and different oxidation states.

De Rijck and Schrevens (1999) reported that each nutrient on sweet pepper shows differential responses to changes in pH of the nutrient solution as described below. In the nutrient solution, NH_3 only forms a complex with H^+. For a pH range between 2 and7, NH_3^+ is completely present as NH_4^+. Increasing the pH above 7 the concentration ofNH_4^+ decreases, while the concentration of NH_3^+ augments.

Epstein (1994) reported that Silicon application in hydroponic systems has been reported beneficial on growth, yield, and also disease resistance of some crops.

Saparamadu (2008) reported that Si concentration leached into water by rice hull and sand mixture (1:1 v/v) was increased up to 92 ppm within a period of 17 weeks while K, P and N were not increased more than 6 ppm which shows that rice hull is a cheap natural source of Si.

Ghehsareh (2013) reported some physicochemical properties of rice hull media such as porosity (73%), water holding capacity (88%), bulk density (0.09 g/cm^3), organic matter content (88.52%), electrical conductivity (2.24 ds/m) and pH (6.2).

Zeiger and Taiz (1998) studied that an essential element of nutrient solution for hydroponic sweet pepper have physiological role and its absence prevents the complete plant life cycle.

Ayers and Westcot (1987) found that as water naturally contains HCO_3^-, this anion turns into CO_3^{2-} when the pH is higher than 8.3 or to H_2CO_3 when it is less than 3.5; the H_2CO_3 is in chemical equilibrium with the carbon dioxide in the atmosphere.

Steiner (1984) found that at a pH above 8.3, Ca^{2+} and Mg^{2+} ions easily precipitate as carbonates (Also, as mentioned above, when the pH of the nutrient solution increases, the HPO_4^{2-} ion predominates, which precipitates with Ca^{2+} when the product of the concentration of these ions is greater than 2.2, expressed in mol m^{-3}.

Hansen (1978) reported that the addition of plant nutrients to hydroponic systems may be performed according to the plant nutrient requirement. Application of nutrients may be performed according to analyses of a specific crop stage that may describe the consumption of the various typical nutrients of the particular crop or by means of analyses of the total plant needs quantitatively adjusted to the rate of growth and the amounts of water supplied.

Steiner (1966) reported that a nutrient solution for hydroponic systems is an aqueous solution containing mainly inorganic ions from soluble salts of essential elements for higher plants. Eventually, some organic compounds such as iron chelates may be present.

Okafor and Okonkwo (2009) reported that rice husk is an agricultural by-product which is poorly utilized. More than 100 million tons of rice hull is generated annually in the world.

Saparamadu *et al.* (2008) reported that simplified hydroponics system which consisted rice hull:river sand (3:2 v/v ratio) medium enhanced growth of bush beans and tomato.

Patel *et al.* (1987) found that the Si content in raw rice husk is 10.3 (wt%).

Michael and Lieth (2008) studied that total pore space for most growing media is 1.5 – 2.8 times higher than the values found for common soils (about 35 per cent V/V) and increase in total pore space will often decrease the water retention, increase oxygen transport and increase root penetration. These, in turn, will influence plant growth.

Jayawardana *et al. (*2016) concluded that the simplified hydroponic system composed of rice hull, as a natural silicon supplement could be used as a low-cost environmentally friendly growing method of capsicum to enhance resistance against anthracnose disease, and to improve plant growth and fruit quality.

Saparamadu (2008) reported that concentration of Si leached by rice hull was increased with time while concentration of Si leached by sand was lower and was not increased with time.

Trejo-Téllez *et al*. (2007) reported that with the exception of carbon and oxygen, which are supplied from the atmosphere, the essential elements are obtained from the growth medium. Other elements such as sodium, silicon, vanadium, selenium, cobalt, aluminum and iodine among others, are considered useful because some of them can incite the growth, or can compensate the toxic effects of other elements, or may replace essential nutrients in a less specific role. The most basic nutrient solutions consider in its composition only nitrogen, phosphorus, potassium, calcium, magnesium and sulphur and they are supplemented with micronutrients. The nutrient composition determines electrical conductivity and osmotic potential of the solution.

Dufour and Guérin (2005) carried that when a nutrient solution is used successfully, plants can uptake ions at very low concentrations. So, it has been reported than a high proportion of the nutrients are not used by plants or their uptake does not impact the production. It was determined that in anthodium, 60% of nutrients are lost in the leachate.

Bradly and Marulanda (2000) found that rice hull can be mixed with other materials such as coal scoria, saw dust, river sand and volcanic scoria and can be successfully used as media in simplified hydroponic systems.

Noto (1993) reported that in soilless crops, the substrate replaces the soil because the natural soil is often poorly suited to cultivation due to chemical (reaction, nutrient availability, etc.), physical (density, structure, water retention, etc.), or biological (presence of pathogens, exhaustion, etc.) limitations, or because in this way it controls plant growth better.

Nappi and Barberis (1993) reported that very low pH can result in toxic concentration of ions such as aluminum, zinc and copper, while chemical bindings can occur at pH above 7.5 and EC above 3.5 $mScm^{-1}$ in substrate causing poor plant growth.

De Rijck and Schreven (1997) reported that with pH 5, 100% of P is present as HPO_4^-, this form change into HPO_4^- at pH 7.3, reaching 100% at pH 10. The pH range that dominates the ion HPO_4^{2-} on $HPO4^-$ is between 5 and 6. Potassium is almost perfectly present as a free ion in a nutrient solution with pH values from 2 to 9; only small amounts of K^+ can form a soluble complex with SO_4^{2-} or can be bound to Cl^-. Like potassium, calcium and magnesium are available to plants in a wide range of pH; however, the presence of other ions interferes in their availability due to the formation of compounds with different grade of solubility.

Winsor and Adams (1987) reported that the total concentration of solutes in the nutrient solution is characterized by the electrical conductivity (EC, dsm^{-1}). Usually EC in commercial tomato production is in the range 2±5 dsm^{-1}. Too low a concentration causes mineral deficiency and restricts plant growth.

Yahya *et al.* (2009) concluded that, certain chemical and physical properties of cocopeat can be improved through incorporation of burnt rice hull. The positive effects of burnt rice hull were seen in the elevation of nutrient availability (as indicated by higher EC), increased bulk density, air-filled porosity, available water and wettability. Improvement in chemical and physical properties following incorporation of burnt rice hull into cocopeat was reflected in a better plant growth.

Materska and Perueka. (2005) reported that there was no significant difference on root dry mass among treatments because it did not show any specific tendency of either increasing or decreasing with increasing nutrient solution concentration. However, there was contrasting results between fresh mass and leaf dry mass whereby fresh mass was decreasing with an increase in nutrient concentration while leaf dry mass was increasing with increasing nutrient concentration. This could be attributed to the fact that plants grown at 1 mS/cm had more water content whereas plants grown a higher EC level (4 mS/cm) had less water content but more dry matter content. The chlorophyll content was not significantly different among the different treatments; however, the highest chlorophyll content was recorded in treatments 2 and 3 while treatments 1 and 4 had equal amount of chlorophyll. This indicate that there was very little nutrients (nutrient deficiency) in the lower EC (1 mS/cm) while high salt content resulted in low chlorophyll content in the higher EC levels (4 mS/cm).

Nitrogen significantly increased with increasing nutrient solution concentration. Phosphorus is good for root development but there was conflicting relationship between the P content in the leaves and the dry root mass which could not be explained. Calcium (Ca) decreased with increasing the EC level while magnesium (Mg) remained constant, but both were slightly lower than the recommended range. However, potassium (K) was below the recommended range although it did not affect sweet pepper quality/taste.

Bilderback *et al.* (2005) suggested the ranges of physical properties of substrates; these values include 0.19–0.70 g cm^{-3} for bulk density, 10–30% for air porosity, and 50–85% for total porosity

Andriolo *et al.* (2005) found the results whereby leaf number was not affected by salinity levels. Fresh mass decreased with increasing nutrient solution concentration but there was no significant difference between the treatments. This decrease meant that there was a decline in yield of sweet pepper during the spring season.

Voogt (2002) indicates that the nutrient solution composition must reflect the uptake ratios of individual elements by the crop and as the demand between species differs, the basic composition of a nutrient solution is specific for each crop. It must also be taken into account that the uptake differs between elements and the system used. For instance, in open-systems with free drainage, much of the nutrient solution is lost by leachate.

Sarro *et al.* (2007) found decreasing fresh shoot mass with increasing nutrient solution concentration in hydroponic system.

McRijck *et al.* (1998) conducted an experiment on sweet pepper (*Capsicum annum*) under three nutrient solution nitrate contents which represented a range of adequate and inadequate environments. Larger, faster-growing plants should have a larger demand for nitrate and hence larger uptake rates than smaller, environmentally stressed plants. Results showed higher sustained levels of nitrate uptake by larger plants. Neither the severity of stress under which a plant was grown nor the plant sizes were the sole determinants of maximum potential uptake behavior, however. Increased light level was related to an increased ability to transport nitrate on a short-term basis. Increased light level was associated with increased maximum nitrate uptake rates. The effects of environmental light and nitrate levels on nitrate uptake were incorporated into a power relationship where the maximum uptake velocity was determined in relation to the shoot growth rate.

Marschner (1995) reported that an important feature of the nutrient solutions is that they must contain the ions in solution and in chemical forms that can be absorbed by plants, so in hydroponic systems the plant productivity is closely related with to nutrient uptake and the pH regulation.

Coic (2003) and steiner (2003) studied that the composition and concentration of the nutrient solution are dependent on culture system, crop development stage, and environmental conditions.

CHAPTER III

MATERIALS AND METHODS

3.1 Experimental site

The experiment was conducted in the semi-greenhouse at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh during August 2017 to April 2018. The location of the study site is situated in 23º 74′N latitude and 90º 35′E longitude. The altitude of the location was 8-m from the sea level (The Meteorological Department of Bangladesh, Agargaon, Dhaka).

3.2 Experimental materials and others

Seeds of capsicum cv. 'California Wonder' were used in the experiment. The seed were collected from Seed Market, Siddique Bazar, Dhaka and they were kept in a sealed packet. The Styrofoam, plastic pot, plastic tray, wood, polythene sheet, etc were collected from Town Hall Market, Mohammadpur, Dhaka. Experimental chemicals were bought from Tikatolli, Dhaka.

3.3 Experimental design and treatments

The experiment was conducted in a two factors Randomized Completely Block Design (RCBD) with three replications. Two factors were considered as treatments in the experiment as follows.

Factor - A: Three types of stem pruning denoted as S:

S_1: No pruning

S_2: Two branches present

S_3: Four branches present

Factor - B: Four levels of electrical conductivity (EC) denoted as EC:

EC_1: 2.0 dS/m

EC_2: 3.0 dS/m

EC_3: 4.0 dS/m

EC_4: 5.0 dS/m

3.4 Nutrient solution

Nutrient solution which was used in experiment was Rahman and Inden (2012). The composition of Rahman and Inden (2012) solution was NO_3-N, P, K, Ca, Mg and S of 17.05, 7.86, 8.94, 9.95, 6.0 and 6.0 meq/L, respectively. The rates of micronutrients were Fe, B, Zn, Cu, Mo and Mn of 3.0, 0.5, 0.1, 0.03, 0.025 and 1.0 mg/L, respectively. The solution was applied in different boxes. The pH$\cong$6.0 was maintained and EC was applied according to the treatments in the nutrient solution.

3.5 Experimental environment

Twelve different styrofoam and wooden boxes (180-cm × 25-cm × 25-cm) were prepared for culturing the plants. Polythene sheet was placed in the inner side of the box so that the nutrient solution could not pass through the wooden and styrofoam boxes. Boxes were filled with substrates mixtures of coco peat, brick broken and rice husk. Six-week-old seedlings were transferred into the culturing boxes. The experiment was conducted in a polythene shade house under intensive care. The room was kept clean and tidy during the time of the experiment. The crop was cultivating and it continued until April, 2018.

3.6 Growing media preparation

The mixtures of coco peat, broken bricks (khoa) and rice husk at the ratio of 50:30:20% (v/v) were prepared (Plate 1). Coconut coir was soaked in a big bowl for 24 hours. Then they were mixed with khoa and rice husk properly. These mixtures were placed in the styrofoam and wooden boxes for culturing plants of capsicum.

Plate 1: Preparation of growing media

3.7 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 shown in plastic tray and covered with newspaper under room temperature for rising seedlings.

3.8 Transplanting of capsicum seedling

Two-week old capsicum seedlings were transferred into the plastic pots containing the mixture of coco peat, khoa and rice husk. Rahman and Inden (2012) solution was given to the seedlings regularly along with fresh water (Plate 2). After that, six-week-old seedlings were transplanted to the main boxes. The seedlings were transplanted in the afternoon carefully to minimize transplanting shock. After transplanting of capsicum seedlings in the boxes, light watering was done with water can.

Plate 2: Seedling and seedling transplanting in the box

3.9 Intercultural operations

3.9.1 Pruning

Four weeks after transplanting, stem pruning was done according to the treatments. Again, the crown flower and the flower on the first node of each stem were removed, allowing plants to develop an adequate vegetative frame before fruit set.

3.9.2 Weeding

No weeding was done in the experiment.

3.9.3 Insect management

Capsicum plants were grown in a semi-controlled greenhouse. So, no insecticides were applied in the experiment.

3.9.4 Diseases management

Capsicum plants were grown in a semi-controlled greenhouse 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 plants. (Plate 3)

Plate 3: Intercultural operations

3.10 Harvesting

The crop was harvested after 75, 120 and 180 DAT. Harvesting of the crop was done according to treatment.

3.11 Data collection

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

Plate 4: Data collection

Properties of growing substrates

The properties of growing substrates, namely initial pH and EC, bulk density, water retention (%), air-filled porosity (%) etc of substrate mixtures were measured. The pH and EC values for all the media before planting were determined by pH and EC meter. Bulk density was determined by using the core method (Teh and Jamal, 2006).

Water retention was measured by using the following formula.

$$\text{Water retention (\%)} = \{(Ws-Wd)/Wd\} \times 100$$

Where, Ws = weight of water saturated substrate mixture, Wd = weight of oven dried substrate mixture.

Air-filled porosity (AFP) was determined using the following formula.

AFP (%) = (Volume of water drained, mL×100)/(Volume of substrate mixture,mL)

Training system:

Capsicum plants used in the experiments develop a single stem with 12—14 leaves. The main stem ends with one or two flowers and branches into two or three side branches. At each (first or higher order) branch one leaf develops and the branch terminates in a flower and divides into two or three higher order branches. In this experiment, two first order branches were retained. Subsequently, the largest of each higher order branch was retained, while the smallest one was removed above the first leaf. All other shoots were removed twice a week. This pruning strategy corresponds largely to common practice of commercial growers.

3.11.1 Plant growth and yield parameter

3.11.1.1 Plant height

Plant height was measured in centimeter (cm) by a meter scale at 0, 30, 60, 90, 120, 150 and180 DAT (days after transplanting) from the point of attachment of growing media up to the tip of the longest leaf.

3.11.1.2 First flowering

First flowering was observed 30 days after transplanting (25-11-2017). But this flower was removed from plant for adequate vegetative growth of plant before fruit set.

3.11.1.3 First Fruiting

First fruiting was observed 15 days after flowering and tagging by tape.

3.11.1.4 Individual fruit length

The individual fruit length was measured during harvesting with the help of a large scale in centimeter unit. (Plate 4)

3.11.1.5 Individual fruit diameter

The individual fruit breadth was measured during harvesting with the help of a large scale in centimeter unit.

3.11.1.6 Individual fruit weight

The individual fruit weights were measured by electric balance at the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka 1207.

3.11.1.7 Individual fruit volume

The individual fruit volume was measured during harvesting with the help of a 500ml beaker in centimeter cube (cc) unit.

3.11.1.8 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.

3.11.1.9 Fresh weight of stem, leaf and root

One plant from each treatment was uprooted at 180 DAT. Leaf was detached from the stem and root was cut at the junction of stem and root. Root was washed by tap water to remove media and Sun dried to remove attaching water. All these three parts of plant was weighted by electric balance.

3.11.1.10 Dry weight of stem, leaf and root

Stem, leaf and root was dried by sun for 2 days separately, after that these was transferred to oven of central laboratory, Sher-e-Bangla Agricultural University It was collected and weighted by electric balance after 72 hours.

3.11.1.11 Percent dry matter of plant

From the random samples of plants weighing then sun dried for seven days. After drying, plants were weighed. An electric balance was used to record the dry weight of plant and it was calculated on percentage basis. The percentage of dry matter of plant was calculated by the following formula.

$$\% \text{ Dry matter of plant} = \frac{\text{Constant dry weight of plant}}{\text{Fresh weight of plant}} \times 100$$

3.11.1.12 Yield per plant

Yield per plant was determined with the following formula.

Yield per plant (g) = Individual fruit weight × Number of fruits per plant

3.11.1.13 Yield per hectare

Yield per hector was determined with the following formula.

$$\text{Yield per hector (kg)} = \frac{\text{Yield per plant} \times 50000}{1000}$$

where, 50000 = number of plant / hectors, and 1000 g = 1 kg

3.11.2 Growth parameter analysis

Growth parameters (dry weights of stem, leaf and root), and different physiological parameters [Leaf area (LA), leaf area ratio (LAR), leaf mass ratio (LMR), Root weight ratio (RWR), Relative growth rate (RGR), and Ret assimilation rate (NAR)] were determined in the experiments. The parameters were measured as described below:

3.11.2.1 Leaf area index (LAI):

Leaf area index (LAI) was measured using Adobe photoshop CS3 program.

3.11.2.2 Leaf area ratio (LAR)

Leaf area ratio (LAR) was determined using the following formula.

$$\text{LAR} = \frac{\text{LA}}{\text{PDW}}$$

Where, LAR = leaf area ratio, LA = Leaf area (cm^2), PDW = plant dry weight (g).

3.11.2.3 Leaf mass ratio (LMA)

Leaf mass ratio was determined using the following formula.

$$\text{LMR} = \frac{\text{LDW}}{\text{PDW}}$$

Where, LMR = leaf mass ratio, LDW = leaf dry weight (g).

3.11.2.4 Root weight ratio (RWR)

Root weight ratio (RWR) was determined using the following formula.

$$\text{RWR} = \frac{\text{RDW}}{\text{PDW}}$$

Where, RWR = root weight ratio, RDW = root dry weight (g).

3.11.2.5 Relative growth rate (RGR)

Relative growth rate (RGR) was determined using following formula.

$$\text{RGR} = \frac{\text{PDW}_1 - \text{PDW}_0}{(\text{t}_1 - \text{t}_0) \times \text{PDW}_0}$$

Where, t = time. Subscripts 0 and 1 refer to the transplanting and final harvest (days), respectively.

3.11.2.6 Net assimilation rate (NAR)

Net assimilation rate (NAR) was determined using the following formula.

$$\text{NAR} = \frac{\text{RGR}}{\text{LAR}}$$

Where, NAR = Net assimilation rate, LAR = Leaf area ratio

3.11.3 Measurement of ascorbic acid

Ascorbic acid content in capsicum was measured from Bangladesh Council of Scientific and Industrial Research (BCSIR).

3.11.4 Benefit cost ratio (BCR)

The cost of production was calculated to find out the economic combination of stem pruning and electrical conductivity of capsicum. All input cost like cost for land lease, structural preparation, nutrient solution, seed, growing media etc are calculated. The interests were calculated @ 13% in simple rate. The market price of capsicum was considered for estimating the return. The benefit cost ratio (BCR) was calculated as follows:

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

3.11.5 Statistical analysis of data

The data obtained for different characters were statistically analyzed with SPSS version 20.0 and means separation were done by Tukey's test at $P \leq 0.05$.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the experiment conducted under semi-greenhouse conditions were presented in table 1 to table 14 and figure 1 to figure 9. The experiment was conducted to study the effect of stem pruning and electrical conductivity of hydroponic capsicum. The results were presented and discussed under the following subheading.

4.1 Plant growth and yield parameters

4.1.1 Plant height

There was significant difference in plant height at 0, 30, 60, 90,120,150 and 180 days after transplanting (DAT) in respect of stem pruning of capsicum (Table 1 and Appendix I). At 0 DAT, the tallest plant (17.40 cm) was found in S_2 and the lowest (11.67 cm) was found in S_1. At 30 DAT, the tallest plant (36.04 cm) was found in S_2 and the lowest (27.92 cm) was found in S_1. At 60 DAT, the tallest plant (58.19cm) was found in S_2 and the lowest (47.75 cm) was found in S_1. At 90 DAT, the tallest plant (79.08cm) was found in S_2 and the lowest (68.07 cm) was found in S_1. At 120 DAT, the tallest plant (89.46 cm) was found in S_2 and the lowest (77.15 cm) was found in S_1. At 150 DAT, the tallest plant (94.69cm) was found in S_2 and the lowest (82.88 cm) was found in S_1. At 180 DAT, the tallest plant (100.11cm) was found in S_2 and the lowest (87.95 cm) was found in S_1. The results revealed that the plant height increased in the advancement of plant maturity. However, the tallest plant was found in S_2 in all the cases. Meanwhile S_1 denoted the lowest plant height. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum vegetative growth of capsicum plant.

There was significant difference in plant height at 0, 30, 60, 90,120,150 and 180 days after transplanting (DAT) in respect of electrical conductivity of nutrient solution (Table 1). At 0 DAT, the tallest plant (17.39 cm) was found in EC_3 and the lowest (12.56 cm) was found in EC_1. At 30 DAT, the tallest plant (34.50 cm) was found in EC_3 and the lowest (28.87 cm) was found in EC_1. At 60 DAT, the tallest plant (55.20 cm) was found in EC_3 and the lowest (49.03cm) was found in EC_1. At 90 DAT, the tallest plant (71.76 cm) was found in EC_3 and the lowest (68.94 cm) was found in EC_1. At 120 DAT, the tallest plant (87.48cm) was found in EC_3 and the lowest (77.83 cm) was found in EC_1. At 150 DAT, the tallest plant (92.96 cm) was found in EC_3 and the lowest (83.22 cm) was found in EC_1. At 180 DAT, the tallest plant (94.36 cm) was found in EC_3 and the lowest (88.50 cm) was found in EC_1. The results revealed that the plant height increased in the advancement of plant maturity. However, the tallest plant was found in EC_3 in all the cases. Meanwhile EC_1 denoted the lowest plant height. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum vegetative growth of capsicum plant.

The combined effect of stem pruning and electrical conductivity showed a significant impact on plant height (Table 2 and Appendix I). There was significant difference in plant height at 0, 30, 60, 90,120,150 and 180 days after transplanting (DAT) in respect of combined effect of stem pruning and electrical conductivity of capsicum (Table 2). At 0 DAT, the tallest plant (39.67 cm) was found in S_2EC_3 and the lowest (25.33 cm) was found in S_1EC_1. At 30 DAT, the tallest plant (39.67 cm) was found in S_2EC_3 and the lowest (25.33cm) was found in S_1EC_1. At 60 DAT, the tallest plant (61.17 cm) was found in S_2EC_3 and the lowest (44.67 cm) was found in S_1EC_1. At 90 DAT, the tallest plant (83.17 cm) was found in S_2EC_3 and the lowest (64.67 cm) was found in S_1EC_1. At 120 DAT, the tallest plant (94.50 cm) was found in S_2EC_3 and the lowest (71.67 cm) was found in S_1EC_1. At 150 DAT, the tallest plant (99.27 cm) was found in S_2EC_3 and the lowest (76.83 cm) was found in S_1EC_1. At 180 DAT, the tallest plant (104.83 cm) was found in S_2EC_3 and the lowest (82.00 cm) was found in S_1EC_1. The results revealed that the plant height increased in the advancement of plant maturity. However, the tallest plant was found in S_2EC_3 in all the cases. Meanwhile S_1EC_1 denoted the lowest plant height. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum vegetative growth of capsicum plant.

Table 1. Main effect of stem pruning system and electrical conductivity on plant height at different days after transplanting

Treatment	Plant height at different days after transplanting (DAT) (cm)						
	0 DAT	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Stem pruning (S)							
S_1	11.67 c[z]	27.97 b	47.75 c	68.07 b	77.15 c	82.88 c	87.95 c
S_2	17.40 a	36.04 a	58.19 a	79.08 a	89.46 a	94.69 a	100.11 a
S_3	13.42 b	30.03 b	50.57 b	71.21 b	81.42 b	87.08 b	92.13 b
Electrical conductivity (EC)							
EC_1	12.56 b	28.87 b	49.03 c	68.94 c	77.83 c	83.22 c	88.50 c
EC_2	13.36 b	30.56 b	51.28b c	71.76 bc	81.39 bc	87.09 b	92.33 b
EC_3	17.39 a	34.50 a	55.20 a	76.33 a	87.48 a	92.96 a	94.36 b
EC_4	13.34 b	31.44 b	53.17 ab	74.11 ab	84.00 ab	89.61 ab	98.39 a
Level of significance (P)							
S	**	*	**	**	**	**	**
EC	*	*	**	*	*	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way analysis of variance. *S_1* = No pruning , *S_2* = two branches present, *S_3* = four branches present. *EC_1* = 2 dS/m, *EC_2* = 3.0 dS/m, *EC_3* = 4.0 dS/m, *EC_4* = 5.0 dS/m. * = Significant at 5%, ** = Significant at 1%.

Table 2. Interaction effects of stem pruning system and electrical conductivity on plant height at different days after transplanting

Treatment combination	Plant height at different days after transplanting (DAT) (cm)						
	0 DAT	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
S_1EC_1	10.00 e[z]	25.33 e	44.67 g	64.67 e	71.67 f	76.83 f	82.00 f
S_1EC_2	10.83 e	27.67 de	46.67 fg	67.10 de	75.33 ef	81.43 ef	86.67 ef
S_1EC_3	14.67 cd	30.83 cde	50.67 defg	71.50 cde	82.77 bcde	88.60 bcde	94.00 bcde
S_1EC_4	11.17 e	28.00 de	49.00 defg	69.00 de	78.83 cdef	84.67 def	89.13 def
S_2EC_1	14.67 cd	32.17 bcd	54.77 bcd	74.00 bcd	84.83 bcde	90.00 bcde	96.17 bcd
S_2EC_2	18.08 ab	35.33 abc	57.17 abc	78.17 abc	88.33 abc	93.50 abc	98.67 abc
S_2EC_3	20.33 a	39.67 a	61.17 a	83.17 a	94.50 a	99.27 a	104.83 a
S_2EC_4	16.51 bc	37.00 bc	59.17 ab	81.00 ab	90.17 ab	96.00 ab	100.77 ab
S_3EC_1	13.00 de	29.10 ed	47.67 efg	68.17 de	77.00 def	82.83 def	87.33 ef
S_3EC_2	11.17 e	28.67 de	50.00 defg	70.00 cde	80.50 cdef	86.33 cde	91.67 cde
S_3EC_3	17.17 abc	33.00 bcd	53.27 bcde	74.33 abcd	85.17 abcd	91.00 bcd	96.33 bcd
S_3EC_4	12.33 de	29.33 cde	51.33 cdfg	72.33 bcde	83.00 bcde	88.17 bcde	93.17 bcde
P	*	*	*	*	*	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$.P represents the level of significance of two-way analysis of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. P = Level of significance, * = Significant at 5%,

4.1.2 First flowering

There was no significant difference in first flowering in respect of stem pruning of capsicum (Table 3). Therefore, early first flowering of capsicum was found in S_2 (35.75 DAT). When two branches remain in a plant it may increase vegetative growth and early flowering. On the other hand, S_3 (39.58 DAT) showed late first flowering because of less vegetative growth.

There was significant difference in first flowering day in respect of electrical conductivity of nutrient solution (Table 3). First flowering of capsicum was found in EC_1 (32.89 DAT), where EC_1 = 2.0 dS/m. On the other hand, EC_4 the maximum period (42.78 DAT), where EC_4 = 5.0 dS/m.

There was no significant difference of combined effect of stem pruning and electrical conductivity on first flowering (Table 4). First flowering of capsicum was found in S_3EC_1 (25.00 DAT). On the other hand, S_2EC_4(43.67 DAT) showed late first flowering because of less vegetative growth. The results revealed that S_3EC_1 indicated the early first flowering, whereas treatment S_2EC_4 denotes late first flowering.

4.1.3 First fruiting

First fruiting of capsicum was no significantly affected by different stem pruning and electrical conductivity (Table 3). First fruiting of capsicum was found in S_2 (16.83 DAF). When two branches remain in a plant it may increase vegetative growth and early fruiting. On the other hand, S_3 (17.83 DAF) showed late first fruiting because of less vegetative growth and late flowering.

Again, first fruiting of capsicum was found in EC_1 (15.89 DAF), where EC_1 = 2.0 dS/m. On the other hand, EC_2 (18.22 DAF), where EC_2 = 3.0 dS/m.

There was no significant difference of combined effect of stem pruning and electrical conductivity on first fruiting (Table 4). First fruiting of capsicum was found in S_1EC_1 (15.00 DAF). On the other hand, S_2EC_4 (19.67 DAT) was showed late first fruiting. The results revealed that S_1EC_1 indicated the early first fruiting, whereas treatment S_2EC_4 denotes late first fruiting.

Table 3. Main effect of stem pruning system and electrical conductivity on first flowering and first fruiting in capsicum

Treatment	First Flowering (DAT)	First Fruiting (DAF)
Stem pruning (S)		
S_1	37.58	17.00
S_2	35.75	16.83
S_3	39.58	17.83
Electrical conductivity (EC)		
EC_1	32.89 b^z	15.89
EC_2	38.33 ab	18.22
EC_3	36.56 ab	17.22
EC_4	42.78 a	17.56
Level of significance (P)		
S	NS	NS
EC	*	NS

^{z}Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. DAT = Days after transplanting, DAF = days after flowering. NS = non-significant, * = Significant at 5%

Table 4. Interaction effects of stem pruning system and electrical conductivity on flower and fruit at 1st flowering and fruiting days after transplanting in capsicum

Treatment combination	1st Flowering (DAT)	1st Fruiting (DAF)
S_1EC_1	32.00	15.00
S_1EC_2	39.33	19.00
S_1EC_3	35.67	18.33
S_1EC_4	43.33	15.67
S_2EC_1	41.67	17.33
S_2EC_2	37.33	17.67
S_2EC_3	35.67	16.67
S_2EC_4	43.67	19.67
S_3EC_1	25.00	15.33
S_3EC_2	38.33	18.00
S_3EC_3	38.33	16.67
S_3EC_4	41.33	17.33
Level of significance (P)		
S × EC	NS	NS

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. DAT = Days after transplanting, DAF = days after flowering. NS = non-significant

4.1.4 Fruit length

There was significant difference in fruit length in respect of stem pruning of capsicum (Table 5 and Appendix II). The highest fruit length of capsicum was found in S_2 (7.48 cm). On the other hand, the lowest fruit length was in S_1 (5.39 cm). The results revealed that the highest fruit length of capsicum was found in S_2. Meanwhile S_1 denoted the lowest fruit length. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fruit length of capsicum. Therefore, the availability of assimilates was low, which has directly affected weight, length and breadth of fruits (Zende, 2008).

There was significant difference in fruit length in respect of electrical conductivity of nutrient solution (Table 5 and Appendix II). The highest fruit length of capsicum was found in EC_3 (7.99 cm). On the other hand, the lowest fruit length of capsicum was EC_1 (4.28 cm). The results revealed that the highest fruit length was found in EC_3. Meanwhile EC_1 denotes the lowest fruit length. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3 = 4.0 dS/m which might be the suitable for its maximum fruit length of capsicum.

There was significant difference in fruit length in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 6 and Appendix II). The highest fruit length of capsicum was found in S_2EC_3 (9.47 cm). On the other hand, the lowest fruit length was found in S_1EC_1 (3.83 cm). The results revealed that S_2EC_3 indicated the highest fruit length, whereas treatment S_1EC_1 denotes the lowest fruit length. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum fruit length of capsicum.

4.1.5 Fruit diameter

There was significant difference in fruit diameter in respect of stem pruning of capsicum (Table 5). The highest fruit diameter of capsicum was found in S_2 (6.30 cm). On the other hand, the lowest fruit diameter of capsicum was found S_1 (4.49 cm). The results revealed that the highest fruit diameter of capsicum was found in S_2. Meanwhile S_1 denoted the lowest fruit diameter. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fruit diameter of capsicum plant. Therefore, the availability of assimilates was low, which has directly affected weight, length and breadth of fruits (Zende, 2008).

There was significant difference in fruit diameter of capsicum in respect of electrical conductivity of nutrient solution (Table 5 and Appendix II). The highest fruit diameter of capsicum was found in EC_3 (6.82 cm). On the other hand, the lowest fruit diameter of capsicum was found EC_1 (3.86 cm). The results revealed that the highest fruit diameter of capsicum was found in EC_3. Meanwhile EC_1 denoted the lowest fruit diameter. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum fruit diameter of capsicum.

There was significant difference in fruit diameter of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 6 and Appendix II). The highest fruit diameter of capsicum was found in S_2EC_3 (8.03 cm). On the other hand, the lowest fruit diameter of capsicum was found in S_1EC_1 (3.17 cm). The results revealed that the highest fruit diameter of capsicum was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest fruit diameter. This might be due to the combined effect of pruning style of brunches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum fruit diameter of capsicum.

4.1.6 Fruit weight

There was significant difference in fruit weight of capsicum in respect of stem pruning of capsicum (Table 5 and Appendix II). The highest fruit weight of capsicum was found in S_2 (161.78 g). On the other hand, the lowest fruit weight was in S_1 (99.76 g). The results revealed that the highest fruit weight of capsicum was found in S_2. Meanwhile S_1 denoted the lowest fruit weight. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fruit weight of capsicum. Therefore, the availability of assimilates was low, which has directly affected weight, length and breadth of fruits (Zende, 2008).

There was significant difference in fruit weight of capsicum in respect of electrical conductivity of nutrient solution (Table 5 and Appendix II). The highest fruit weight of capsicum was found in EC_3 (155.5 g). On the other hand, the lowest fruit weight of capsicum was found in EC_1 (106.1 g). The results revealed that the highest fruit weight of capsicum was found in EC_3. Meanwhile EC_1 denoted the lowest fruit weight. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum fruit weight of capsicum.

There was significant difference in fruit weight of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 6 and Appendix II). The highest fruit weight of capsicum was found in S_2EC_3 (190.83 g). On the other hand, the lowest fruit weight was found in S_1EC_1 (82.33 g). The results revealed that the highest fruit weight of capsicum was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest plant height. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two brunches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum fruit weight of capsicum.

4.1.7 Fruit volume

There was significant difference in fruit volume of capsicum in respect of stem pruning of capsicum (Table 5 and Appendix II). The highest fruit volume of capsicum was found in S_2 (190.91 cc). On the other hand, the lowest fruit volume was found in S_1 (128.0 cc). The results revealed that the highest fruit volume was found in S_2. Meanwhile S_1 denoted the lowest fruit volume. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fruit volume of capsicum plant.

There was significant difference in fruit volume of capsicum in respect of electrical conductivity of nutrient solution (Table 5 and Appendix II). The highest fruit volume of capsicum was found in EC_3 (184.81 cc). On the other hand, the lowest fruit volume was found in EC_1 (132.43 cc). The results revealed that the highest fruit volume of capsicum was found in EC_3. Meanwhile EC_1 denoted the lowest fruit volume. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum fruit volume of capsicum.

There was significant difference in fruit volume of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 6 and Appendix II). The highest fruit volume of capsicum was found in S_2EC_3 (220.70 cc). On the other hand, the lowest fruit volume was found in S_1EC_1 (108.97 cc). The results revealed that the fruit volume of capsicum was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest fruit volume. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum fruit volume of capsicum.

4.1.8 Number of fruits per plant

There was significant difference in number fruit per plant of capsicum in respect of stem pruning of capsicum (Table 5 and Appendix II). The highest number of fruit per plant of capsicum was found in S_2 (8.25). On the other hand, the lowest number of fruits per plant was found in S_1 (4.75). The results revealed that the highest number of fruits per plant was found in S_2. Meanwhile S_1 denoted the lowest number of fruits per plant. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum number of fruits per plant of capsicum plant. Maboko & Du Plooy (2008), plants pruned to two stems performed the higher number of fruits per plant.

There was significant difference in number of fruits per plant of capsicum in respect of electrical conductivity of nutrient solution (Table 5 and Appendix II). The highest number fruit per plant of capsicum was found in EC_3 (8.89). On the other hand, the lowest number of fruits per plant was found in EC_1 (4.44). The results revealed that the highest number fruit per plant of capsicum was found in EC_3. Meanwhile EC_1 denoted the lowest number fruit per plant. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum number fruit per plant of capsicum.

There was significant difference in number fruit per plant of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 6 and Appendix II). The highest number fruit per plant of capsicum was found in S_2EC_3 (12.0). On the other hand, the lowest number fruit per plant was found in S_1EC_1 (3.0). The results revealed that the number fruit per plant of capsicum was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest number of fruits per plant. This might be due to the combined effect of pruning style of brunches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum number of fruits per plant of capsicum.

Table 5. Main effect of stem pruning system and electrical conductivity on fruit length, fruit diameter, fruit weight, fruit volume, no of fruit per plant in capsicum

Treatment	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (cc)	No of fruit/plant
Stem pruning (S)					
S_1	5.39 c[z]	4.49 c	99.76 c	128.0 c	4.75 c
S_2	7.48 a	6.30 a	161.78 a	190.91 a	8.25 a
S_3	6.19 b	5.19 b	131.78 b	159.43 b	6.25 b
Electrical conductivity (EC)					
EC_1	4.28 c	3.86 c	106.1 d	132.43 d	4.44 c
EC_2	6.11 b	5.19 b	122.9 c	151.69 c	6.33 b
EC_3	7.99 a	6.82 a	155.5 a	184.81 a	8.89 a
EC_4	6.53 b	5.44 b	139.89 b	168.86 b	6.67 b
Level of significance (P)					
S	*	*	*	*	*
EC	*	*	*	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1= No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. * = Significant

Table 6. Interaction effects of stem pruning system and electrical conductivity on fruit length, fruit diameter, fruit weight, fruit volume, no of fruit per plant in capsicum

Treatment combination	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (cc)	No of fruit/plant
S_1EC_1	3.83 f[z]	3.17 g	82.33 g	108.97 g	3.0 e
S_1EC_2	5.17 ef	4.33 efg	91.87 fg	119.83 fg	5.0 de
S_1EC_3	6.8b cd	5.83 bcde	120.0 def	148.20 def	6.33 cd
S_1EC_4	5.71 de	4.63 cdefg	104.83 efg	135.0 efg	4.67 de
S_2EC_1	5.57 de	4.60 defg	129.23 cde	157.70 bcd	6.0 cd
S_2EC_2	7.28 bcd	6.23 bcd	156.13 bc	185.57 bc	8.00 bc
S_2EC_3	9.47 a	8.03 a	190.83 a	220.70 a	12.0 a
S_2EC_4	7.50 bc	6.33 abc	170.87 ab	199.67 ab	9.0 b
S_3EC_1	4.83 ef	3.80 fg	106.73 efg	130.63 efg	4.33 de
S_3EC_2	5.88 cde	5.0 bcdef	120.73 def	149.67 de	6.0 cd
S_3EC_3	7.67 b	6.60 ab	155.67 bc	185.53 bc	8.33 bc
S_3EC_4	6.37 bcde	5.37 bcdef	143.97 bcd	171.90 bcd	6.33 cd
P	*	*	*	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1= 2.0 dS/m, EC_2= 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. P = level of significance, * = Significant at 5%

4.1.9 Yield per plant

There was significant difference in yield per plant of capsicum in respect of stem pruning of capsicum (Figure 1). The highest yield per plant of capsicum was found in S_2 (1406.59 gm). On the other hand, the lowest yield per plant was found in S_1 (479.54 gm). The results revealed that the highest yield per plant was found in S_2. Meanwhile S_1 denoted the lowest yield per plant. This might be due to the pruning style of brunches. In S_2, two branches remain which might be the suitable for its maximum yield per plant of capsicum. The usual practice is to prune sweet pepper in greenhouse production to two stems (Cebula, 1995).

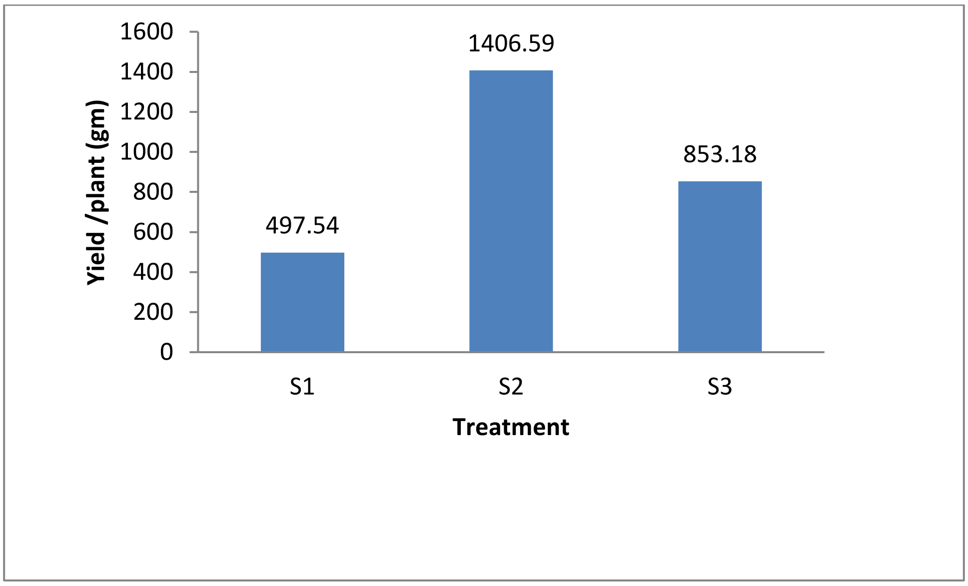

Figure 1: Effect of stem pruning system on yield/plant of capsicum

^{z}Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m

There was significant difference in yield per plant of capsicum in respect of electrical conductivity of nutrient solution (Figure 2). The highest yield per plant of capsicum was found in EC_3 (1395.39gm). On the other hand, the lowest yield per plant was found in EC_1 (477.42gm). The results revealed that the highest yield per plant of capsicum was found in EC_3. Meanwhile EC_1 denoted the lowest yield per plant. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum yield per plant of capsicum.

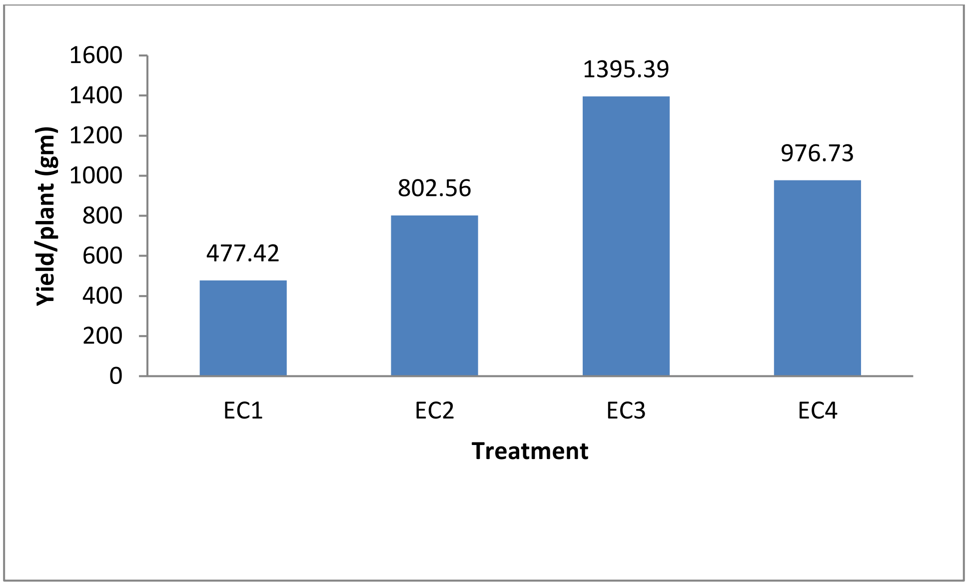

Figure 2: Effect of electrical conductivity on yield/plant of capsicum

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m

There was significant difference in yield per plant of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Figure 3).The highest yield per plant of capsicum was found in S_2EC_3 (2113.17 gm). On the other hand the lowest yield per plant was found in S_1EC_1 (247.0 gm). The results revealed that the yield per plant of capsicum was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest yield per plant. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum yield per plant of capsicum.

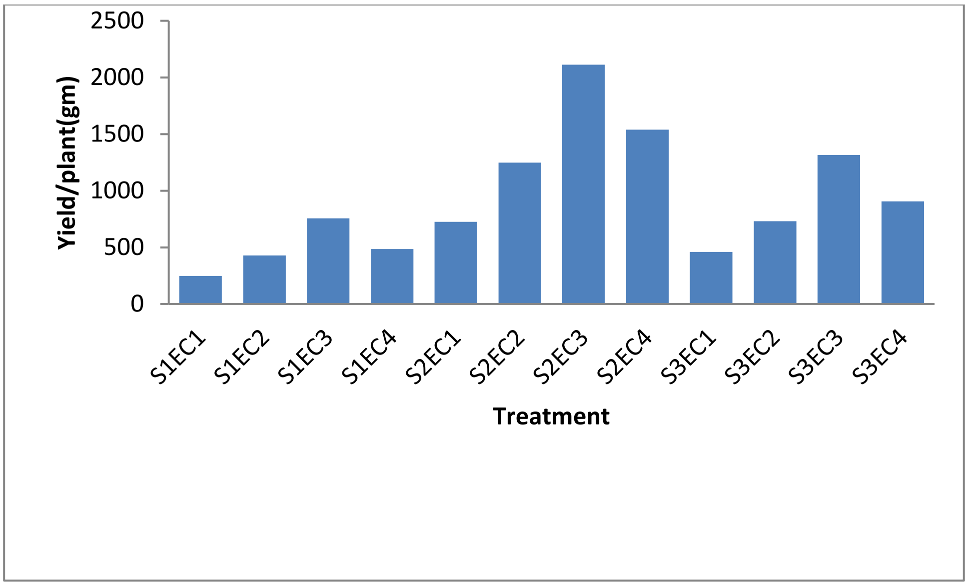

Figure 3: Interaction effects of stem pruning system and electrical conductivity on yield/plant of capsicum

^{z}Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m

4.1.10 Yield per hectare

There was significant difference in yield per hectare of capsicum in respect of stem pruning of capsicum (Figure 4). The highest yield per hectare of capsicum was found in S_2 (70317.92 kg). On the other hand, the lowest yield per hectare of capsicum was found in S_1 (23977.08 kg). The results revealed that the highest yield per hectare was found in S_2. Meanwhile S_1 denoted the lowest yield per hectare. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum yield per hectare of capsicum plant. Similarly, Aminifard et al. (2010), Jovicith et al. (2004), Lorenzo and Castilla (1995), and Cebula (1995) reported an increase in pepper yield at higher plant populations.

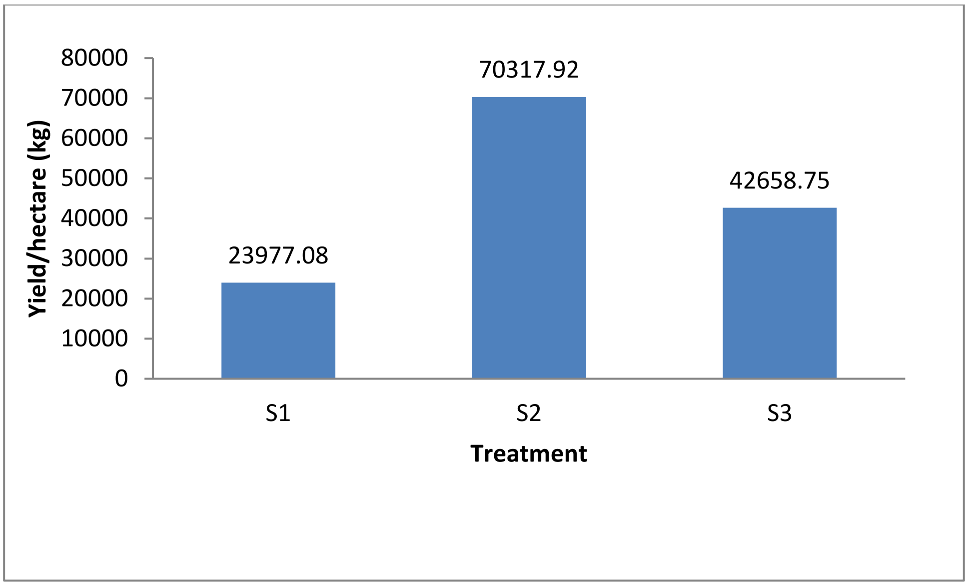

Figure 4: Effect of stem pruning system on yield/hectare of capsicum

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m

There was significant difference in yield per hectare of capsicum in respect of electrical conductivity of nutrient solution (Figure 5). The highest yield per hectare of capsicum was found in EC_3 (69769.44 kg). On the other hand, the lowest yield per hectare was found in EC_1 (23871.11 kg). The results revealed that the highest yield per hectare of capsicum was found in EC_3. Meanwhile EC_1 denoted the lowest yield per hectare. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum yield per hectare of capsicum.

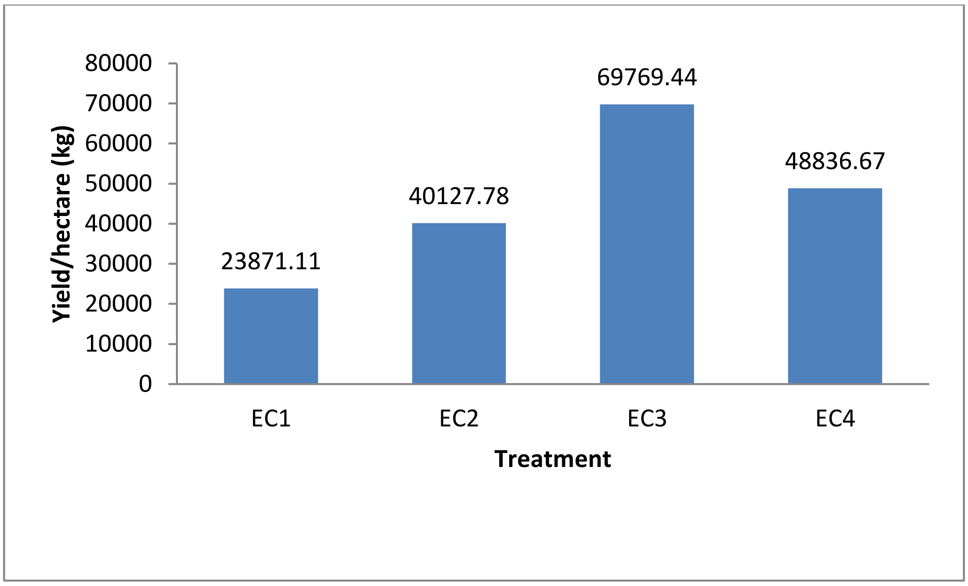

Figure 5: Effect of electrical conductivity on yield/hectare of capsicum

[z]Means with different letters are significantly different by Tukey's test at P ≤ 0.05. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m

There was significant difference in yield per hectare of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Figure 6). The highest yield per hectare of capsicum was found in S_2EC_3 (105658.33 kg). On the other hand, the lowest yield per hectare was found in S_1EC_1 (12350.0 kg). The results revealed that the yield per hectare of capsicum was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest yield per hectare of capsicum. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum yield per hector of capsicum.

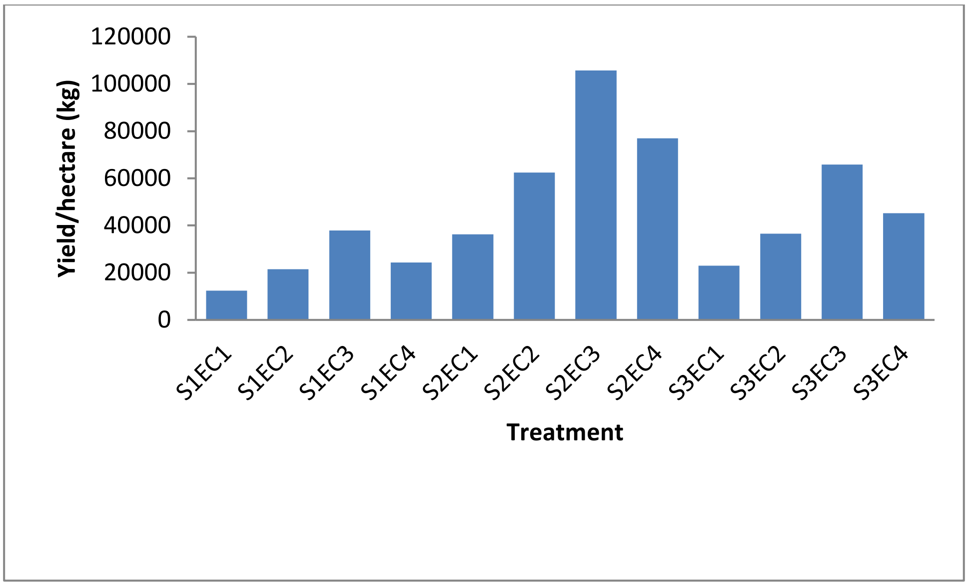

Figure 6: Interaction effects of stem pruning system and electrical conductivity on yield/hectare of capsicum

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m

4.1.11Fresh weight of leaf

Fresh weight of capsicum leaf at 180 DAT was significantly affected by different stem pruning and electrical conductivity (Table 7 and Appendix III). The highest leaf fresh weight of capsicum was found in S_2 (69.30 g). On the other hand, the lowest fresh weight of leaf was found in S_1 (39.42 g). The results revealed that the highest fresh weight of leaf was found in S_2. Meanwhile S_1 denoted the lowest fresh weight of leaf of capsicum. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fresh weight of leaf of capsicum plant.

Again,the highest leaf fresh weight of capsicum was found in EC_3 (62.46 g). On the other hand, the lowest leaf fresh weight was found in EC_1 (49.24 g). The results revealed that the highest fresh weight was found in EC_3. Meanwhile EC_1 denoted the lowest fresh leaf weight. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum fresh leaf weight of capsicum.

There was significant difference in fresh leaf weight of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 8 and Appendix III). The highest leaf fresh weight of capsicum was found in S_2EC_3 (76.81 g). On the other hand, the lowest fresh weight of capsicum was found in S_1EC_1 (32.86 g). The results revealed that S_2EC_3 indicated the highest leaf fresh weight. Meanwhile S_1EC_1 denoted the lowest leaf fresh weight. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum fresh weight of leaf of capsicum plant.

4.1.12 Fresh weight of Stem

Fresh weight of capsicum stem at 180 DAT was significantly affected by different stem pruning and electrical conductivity (Table 7 and Appendix III). The highest stem fresh weight of capsicum was found in S_2 (79.88 g). On the other hand, the lowest stem fresh weight was found in S_1 (40.75 g). The results revealed that the highest fresh weight of stem was found in S_2. Meanwhile S_1 denoted the lowest fresh weight of stem. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fresh weight of stem of capsicum plant.

Again, the highest stem fresh weight of capsicum was found in EC_3 (68.42 g) On the other hand the lowest stem fresh weight was found in EC_1 (54.66 g). The results revealed that the fresh weight of stem was found in EC_3. Meanwhile EC_1 denoted the lowest fresh weight of stem. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum fresh weight of stem of capsicum plant.

There was significant difference in fresh weight of stem in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 8 and Appendix III). The highest stem fresh weight of capsicum was found in S_2EC_3 (89.20 g). On the other hand, the lowest fresh weight of stem was found

S_1EC_1 (35.67 g). The results revealed that the highest fresh weight of stem was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest fresh weight of stem. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum fresh weight of stem of capsicum plant.

4.1.13 Fresh weight of root

Fresh weight of capsicum root at 180 DAT was significantly affected by different stem pruning and electrical conductivity (Table 7 and Appendix III). The highest fresh weight of root of capsicum was found in S_2 (36.12 g). On the other hand, the lowest fresh weight of root was found in S_1 (22.93 g). The results revealed that the highest fresh weight of root was found in S_2. Meanwhile S_1 denoted the lowest fresh weight of root. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fresh weight of root of capsicum plant.

Again, the highest fresh weight of root of capsicum was found in EC_3 (32.22 g). On the other hand, the lowest fresh weight of root was found in EC_1 (25.83 g). The results revealed that the highest fresh weight of root was found in EC_3. Meanwhile EC_1 denoted the lowest fresh weight of root. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum fresh weight of root of capsicum plant.

There was significant difference in fresh weight of root in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 8 and Appendix III). The highest fresh weight of root of capsicum was found in S_2EC_3 (41.67 g). On the other hand, the lowest fresh weight of root was found in S_1EC_1 (20.26 g). The results revealed that the highest fresh weight of root was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest fresh weight of root. This might be due to the combined effect of pruning style of brunches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum fresh weight of root of capsicum plant.

Table 7. Main effect of stem pruning system and electrical conductivity on plant fresh weights of capsicum

Treatment	Fresh weight/plant (g)		
	Leaf	Stem	Root
Stem pruning (S)			
S_1	39.42 c^z	40.75 c	22.93 c
S_2	69.30 a	79.88 a	36.12 a
S_3	58.42 b	62.98 b	27.93 b
Electrical conductivity (EC)			
EC_1	49.24 d	54.66 d	25.83 d
EC_2	53.46 c	58.93 c	27.97 c
EC_3	62.46 a	68.42 a	32.22 a
EC_4	57.46 b	62.79 b	29.88 b
Level of significance (P)			
S	*	*	*
EC	*	*	*

^{z}Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1= No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. * = Significant at 5%,

Table 8. Interaction effects of stem pruning system and electrical conductivity on plant fresh weights of capsicum

Treatment combination	Fresh weight/plant (g)		
	Leaf	Stem	Root
S_1EC_1	32.86 i[z]	35.67 i	20.26 h
S_1EC_2	36.68 hi	38.28 i	22.85 gh
S_1EC_3	46.58 g	46.57 g	24.68 fg
S_1EC_4	41.58 gh	42.45 h	23.93 gh
S_2EC_1	62.41 cde	71.58 d	31.47 bc
S_2EC_2	66.33 bc	76.70 c	34.04 bc
S_2EC_3	76.81 a	89.20 a	41.67 a
S_2EC_4	71.66 ab	82.02 b	37.29 b
S_3EC_1	52.44 f	56.71 f	25.75 fg
S_3EC_2	57.36 ef	61.81 e	27.00 efg
S_3EC_3	63.99 cd	69.49 f	30.29 cde
S_3EC_4	59.51 de	63.91 e	28.44 def
P	*	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. P = Level of significance, * = Significant at 5%

4.1.14Dry weight of leaf

Dry weight of capsicum leaf at 180 DAT was significantly affected by different stem pruning and electrical conductivity (Table 9 and Appendix IV). The highest leaf dry weight of capsicum was found in S_2 (13.04 g). On the other hand, the lowest leaf dry weight was found in S_1 (6.56 g). The results revealed that the highest leaf dry weight was found in S_2. Meanwhile S_1 denoted the lowest leaf dry weight. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum leaf dry weight of capsicum plant.

Again, highest leaf dry weight of capsicum was found in EC_3 (12.11 g). On the other hand, the lowest leaf dry weight was found in EC_1 (7.98 g). The results revealed that the highest leaf dry weight was found in EC_3. Meanwhile EC_1 denoted the lowest leaf dry weight. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum leaf dry weight of capsicum plant.

There was significant difference in dry weight of leaf in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 10 and Appendix IV). The highest dry weight of leaf of capsicum was found in S_2EC_3 (16.52 g). On the other hand, lowest leaf dry weight was found in S_1EC_1 (4.49 g). The results revealed that the highest leaf dry weight was found in S_2EC_3 in all the cases. Meanwhile S_1EC_1 denoted the lowest leaf dry weight. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum dry weight of leaf of capsicum plant.

4.1.15 Dry weight of stem

Dry weight of capsicum stem at 180 DAT was significantly affected by different stem pruning and electrical conductivity (Table 9 and Appendix III). The highest stem dry weight of capsicum was found in S_2 (15.17 g). On the other hand, the lowest stem dry weight was found S_1 (5.47 g). The results revealed that the highest stem dry weight was found in S_2. Meanwhile S_1 denoted the lowest stem dry weight. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum stem dry weight of capsicum plant.

Again, the highest stem dry weight of capsicum was found in EC_3 (12.67 g). On the other hand, the lowest stem dry weight was found in EC_1 (8.52 g). The results revealed that the highest stem dry weight was found in EC_3. Meanwhile EC_1 denoted the lowest stem dry weight. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum stem dry weight of capsicum plant.

There was significant difference in dry weight of stem in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 10 and Appendix IV). The highest stem dry weight of capsicum was found in S_2EC_3 (18.74 g). On the other hand, the lowest stem dry weight was found in S_1EC_1 (4.11 g). The results revealed that the highest stem dry weight was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest stem dry weight. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum stem dry weight of capsicum plant.

4.1.16 Dry weight of root

Dry weight of capsicum root at 180 DAT was significantly affected by different stem pruning and electrical conductivity (Table 9 and Appendix IV). The highest root dry weight of capsicum was found in S_2 (5.50 g). On the other hand, the lowest root dry weight was found in S_1 (2.52 g). The results revealed that the highest root dry weight was found in S_2. Meanwhile S_1 denoted the lowest root dry weight. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum root dry weight of capsicum plant.

Again, the highest root dry weight of capsicum was found in EC_3 (4.89 g). On the other hand, the lowest root dry weight was found in EC_1 (3.10 g). The results revealed that the highest root dry weight was found in EC_3. Meanwhile EC_1 denoted the lowest root dry weight. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum root dry weight of capsicum plant.

There was significant difference in dry weight of root in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 10 and Appendix IV). The highest root dry weight of capsicum was found in S_2EC_3 (7.24 g). On the other hand, the lowest root dry weight was found in S_1EC_1 (1.89 g). The results revealed that the highest root dry weight was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest root dry weight. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum root dry weight of capsicum plant.

4.1.17 Total dry weight

Total dry weight of capsicum plant at 180 DAT was significantly affected by different stem pruning and electrical conductivity (Table 9 and Appendix IV). The highest total dry weight of capsicum was found in S_2 (33.71 g). On the other hand, the lowest total dry weight was found in S_1 (14.55 g). The results revealed that the highest total dry weight was found in S_2. Meanwhile S_1 denoted the lowest total dry weight. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum total dry weight of capsicum plant.

Again, the highest total dry weight of capsicum was found in EC_3 (29.66 g). On the other hand, the total dry weight was found in EC_1 (19.60 g). The results revealed that the highest total dry weight was found in EC_3. Meanwhile EC_1 denoted the lowest total dry weight. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum total dry weight of capsicum plant.

There was significant difference in total dry weight of capsicum plant in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 10 and Appendix IV). The highest total dry weight of capsicum plant was found in S_2EC_3 (42.50 g). On the other hand, the lowest total dry weight of capsicum plant was found in S_1EC_1 (10.50 g). The results revealed that the highest total dry weight was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest total dry weight. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum total dry weight of capsicum plant.

Table 9. Main effect of stem pruning system and electrical conductivity on plant dry weights of capsicum

Treatment	Dry weight/plant (g)			
	Leaf	Stem	Root	Total dry
Stem pruning (S)				
S_1	6.56 c[z]	5.47 c	2.52 c	14.55 c
S_2	13.04 a	15.17a	5.50 a	33.71 a
S_3	9.90 b	10.50 c	3.71 b	24.10 b
Electrical conductivity (EC)				
EC_1	7.98 d	8.52 c	3.10 c	19.60 c
EC_2	9.16 c	9.87 b	3.51 c	22.54 b
EC_3	12.11 a	12.67 a	4.89 a	29.66 a
EC_4	10.08 b	10.47 b	4.16 b	24.67 b
Level of significance (P)				
S	*	*	*	*
EC	*	*	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. * = Significant at 5%

Table 10. Interaction effects of stem pruning system and electrical conductivity on plant dry weights of capsicum

Treatment combination	Dry weights(g)			
	Leaf	Root	Stem	Total dry weight
S_1EC_1	4.49 g[z]	1.89 g	4.11 h	10.50 i
S_1EC_2	5.86 fg	2.17 fg	5.40 gh	13.43 hi
S_1EC_3	8.91 c	3.21 def	6.81 g	18.93 g
S_1EC_4	6.96 f	2.81 efg	5.54 gh	15.33 h
S_2EC_1	10.63 cd	4.19 cd	12.63 cd	27.45 cd
S_2EC_2	11.78 bc	4.80 bc	14.30 bc	30.89 bc
S_2EC_3	16.52 a	7.24 a	18.74 a	42.50 a
S_2EC_4	13.21 b	5.77 b	15.02 b	34.00 b
S_3EC_1	8.81 e	3.21 def	8.82 f	20.84 fg
S_3EC_2	9.84 de	3.55 cde	9.90 ef	23.30 ef
S_3EC_3	10.89 cd	4.21 cd	12.45 cd	27.56 cd
S_3EC_4	10.05 de	3.88 cde	10.85 de	24.69 ed
P	*	*	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. P = Level of significance, * = Significant at 5%

4.2.1 Leaf area

There was significant difference in leaf area of capsicum in respect of stem pruning of capsicum plant (Table 11). The highest leaf area of capsicum was found in S_2 (597.10 cm^2). On the other hand, the lowest leaf area was found in S_1 (545.90 cm^2). The results revealed that the highest leaf area of capsicum was found in S_2. Meanwhile S_1 denoted the lowest leaf area of capsicum. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum fruit length of capsicum plant. Leaf area is an important determinant of light interception and consequently of transpiration, photosynthesis and plant productivity (Dufourand Guérin 2005).

There was significant difference in leaf area of capsicum plant in respect of electrical conductivity of nutrient solution (Table 11). Again, the highest leaf area of capsicum was found in EC_3 (582.63 cm^2). On the other hand, the lowest leaf was found in EC_1 (559.94 cm^2) lowest leaf area. The results revealed that the highest leaf area was found in EC_3. Meanwhile EC_1 denoted the lowest leaf area. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum leaf area of capsicum plant.

There was significant difference in leaf area of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 12). The highest leaf area of capsicum was found in S_2EC_3 (611.67 cm^2). On the other hand, the lowest leaf area was found in S_1EC_1 (532.42 cm^2). The results revealed that the highest leaf area was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest leaf area. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum leaf area of capsicum plant.

4.2.2 Leaf mass ratio

There was significant difference in leaf mass ratio in respect of stem pruning of capsicum (Table 11). The highest leaf mass ratio of capsicum was found in S_2 (0.4483 gg^{-1}). On the other hand, the lowest leaf mass ratio was found in S_1 (0.3858 gg^{-1}). The results revealed that the highest leaf mass ratio was found in S_2. Meanwhile S_1 denoted the lowest leaf mass ratio. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum leaf mass ratio of capsicum plant. Prieto *et al.* (2007) reported that increased LMR gave the plants an increased ability to intercept light.

There was no significant difference in leaf mass ratio in respect of electrical conductivity of nutrient solution (Table 11). The highest leaf mass ratio of capsicum was found in EC_3 (0.41777 gg^{-1}). On the other hand, the leaf mass ratio was found in EC_1 (0.41222 gg^{-1}). The results revealed that the highest leaf mass ratio was found in EC_3. Meanwhile EC_1 denoted the lowest leaf mass ratio. Prieto *et al.* (2007) reported that increased LMR gave the plants an increased ability to intercept light.

There was significant difference in leaf mass ratio of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 12). The highest leaf mass ratio of capsicum was found in S_2EC_3 (0.4700 gg^{-1}). On the other hand, the lowest leaf mass ratio was found in S_1EC_{21}(0.3800 gg^{-1}). The results revealed that the highest leaf mass ratio was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest leaf mass ratio. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum leaf mass ratio of capsicum plant. Prieto *et al.* (2007) reported that increased LMR gave the plants an increased ability to intercept light.

4.2.3 Leaf area ratio

Leaf area ratio of capsicum was significantly affected by different stem pruning and electrical conductivity (Table 11). The lowest leaf area ratio of capsicum was found in S_2 (18.1452 cm^2g^{-1}). On the other hand the highest leaf area ratio was found in S_1 (39.26 cm^2g^{-1}). Lower LAR is one of the important criteria for producing higher metabolites. The results revealed that the lowest leaf area ratio of capsicum was found in S_2. Meanwhile S_1 denoted the highest leaf area ratio of capsicum. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its minimum leaf area ratio of capsicum plant. Decreased LAR was found by Starck (1983) in tomato, which agreed with our findings.

Again, the lowest leaf area ratio of capsicum was found in EC_3 (21.6469 cm^2g^{-1}). On the other hand, the highest leaf area ratio was found in EC_1 (33.1269 cm^2g^{-1}). Lower LAR is one of the important criteria for producing higher metabolites. The results revealed that the lowest leaf area ratio of capsicum was found in EC_3. Meanwhile EC_1 denoted the highest leaf area ratio of capsicum. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its manimum leaf area ratio of capsicum. Lower Decreased LAR was found by Starck (1983) in tomato, which agreed with our findings.

There was significant difference in leaf area ratio of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 12). The lowest leaf area ratio of capsicum was found in S_2EC_3 (14.4511 cm^2g^{-1}). On the other hand, the highest leaf ratio was found in S_1EC_1 (51.00099 cm^2g^{-1}). Lower LAR is one of the important criteria for producing higher metabolites. The results revealed that the lowest leaf area ratio was found in S_2EC_3. Meanwhile S_1EC_1 denoted the highest leaf area ratio. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its minimum leaf area ratio of capsicum plant. Decreased LAR was found by Starck (1983) in tomato, which agreed with our findings.

4.2.4 Root weight ratio

Root weight ratio of capsicum was significantly affected by different stem pruning (Table 11). The lowest root weight ratio of capsicum was found in S_2 (0.15404 gg^{-1}). On the other hand, the highest root weight ratio was found in S_1 (0.1740 gg^{-1}). The results revealed that the lowest root weight ratio was found in S_2. Meanwhile S_1 denoted the highest root weight ratio. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its manimun fruit root weight ratio of capsicum plant. Lower RWR is one of the important criteria for producing higher metabolites. Decreased

RWR was found by Starck (1983) in tomato, which agreed with our findings.

There was no significant difference in leaf mass ratio in respect of electrical conductivity of nutrient solution (Table 11). The lowest root weight ratio of capsicum was found in EC_3 (0.16301 gg^{-1}). On the other hand, the highest root weight ratio was found in EC_4 (0.16995 gg^{-1}). The results revealed that the lowest root weight ratio was found in EC_3. Meanwhile EC_1 denoted the root weight ratio.

There was no significant difference in root weight ratio of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 12). The lowest root weight ratio of capsicum was found in S_2EC_3 (0.1524 gg^{-1}). On the other hand, the highest root weight was found in S_1EC_4 (0.1824 gg^{-1}). T The results revealed that the lowest root weight ratio was found in S_2EC_3. Meanwhile S_1EC_4 denoted the highest root weight ratio.

4.2.5 Net assimilation rate (NAR)

Net assimilation rate of capsicum was significantly affected by different stem pruning and electrical conductivity (Table 11). The highest net assimilation of capsicum was found in S_2 (0.00491 $gcm^{-2}d^{-1}$). On the other hand, S_1 (0.0024 $gcm^{-2}d^{1}$) showed the lowest net assimilation rate. The results revealed that the highest net assimilation rate was found in S_2. Meanwhile S_1 denoted the lowest net assimilation. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum net assimilation rate of capsicum plant. Higher NAR is one of the important criteria for producing higher metabolites. Prieto *et al.* (2007) reported that increased NAR gave the plants an increased ability to intercept light.

Again, the highest net assimilation rate of capsicum was found in EC_3 (0.00203 $gcm^{-2}d^{-1}$). On the other hand, EC_1 (0.00094 $gcm^{-2}d^{-1}$) showed the lowest net assimilation rate. The results revealed that the highest net assimilation rate was found in EC_3. Meanwhile EC_1 denoted the lowest net assimilation rate. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum net assimilation rate of capsicum plant. Higher NAR is one of the important criteria for producing higher metabolites. Prieto *et al.* (2007) reported that increased NAR gave the plants an increased ability to intercept light.

The combined effect of stem pruning and electrical conductivity showed a significant impact on net assimilation rate (Table 12). The highest net assimilation rate of capsicum was found in S_2EC_3 (0.003766 $gcm^{-2}d^{-1}$). On the other hand, S_1EC_1 (0.00026 $gcm^{-1}d^{-1}$) showed the lowest net assimilation rate. The results revealed that S_2EC_3 indicated the highest net assimilation, whereas treatment S_1EC_1 denotes lowest net assimilation rate. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum net assimilation rate of capsicum plant. Higher NAR is one of the important criteria for producing higher metabolites. Prieto et al. (2007) reported that increased NAR gave the plants an increased ability to intercept light.

4.2.6 Relative growth rate

Relative growth rate of capsicum was significantly affected by different stem pruning and electrical conductivity (Table 11). The highest relative growth rate of capsicum was found in S_2 (0.0417 g $g^{-1}d^{-1}$). On the other hand, S_1 (0.0179 g $g^{-1}d^{-1}$) showed the lowest relative growth rate. The results revealed that the highest relative growth rate was found in S_2. Meanwhile S_1 denoted the lowest relative growth rate. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum relative growth rate of capsicum plant. Prieto *et al.* (2007) reported that increased RGR gave the plants an increased ability to intercept light which was similar with these findings.

Again, the highest relative growth rate of capsicum was found in EC_3 (0.03666 g $g^{-1}d^{-1}$). On the other hand, EC_1 (0.02420 g $g^{-1}d^{-1}$) showed the lowest relative growth rate. The results revealed that the highest relative growth rate was found in EC_3. Meanwhile EC_1 denoted the lowest relative growth rate. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum relative growth rate of capsicum plant. Prieto *et al.* (2007) reported that increased RGR gave the plants an increased ability to intercept light which was similar with these findings.

The combined effect of stem pruning and electrical conductivity showed a significant impact on relative growth rate (Table 12). The highest relative growth rate of capsicum was found in S_2EC_3 (0.05255 g $g^{-1}d^{-1}$). On the other hand, S_1EC_1 (0.01294 g $g^{-1}d^{-1}$) showed the lowest relative growth rate because of less vegetative growth. The results revealed that S_2EC_3 indicated the highest relative growth rate, whereas treatment S_1EC_1 denotes lowest relative growth rate. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum relative growth rate of capsicum plant. Prieto *et al.* (2007) reported that increased RGR gave the plants an increased ability to intercept light which was similar with these findings.

Table 11. Main effect of stem pruning system and electrical conductivity on physiological growth parameters of capsicum

Treatment	Growth parameters					
	LA (cm^2)	LMR ($g\ g^{-1}$)	LAR ($cm^2\ g^{-1}$)	RWR ($g\ g^{-1}$)	NAR ($g\ cm^{-2}\ d^{-1}$)	RGR ($g\ g^{-1}\ d^{-1}$)
Stem pruning (S)						
S_1	545.90 c[z]	0.3858	39.26 a	0.1740 a	0.0024 c	0.0179 c
S_2	597.10 a	0.4483 a	18.1452 c	0.15404 ab	0.00491 a	0.0417 a
S_3	570.76 b	0.41083 c	23.91 b	0.16201 b	0.00127 b	0.0298 b
Electrical conductivity (EC)						
EC_1	559.94 c	0.41222	33.1269 a	.16301	.00094 c	.02420 d
EC_2	568.25 b	.41777	28.0714 b	.16302	.00119 b	.02783 c
EC_3	582.63 a	.41222	21.6460 d	.16995	.00203 a	.03666 a
EC_4	574.20 b	.41666	25.5661 c	.16394	.00141 b	.03052 b
Level of significance (P)						
S	*	*	*	**	*	*
EC	*	NS	*	NS	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. LA = Leaf area, LMR = Leaf Mass Ratio, LAR = Leaf Area Ratio , RWR = Root weight Ratio, NAR = Net Assimilation Rate , RGR = Relative Growth Rate. NS = non-significant, ** = Significant at 1%, * = Significant at 5%

Table 12. Interaction effect of stem pruning system and electrical conductivity on physiological growth parameters of capsicum

Treatment	Growth parameters					
	LA (cm^2)	LMR ($g\ g^{-1}$)	LAR ($cm^2\ g^{-1}$)	RWR ($g\ g^{-1}$)	NAR ($g\ cm^{-2}\ d^{-1}$)	RGR ($g\ g^{-1}\ d^{-1}$)
S_1EC_1	532.42 j[z]	0.3800abcd	51.000990 a	o.1823	.00026 i	.01294 i
S_1EC_2	544.74 i	0.4400 abc	40.636780 b	0.1614	.00041 ih	.01656 ih
S_1EC_3	556.66 g	0.3900 d	29.45761 bc	0.1689	.00078 fgh	.02338 g
S_1EC_4	549.76 h	0.4567 ab	35.9276 b	0.1834	.0005 ghi	.01891 i
S_2EC_1	583.93 d	0.3867 d	21.2768 ef	0.1526	.00159 cd	.03393 cd
S_2EC_2	592.32 c	0.4247 d	19.1885 efg	0.1557	.00199 bc	.03818 bc
S_2EC_3	611.67 a	0.4700 a	14.4511 g	0.1525	.003766 a	.05255 a
S_2EC_4	600.48 b	0.3867d	17.6642 fg	0.1698	.00238 b	.04203 b
S_3EC_1	563.46 f	0.4233abcd	27.1028 cd	0.1542	.00095 efg	.02573 fg
S_3EC_2	567.69 ef	0.4200 bcd	24.3888 cde	0.1699	.00118 def	.02878 ef
S_3EC_3	579.55 d	0.3933 cd	21.0294 ef	0.1528	.00162 cd	.03406 cd
S_3EC_4	572.35 e	0.4067cd	23.1065 ed	0.1567	.00133 de	.03062 de
P	*	*	*	NS	*	*

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m. LA = Leaf area, LMR = Leaf Mass Ratio, LAR = Leaf Area Ratio , RWR = Root Weight Ratio, NAR = Net Assimilation Rate , RGR = Relative Growth Rate. P = level of significance, NS = non-significant, * = Significant at 5%

4.3 Ascorbic acid content

Ascorbic acid content of sweet pepper was significantly affected by different stem pruning (Figure 7). The highest ascorbic acid content of capsicum was found in S_2 (180.58 cc). On the other hand, the lowest ascorbic acid content of capsicum was found in S_1 (141.94 cc). The results revealed that the highest ascorbic acid was found in S_2. Meanwhile S_1 denoted the lowest ascorbic acid. This might be due to the pruning style of branches. In S_2, two branches remain which might be the suitable for its maximum ascorbic acid content of capsicum plant.

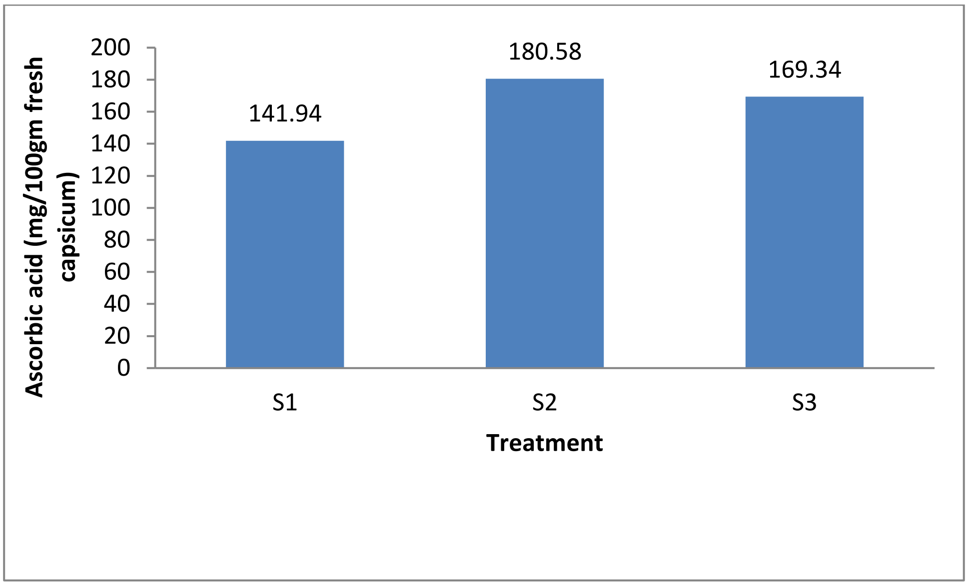

Figure 7: Effect of stem pruning system on ascorbic acid contents in capsicum

[z]Means with different letters are significantly different by Tukey's test at P ≤ 0.05. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m.

Ascorbic acid content of capsicum was significantly affected by different electrical conductivity (Figure 8).Again, the highest ascorbic acid content of capsicum was found in EC_3 (177.55 cc). On the other hand the ascorbic acid content of capsicum was found in EC_1 (147.76 cc). The results revealed that the highest ascorbic acid was found in EC_3. Meanwhile EC_1 denoted the lowest ascorbic acid. This might be due to the electrical conductivity of nutrient solution. In EC_3, EC_3= 4.0 dS/m which might be the suitable for its maximum ascorbic acid content of capsicum.

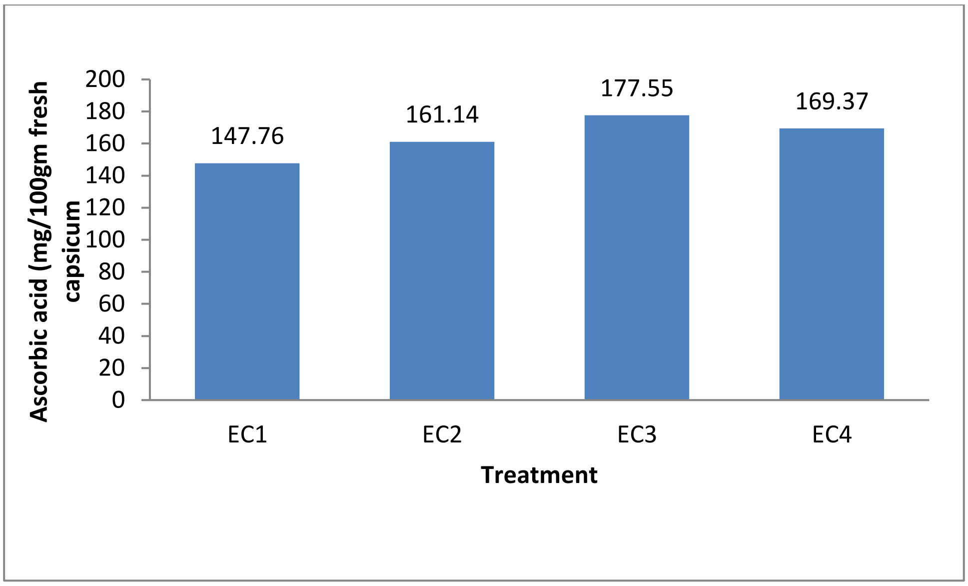

Figure 8: Effect of electrical conductivity on ascorbic acid contents in capsicum

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m.

There was significant difference in ascorbic acid content of capsicum in respect of combined effect of stem pruning and electrical conductivity of nutrient solution (Table 12). The highest ascorbic acid content of capsicum was found in S_2EC_3 (202.03 cc). On the other hand, the lowest ascorbic acid content of capsicum was found in S_1EC_1 (132.7 cc). The results revealed that the highest ascorbic acid was found in S_2EC_3. Meanwhile S_1EC_1 denoted the lowest ascorbic acid. This might be due to the combined effect of pruning style of branches and electrical conductivity of nutrient solution. In S_2EC_3, combined effect two branches remain and EC_3 = 4.0 dS/m which might be the suitable for its maximum capsicum of capsicum.

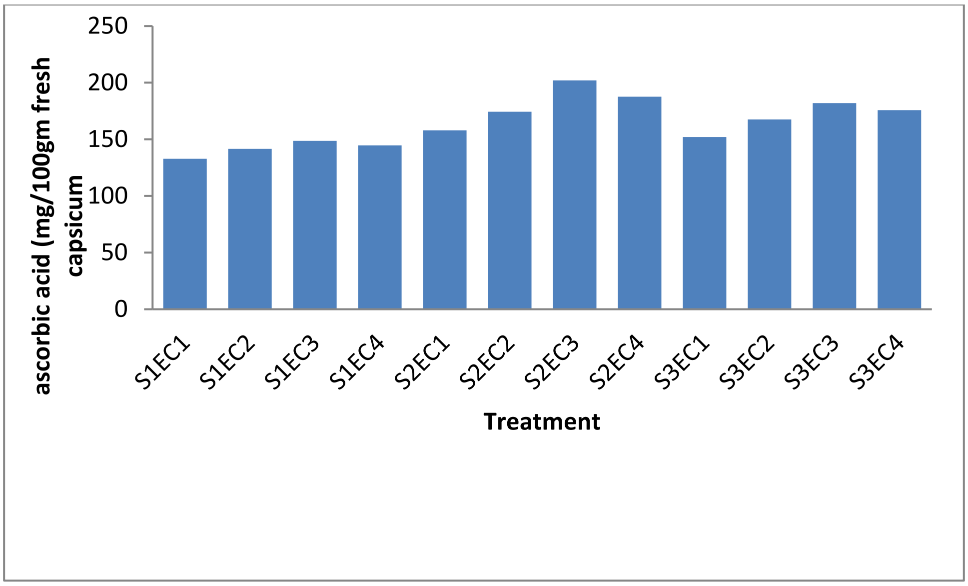

Figure 9: Interaction effects of stem pruning system and electrical conductivity on ascorbic acid content in capsicum.

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m.

4.4 Benefit cost ratio

Input costs for, structural preparation, media, irrigation pipe, seed, nutrient solution and manpower required for all the operations from seed sowing to harvesting of capsicum were recorded for unit box and converted into cost per hectare (Appendix V). Price of capsicum was considered as per market rate. The economic analysis presented under the following headings-

4.4.1 Gross return

The interaction effect of stem pruning and electrical conductivity showed different values in terms of gross return under the treatment (Table 13). The highest gross return (Tk. 348500) was found S_2EC_3 and the lowest gross return (Tk. 170000) was obtained from S_1EC_1.

4.4.2 Net return

In case of net return, different treatment combination showed different levels of net return (Table 13). The highest net return (Tk. 190625) was found from the treatment combination S_2EC_3 and the lowest (Tk. 12125) net return was obtained S_1EC_1.

Table 13. Benefit cost ratio and return of capsicum cultivation as influenced by stem pruning and electrical conductivity

Treatment	Cost of production (Tk/500sft)	Yield of capsicum (Kg/500sft)	Gross return (Tk/500sft)	Net return (Tk/500sft)	Benefit cost ratio (BCR)
S_1EC_1	157875	357	170000	12125	1.07
S_1EC_2	157875	391	195500	37625	1.24
S_1EC_3	157875	425	212500	54625	1.34
S_1EC_4	157875	408	204000	46125	1.30
S_2EC_1	157875	527	263500	105625	1.67
S_2EC_2	157875	561	280500	122625	1.78
S_2EC_3	157875	697	348500	190625	2.21
S_2EC_4	157875	578	289000	131125	1.83
S_3EC_1	157875	442	221000	63125	1.40
S_3EC_2	157875	476	238000	80125	1.51
S_3EC_3	157875	544	272000	114125	1.72
S_3EC_4	157875	493	246500	88625	1.56

[z]Means with different letters are significantly different by Tukey's test at $P \leq 0.05$. P represents the level of significance of two-way of variance. S_1 = No pruning, S_2 = two branches present, S_3 = four branches present. EC_1 = 2.0 dS/m, EC_2 = 3.0 dS/m, EC_3 = 4.0 dS/m, EC_4 = 5.0 dS/m.

Market price capsicum: @ Tk. 500/kg

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted in the semi green house at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh during November 2017 to April 2018. Three different types of stem pruning system viz S_1 = No pruning, S_2= Two branches present, and S_3= Four branches present; and four levels of electrical conductivity viz EC_1= 2.0 dS/m, EC_2= 3.0 dS/m, EC_3= 4.0 dS/m and EC_4= 5.0 dS/m were used in this experiment. Crop growth, yield, and physiological traits of capsicum were measured in the experiment. The summary was described here.

Results showed that three stem pruning system of capsicum had significant effect on growth and yield of capsicum. In case of growth parameters of capsicum, the highest plant (100.11 cm) was recorded from plant grown in S_2 while the shortest plant height (87.95 cm) was recorded from S_1, in case of fruit length, the highest fruit length (7.48 cm) was recorded from the plant grown in S_2 and the lowest fruit length (5.39 cm) recorded from the plant grown in S_1, in case of fruit diameter, higher fruit diameter (6.30 cm) was recorded from plant grown in S_2 and lower fruit diameter (4.49 cm) recorded from plant grown in S_1 , in case of fruit volume, higher fruit volume (190.91 cc) was recorded from plant grown in S_2 and lower fruit volume (128.0 cc) recorded from plant grown in $S_{1,}$ in case of number of fruit per plant, the maximum (8.25) number of fruit per plant was recorded from plant grown in S_2 while the minimum number of fruit/plant (4.75) was recorded plant grown in S_1, in case of individual fruit weight, the highest (161.78 g) individual fruit weight was recorded from plant grown in S_2 while the lowest individual fruit weight (99.76 g) was recorded plant grown in S_1, in case of leaf fresh weight at 180 DAT, the maximum leaf fresh weight (69.30 g/plant) was recorded from the plant grown in S_2 and minimum leaf fresh weight (39.42 g/plant) recorded from the plant grown in S_1, in case of stem fresh weight at 180 DAT, the maximum stem fresh weight (79.88 g/plant) was recorded from the plant

grown in S_2 and the minimum stem fresh weight (40.75 g/plant) recorded from the plant grown in $S_{1,}$in case of root fresh weight at 180 DAT, the maximum root fresh weight (36.12 g/plant) was recorded from the plant grown in S_2 and the minimum root fresh weight (22.93 g/plant) recorded from the plant grown in $S_{1.}$In case of dry weight of capsicum leaf at 180 DAT, the highest leaf dry weight was found in S_2 (13.04 g) and the lowest leaf fresh weight was found in S_1 (6.56 g), in case of dry weight of capsicum stem at 180 DAT, the highest stem dry weight was found in S_2 (15.17 g) and the lowest stem fresh weight was found in S_1 (5.47 g), in case of dry weight of capsicum root at 180 DAT, the highest root dry weight was found in S_2 (5.50g) and the lowest root fresh weight was found in S_1 (2.52 g). In case of ascorbic acid content of 100gm capsicum, the highest ascorbic acid content was found in S_2 (180.58 mg) and the lowest ascorbic acid content was found in S_1 (141.94mg).
Different physiological parameters; viz. in case of leaf area (LA), the higher leaf area (LA) was found in S_2 and the lower was found in S_1, in case of Leaf Mass Ratio (LMR), the higher Leaf Mass Ratio (LMR) was found in S_2 and the lower was found in $S_{1,}$ in case of Leaf Area Ratio (LAR), the lower Leaf Area Ratio (LAR) was found in S_2 while the higher was found in S_1, in case of Root Weight Ratio (RWR), the lowest Root Weight Ratio (RWR) was found in S_2 while the highest was found in S_1, in case of Net Assimilation Rate (NAR), the highest Net Assimilation Rate (NAR) was found in S_2 and the lowest was found in S_1,in case of Relative Growth Rate (RGR), the highest Relative Growth Rate (RGR) was found in S_2 and the lowest was found in S_1. Best result was found from plant grown in S_2. That means, the two branches stem gave highest yield and No pruning and electrical conductivity 2.0 dS/m gave lowest yield.

Results showed that electrical conductivity of nutrient solution of capsicum plant had significant effect on growth and yield of capsicum. In case of growth parameters of capsicum, highest plant (94.36 cm) was recorded from plant grown in EC_3 while the shortest plant height (88.50 cm) was recorded from EC_1, in case of fruit length, highest fruit length (7.99 cm) was recorded from the plant grown in EC_3 and lowest fruit length (4.28 cm) recorded from the plant grown in EC_1, in case of fruit diameter, higher fruit diameter (6.82 cm) was recorded from plant grown in EC_3 and lower fruit diameter (3.86 cm) recorded from plant grown in EC_1 , in case of fruit volume, higher fruit volume (184.81 cc) was recorded from plant grown in EC_3 and lower fruit volume (132.43 cc) recorded from plant grown in $EC_{1,}$ in case of number of fruit per plant, the maximum (8.89) number of fruit per plant was recorded from plant grown in EC_3 while the minimum number of fruit/plant (4.44) was recorded plant grown in EC_1, in case of individual fruit weight, the highest (155.5 g) individual fruit weight was recorded from plant grown in EC_3 while the lowest individual fruit weight (106.1 g) was recorded plant grown in EC_1, in case of leaf fresh weight at 180 DAT, the maximum leaf fresh weight (62.46 g/plant) was recorded from the plant grown in EC_3 and minimum leaf fresh weight (49.24 g/plant) recorded from the plant grown in EC_1, in case of stem fresh weight at 180 DAT, the maximum stem fresh weight (68.42 g/plant) was recorded from the plant grown in EC_3 and the minimum stem fresh weight (54.66 g/plant) recorded from the plant grown in $EC_{1,}$in case of root fresh weight at 180 DAT, the maximum root fresh weight (32.22 g/plant) was recorded from the plant grown in EC_3 and the minimum root fresh weight (25.83 g/plant) recorded from the plant grown in $EC_{1.}$In case of dry weight of capsicum leaf at 180 DAT, the highest leaf dry weight was found in EC_3 (12.11 g) and the lowest leaf dry weight was found in EC_1 (7.98 g), in case of dry weight of capsicum stem at 180 DAT, the highest stem dry weight was found in EC_3 (12.67 g) and the lowest stem dry weight was found in EC_1 (8.52g), in case of dry weight of capsicum root at 180 DAT, the highest root dry weight was found in EC_3 (4.89 g) and the lowest root dry weight was found in EC_1 (3.10 g). In case of ascorbic acid content of 100gm sweet pepper, the highest ascorbic acid content was found in EC_3 (177.55mg) and the lowest ascorbic acid content was found in EC_1 (147.76 mg).

Different physiological parameters; viz. in case of leaf area (LA), the higher leaf area (LA) was found in EC_3 and the lower was found in EC_1, in case of Leaf Mass Ratio (LMR), the higher Leaf Mass Ratio (LMR) was found in

$EC_3$and the lower was found in EC_1, in case of Leaf Area Ratio (LAR), the lower Leaf Area Ratio (LAR) was found in EC_3 while the higher was found in EC_1, in case of Root Weight Ratio (RWR), the lower Root Weight Ratio (RWR) was found in EC_3 while the higher was found in EC_1, in case of Net Assimilation Rate (NAR), the higher Net Assimilation Rate (NAR) was found in EC_3 and the lower was found in EC_1, in case of Relative Growth Rate (RGR), the higher Relative Growth Rate (RGR) was found in EC_3 and the lower was found in EC_1. Best result was found from plant grown in EC_3. That means, electrical conductivity 4.0 dS/m gave highest yield and electrical conductivity 2.0 dS/m gave lowest yield.

Interaction effect of stem pruning system and different electrical conductivity of nutrient solution also significantly affected on physiological growth as well as yield of capsicum. In case of growth parameters of capsicum, highest plant (104.83 cm) was recorded from plant grown in S_2EC_3 while the shortest plant height (82.00 cm) was recorded from S_1EC_1, in case of fruit length, highest fruit length (9.47 cm) was recorded from the plant grown in S_2EC_3 and lowest fruit length (3.83 cm) recorded from the plant grown in S_1EC_1, in case of fruit diameter, higher fruit diameter (8.03 cm) was recorded from plant grown in S_2EC_3 and lower fruit diameter (3.17 cm) recorded from plant grown in S_1EC_1 , in case of fruit volume, higher fruit volume (220.70 cc) was recorded from plant grown in S_2EC_3 and lower fruit volume (108.97 cc) recorded from plant grown in S_1EC_1, in case of number of fruit per plant, the maximum (12.0) number of fruit per plant was recorded from plant grown in S_2EC_3 while the minimum number of fruit/plant (3.0) was recorded plant grown in S_1EC_1, in case of individual fruit weight, the highest (190.83 g) individual fruit weight was recorded from plant grown in S_2EC_3 while the lowest individual fruit weight (82.33 g) was recorded plant grown in S_1EC_1, in case of leaf fresh weight at 180 DAT, the maximum leaf fresh weight (76.81 g/plant) was recorded from the plant grown in S_2EC_3 and minimum leaf fresh weight (32.86 g/plant) recorded from the plant grown in S_1EC_1, in case of stem fresh weight at 180 DAT, the maximum stem fresh weight (89.20 g/plant) was recorded from the plant grown in S_2EC_3 and the minimum stem fresh weight (35.67 g/plant) recorded from the plant grown in S_1EC_1,in case of root fresh weight at 180 DAT, the maximum root fresh weight (41.67 g/plant) was recorded from the plant grown in S_2EC_3 and the minimum root fresh weight (20.26 g/plant) recorded from the plant grown in S_1EC_1.In case of dry weight of capsicum leaf at 180 DAT, the highest leaf dry weight was found in S_2EC_3 (16.52 g) and the lowest leaf dry weight was found in S_1EC_1 (4.49 g), in case of dry weight of capsicum stem at 180 DAT, the highest stem dry weight was found in S_2EC_3 (18.74 g) and the lowest stem dry weight was found in S_1EC_1 (4.11 g), in case of dry weight of capsicum root at 180 DAT, the highest root dry weight was found in S_2EC_3 (7.24 g) and the lowest root fresh weight was found in S_1EC_1 (1.89 g). In case of ascorbic acid content of 100g sweet pepper, the highest ascorbic acid content was found in S_2EC_3 (202.03 mg) and the lowest ascorbic acid content was found in S_1EC_1 (132.70 mg).

Different physiological parameters; viz. in case of leaf area (LA), the higher leaf area (LA) was found in S_2EC_3 and the lower was found in S_1EC_1, in case of Leaf Mass Ratio (LMR), the higher Leaf Mass Ratio (LMR) was found in S_2EC_3 and the lower was found in S_1EC_1, in case of Leaf Area Ratio (LAR), the lower Leaf Area Ratio (LAR) was found in S_2EC_3 while the higher was found in S_1EC_1, in case of Root Weight Ratio (RWR), the lower Root Weight Ratio (RWR) was found in S_2EC_3 while the higher was found in S_1EC_1, in case of Net Assimilation Rate (NAR), the highest Net Assimilation Rate (NAR) was found in S_2EC_3 and the lowest was found in S_1EC_1,in case of Relative Growth Rate (RGR), the highest Relative Growth Rate (RGR) was found in S_2EC_3 and the lowest was found in S_1EC_1. Best result was found from plant grown in S_2EC_3. That means, the two branches stem and electrical conductivity 4.0 dS/m gave highest yield and No pruning and electrical conductivity 2.0 dS/m gave lowest yield.

CONCLUSIONS

According to the findings of the present experiment, the following conclusions were drawn.

1. Improved physicochemical properties were found in two branches remain and electrical conductivity at 4.0 dS/m (S_2EC_3) for growing capsicum in aggregate hydroponic system.

2. Higher fruit yield and other vegetative growth parameters and physiological traits of capsicum were found in S_2EC_3 treatment in aggregate hydroponic system.

3. Higher benefit cost ratio was found in S_2EC_3 and lower benefit cost ratio was found in S_1EC_1.

Therefore, it can be concluded that two branches remain and electrical conductivity 4.0 dS/m of nutrient solution is suitable for capsicum production in aggregate hydroponic system in Bangladesh.

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APPENDICES

Appendix I. Analysis of variances of plant height at different days after transplanting (DAT) of capsicum

Sources of variation	Degrees of freedom (df)	Means squares for plant height at different days after transplanting (DAT) (cm)						
		0 DAT	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Stem pruning (S)	2	103.601**	211.623*	350.205**	386.505**	468.736**	429.927**	457.979**
Electrical conductivity(EC)	3	128.812*	150.563*	187.281**	271.430*	449.263*	455.561*	458.548*
S×EC	6	32.614	53.98	80.901	95.889	127.018	120.654	126.194
Error	24	1.170	4.166	4.916	9.678	10.779	8.702	7.224

S= Stem pruning (S_1 = No pruning, S_2= Two branches present, and S_3 = Four branches present). EC= Electrical conductivity (EC_1 = 2.0 dS/m, EC_2 = 3 dS/m, EC_3 = 4.0 dS/m and EC_4 = 5.0 dS/m).

** indicates significant at 1% level of probability.

* indicates significant at 5% level of probability.

Appendix II. Analysis of variances of fruit parameters

Sources of variation	Degrees of freedom (df)	Mean square				
		Fruit length (cm)	Fruit diameter (cm)	fruit weight (cm)	fruit volume (cc)	No of fruit/plant
Stem pruning (S)	2	13.344*	9.977*	11539.201*	11872.377*	49.00*
Electrical conductivity (EC)	3	47.228*	39.903*	12281.962*	13696.070*	89.639*
S×EC	6	6.813	5.493	3267.402	3452.169	17.765
Error	24	.319	.346	109.476	99.117	.722

S= Stem pruning (S_1 = No pruning, S_2= Two branches present, and S_3 = Four branches present). EC= Electrical conductivity (EC_1 = 2.0 dS/m, EC_2 = 3 dS/m, EC_3 = 4.0 dS/m and EC_4 = 5.0 dS/m).

* indicates significant at 5% level of probability.

Appendix III. Analysis of variances of fresh weight of different part of capsicum

Sources of variation	Degrees of freedom (df)	Mean Square of Fresh of weight plant		
		Leaf	Stem	Root
Stem pruning (S)	2	2741.359*	4621.986*	532.467*
Electrical conductivity (EC)	3	864.541*	923.541*	200.187*
S×EC	6	578.557	928.436	118.825
Error	24	3.286	1.617	2.022

S= Stem pruning (S_1 = No pruning, S_2= Two branches present, and S_3 = Four branches present). EC= Electrical conductivity (EC_1 = 2.0 dS/m, EC_2 = 3 dS/m, EC_3 = 4.0 dS/m and EC_4 = 5.0 dS/m).

* indicates significant at 5% level of probability.

Appendix IV. Analysis of variances of dry weight of different part of capsicum

Sources of variation	Degrees of freedom (df)	Mean Square of dry of weight plant		
		Leaf	Stem	Root
Stem pruning (S)	2	125.980*	282.702*	26.979*
Electrical conductivity (EC)	3	82.119*	80.622*	16.526*
S×EC	6	31.679	59.779	6.795
Error	24	.325	.186	.410

S= Stem pruning (S_1 = No pruning, S_2= Two branches present, and S_3 = Four branches present). EC= Electrical conductivity (EC_1 = 2.0 dS/m, EC_2 = 3 dS/m, EC_3 = 4.0 dS/m and EC_4 = 5.0 dS/m).

^{NS} indicates nonsignificant

* indicates significant at 5% level of probability.

Appendix V. Production cost of capsicum (500 sft)

Treatment	Cost of lease of land (500sft)	Structural preparation (Tk)	Media (Tk)	Irrigation pipe (Tk)	Seed and seedling (Tk)	Nutrient solution (Tk)	Labour cost (Tk)	Miscellaneous cost (Tk)	Total cost (Tk)
S_1EC_1	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_1EC_2	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_1EC_3	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_1EC_4	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_2EC_1	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_2EC_2	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_2EC_3	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_2EC_4	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_3EC_1	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_3EC_2	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_3EC_3	4875	48000	12000	32000	3000	8000	30000	20000	157875
S_3EC_4	4875	48000	12000	32000	3000	8000	30000	20000	157875

S= Stem pruning (S_1 = No pruning, S_2= Two branches present, and S_3 = Four branches present). EC= Electrical conductivity (EC_1 = 2.0 dS/m, EC_2 = 3 dS/m, EC_3 = 4.0 dS/m and EC_4 = 5.0 dS/m).

Plate 5: Fruit of capsicum