EFFECT OF GIBBERELLIC ACID AND CLYBIO ON GROWTH AND YIELD OF SAU YELLOW CHERRY TOMATO

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CERTIFICATE

*This is to certify that the thesis entitled, "**EFFECT OF GIBBERELLIC ACID AND CLYBIO ON GROWTH AND YIELD OF SAU YELLOW CHERRY TOMATO"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS)** in **HORTICULTURE**, embodies the result of a piece of bona fide research work carried out by **JANNATUL FERDOWS,** Registration number: **15-06572,** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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The Author

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ABSTRACT

An experiment was conducted in Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka-1207 during December 2021 to April 2022. The study was carried out to investigate the effect of different concentrations of gibberellic acid (G_0: 0mg/L, G_1: 25mg/L, G_2: 50mg/L) and different concentrations of clybio (C_0: 0ml/L, C_1: 4ml/L, C_2: 6ml/L) on growth and yield of the SAU yellow cherry tomato. The experiment was conducted in Randomized Completely Block Design (RCBD) with 3 replications. For this study, data were calculated on average plant height, number of branches, number of clusters, number of flowers per plant, number of fruits per plant, fruit length, fruit weight, yield per plant, SPAD value. The maximum plant height (199.8 cm), maximum number of branch (6.3), maximum number of clusters (31.7), the highest number of flowers per plant (2685.7), highest number of fruits per plant (1212.3), maximum fruit length (26.3 mm), highest individual fruit weight (8.8 g), maximum average yield per plant (10.7 kg), maximum SPAD value (71.7) were found in G_2C_2 concentration (G_2-50 mg/L, C_2-6 ml/L). While the minimum plant height (149.2 cm), minimum number of branch (3.7), minimum number of clusters (18.0), minimum number of flowers per plant (1295.3), minimum number of fruits per plant (590.7), minimum fruit length (18.3 mm), the lowest individual fruit weight (5.5 g), minimum average yield per plant (3.3 kg), minimum SPAD value (46.6) were found in G_0C_0 (No treatment/control). G_2C_2 concentration (G_2-50 mg/L, C_2-6 ml/L) is the prominent application on growth and yield of SAU yellow cherry tomato.

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LIST OF ABBREVIATED TERMS

AEZ	=	Agro-Ecological Zone
Agric.	=	Agriculture
Agril.	=	Agricultural
ANOVA	=	Analysis of Variance
BARI	=	Bangladesh Agricultural Research Institute
Coeff.	=	Coefficient
cm	=	Centimeter
CV	=	Coefficient of Variation
CV %	=	Percentage of Coefficient of Variation
DAT	=	Days After Transplanting
EM	=	Effective Microorganism
et al.	=	And others
Fig.	=	Figure
g	=	Gram
Hort.	=	Horticulture
IM	=	Irrigation Method
J.	=	Journal
Kg	=	Kilogram
LSD	=	Least Significant Difference
mm	=	Millimeter
RCBD	=	Randomized Complete Block Design
SAU	=	Sher-e-Bangla Agricultural University
Viticult	=	Viticulture

CHAPTER I

INTRODUCTION

Cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*) is a cultivated variety of tomato belonging to the family Solanaceae. It is thought to have originated in Peru and Northern Chile. It is the probable ancestor of all the cultivated tomatoes. The variety is generally considered to be similar but not identical to the wild relatives of the domestic tomato (Prema *et al*., 2011). Cherry tomatoes are widely cultivated in Central America and distributed in California, Korea, Germany, Mexico and Florida. It is grown for its edible fruits; these are perfect for making processed products like sauce, soup, ketchup, puree, curries, paste, powder, rasam and sandwitch (Anonymous, 2009). It is a popular type of table tomato with small fruits (1.5-3.5 cm in diameter) on long panicles and its demand for has been increased in the market, chiefly due to the recognition of their high quality and good taste (Kobryn and Hallmann, 2005). Cherry tomato is beneficial to human health because of its high contents of antioxidants and phytochemical compounds, including lycopene, β-carotene, flavonoids, vitamin C and many essential nutrients (Rosales *et al*., 2011). They are a great source of vitamin C (13 mg/100 g), dietary fibre (2.0 g), vitamin A (25%) and vitamin K and also a good source of vitamin E (Alpha Tocopherol), thiamine, niacin, vitamin B_6, foliate, phosphorus, copper, potassium and manganese (Anonymous, 2009). Cherry tomato is a tomato variety with small fruit, different shapes and colours and mainly used for fresh consumption. It has a sweeter taste, intense colour and flavour, generally round and weighing 10 to 30g (Prema *et al*., 2011). Its fruits are consumed more as a salad rather than as a vegetable. Cherry tomato often called 'Salad tomato too'.

A new variety of yellow cherry tomato called Golden Purna has been adapted in the climatic condition of Bangladesh. Recently, it has been recognised by the National Seed Board. Post graduate student of Sher-e-Bangla Agricultural University (SAU) named Rakibuzzaman Moni and Rahul Sheikh under the supervision of Dr Jamal Uddin, a professor of Horticulture conducted the research. According to the university name, they named it 'SAU Yellow Cherry Tomato (Golden Purna)'. Researchers already mentioned it will give about 2 times higher yield than other varieties of cherry tomato. SAU yellow cherry tomato is a yellow-coloured tomato which attracts people more; has a powerful immunity and contains carotenoid which is very beneficial for human eyes.

Due to the growing population, a major challenge of agriculture is to increase food production to meet the global food demand without damaging the environment. In the recent era, consumer preference for organic and safe production as well as public concerns about the negative effects of chemicals fertilizer on the environment and human health are increasing. Due to their safe and environment-friendly nature, bio-fertilizer applications are increasing day by day. Bio-fertilizer application is very efficient for organic and safe crop production.

Gibberellins, one of the natural plant growth regulators, are among the most widely used plant hormones in the world. In plants gibberellins are abundant in buds, embryos, roots, young leaves, flowers, fruits, and cambiums. Among the gibberellins, GA_3 (Gibberellic acid) is the most widely used in agriculture. GA_3 have a potential effect on growth and yield of plant. GA_3 substitutes for pollination and fertilization, high temperatures probably have a much less negative impact on GA_3 treated plants (Raquel and Rebecca, 1998). GA_3 enhances chlorophyll synthesis and increases efficiency of photosynthetic materials thus increases the rate of photosynthesis (Sardoei and Shahdadneghad, 2014). GA_3 increases cell division, causes cell enlargement thus causes tissues development and growth of the plant. GA_3 also increases flowering, fruit setting and the size of fruits (Williamson *et al*., 1995).

Effective microorganism (EM) is a concept and technology that was developed by Professor Teruo Higa, University of the Ryukyus, Okinawa, Japan. EM consists of mixed culture of some naturally occurring microorganisms (i.e., bacteria, fungi, actinomycetes and yeast) (Higa, 1988). Effective microorganisms (EM) maintain the soil ecological balance by supress the harmful pathogen and enhance soil quality. Microorganisms enhance the nutrient uptake of the plant by breakdown of complex nutrient sources. It also increases the crop yield by increasing the photosynthetic efficiency and improve the crop quality. Microorganisms that contained in EM produce plant hormones, beneficial bioactive substances and antioxidants while solubilize nutrients (Higa, 1994). Effective microorganisms are not widespread in Bangladesh. There are many EM brands are produced all over the world. Clybio is one kind of EM Brand that is produced by Cribio Co. Ltd. Japan. Clybio an organic biofertilizer popular at Japan successfully adopted on vegetables production of Bangladesh by Prof Dr A F M Jamal Uddin, Department of Horticulture, Sher-e-Bangla Agricultural University (SAU) collaboration with Aqua Company of Japan. Clybio is the unique and complex microbe that contains bacteria like

Lactobacilli bacteria, Lactic acid bacteria, Bacillus natto bacteria and yeast fungus. It has the potentiality to improve the crops growth, yield and quality parameters.

Like other developing countries, the population of Bangladesh has been increasing day by day and there is a threat of food shortage in near future. The research project was initiated to find out the best levels of gibberellic acid and clybio also its amount of application for the maximum growth and yield of SAU yellow cherry tomato crop.

Considering the above facts and present situation, the study has been undertaken the following objectives:

i. to evaluate the influence of gibberellic acid concentration on growth and yield of SAU yellow cherry tomato;
ii. to investigate the influence of clybio concentration on growth and yield of SAU yellow cherry tomato; and
iii. to find out the suitable combination of gibberellic acid and clybio concentration on growth and yield of SAU yellow cherry tomato.

CHAPTER II

REVIEW OF LITERATURE

A comprehensive and critical review of past researches is very essential for any scientific investigation. It provides not only knowledge of work already done in the field but insight in the methods and procedures too. It furthers provides a basis for operational definitions of major concepts. Relevant reviews also support the results and discussion of the study.

Some of the significant research works have been done home and abroad related to this experiment have been presented (year wise) in this chapter.

Uddin (2021) conducted research on 'Organic Bio-stimulator Application on Growth and Yield of Strawberry'. The application of inorganic and synthetic chemicals has increased vastly and has a negative impact on human health as well as environment. The aim of this study was to investigate the influence of organic bio-stimulator on growth and yield attributes of strawberry. The experiment was consisted of four treatments, T_0: Control; T_1: Neem oil; T_2: Bordeaux mixture; T_3: Clybio; and arranged in Randomized Complete Block Design (RCBD) with three replications. The effects on vegetative growth, yield attributes and fruit quality (Brix %) were investigated and they showed significant variation. Furthermore, strawberry fruit color (fruit skin and flesh) measured and expressed through L* (lightness), a* and b* (two Cartesian coordinates) including C* and hab (Chroma & Hue angle) based on CIELab scale. The results showed that, clybio (T_3) and bordeaux mixture (T_2) treatment more prominently enhanced vegetative growth (crown height, SPAD value, runner number) and yield attributes (flower number, fruit length); maximum fruit number (26.3), fruit weight (25.3 g), Brix value (7.1) recorded in T_3 treatment, and clybio led to greater improvement in fruit yield (69.6%) over control treatment. So, it can be concluded that clybio can be recommended as a bio-fertilizer that had the bio-stimulating impact to improve vegetative growth as well as higher yield.

Shoaib (2019) in his journal new variety of yellow cherry tomato called Golden Purna and SAU Professor Dr Jamal Uddin added a new variety of yellow cherry tomato called Golden Purna has been adapted in the climatic condition of Bangladesh. In 2014, Prof Dr Jamal started this research with the seed of cherry tomato which he collected from Japan and tried to get adaptability of those seed in the climatic condition of Bangladesh. He also added after continuous efforts of long five (5) years, he got the success. Recently, it has

been recognized by the National Seed Board, according to the researchers, this new variety can be cultivated everywhere in Bangladesh.

Nurul *et al.* (2019) conducted a field experiment aim to performance of new variety of cherry tomato in Bangladesh and said that new varieties of cherry tomatoes would spread all over the country and people would benefit from it. He added that the tomato is attractive to look at, delicious to eat and the kids love it. highest yield of cherry tomatoes should invent in the country for unique in form and quality and enriched in nutrients. To make the color, shape and immunity rich new variety of tomatoes should release and that would increase the farmers profitability.

Abdel-Gawad and Youssef (2019) reported that an experiment was conducted at Experimental Farm, Faculty of Agriculture, Al-Azhar University, Egypt during the winter season of 2017 to 2018. The purpose was to evaluate the response of Faba bean to foliar application of Yeast extract, Bio-fertilizer and Humic acid. Results showed that foliar application of Yeast extract (10 g/L) increased growth and yield significantly.

Al Rubaye *et al.* (2019) directed a field experiment that was carried out in loam soil at the research station of the College of Agriculture University of Baghdad, using randomized complete block design. The experiment included three local biofertilizers types (*Bacillus megaterium, Pseudomonas fluorescens, Azotobacter chrococcum*) and an imported biofertilizer (Nitrosoil) by Iraqi's Ministry of Agriculture, besides, two levels of mineral fertilization (50% and 75%) of the mineral fertilizer recommendation with use of two types of carriers (corn cobs residue, broth liquid medium) in addition to the control treatments. Three replicates for each treatment were used on growth and yield of potato. The results showed a significant effect of biofertilizer in most of the studied traits. The results also showed that use of local biofertilizer with (75%) of mineral fertilizer increased plant height, dry weight of the total vegetables part of plants and total yield tuber with value reached 73.53 cm, 2.48 and 21.97 Mg ha-1 12.33 respectively, compared with the imported biofertilizer and control treatments, while the results showed that the use of half of the fertilizer 9 recommendation with local bio-fertilization carried with liquid medium was sufficient to reach the best amount of nitrogen and phosphorus concentration by the plants in which the value reached to 2.62%, 0.79% compared to imported biofertilizer treatment which showed superiority in the amount of potassium absorbed to the same level of the recommendation and the value was 1.20%.

El-Ramady *et al*. (2018) an experiment on Nano fertilizers vs. Bio fertilizers: New Insights State that Bio and Nano fertilizers are one of the most important tools in modern agriculture and agri-food as well as a driving economic force in the near future. Also, bio and Nano fertilizers also play an important role as promising methods for increasing use efficiency of different water and land resources, reducing environmental pollutions as well. So, environment friendly biotechnological approaches may offer alternatives to chemical fertilizers. Types of bio-fertilizers such as Rhizobium, Azospirillum, Cyanobacteria, Azolla, Azotobacter and Acetobaceteras well as P, K and Zn solubilizer microbes are the most important microbial traits in soil biogeochemical cycles and plant growth promotion.

Karunarathna and Seran (2016) conducted a study to assess the effect of effective microorganisms (EM) along with cattle manure on growth and yield of capsicum (Capsicum annum L.) at the Crop farm, Eastern University, Sri Lanka. Six treatments with three replications were arranged in a Randomized Complete Block Design. The treatments were T_1: Inorganic fertilizer application, T_2: No fertilizer application, T_3: Cattle manure 5 t/ha + EM, T_4: Cattle manure 10 t/ha + EM, T_5: Cattle manure 15 t/ha + EM and T_6: Cattle manure 20 t/ha + EM. The results showed that there was no significant difference in canopy height among the treatments up to 20 DAT. Remarkable variations in number of leaves per plant at 10, 20 and 30 DAT which was confirmed with P values of 0.197, 0.700 and 0.075 and chisquare of 7.33, 3.00 and 10.00 respectively. The diameter of pod was increased up to 3rd picking thereafter it was decreased in most of the treatments. Increasing cattle manure from T_3 to T_4 increased number of pods per plant. Fresh weight of pods, number of seeds per pod and dry weights of pods and seeds were high in T_4.

Kang (2016) directed a study on the govern of Lactobacillus in Modern Agriculture Practice using Lactobacillus to fortified fertilizer, put them in the land, cultivation improves. It also allows for slow release of nutrients found in the rhizosphere to be absorbed by the plants slowly over time. The roots become healthy upon inspection and exudates composition dependent and disease suppressive soil allows for a progressive soil remediation. Most amazing the farmers also attested to the benefits of using lactobacillus, such as being able to grow low land crops in the highland and vice-versa.

Olle and Williams (2015) directed an experiment at the Estonian Crop Research Institute during 2014 to evaluate the influence EM on growth and nitrate content of cucumber, pumpkin and squash. Two treatments were T_1: Without EM and T_2: With EM. Result revealed that Plant height (cm), stem diameter (cm) and yield of cucumber, pumpkin and squash were highest at T_2.

Kang *et al.* (2015) conducted a study to find out the effect of plant growth promoting microorganisms on cucumber. *Rhodobacter sphaeroides, Lactobacillus plantarum* and *Saccharomyces cerevisiae* microorganisms were used as treatment. Result showed that treatment with all three bio-inoculants significantly increased the shoot length, root length, shoot fresh weight, shoot dry weight, and chlorophyll content, via secretion of IAA and organic acids. Inoculation with *R. sphaeroides* had more positive effect on plant growth than did inoculation with *L. plantarum* or *S. cerevisiae*, by significantly enhancing gibberellin and reducing abscisic acid contents.

Kleiber *et al.* (2014) conducted an experiment at Marcelin Experimental Station, Poznan University of Life Sciences, Poland during 2010-2011 to investigate the application of EM and controlled recommended fertilizer (CRF) on nutrient content of leaves and yield of tomato. Three levels of fertilizer and four levels of EM concentrations were used. EM application showed significant effect when applied seed inoculation or seed inoculation + spraying of plants increased the total and commercial yields of tomato by (35.8 % and 40 %, 44.6 % and 35.9 % respectively).

Akash *et al.* (2014) conducted a study with the objective to determine the effects of gibberellic acid (GA_3) on growth, fruit yield and quality of tomato. The experiment consisted of one tomato variety- Golden, and six treatments with five levels of gibberellic acid (GA_3- 10 ppm, 20 ppm, 30 ppm, 40 ppm and 50 ppm), arranged in randomized block design with three replications. The highest plant height, number of leaves, number of fruits, fresh fruit weight has been observed and ascorbic acid, total soluble solid (TSS) was estimated for GA_3 50 ppm.

Olle and Williams (2013) gathered data from various scientific papers and indicated that effective microorganisms (EM) had positive effect on the growth of vegetables while in other 30% they had no significant influence. Investigation among 22 reports on the effect of effective microorganisms (EM) on vegetables 84 % showed positive effect, 4% negative effect and 12 % showed no significant effect.

Mondol *et al.* (2013) on their research Influence of plant residual compost on yield and economic performance of cherry tomato said that the majority of tomato growers in Bangladesh do not get good quality fruit and high yield because of their ignorance about improved production technology including use of proper organic and inorganic nutrients.

Ayyub *et al.* (2013) conducted an experiment and found that application of GA_3(100 mg/Kg) at different growth stages of okra predominantly boosted the stem elongation, number of leaves per plant, number of pods per plant, number of seeds per pod, seed weight and seed yield. He concluded that foliar application of GA_3 may be an effective strategy for maximizing the growth and yield of okra.

Asadi *et al*. (2013) Gibberellins have important role in several important biochemical and morphogenetic responses in plants. Treatments including: GA_3 (0, 25 and 50 mg/L) arranged in a completely randomized design with 4 replications. The effect of GA_3 applications were evaluated on yield, flowering and vegetative characteristics. Marketable yield, square meter yield, average fruit weight, fertilized flowers and not fertilized flower, Leaf and branch crown, did not affect by GA_3 application significantly, while number flower on inflorescence and Runner significantly increased.

Lolaei *et al*. (2013) conducted an experiment to study the effect of gibberellic acid GA_3 on the strawberry yield and fruit quality. Results indicated that the treatment of gibberellic acid (150ppm) have the greatest effect on the amount of leaf number, and fruit number. Gibberellic acid (GA_3) spray at 50, 100 and 150 ppm increased fruit weight compared to the control.

Uddin *et al*. (2012) conducted an experiment to study the responses of gibberellic acid concentrations on the growth and yield of strawberry germplasm at Horticulture Farm, Sher-e-Bangla Agricultural University. The experiment consisted of different GA_3 concentrations viz. control, 50 ppm, 75 ppm and 100 ppm. Tallest plant (31.4 cm), the maximum number of leaves (11.1), maximum leaf area (64.5 cm^2), maximum number of flower bud (30.0) and highest number of flower (28.7) was recorded from 75 ppm GA_3 treated strawberry plant. Maximum number of fruits (25.9/plant), fruit weight (13.2 g) and yield (336.6 g) per plant were found with 75 ppm GA_3 application, whereas the minimum was recorded in control. Foliar application with 75 ppm GA_3 showed the best performance on growth and yield of strawberry. Application of GA_3 also increased the sweetness of the berries in comparison to control.

Agamy *et al*. (2012) investigated that the use of yeast as a bio-fertilizer in agriculture has received considerable attention because of their bioactivity and safety for human and the environment. They evaluated the effect of soil amendment with three newly isolated yeast strains on the productivity and the external and internal structure of sugar beet to prove their application as bio-fertilizer. A two-year pot experiment was conducted to investigate the effects of *Kluyveromyces walti, Pachytrichospora transvaalensis* and *Sacharromycopsis cataegensis* on the growth and productivity of sugar beet. Soil was inoculated with three doses of each strain (0.0, 50.0 and 100.0-ml pot^{-1} with concentration of ~108 cfu ml^{-1}). Results revealed that application of the yeasts significantly increased the photosynthetic pigments and soluble sugars of sugar beet. K. walti showed the best results among the three yeasts. It increased the sucrose content by about 43% of the control. Anatomy of the leaf and the root showed an increase in thickness of the blade and mid vein as the result of application of yeasts. They assume that application of *K. walti, P. transvaalensis* and *S. cataegensis* as biofertilizers is a good alternative of the chemicals in the sustainable and organic farming.

Hassanpouraghdam *et al*. (2011) conducted an experiment with following treatments: control (foliar spray with distilled water), GA_3 foliar application at 100, 200 and 300 mg/l plus foliar spray with formulated GA_3 tablet prepared at 100 mg/l concentrations in Lavender. The results showed that the highest amounts for volatile oil content and yield shoed by 300 mg/l GA_3 treatment. It was also observed that GA_3 produces higher amount of volatile acid production, chlorophyll percentage and leave fresh weight.

Abbas (2011) conducted an experiment to examine the effects of GA_3 on carrot. In using the GA_3 concentration at (50 ppm) led to increase significantly the studied characteristics particularly plant height, number of branch/ plants, number of flower/ plants, shoot fresh weight, fresh weight of biological weight, shoot dry weight, dry weight of biological weight per plant, chlorophyll content, when compared with the other concentrations levels and controlling plants. And GA_3 decreases significantly some of the studied characteristics as root fresh weight, root dry weight and soluble carbohydrate which that compared with the controlling plants.

Roy and Nasiruddin (2011) conducted an experiment to study the effect of GA_3 on growth and yield of cabbage consisted of four concentrations of GA_3, viz., 0, 25, 50 and 75 ppm. Significantly the minimum number of days to head formation (43.54 days) and maturity

(69.95 days), highest diameter (23.81 cm) highest yield (45.22 kg/plot and 104.66 t/ha) was recorded with 50 ppm GA_3 while control (0 ppm GA3) treatment gave the inferior result.

Studies on influence of GA, NAA and CCC at three different concentrations on different growth parameters of cabbage (cv. PRIDE OF INDIA) were studied by Lendve *et al*. (2010) found that application of GA_3 50 ppm was found significantly superior over most of the treatments in terms of number of the leaves, plant spread, and circumference of stem, left area, fresh and dry weight of the plant, shape index of head, length of root, fresh and dry weight of root. Except treatment GA_3 75 ppm, which gave better results for days required for head initiation and head maturity.

An experiment was conducted by Rashid (2010) to conclude the effect of GA_3 on onion, He experienced that GA_3 with concentration of 100 ppm increased plant height, leaf number and different bulb related attributes. He sensed a positive effect of GA_3 on onion growth and yield.

Idris *et al*. (2008) carried out a field experiment at Research Farm in Wad Medani University during 2004-05 to study the response of tomato *(Lycopersicon esculentum Mill.)* to the application of effective microorganisms (EM). Effective microorganisms (EM) applied at three rates of 0.01%, 0.02% and 0.05% either alone or in combinations with chicken manure or urea. Chicken manure (6 tons/ha) was added to the soil and urea (0.10 ton/ha) was applied. Spraying intervals were 7 and 14 days and application methods were soil and foliar application. Findings showed that significant differences between the different treatments. EM sprayed at a dilution rate of 0.05% every seven days in combination with chicken manure gave significant increases in plant height, number of branches/plants, number of fruits/cluster and total yield.

Moyazzama (2008) carried out an experiment to find out the effect of different concentration of GA_3 and potassium on the growth and yield of cabbage at Sher-e- Bangla Agricultural University Farm in Dhaka. She applied GA_3 at 0, 65 and 85 ppm. The maximum plant height and diameter of head was obtained from 85 ppm of GA_3.

Two field experiments were carried out by Abdel–Moutyand El-Greadly (2008) during the two successive seasons of 2005 and 2006. To observe the effects of GA_3 on growth and yield characteristics of okra. The obtained results indicated that the application of GA_3 as

foliar spray with 50 ppm gained the better plant growth and pods yield as well as its physical and chemical properties.

Nazia (2007) conducted an experiment on cauliflower cultivar, 'Shirajuki' at Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka and found out that application of GA_3 100 ppm (G_2) resulted the highest pure curd height (14.59 cm), curd weight with leaves (1.90 kg) at harvest, marketable curd weight (1.33 kg /plant) and curd yield (53.33 t/ha) while the lowest was recorded from control treatment.

Khan *et al*. (2006) conducted an experiment to study the effect of 4 levels of gibberellic acid spray on the growth, leaf NPK content, yield and quality parameters of 2 tomato cultivars (*Lycopersicon esculentum Mill*.), namely "Hyb-SC-3''and "Hyb-Himalata''. They reported that irrespective of its concentration, spray of gibberellic acid proved beneficial for most parameters especially in the case of "Hyb-SC-3''.

The effect of growth hormones on the morphology of shoot of lentil was examined by Naeem *et al*. (2004). Different concentrations of hormone were used. GA_3 showed a marked elongation in the length of shoot and increase in the number of internodes and compound leaves. The combined dose of GA_3+IAA, GA_3+kinetin and GA_3+IAA+kinetin showed a significant increase in length and number of internodes as well as in the number of compound leaves. In GA_3 treated plants, early flowering with higher number of floral buds was recorded. The mixed doses of GA_3 with IAA and kinetin revealed early flowering.

Yadav (2002) directed an experiment to find out the effect of effective microorganism (EM) on vegetable crops at Kakani, Kathmandu vally, Nepal during the year 1999. There were three replication and designed randomized complete block design (RCBD). Foliar spray of EM was at 15, 30 and 45 days interval of cabbage and radish. EM solution was diluted at 1: 1000 and 1: 500 concentrations. Results showed that foliar application at 15 days interval 1:500 given the highest yield to cabbage and radish. The highest yield (36.30 kg) of cabbage was obtained with 1: 1000 at 15 days intervals. The highest yield (16.20 kg) radish was with 1:1000 at 15 days intervals. EM 1:1000 at 15 days interval foliar spray increase the yield of cabbage and radish 91.05% and 71.50 % compared with no foliar spray of EM respectively.

Xiaohou *et al*. (2001) conducted various studies in China to investigate the effect of foliar application of beneficial microorganisms on yield and quality of various crops. He reported

that in field trials, sprinkling of 0.1% beneficial microorganisms' solution improved the quality and enhanced yields of tea, cabbage, and sugar corn by 25%, 14%, and 12.5%, respectively.

Yousaf *et al*. (2000) investigated the effect of seed treatment and foliar application of beneficial microorganisms on growth and yield of two varieties of groundnut (*Arachis hypogaea* L.). Two varieties ICG-2261 and ICGV-86550 and three treatments T_1: Control, T_2: Seed inoculation with EM, T_3: Seed inoculation with EM + EM spray. Result showed that root length and plant height range from 13.4 cm and 83.0 cm to 13.1 cm and 79.8 cm. Maximum root length, plant height, number of branch (29.13) 13 and weight (198.1 gm) were at T_3, while minimum number of branch (21.3) and weight (144.4 gm) were at in T_1.

Daly *et al*. (1999) carried out an experiment at organic farms in Canterbury, New Zealand during 1994-1995 to assess the effect of effective microorganisms (EM) on vegetable production. Total three crops were tested (onion, pea and sweet corn). Effective microorganisms (EM) and molasses were both applied at (10 L/ha in 10000 L/ha water) three times were applied at onion, twice at pea and seven times to sweet corn. Results showed that EM and molasses increased the onion, pea and sweet corn yield by 29%, 31% and 23% respectively.

Widdiana and Higa (1998) directed a field plot experiment during 1993 at crop production center for horticultural Crops, Lembang, West Java to determine the effects of foliar applied EM on the production of garlic, onion, tomato, and watermelon. T_1: Control (fertilizer + manure only), T_2: EM (0.1%) applied weekly, T_3: EM (0.5%) applied weekly, T_4: EM (1.0%) applied weekly, T_5: EM (0.1%) applied biweekly, T_6: EM (0.5%) applied biweekly and T_7: EM (1.0%) applied biweekly treatments were used. The highest garlic yield (98.4 kg/ha) was obtained at T_2 the highest yield of onion (167.4 kg/ha) at T_4; and the highest yield of tomato (265.0 kg/ha) at T_4. Yield increase percentage of garlic, onion and tomato (from EM) of 12.5, 11.5 and 19.5% compared with the fertilized (no EM) controls. There was no significant increase in watermelon yields from foliar application of EM at any treatment.

Hussain *et al*. (1995) investigated many field and greenhouse experiments in Pakistan since 1990 to determine the use of effective microorganisms (EM) as an alternative to chemical fertilizer in crop production. One such study was a long-term field experiment conducted for 5 years on a rice-wheat rotation with the treatments: control, chemical fertilizer (NPK),

green manure (GM), and farmyard manure (FYM), all with and without the application of EM. Results showed that EM increased crop yield and improved soil physical properties, especially when applied with organic amendments.

Sanyal *et al*. (1995) studied that the effects of plant growth regulators (IAA or NAA at 15, 25 or 50 ppm or GA_3 at 50, 75 or 100 ppm) and methods of plant growth regulator application on the quality of tomato fruits. Plant growth regulators had profound effects on fruit length, weight and sugar: acid ratio. The effects of presoaking seeds and foliar application of plant growth regulators were more profound than presoaking alone.

Sharifuddin *et al*. (1993) carried out an experiment at Malaysia to evaluate the effect of Effective microorganisms (EM) on crop production in Malaysia. Results showed that EM using with soil amendments increase the growth and yield of sweet corn and leaf mustard.

Chowdhury *et al*. (1991) directed a series of studies at research filed of Institute of Post Graduation Studies in Agriculture (IPSA), Salna, Gazipur during 1992-1993 to evaluate the effect of EM on growth and yield of some selected crops. Onion (*Allium cepa* L.) and String bean (*Vigna sequipedalis* L.) were cultivated at field and chili pepper (*Capsicum flutescens* L.) was at pot. Four treatments were used with EM and without EM (T_1: Control, T_2: Cow dung @ 10 t/ha, T_3: Rice straw @ 10 t/ha, T_4: Recommended N-PK fertilizer rate). The highest onion yield (7.2 t/ha) was obtained by T_2 with EM and was greater than that produced by T_4 (6.3 t/ha)). EM increased leaf chlorophyll and yield of string bean significantly. Highest yield of chili peppers was obtained with EM but was not significantly different than the other treatments.

Lilov and Donchev (1984) observed that by the application of GA_3 at 20,40 or 100mg/L the yields were reduced compared with the non-treated control.

Chern *et al*. (1983) presented that one-month-old transplanted tomato plants were sprayed with 1, 10 or 100 ppm GA_3 and observed that GA_3 at 100ppm increased leaf area, plant height and stem fresh and dry weight but 10ppm inhibited growth.

Leonard *et al*. (1983) observed that inflorescence development in tomato plants (cv.King plus) grown under a low light regime was promoted by GA_3 applied directly on the inflorescence.

Onofeghara (1983) conducted an experiment on tomato sprayed with GA_3 at 20-1000 ppm and NAA at 25-50 ppm. He observed that GA_3 promoted 10 flower primordia production and the number of primordia and NAA promoted flowering and fruiting.

Saleh and Abdul (1980) performed an experiment with GA_3 (25 or 50 ppm) applied 3 times in June or early July. They reponed that GA_3 stimulated plant growth. The substance reduced the total number of flowers per plant but increased the total yield compared with the control. GA_3 also improved fruit quality.

Hossain (1974) investigated the effect of GA_3 along with 4-CPA on the production of tomato. He found that GA_3 applied with 50, 100 and 200 ppm produced an increased fruit set. However, GA_3 treatment induced small size fruit production A gradual increase in the yield plant^{-1} was obtained with higher concentration of GA_3.

Kaushik *et al*. (1974) carried out experiment with the application of GA_3 at 1, 10 or 100 mg/L on tomato plants at 2 leaf stages and at weekly interval until 5 leaf stages. They reported that GA_3 increased the number and weight of fruits per plant at higher concentration.

Sawhney and Greyson (1972) reported that application of GA_3 non flowering plants of tomato induced multilocular, multicarpellary ovaries which were larger at anthesis than control upon pollination produced fruits which were significantly larger with higher fresh weight.

Chowdhury and Faruque (1972) reported that the percentage of seedless fruit increased with the increase in GA_3 concentration from 50 ppm to 100 ppm. However, the fruit weight was found to decrease by GA_3.

Jansen (1970) reported that tomato plants treated with GA_3 neither increased the yield nor accelerated fruit ripening. He also mentioned that increasing concentration of GA_3 reduced both the number and size of fruits.

Adlakha and Verma (1965) observed that when the first four clusters of tomato plants were sprayed three times at unspecified intervals with GA_3 at 50 and 100 ppm, the fruit setting, fruit weight and total yield increased by 5,35 and 23% respectively with the higher concentration than the lower.

Adlakha and Verma (1964) sprayed of GA_3 in concentration of 50 and 100 ppm on flower cluster at anthesis and noted that the application of GA_3 at 100 ppm could appreciably increase fruit size, weight, protein sugar and ascorbic acid contents.

Gustafson (1960) worked with different concentration of GA_3 and observed that when 35 and 70 ppm GA_3 were sprayed to the flowers and flower buds of the first three clusters, percentage of fruits set increased but there was a decrease in the total weight. When only the first cluster was sprayed, the number of fruits set and the total weight per cluster was increased, but this response did not occur in subsequent clusters.

CHAPTER III

MATERIALS AND METHODS

This chapter demonstrates information regarding methodology that was exploited in the accomplishment of the experiment. It encompasses a brief outline of the location of the experiment, climate conditions and the materials used for the experiment. It also flourishes the treatments of the experiment, data collection and for procedures data analyses.

3.1 Experimental location

The field experiment was conducted at Horticulture farm of Sher-e-Bangla Agricultural University, Shere-Bangla Nagar, Dhaka-1207, Bangladesh during the period from December, 2021 to April, 2022 to observe the growth, yield and quality performance of SAU yellow cherry tomato under different treatments of gibberellic acid and clybio concentration. The location of the experimental site was at 23.750^0 N latitude and 90.340^0 E longitudes with an elevation of 8.45 meter from the sea level in the Agro-Ecological Zone of Madhupur Tract (AEZ No. 28).

3.2 Climate

The experimental site was located in the subtropical monsoon climatic zone, set part by heavy rainfall during the months from April to September (Kharif season) and scantly of rainfall during the rest of the year (Rabi season). Plenty of sunshine and moderately low temperature prevails during October to March (Rabi season).

3.3 Soil

The selected experimental plot was medium high land and the soil series was Tejgaon. The characteristics of soil under experimental plot were analyzed in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka. The soil of the experimental field initially had a pH of 6.5 (Agro Ecological Zone – Banglapedia).

3.4 Planting materials

SAU yellow cherry tomato was used as a cultivar in this experiment. Good quality and healthy seedlings were used.

3.4.1 Gibberellic acid concentration

Gibberellic acid (also called gibberellins A3, GA, and GA_3) is a hormone found in plants and fungi. Its chemical formula is $C_{19}H_{22}O_6$. When purified, it is a white to pale-yellow solid. Plants in their normal state produce large amounts of GA_3. It is possible to produce the hormone industrially using microorganisms. Gibberellic acid is a simple gibberellin, a pentacyclic di-terpene acid promoting growth and elongation of cells. It affects decomposition of plants and helps plants grow if used in small amounts, but eventually plants develop tolerance to it.GA stimulates the cells of germinating seeds to produce mRNA molecules that code for hydrolytic enzymes. Gibberellic acid is a very potent hormone whose natural occurrence in plants controls their development. Since GA regulates growth, applications of very low concentrations can have a profound effect while too much will have the opposite effect. It is usually used in concentrations between 0.01 and 10 mg/L. Gibberellins have a number of effects on plant development. They can stimulate rapid stem and root growth, induce mitotic division in the leaves of some plants, and increase seed germination rates.

3.4.2 Clybio concentration

Clybio is a human and earth friendly complex microorganism popular at Japan obtained by fermenting and cultivating superior Lactobacilli, Bacillus Natto, Yeast fungus controlling the quality with our biotechnology. It is an organic bio-fertilizer that can improve crop yield, quality, and taste of vegetables. It is applied to increase crop growth and yield. Clybio can control these fungal pathogens. Clybio can improve the taste of fruits and vegetables. Clybio is less expensive and found all the ingredients at the domestic market. 1 ml clybio at 1000 ml water concentration is enough for large farm area.

3.5 Treatments

The experiment was conducted to observe the growth and yield performance of SAU yellow cherry tomato under different treatment of gibberellic acid and clybio. There were two factors in this experiment following as:

Factor A: **Gibberellic acid concentration (Plate 2.a)**

1. G_0- No GA_3
2. G_1- GA_3 25 mg/L (25ppm)
3. G_2- GA_3 50 mg/L (50ppm)

Factor B: **Clybio concentration (Plate 2.b)**

1. C_0- No Clybio
2. C_1- Clybio 4 ml/L
3. C_2- Clybio 6 ml/L

The treatment combinations were as follows:

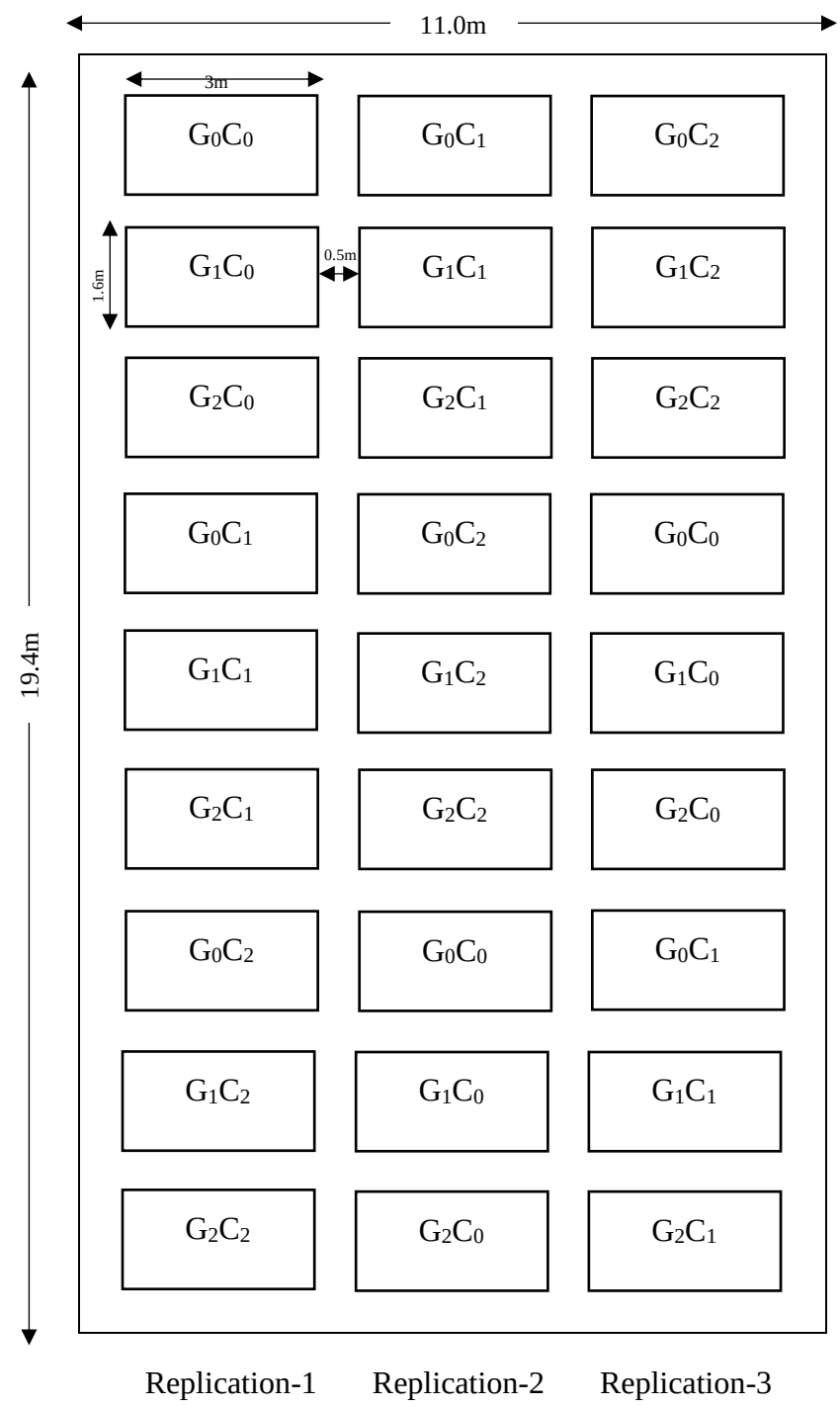
G_0C_0, G_0C_1, G_0C_2, G_1C_0, G_1C_1, G_1C_2, G_2C_0, G_2C_1 and G_2C_2

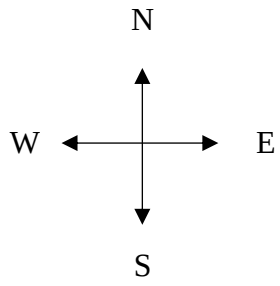
3.6 Treatments application methodology

Gibberellic acid and clybio were applied to the whole plant including leaves by foliar spray. 25 ppm and 50 ppm GA_3 was dissolved separately with 100 ml water and the solution was raised to 1000 ml. Thus, the concentration of GA_3 solution was 1000-fold. Similarly, 4 ml and 6 ml of clybio was dissolved separately with 100 ml water and the volume was raised to 1000 ml. First application was done at 15 days after transplanting of seedlings. After that next treatment was sprayed at an interval of 20 days. It is so safe and organic that is why it can be applied to the fruits also.

3.7 Design and layout

The randomized complete block design (RCBD) is a standard design for agricultural experiments in which similar experimental units are grouped into blocks or replicates. It is used to control variation in an experiment by, for example, accounting for spatial effects in field or greenhouse. The defining feature of the RCBD is that each block sees each treatment exactly once.





Plot size: 3 m × 1.6 m

Plant Spacing:

60 cm × 40 cm

Plot spacing: 0.5m

Gibberellic acid (GA_3)

G_0 : No GA_3

G_1 : 25 ppm GA_3

G_2 : 50 ppm GA_3

Clybio

C_0 : No clybio

C_1 : 4 ml/L

C_2 : 6 ml/L

Plate 1. Experimental layout of the two factors experiments in the Randomized Complete Block Design (RCBD)

3.8 Land preparation

The land was opened with a spade during preparation. The land was ploughed and cross-ploughed several times followed by laddering and harrowing to obtain a good tilth. The land was leveled. The corners of the plots were trimmed with spade and large clods were broken into small pieces as far as possible. All the weeds and stubbles were removed, and the land was finally prepared five days before sowing of seeds. After final land preparation the experimental plots were laid out as per experimental design.

3.9 Application of Manures and Fertilizers

For this experiment BARI (2019) recommended manures and fertilizers doses were used:

Table 1. Manures and fertilizer used as per BARI (2019) recommend action

Manures/Fertilizers	**Recommended dose**
Cowdung	10 t/ha
Urea	180 kg/ha
TSP	150 kg/ha
MoP	80 kg/ha

3.10 Transplanting of Seedlings

The seedlings were raised in the seedbed in usual way and 25 days old seedlings were transplanted in the plots on December 02, 2021. Row to row distance was maintained 60 cm and plant to plant distance was 40 cm (Plate 2.c).

3.11 Tagging of the plants:

The plants in each entry were selected and were tagged (Plate 2.d). These tagged plants were used for recording observations.

3.12 Treatment spraying

First application was done at 15 days after transplanting of seedlings. After that next treatment was sprayed at an interval of 20 days up to the harvesting time. It is so safe and organic that is why it was applied to the fruits also (Plate 2.e).

3.13 Intercultural operations

After transplanting of seedlings, various intercultural operations such as irrigation, weeding and top dressing etc. were accomplished for better growth and development of the cherry tomato seedlings. Intercultural operations were carried out as and when needed.

3.13.1 Weeding

Weeding was necessary to keep the plant from weeds. The newly emerged weeds were uprooted carefully from the field after complete emergence of sprouts and afterwards when necessary.

3.13.2 Gap filling

A few gaps filling was done by healthy seedlings of the same stock where initial planted seedlings failed to survive.

3.13.3 Staking

When the plants were well established, staking was done to each plants using bamboo sticks with rope to keep the plants erect. As the plants grew up within a few days of staking, other cultural operations were carried out.

3.13.4 Irrigation

Irrigation was given as when as necessary by observing the soil moisture condition. Irrigation was given throughout the growing period. Drip irrigation method was followed during this experiment.

3.13.5 Pruning

Pruning was done several times to remove unwanted branch, leaf, flower and fruit due to better growth and yield during the experiment.

3.13.6 Plant protection

No pesticide was applied in this experiment. This experiment was done in an organic way by using GA_3 and clybio instead of chemicals for getting fresh, safe and organic cherry tomato.

3.13.7 De-suckering

Removed sucker by hand time to time (Plate 2.f).

3.13.8 Harvesting

The crop was harvested depending upon the maturity of the fruits. Fruits were harvested at an interval of 7 days. Harvesting was done from middle March to first week of April. Harvesting was done after 100 to 105 days of transplanting (Plate 2.g).

3.14 Studied parameters

The experiment was observed daily in the field. Data on the following parameters were studied from the plants during the experiment (Plate 2.h).

3.14.1 Plant height (cm)

Plant height was taken at three times and measured in centimeter from ground level to tip of the main stem from each plant of each treatment and mean value was calculated.

3.14.2 Number of branches per plant

Total number of branches from each selected plant was counted at the mature stage of the plant then the average number of branches per plant for each treatment was calculated.

3.14.3 Number of flower cluster

The number of flower cluster was counted manually from every cluster of the selected plant at a certain day of interval and the average was computed and finally expressed as the average number of flower cluster (Plate 2.i).

3.14.4 Number of flowers per plant

The number of flowers per plant was recorded manually from every cluster of the selected plant at a certain day of interval and the average was computed and as expressed in average number of flowers per plant.

3.14.5 Number of fruits per cluster

The number of fruits in every cluster was recorded manually from selected plant, then the average was calculated and expressed as the average number of fruits per cluster (Plate 2.j).

3.14.6 Number of fruits per plant

The number of fruits from selected plant was counted and then the average was calculated and expressed as the average number of fruits per plant.

3.14.7 SPAD value

SPAD value is measured by using SPAD meter.

3.14.8 Fruit length and diameter (cm)

Fruit length and diameter were measured by using Digital slide caliper-515 (DC515) in millimeter (mm) at the middle portion of three selected fruits. Then the mean was calculated for each treatment (Plate 2.k).

3.14.9 Individual fruit weight (g)

The fruits except 1st and last harvest were considered to take individual fruit weight. Fruit weight was measured by Electronic Precision Balance in gram (Plate 2.l). Total fruit weight of each pot was obtained by addition of weight of the total fruit number and average fruit weight was obtained from division of the total fruit weight by the total number of fruits.

3.14.10 Yield/ plant (kg)

Yield per plant was calculated in kilogram (kg) by a balance from the total weight of fruits per plant which were harvested at different periods.

3.15 Statistical analysis

Collected data were statistically analysed using Statistix-10 computer package program. Mean for all treatments were calculated and analysis of variance for each one of characters was performed by F–test (Variance Ratio). Finally, the difference between treatments was assessed by Least Significant Difference (LSD) test at 0.05% level of significance (Gomez and Gomez, 1984).

(a)

(b)

(c)

(d)

(e)

(f)

Plate 2: Pictorial presentation of different methodological works, equipment and data collection (a) GA_3 concentration, (b) Clybio concentration, (c) Transplanting of seedlings, (d) Tagging of plants, (e) Treatment spraying, (f) De-suckering by hand

(g)

(h)

(i)

(j)

(k)

(l)

Plate 2 (continued): Pictorial presentation of different methodological works, equipment and data collection (g) Harvesting, (h) Data collection, (i) Number of flower cluster, (j) Number of fruits per cluster, (k) Measurement of fruit length and diameter, (l) Measurement of individual fruit weight

CHATER IV

RESULTS AND DISCUSSION

The experiment was performed in Horticulture farm of Sher-e-Bangla Agricultural University, Shere-Bangla Nagar, Dhaka-1207, Bangladesh to evaluate the effect of gibberellic acid and clybio concentration on growth, yield of SAU yellow cherry tomato. Findings of the research work have been presented and discussed in this chapter. Illustration of this chapter has been focused by tables and figures to enhance their parallel and dissimilar traits through discussion, comprehension and perceiving. A summary of the analysis of variances in regard to all parameters have been arrayed in appendix. Results have been presented, discussed and possible interpretations are given under the following headings.

4.1 Plant height (cm)

Significant variation was found in case of GA_3 concentration in terms of plant height (Appendix I). The plant height is the most important parameters which is positively correlated. Treatment wise heights were recorded at different stages of growth for an understanding on which treatment plant grow more. For this parameter, the plant height is measured at 35,70 and 105 days (Figure 1). It was observed from the experiment that at 35 days at the transplanting (DAT) the highest height of cherry tomato plant is 42.2 cm at G_2 and lowest height were observed at G_0 was 36.4 cm. At 70 days at the transplanting the highest height of cherry tomato plant is 96.5 cm at G_2 and lowest height were observed at G_0 was 76.8 cm. On the other hand, at 105 days at the transplanting the highest height of cherry tomato plant is 188.2 cm at G_2 and lowest height were observed at G_0 was 160.2 cm. From the cherry tomato plant height, it is clear from the result that the GA_3 concentration (G_2) is superior to others concentrations.

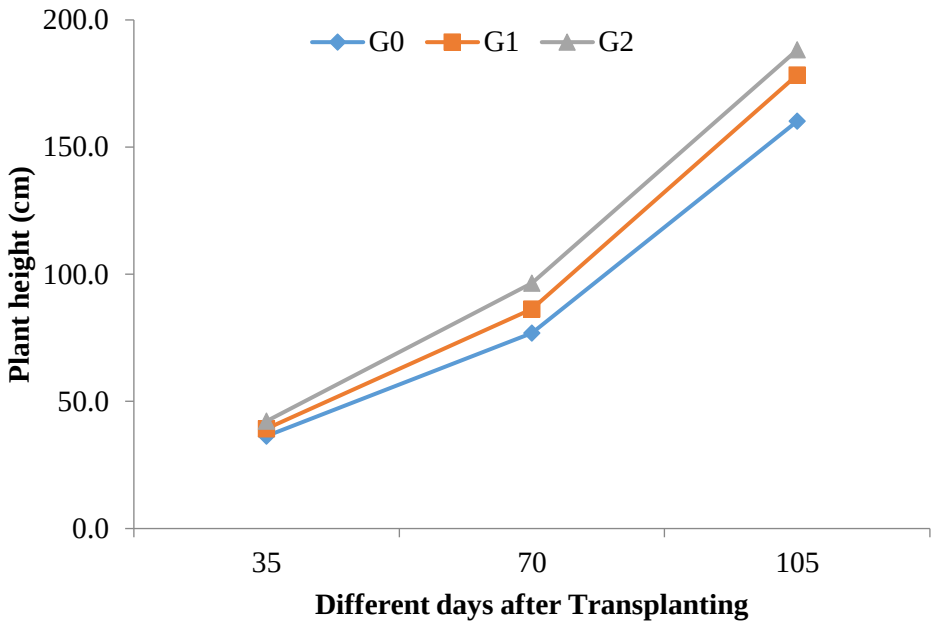


Fig.1. Effect of gibberellic acid concentration on plant height of cherry tomato at different days after transplanting (G_0=Control; G_1=25 mg/L; G_2=50 mg/L)

Significant variation was found in case of clybio concentration in terms of plant height (Appendix I). The plant height is the most important parameters which is positively correlated. Treatment wise heights were recorded at different stages of growth for an understanding on which treatment plant grow more. For this parameter, the plant height is measured at 35,70 and 105 days and data were presented in (Figure 2). It was observed from the experiment that at 35 days at the transplanting (DAT) the highest height of cherry tomato plant is 42.3 cm at C_2 and lowest height were observed at C_0 was 36.1 cm. At 70 days at the transplanting the highest height of cherry tomato plant is 92.8 cm at C_2 and lowest height were observed at C_0 was 79.2 cm. On the other hand, at 105 days at the transplanting the highest height of cherry tomato plant is 186.7 cm at C_2 and lowest height were observed at C_0 was 163.9 cm. From the cherry tomato plant height, it is clear from the result that the clybio concentration (C_2) is superior to others concentrations.

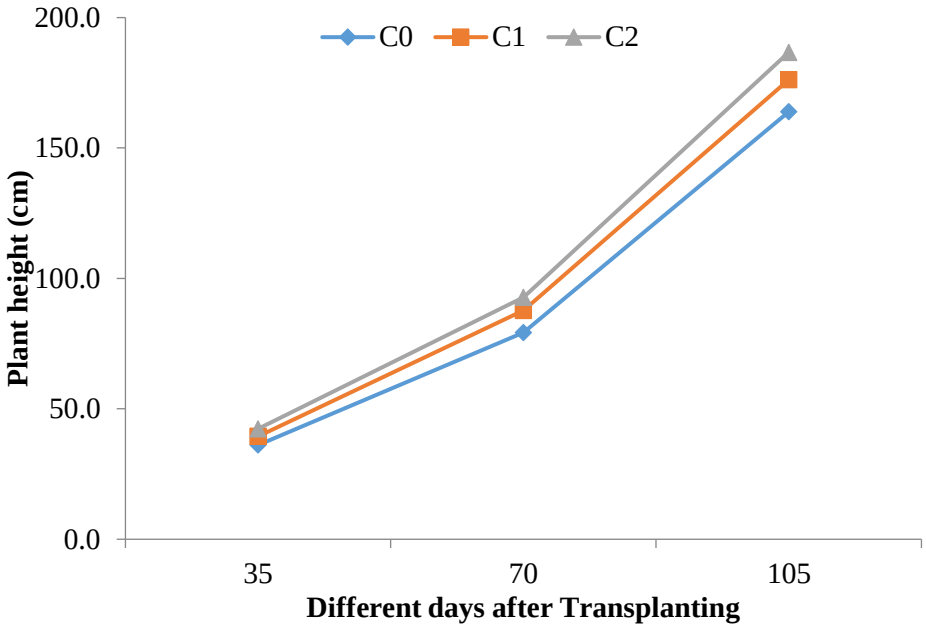


Fig. 2. Effect of clybio concentration on plant height of cherry tomato at different days after transplanting (C_0=Control; C_1=4 ml/L; C_2=6 ml/L)

Significant variation was found in case of combination effect of gibberellic acid and clybio concentration in terms of plant height (Appendix I). The plant height is the most important parameters which is positively correlated. Treatment wise heights were recorded at different stages of growth for an understanding on which treatment plant grow more. For this parameter, the plant height is measured at 35,70 and 105 days and data were presented in (Table 2). It was observed from the experiment that at 35 days at the transplanting (DAT) the highest height of cherry tomato plant is 46.6 cm at G_2C_2 and lowest height were observed at G_0C_0 was 34.1 cm. At 70 days at the transplanting the highest height of Cherry tomato plant is 103.3 cm at G_2C_2 and lowest height were observed at G_0C_0 was 70.4 cm. On the other hand, at 105 days at the transplanting the highest height of cherry tomato plant is 199.8 cm at G_2C_2 and lowest height were observed at G_0C_0 was 149.2 cm. From the cherry tomato plant height, it is clear from the result that the G_2C_2 concentration is superior to others concentrations (Table 2).

Table 2: Combination effect of gibberellic acid and clybio concentration on plant height of cherry tomato at different days after transplanting

	Days After Transplanting		
Treatment*	**35**	**70**	**105**
G_0C_0	34.1 b-d	70.4 f	149.2 g
G_0C_1	36.7 c-e	76.6 ef	160.8 fg
G_0C_2	38.3 e	83.5 cd	170.4 d-f
G_1C_0	35.5 de	79.8 de	166.0 ef
G_1C_1	40.2 bc	87.5 bc	179.3 b-d
G_1C_2	42.1 b	91.5 b	189.8 ab
G_2C_0	38.7 b-d	87.4 bc	176.5 c-e
G_2C_1	41.4 b	98.9 a	188.4 a-c
G_2C_2	46.6 a	103.3 a	199.8 a
LSD (0.05)	4.14	6.38	12.70
CV %	6.09	4.26	4.18

*Here, G_0=Control; G_1=25 mg/L; G_2=50 mg/L; C_0=Control; C_1=4 ml/L; C_2=6 ml/L

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

4.2 Number of branches/plants

Significant differences were observed with respect to number of branches (Appendix II). Maximum number of branch 5.7 and minimum number of branches 4.1 was found (Fig. 3). Significant different was found in case of GA_3 concentration in terms of number of branches. The maximum number of branch 5.7 was found in G_2 (G_2 -50mg/L) followed by 4.9 G_1 (G_1 -25 mg/L) while the minimum number of branches 4.1 was found in G_0 (No GA_3) (Fig. 3). Here, also it is clear from the result that the GA_3 concentration (G_2) is superior to others concentrations.

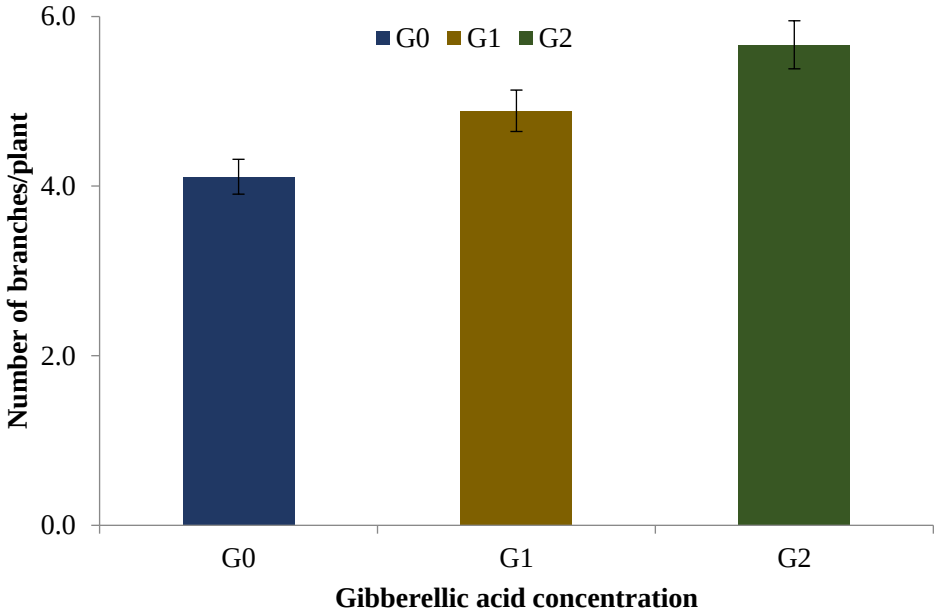


Fig. 3. Effect of gibberellic acid concentration on number of branches of cherry tomato plant (G_0=Control; G_1=25 mg/L; G_2=50 mg/L)

Significant differences were observed with respect to number of branches (Appendix II). Maximum number of branches was 5.6 and minimum number of branches 4.2 was found (Fig. 4). Significant different was found in case of clybio concentration in terms of number of branches. The maximum number of branches 5.6 was found in C_2 (C_2 -6 ml/L) followed by 4.9 C_1 (C_1 -4 ml/L) while the minimum number of branches 4.2 is found in C_0 (No Clybio) (Fig. 4). Here, also it is clear from the result that the clybio concentration (C_2) is superior to others concentrations.

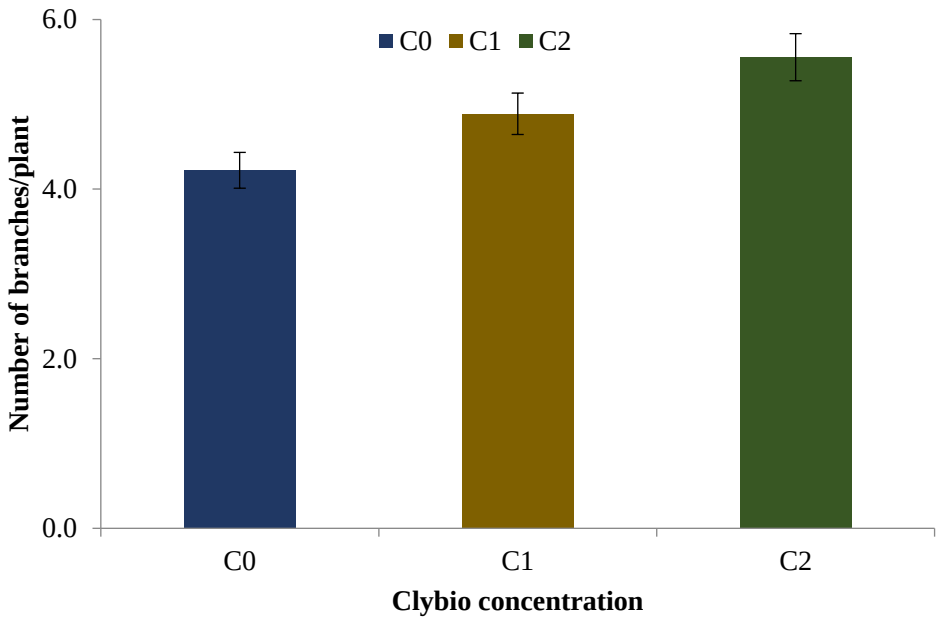


Fig. 4. Effect of clybio concentration on number of branches of cherry tomato plant (C_0=Control; C_1=4 ml/L; C_2=6 ml/L)

4.3 SPAD value of leaves

Significant differences were observed with respect to SPAD value of leaves (Appendix II). SPAD meter values that are proportional to the amount of chlorophyll present in the leaf. The SPAD value is observed at different GA_3 concentration like G_0, G_1, G_2. It was recorder maximum SPAD value was 65.8 in G_2 and minimum was 51.5 in G_0 (Fig. 5). So, from this result; it may be concluded that treatment at G_2 is superior to treatment at G_0.

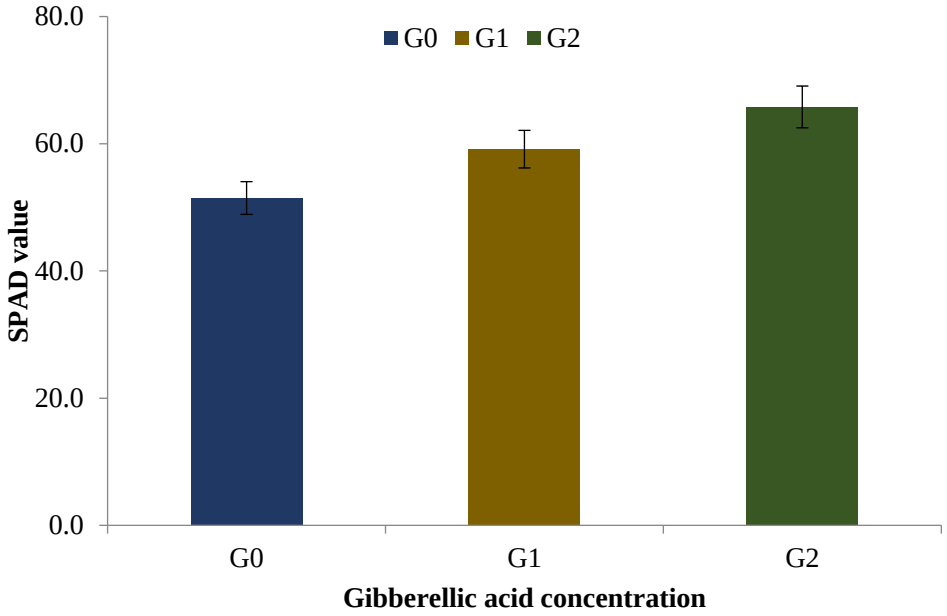


Fig. 5. Effect of gibberellic acid concentration on SPAD value of cherry tomato plant

(G_0=Control; G_1=25 mg/L; G_2=50 mg/L)

Significant differences were observed with respect to SPAD value of leaves (Appendix II). SPAD meter values that are proportional to the amount of chlorophyll present in the leaf. The SPAD value is observed at different clybio concentration like C_0, C_1, C_2. It was recorder maximum SPAD value was 66.2 in C_2 and minimum was 51.5 in C_0 (Fig. 6). So, from this result; it may be concluded that treatment at C_2 is superior to treatment at C_0.

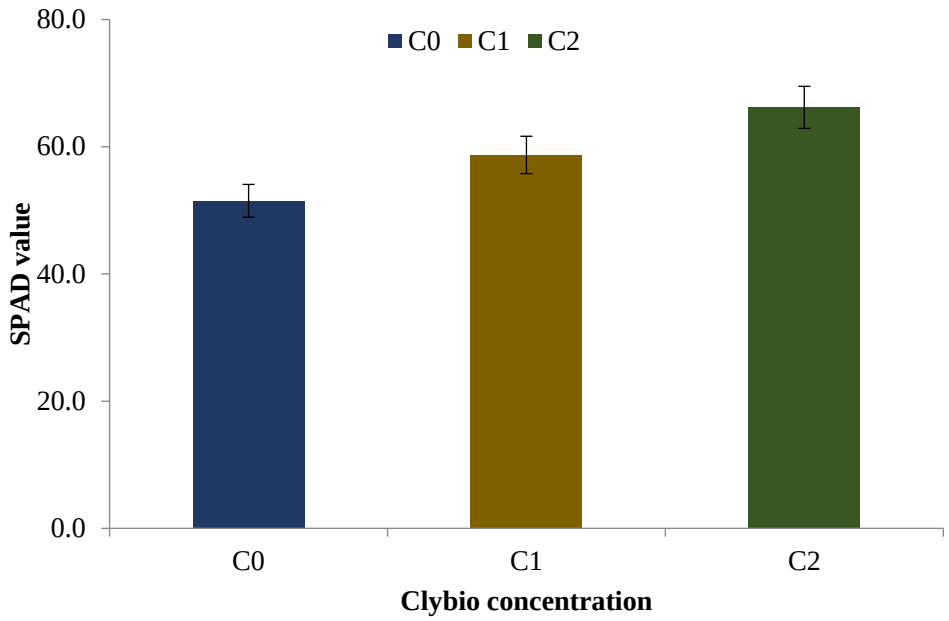


Fig. 6. Effect of clybio concentration on SPAD value of cherry tomato plant (C_0=Control; C_1=4 ml/L; C_2=6 ml/L)

4.4 Leaf area

Significant differences were observed with respect to leaf area (Appendix II).

Leaf area index (LAI) is a dimensionless quantity that characterizes plant canopies. The leaf area is observed at different GA_3 concentration like G_0, G_1, G_2. It was recorder maximum leaf area was 118.0 cm^2 in G_2 and minimum was 87.4 cm^2 in G_0 (Fig. 7). So, from this result; it may be concluded that treatment at G_2 is superior to treatment at G_0.

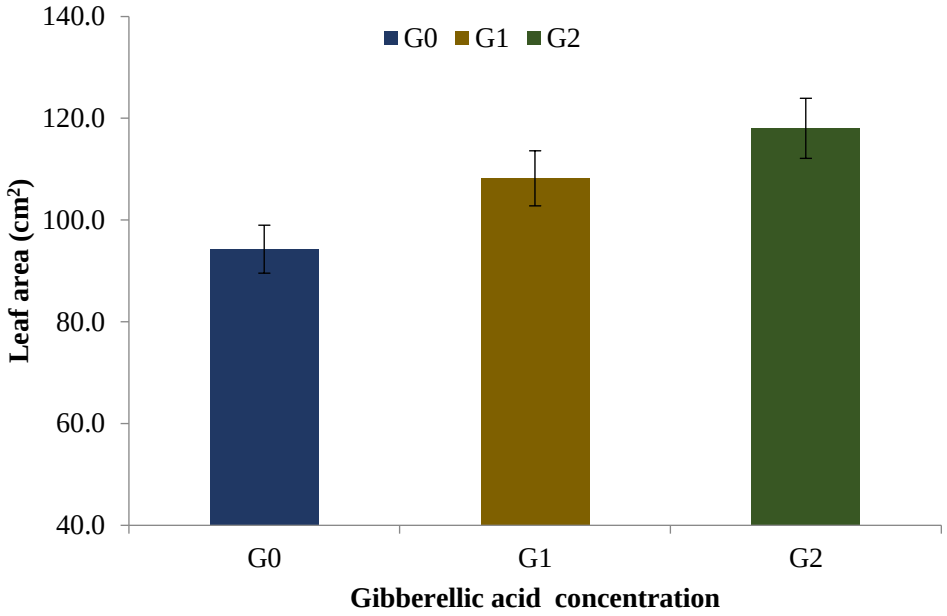


Fig. 7. Effect of gibberellic acid concentration on leaf area of cherry tomato plant (G_0=Control; G_1=25 mg/L; G_2=50 mg/L)

Significant differences were observed with respect to leaf area (Appendix II). Leaf area index (LAI) is a dimensionless quantity that characterizes plant canopies. The leaf area is observed at different clybio concentration like C_0, C_1, C_2. It was recorder maximum leaf area was 118.0 cm^2 in C_2 and minimum was 90.3 cm^2 in C_0 (Fig. 8). So, from this result; it may be concluded that treatment at C_2 is superior to treatment at C_0.

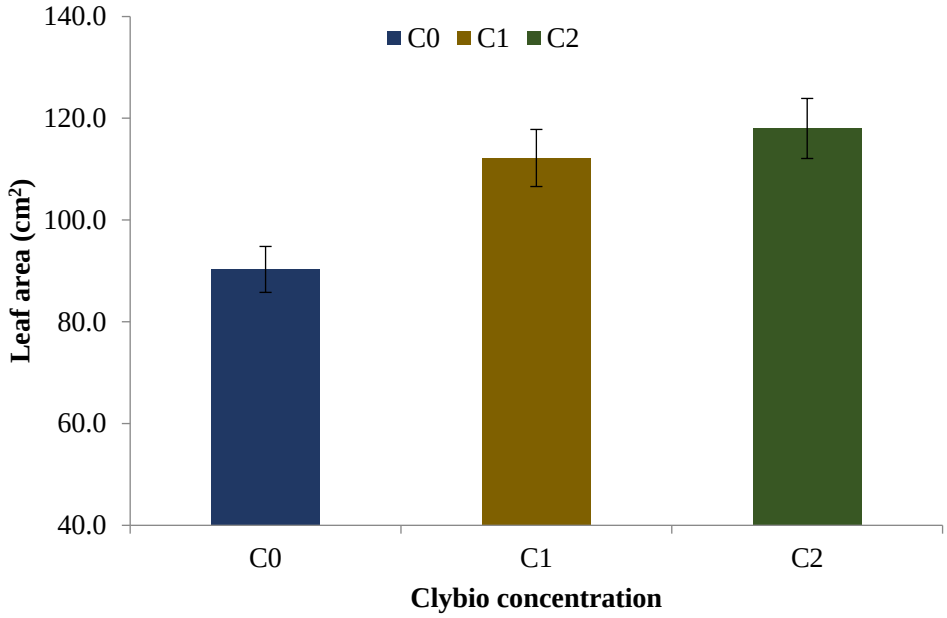


Fig. 8. Effect of clybio concentration on leaf area of cherry tomato plant (C_0=Control; C_1=4 ml/L; C_2=6 ml/L)

4.5 Number of flower cluster

Significant differences were observed with respect to number of flower cluster (Appendix III). Maximum number of flower cluster was 27.7 and minimum number of flower cluster 20.2 was found (Fig. 9). Significant different was found in case of GA_3 concentration in terms of number of flower cluster. The maximum number of flower cluster 27.7 was found in G_2 (G_2 -50 mg/L) followed by 24.2 G_1 (G_1 -25 mg/L) while the minimum number of flower cluster 20.2 was found in G_0 (No GA_3) (Fig. 9). Here, also it is clear from the result that the GA_3 concentration (G_2) is superior to others concentrations.

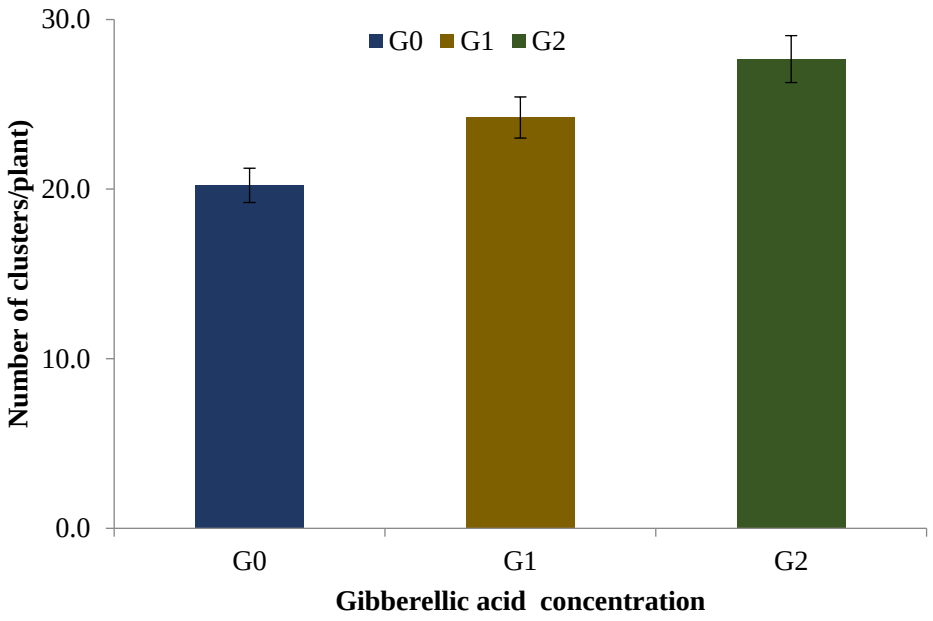


Fig. 9. Effect of gibberellic acid concentration on number of flower cluster of cherry tomato plant (G_0=Control; G_1=25 mg/L; G_2=50 mg/L)

Significant differences were observed with respect to number of flower cluster (Appendix III). Maximum number of flower cluster was 27.1 and minimum number of flower cluster 21.0 was found (Fig. 10). Significant different was found in case of clybio concentration in terms of number of flower cluster. The maximum number of flower cluster 27.1 was found in C_2 (C_2 -6 ml/L) followed by 24.0 C_1 (C_1 -4 ml/L) while the minimum number of flower cluster 21.0 is found in C_0 (No Clybio) (Fig. 10). Here, also it is clear from the result that the clybio concentration (C_2) is superior to others concentrations.

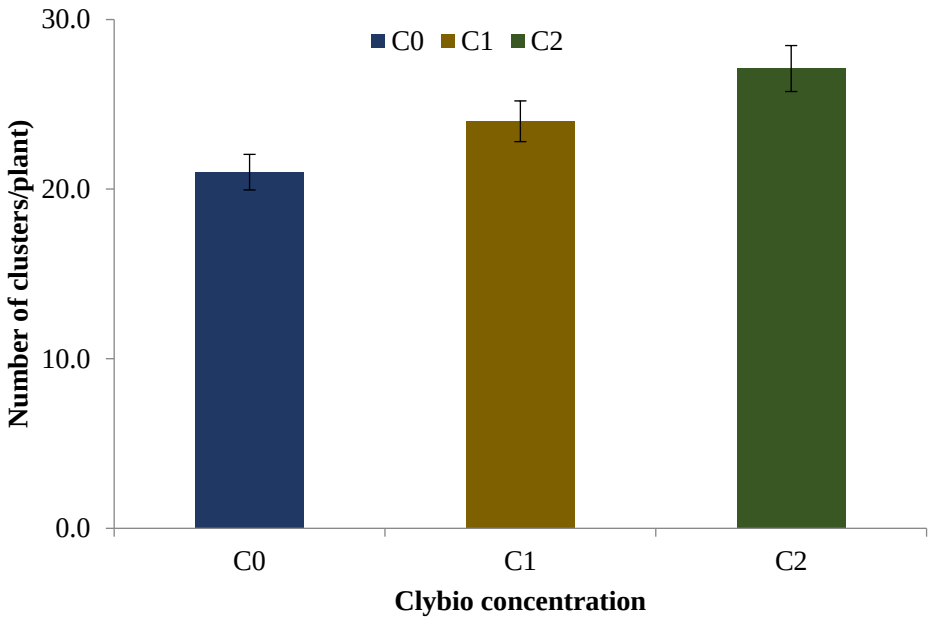


Fig. 10. Effect of clybio concentration on number of flower cluster of cherry tomato plant (C_0=Control; C_1=4 ml/L; C_2=6 ml/L)

4.6 Combination effects of gibberellic acid and clybio concentration

Significant different was found in terms of combination effect on number of branches/plants, SPAD value, leaf area and number of cluster/plant of cherry tomato (Appendix II & III). It was found highest number of branches per plant was 6.3 in G_2C_2 and lowest branches per plant was found 3.7 in G_0C_0. (Table 03**).** Highest SPAD value was 71.7 in G_2C_2 and lowest SPAD value was found 46.6 in G_0C_0 (Table 03). Highest leaf area was 131.4 in G_2C_2 and lowest leaf area was found 83.6 in G_0C_0. (Table 03). In this experiment maximum number of clusters per plant was recorded 31.7 in G_2C_2 and minimum number of clusters per plant was recorded 18.0 in G_0C_0. (Table 03). So, from this experiment it is clear that G_2C_2 is more effective and efficient than G_0C_0.

Table 3. Combination effect of gibberellic acid and clybio concentration on number of branches/plants, SPAD value, leaf area and number of cluster/plant of cherry tomato

Treatment*	Branches/plant		SPAD value		Leaf area (cm^2)		Clusters/Plant	
G_0C_0	3.7	d	46.6	b	83.6	g	18.0	d
G_0C_1	4.0	cd	47.6	ab	94.7	ef	20.3	cd
G_0C_2	4.7	a-d	60.2	ab	104.5	d	22.3	c
G_1C_0	4.3	b-d	49.9	ab	90.5	f	21.7	c
G_1C_1	4.7	a-d	60.9	ab	115.9	c	23.7	c
G_1C_2	5.7	a-c	66.7	ab	118.1	c	27.3	b
G_2C_0	4.7	a-d	58.0	ab	96.8	e	23.3	c
G_2C_1	6.0	ab	67.6	ab	125.8	b	28.0	b
G_2C_2	6.3	a	71.7	a	131.4	a	31.7	a
LSD (0.05)	1.94		24.46		4.45		3.65	
CV%	12.87		14.04		2.41		8.78	

*Here, G_0=Control; G_1=25 mg/L; G_2=50 mg/L; C_0=Control; C_1=4 ml/L; C_2=6 ml/L

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

Significant different was found in terms of flower/plant, fruit/plant, fruit length, fruit diameter, single fruit weight and yield/plant of cherry tomato (Appendix III & IV). It was found highest flower/plant was 2259.0 in G_2 and lowest flower number/plant was found in 1500.0 in G_0. (Table 04). Highest fruit/plant was 1118.8 in G_2 and lowest fruit number/plant was found in 771.1 in G_0. (Table 04). Highest fruit length was 24.1 mm in G_2 and lowest fruit diameter was found in 19.5 mm in G_0 (Table 04). Highest fruit diameter was 25.1 mm in G_2 and lowest fruit diameter was found in 20.3 mm in G_0. (Table 04). In this experiment maximum single fruit weight was recorder 7.9 g in G_2 and minimum single fruit weight was recorded 6.1 g in G_0. (Table 04). On the other hand, highest yield/plant was found 8.8 kg in G_2 and lowest yield/plant was found 4.7 kg in G_0. (Table 04). So, from this experiment it is clear that G_2 is more effective and efficient than G_0.

Table 4. Effect of gibberelic acid concentration on flower/plant, fruit/plant, fruit length, fruit diameter, single fruit weight and yield/plant of cherry tomato

Treatment*	Flowers/plant	Fruit/plant	Fruit length (mm)	Fruit diameter (mm)	Single fruit wt. (g)	Yield/plant (kg)
G_0	1500.0 c	771.1 c	19.5 c	20.3 c	6.1 c	4.7 c
G_1	1883.0 b	996.3 b	22.1 b	22.5 b	7.1 b	7.1 b
G_2	2259.0 a	1118.8 a	24.1 a	25.1 a	7.9 a	8.8 a
LSD (0.05)	4.32	2.71	0.75	0.40	0.51	0.10
CV %	0.23	0.28	3.43	1.77	7.25	1.51

*Here, G_0=Control; G_1=25 mg/L; G_2=50 mg/L

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

Significant different was found in terms of flower/plant, fruit/plant, fruit length, fruit diameter, single fruit weight and yield/plant of cherry tomato (Appendix III & IV). It was found highest flower/plant was 2189.9 in C_2 and lowest flower number/plant was found in 15071.3 in C_0. (Table 05). Highest fruit/plant was 1099.9 in C_2 and lowest fruit number/plant was found in 794.6 in C_0. (Table 05). Highest fruit length was 23.4 mm in C_2 and lowest fruit diameter was found in 20.3 mm in C_0 (Table 05). Highest fruit diameter was 23.9 mm in C_2 and lowest fruit diameter was found in 21.3 mm in C_0. (Table 05). In this experiment maximum single fruit weight was recorded 7.7 g in C_2 and minimum single fruit weight was recorded 6.4 g in C_0. (Table 05). On the other hand, highest yield/plant was found 8.5 kg in C_2 and lowest yield/plant was found 5.1 kg in C_0. (Table 05). So, from this experiment it is clear that C_2 is more effective and efficient than C_0.

Table 5. Effect of clybio concentration on flower/plant, fruit/plant, fruit length, fruit diameter, single fruit weight and yield/plant of cherry tomato

Treatment*	Flowers/plant	Fruit/plant	Fruit length (mm)	Fruit diameter (mm)	Single Fruit wt. (g)	Yield/plant (kg)
C_0	1571.3 c	794.6 c	20.3 c	21.3 c	6.4 c	5.1 c
C_1	1880.8 b	991.8 b	22.0 b	22.6 b	7.0 b	7.1 b
C_2	2189.9 a	1099.9 a	23.4 a	23.9 a	7.7 a	8.5 a
LSD (0.05)	4.32	2.71	0.75	0.40	0.51	0.10
CV %	0.23	0.28	3.43	1.77	7.25	1.51

*Here, C_0=Control; C_1=4 ml/L; C_2=6 ml/L

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

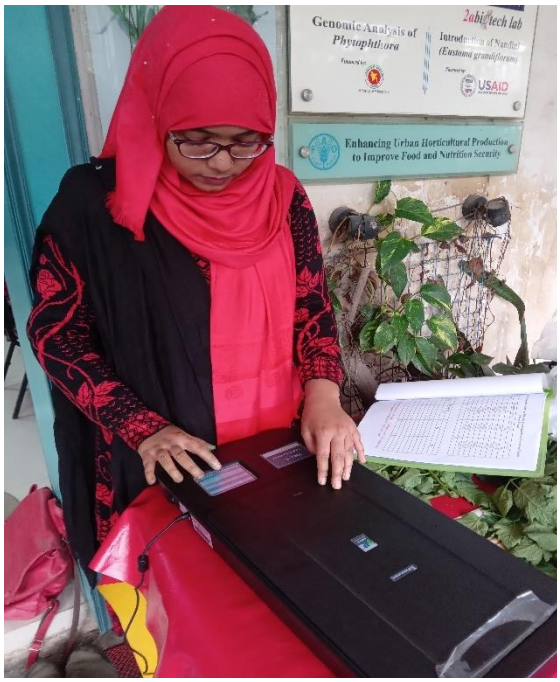
Significant different was found in terms of combination effect on flower/plant, fruit/plant, fruit length, fruit diameter, single fruit weight and yield/plant of cherry tomato (Appendix III & IV). It was found highest flower/plant was 2685.7 in G_2C_2 and lowest flower number/plant was found in 1295.3 in G_0C_0. (Table 06). Highest fruit/plant was 1212.3 in G_2C_2 and lowest fruit number/plant was found in 590.7 in $G_0C_0C_0$. (Table 06). Highest fruit lenth was 26.3 mm in G_2C_2 and lowest fruit diameter was found in 18.3 mm in G_0C_0 (Table 06). Highest fruit diameter was 26.8 mm in G_2C_2 and lowest fruit diameter was found in 19.5 mm in G_0C_0. (Table 06). In this experiment maximum single fruit weight was recorded 8.8 g in G_2C_2 and minimum single fruit weight was recorded 5.5 g in G_0C_0. (Table 06). On the other hand, highest yield/plant was found 10.7 kg in G_2C_2 and lowest yield/plant was found 3.3 kg in G_0C_0. (Table 06). So, from this experiment it is clear that G_2C_2 is more effective and efficient than G_0C_0.

Table 6: Combination effect of gibberellic acid and clybio concentration on flower/plant, fruit/plant, fruit length, fruit diameter, single fruit weight and yield/plant of cherry tomato

Treatment*	Flowers/Plant	Fruits/Plant	Fruit length (mm)	Fruit diameter (mm)	Per fruit wt. (g)	Yield/plant (kg)
G_0C_0	1295.3 i	590.7 i	18.3 f	19.5 f	5.5 e	3.3 i
G_0C_1	1506.3 h	759.3 h	19.3 f	20.4 e	5.9 de	4.5 h
G_0C_2	1698.3 f	963.3 f	20.9 de	21.1 e	6.9 c	6.4 f
G_1C_0	1623.3 g	798.7 g	20.7 e	20.7 e	6.7 cd	5.3 g
G_1C_1	1840.0 d	1066.3 d	22.5 c	22.8 d	7.2 bc	7.6 d
G_1C_2	2185.7 c	1124.0 c	23.0 bc	23.9 c	7.5 bc	8.5 c
G_2C_0	1795.3 e	994.3 e	22.0 cd	23.8 c	7.0 bc	6.7 e
G_2C_1	2296.0 b	1149.7 b	24.1 b	24.6 b	7.9 b	9.1 b
G_2C_2	2685.7 a	1212.3 a	26.3 a	26.8 a	8.8 a	10.7 a
LSD (0.05)	7.48	4.69	1.30	0.69	0.89	0.18
CV %	0.23	0.28	3.43	1.77	7.25	1.51

*Here, G_0=Control; G_1=25 mg/L; G_2=50 mg/L; C_0=Control; C_1=4 ml/L; C_2=6 ml/L

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



(a)

(b)

(c)

Plate 3. Pictorial presentation of recording data (a)measurement of leaf area, (b)measurement of SPAD value, (c)treatment-wise fruits

CHAPTER V

SUMMARY AND CONCLUSIONS

A field experiment was conducted at the Horticulture farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh during the period from December, 2021 to April, 2022 to observe the growth and yield performance of SAU yellow cherry tomato under different treatments of gibberellic acid and clybio concentration. Collected data were statistically analyzed for the evaluation of treatments for the detection about the best treatment for new released cherry tomato variety. The findings and conclusion have been described in this segment. Significant different were observed in case of growth and yield performance as well as gibberellic acid and clybio concentration application of all parameters like as following –

It was observed from the experiment that at 35 days at the transplanting (DAT) the highest height of cherry tomato plant is 46.6 cm at G_2C_2 and lowest height were observed at G_0C_0 was 34.1 cm. At 70 days at the transplanting the highest height of cherry tomato plant is 103.3 cm at G_2C_2 and lowest height were observed at G_0C_0 was 70.4 cm. On the other hand, at 105 days at the transplanting the highest height of cherry tomato plant is 199.8 cm at G_2C_2 and lowest height were observed at G_0C_0 was 149.2 cm.

For gibberellic acid the maximum number of branch 5.7 was found in G_2 (G_2 -50mg/L followed by 4.9 G_1 (G_1-25 mg/L) while the minimum number of branches 4.1 was found in G_0 (No GA_3). For clybio the maximum number of branches 5.6 was found in C_2 (C_2 - 6 ml/L followed by 4.9 C_1 (C_1-4 ml/L) while the minimum number of branches 4.2 is found in C_0 (No Clybio). The maximum number of sucker/plant for Gibberellic Acid concentration 9.8 was found in G_2 (G_2 -50mg/L followed by 7.9 G_1 (G1-25 mg/L) while the minimum number of sucker 6.4 was found in G_0 (No GA_3). For clybio concentration the maximum number of sucker/plants 9.2 was found in C_2 (C_2 -6 ml/L) followed by 8.3 C_1 (C_1-4 ml/L) while the minimum number of suckers 6.6 is found in C_0 (No Clybio). It was recorded maximum SPAD value for GA_3 was 65.8 in G_2 and minimum was 51.5 in G_0. For clybio concentration maximum SPAD value was 66.2 in C_2 and minimum was 51.5 in C_0. The maximum leaf area for GA_3 was 118.0 cm^2 in G_2 and minimum was 87.4 cm^2 in G_0. For clybio maximum leaf area was 118.0 cm^2 in C_2 and minimum was 90.3 cm^2 in C_0. The maximum number of flower cluster was 27.7 in G_2 and minimum number

of flower cluster 20.2 was found in G_0 for GA_3. The maximum number of flower cluster was 27.1 in C_2 and minimum number of flower cluster 21.0 was found in C_0 for clybio.

For combination of gibberellic acid and clybio concentration it was found highest number of branches per plant was 6.3 in G_2C_2 and lowest branches per plant was found 3.7 in G_0C_0. Highest number of suckers per plant was 11.3 in G_2C_2 and lowest number of suckers per plant was found 5.0 in G_0C_0. Highest SPAD value was 71.7 in G_2C_2 and lowest SPAD value was found 46.6 in G_0C_0. Highest leaf area was 131.4 in G_2C_2 and lowest leaf area was found 83.6 in G_0C_0. In this experiment maximum number of clusters per plant was recorded 31.7 in G_2C_2 and minimum number of clusters per plant was recorded 18.0 in G_0C_0. So, from this experiment it is clear that G_2C_2 is more effective and efficient than G_0C_0.

It was found for GA_3 treatment highest flower/plant was 2259.0 in G_2 and lowest flower number/plant was found in 1500.0 in G_0. Highest fruit/plant was 1118.8 in G_2 and lowest fruit number/plant was found in 771.1 in G_0. Highest fruit length was 24.1 mm in G_2 and lowest fruit diameter was found in 19.5 mm in G_0 Highest fruit diameter was 25.1 mm in G_2 and lowest fruit diameter was found in 20.3 mm in G_0. In this experiment maximum single fruit weight was recorder 7.9 gm in G_2 and minimum single fruit weight was recorded 6.1 gm in G_0**.** On the other hand, highest yield/plant was found 8.8 kg in G_2 and lowest yield/plant was found 4.7 kg in G_0**.** For clybio it was found highest flower/plant was 2189.9 in C_2 and lowest flower number/plant was found in 15071.3 in C_0. Highest fruit/plant was 1099.9 in C_2 and lowest fruit number/plant was found in 794.6 in C_0. Highest fruit length was 23.4 mm in C_2 and lowest fruit diameter was found in 20.3 mm in C_0. Highest fruit diameter was 23.9 mm in C_2 and lowest fruit diameter was found in 21.3 mm in C_0. In this experiment maximum single fruit weight was recorded 7.7 gm in C_2 and minimum single fruit weight was recorded 6.4 gm in C_0. On the other hand, highest yield/plant was found 8.5 kg in C_2 and lowest yield/plant was found 5.1 kg in C_0.

For combination of gibberellic acid and clybio concentration it was found highest flower/plant was 2685.7 in G_2C_2 and lowest flower number/plant was found in 1295.3 in G_0C_0. Highest fruit/plant was 1212.3 in G_2C_2 and lowest fruit number/plant was found in 590.7 in $G_0C_0C_0$. Highest fruit length was 26.3 mm in G_2C_2 and lowest fruit diameter was found in 18.3 mm in G_0C_0.Highest fruit diameter was 26.8 mm in G_2C_2 and lowest fruit diameter was found in 19.5 mm in G_0C_0. In this experiment maximum single fruit weight

was recorded 8.8 gm in G_2C_2 and minimum single fruit weight was recorded 5.5 gm in G_0C_0.On the other hand, highest yield/plant was found 10.7 kg in G_2C_2 and lowest yield/plant was found 3.3 kg in G_0C_0.

In view of overall performances, it can be stated that, SAU yellow cherry tomato is an effective profitable and high yielding variety for Bangladesh and gibberellic acid and clybio concentration of G_2 (G_2-50 mg/L) and C_2 (C_2-6 ml/L) respectively is the most effective on growth, yield of SAU yellow cherry tomato cultivation. So, SAU yellow cherry tomato with gibberellic acid and clybio concentration of G_2 (G_2-50 mg/L) and C_2 (C_2-6 ml/L) application will be the potential for higher growth and high yield of SAU yellow cherry tomato production.

From the experimental results and conclusions, the following recommendations are suggested:

- Application of gibberellic acid and clybio concentration of G_2 (G_2-50 mg/L) and C_2 (C_2-6 ml/L) can be used to improve plant growth and productivity under normal and stressful condition.
- SAU yellow cherry tomato can be the best an effective profitable and high yielding variety for Bangladesh.
- Application of gibberellic acid and clybio concentration seems to be an organic and eco-friendly process. In this process farmers can produce safe and healthy cherry tomato with high yield potential for Bangladesh.

However further investigation is necessary to reach the pin point of gibberellic acid and clybio concentration on cherry tomato production before final recommendation.

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APPENDICES

Appendix I. Analysis of variance for plant height at different days after transplanting of cherry tomato				
Source of variation	**Degrees of freedom**	**Mean square for plant height (cm)**		
		35 DAT	**70 DAT**	**105 DAT**
Factor A (GA_3)	2	77.149*	874.591*	1822.95*
Factor B (Clybio)	2	87.549*	424.493*	1170.90*
Interaction (A×B)	4	4.209*	7.331*	1.85*
Error	16	5.733	13.567	53.86
***: Significant at 0.05 level of probability**				

Appendix II. Analysis of variance for number of branches/plants, SPAD value for leaves, leaf area				
Source of variation	**Degrees of freedom**	**Mean square of**		
		No. of branches /plants	**SPAD value for leaves**	**Leaf area**
Factor A (GA_3)	2	5.44444*	462.334*	1282.27*
Factor B (Clybio)	2	4.00000*	485.521*	1918.72*
Interaction (A×B)	4	0.27778*	26.097*	75.49*
Error	16	1.25000	199.764	6.61
***: Significant at 0.05 level of probability**				

Appendix III. Analysis of variance for number of clusters/plants, number of flowers/plants, number of fruits/plants				
Source of variation	**Degrees of freedom**	**Mean square of**		
		No. of clusters/plants	**No. of flowers/plants**	**No. of fruits/plants**
Factor A (GA_3)	2	124.926*	1296219*	279885*
Factor B (Clybio)	2	84.037*	860875*	215720*
Interaction (A×B)	4	3.593*	49973*	8474*
Error	16	4.454	19	7
***: Significant at 0.05 level of probability**				

Appendix IV. Analysis of variance for fruit length, fruit diameter, individual fruit weight, yield/plant					
Source of variation	**Degrees of freedom**	**Mean square of**			
		Fruit length (mm)	**Fruit diameter (mm)**	**Individual fruit weight (g)**	**Yield/plant (Kg)**
Factor A (GA_3)	2	47.7581*	50.5581*	7.06333*	38.1670*
Factor B (Clybio)	2	21.0404*	15.0804*	4.02834*	26.6937*
Interaction (A×B)	4	1.1320*	0.9931*	0.21351*	0.5059*
Error	16	0.5662	0.1611	0.26144	0.0109
***: Significant at 0.05 level of probability**					