INFLUENCE OF CLYBIO CONCENTRATIONS ON GROWTH AND PRODUCTIVITY OF FOUR TOMATO VARIETIES

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INFLUENCE OF CLYBIO CONCENTRATIONS ON GROWTH AND PRODUCTIVITY OF FOUR TOMATO VARIETIES

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This is to certify that the thesis entitled **"INFLUENCE OF CLYBIO CONCNTRATIONS ON GROWTH AND PRODUCTIVITY OF FOUR TOMATO VARIETIES"** submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements of **the degree of MASTER OF SCIENCE in HORTICULTURE,** embodies the result of piece of bona fide research work carried out by **MD. AMAN ULLAH AMAN,** Registration No. **18-09173** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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MY BELOVED PARENTS

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ABSTARCT

A field experiment was conducted at Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from September 2019 to March 2020 to find out the influence of clybio on growth and productivity of tomato varieties. The experiment was designed in Randomized Complete Block Design with three replications. There were two factors, Factor A: Four tomato varieties; BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3) and BARI Tomato-21 (V_4). Factor B: Clybio concentration; control (C_0); Clybio 2 ml/L (C_1) and Clybio 4 ml/L (C_2). There were 12 treatment combinations. Among varieties highest number of flower per cluster (8.57), number of fruit per cluster (6.48), number of fruit per plant (34.22), fruit yield (96.39 t/ha) was obtained at V_1 and lowest number of fruit per cluster (4.18), number of fruit per plant (14.33) and fruit yield (73.08 t/ha) was obtained at V_2. In case of clybio treatments maximum fruit yield (91.74 t/ha) was found from C_2 and minimum fruit yield (74.39 t/ha) was found from C_0. In combination of two factors maximum fruit yield (105.0 t/ha) was recorded from the V_1C_2 and minimum fruit yield (65.95 t/ha) from V_2C_0. So, it can be concluded that, clybio treatment C_2 on BARI Tomato-14 provided best result for growth and productivity.

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ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS		FULL WORD
AEZ	….	Agro-Ecological Zone
EM	….	Effective microorganisms
BARI	….	Bangladesh Agricultural Research Institute
Bio	….	Biology
Agric.	….	Agriculture
FAO	….	Food and Agriculture Organization
Hort	….	Horticulture
et al.	….	And others
i.e	….	That is
LSD	….	Least Significant Difference
CV	….	Coefficient of Variance
Res.	….	Research
Sci.	….	Science
J.	….	Journal
DAT	….	Days after Transplanting
Cm	….	Centimeter
g	….	Gram
L	….	Liter
ml	….	Mililter
MoP	….	Muriate of Potash
TSP	….	Triple Super Phosphate
t/ha	….	Ton per hactre
Kg	….	Kilogram
BBS	….	Bangladesh Bureau of Statistics

CHAPTER I

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and widely cultivated vegetable. It belongs to the solanacious family and self pollinated. It was originated in tropical America mainly in peru, Ecuador and Bolivia (Salunkhe *et al*., 1987). Due to its adaptability to wide range of soil and climate it is cultivated all over the country (Ahmed, 1986). Tomatoes are largely grown in winter season but now it is cultivated in summer season also. During the year (2018-19) tomato covered 69697 acres of land, the total production was approximately 387653 metric tons and average yield was 5562 per acres (BBS, 2019). It is highly nutritious and containing vitamin A, vitamin C and minerals like calcium potassium etc (Thompson and Kelly, 1957). It can be consumed either fresh, cooked or in processed product such as juice, jam, jelly, sauce, ketchup etc.

Farmers generally apply chemical fertilizers for better yield on tomato field. Applications of excess amount of fertilizer increase the production cost as well as destroy the microclimate of soil. It also has negative impact on environment. Excessive use of fertilizers reduce the quality of food like decrease the sugar percentages in vegetables, fruits also triggers to add heavy metals even also having the residual effect that are really harmful for human health.

Thus, the main thought is the selection of alternative technologies. That can enhance the availability of plant nutrients and their uptake by plants. 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 pathgen and enhance soil quality. Microorganisms enhance the nutrient uptake of the plant by breakdown of complex nutreint sources. It also increase the crop yield by increasing the photosynthetic efficieny and improve the crop quality. EM also has the capacity to control some diseases.

Microorganisms that contained in EM produce plant hormones, beneficial bioactive substances and antioxidants while solubilize nutrients (Higa, 1994). Lactic acid bacteria produce lactic acids from sugar that increase the rate of organic matter decomposition. Yeast produces bio active photo hormones and enzymes that enhance the cell division. Actinomecetes produces anti microbial activities from amino acid that suppress the harmful microorganisms in soil (Condor *et al*., 2007). It improves the crop health and yield by increasing the photosynthetic rate and accelerating decomposition of soil organic matter for release of plant nutrient (Hussain *et al*., 1999). Many research proved that EM enhance the growth and yield of many vegetable crops (Chowdhury *et al*., 1994; Javid, 2006; khaliq *et al*., 2006).

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 is the unique and complex microbe that contains bacteria like Lactobacilli bacteria, Lactic acid bacteria, *Bacillus natto* bacteria yeast and fungus. It has the potentiality to improve the crops growth, yield and quality parameters.

Considering the above facts, the present study was undertaken to evaluate the influence of clybio on the production of tomato.

The objectives of the study were as follows:

1. To find out the growth and yield performance of four tomato varieties.

2. To find out the influence of different clybio concentration on growth and yield of tomato varieties.

CHAPTER II

REVIEW OF LITERATURE

Tomato (*Lycopersicum esculentum* Mill.) is one of the most important vegetable crops in Bangladesh. Tomato cultivation occurs in large area of Bangladesh every year. Effective microorganisms (EM) are mixture of some beneficial microorganisms. Application of EM has influences on growth, yield and yield contributing characters of tomato as well as other vegetables. Some of the significant research work have been done home and abroad related to this experiment have been presented (Year wise) in this chapter.

Hurtado *et al.* (2019) conducted a field trial at Collective farm "Martires de Taguasco" in Sancti Spíritus, Cuba to evaluate the effect of Effective microorganisms (EM) on growth and yield of bean. Different forms of effective microorganisms were applied to evaluate the production of two cultivars of the common bean from November of 2013 to March of 2014. Two factors were studied. The first one was comprised of the two cultivars, Velazco Largo (VL) and Cuba Cueto (CC-25-9-N). Second factor consisted of four treatments with EM; without EM (control), soil inoculation (100 ml/L), foliage applications (100 ml/L), and the combined soil inoculation (100 ml/L) plus foliar applications (100 ml/L). Growth and yield indicators were evaluated as the number of leaves per plant, the height of plants, number of pods per plant, number of seeds per pod, the mass of 100 seeds (g) and the yield (t/ha). The results showed that the different forms of application of efficient microorganisms stimulated the growth and yield indicators evaluated in both crops. Associated applications between the inoculation of the soil and foliage applications of efficient microorganisms provided better results, producing increments in the yield of VL(1.13 t/ha) and in CC-25-9-N(2.15 t/ha).

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.

Iriti *et al.* (2019) reported that effective microorganisms (EM) treatments has effect on leaf chlorophyll content, yield and micronutrient content of bean plants grown in different substrates (nutrient rich substrate vs. nutrient poor sandy soil) in restricted environmental conditions. EM treated plants maintained optimum leaf photosynthetic effectiveness two weeks longer than the control plants and also increase yield.

Kodippili and Nimalan (2018) reported that the study was conducted at Hunumulla agricultural farm, Gampaha District, Sri lanka to evaluate the effect of homemade EM along with compost on growth and yield parameters of chilli (*Capsicum annuum*). Experiment was planned in Randomized complete block design (RCBD) with three replications. Treatments were as follows Control (T_1), Compost (T_2) and EM + Compost (T_3). Results showed that EM + Compost treated crops showed significantly highest plant height (29.76cm), number of leaves per plant (176.40), number of branches per plant (44.67), number of flowers per plant (15.47) and number of chilli pods per plant (10.60), but there were no significant differences observed between the EM + compost and compost in pod length, pod width and the weight of total chilli pods per crop. This study concluded that growth and yield of the chilli crops were increased by the application of EM with compost compared to the application of compost only.

Karunarathna and Seran (2016) conducted a study to evaluate 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 chi-square 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.

Aredehey and Berhe (2016) carried out an experiment at two places of Tigray region (Maimegelta's Kebele Farmers Training Center) and (Illala Research site), Ethiopia to find out the effect of compost with effective microorganisms on grain and biomass yield of wheat. Experiment was outlined in randomized complete block design. The treatments were as follows, Control, Recommended chemical fertilizer (100 kg/ha of urea and 100 kg/ha of DAP), Compost with EM (5 t/ha) and Compost without EM (5 t/ha). Results showed that there was no significant difference among the treatments at 5% level of significant but the highest grain yield of wheat was obtained for the treatments compost with EM.

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.

Olle and Williams (2015) carried out 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 showed that Plant height (cm), stem diameter (cm) and yield of cucumber, pumpkin and squash were highest at T_2.

Shaheen *et al.* (2014) conducted a two years pot experiment at Gomal University 2009 to 2011 to study the effect of organic manure and complex chemical fertilizer (NPK) with or without effective microorganism (EM) on the agronomic performance of spinach crop. Commercial product Bio-Aab was used as a source of EM. The treatments were T_1: (no N or EM), T_2: (FYM applied at 10 t/ha), T_3: (press mud applied at 20 t/ha), T_4: (compost applied at 0.7 t/ha) and T_5: (poultry manure applied at 5 t/ha). In 2009-10, the application of EM with Press mud @ 20 t/ha significantly enhanced spinach growth by exhibiting higher average spinach plant height (35 cm), number of leaves (16.4), fresh foliage yields (330 g/pot), dry foliage yields (32 g/pot) and leaf length (40.5 cm) relative to poultry manure, compost or FYM treatments.

Similar result was observed during 2010-11. Press mud with EM was more efficient in improving soil quality and enhancing spinach growth and quality followed by FYM and poultry manure.

Kleiber *et al.* (2014) conducted an experiment at Marcelin Experimental Station, PoznaĔ Uiversity of Life Sciences, Poland during 2010-2011 to investigate the pplication 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).

Olle and Willians (2013) collected data from various scientific papers and reported 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.

Kleiber *et al.* (2013) reported that a study was conducted in a special greenhouse located within the area of the Experimental Station of the Faculty of Horticulture and Landscape Architecture of the University of Life Sciences in Poznan, Poland. The study was conducted to evaluate the influence of the chemical composition of a nutrient solution (NS I, NS II), seed inoculation with Effective Microorganisms (EM), and assimilation illumination (AI) of plants on the growth, development and nutritional status of lettuce (*Lactuca sativa* L.) in hydroponic cultivation and microbiological changes in the medium. The measurements were as follows: quantity of leaves per plant (LQ), surface area of the biggest leaves of plants (SBL), relative chlorophyll content (SPAD units), total fresh weight (TFW). Results showed that application of NS II and EM-A had a positive influence on the development of leaves, relative chlorophyll content on the plant.

Fawzy *et al.* (2012) conducted two field experiments at Wady Elmollak, Ismailia Governorate, Egypt in two successive seasons of 2009 to 2010 and 2010 to 2011. The aim of the study was to evaluate the foliar effect of EM, amino acids and yeast on growth and yield of on onion. Two cultivars Giza 20 and Super X were used. There was ten treatments control (spray with tap water), EM_1 (1cm/L), EM_2 (2cm/L), EM_3

(3cm/L), AG_1 (1 cm/L), AG_2 (2 cm/L), AG_3 (3cm/L), Y_1 (1gm/L), Y_2 (2gm/L) and Y_3 (3gm/L). Results showed that Giza 20 gave the highest amount of vegetative growth plant height (51.23 cm; 42.23 cm) in the two seasons. With regard to foliar application treatments the results indicated that using EM, amino acids and yeast had positive promoting effects by providing supplemental doses of these components on growth, yield and its quality as well as all chemical composition compared with control plants. It may be concluded that using yeast at rates of Y_3 gives the highest growth parameters. However, using EM at rates of EM_3 gives the highest yield (15.69 t/ha).

Agamy *et al.* (2012) reported 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 showed 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 bio-fertilizers is a good alternative of the chemicals in the sustainable and organic farming.

Ncube *et al.* (2011) conducted a field experiment during the 2004-2005 summer season to evaluate the agronomic suitability of effective microorganism (EM) on tomato (*Lycopersicon esculentum* Mill).Treatments included: Control (T_1), Effective microorganism (T_2), Mineral fertilizer (T_3), Effective microorganism (EM) + Mineral fertilizer (T_4), Compost + Effective microorganism (T_5), Compost + Mineral fertilizer (T_6) and Compost + Mineral fertilizer +Effective microorganism (T_7). Results showed that application of EM significant effect on tomato production. Number of fruited tomato plants at T_5 resulted in 33.3% increase in the number of fruited plants relative to the T_1. Highest Yield (36.3 t/ha) was at T_4 and lowest yield (17.5 t/ha) at T_7.

Ndona *et al.* (2011) conducted a pot experiment at University of Natural Resources and Life Sciences, Vienna during 2006 and 2007 to evaluate the effect of treating organically grown tomato plants with Effective Micro-organisms (EM) combined with a stone dust-suspension (EM treatment). Results showed that total yield was higher and the number of fruits damaged by blossom-end rot was reduced in the EM-treated plants in 2007. Percentage of best quality fruits was significantly higher in the EM treatment in both years.

Javaid and Bajwa (2011) conducted a field experiment to find out the effect of EM on mung bean cultivation. Experiment field soil was amended with farmyard manure at 20 t/ha, *Trifolium alexandrinum* green manure at 20 t/ha, Recommended (NPK) and half (½ NPK) doses of chemical fertilizers. EM was applied in the form of a dilute solution in water (1:1000) at fortnight intervals throughout the experiment period. EM application significantly enhanced shoot biomass in farmyard manure, ½ NPK and NPK amendments. Similarly, EM significantly increased grain yield by 24% and 46% in farmyard manure and NPK fertilizers amendments, respectively. By contrast, in green manure amendment, EM application resulted in a significant decline of 23% in grain yield. In ½ NPK amendments, the effect of EM application on grain yield was insignificant. However, in NPK amended soil, EM application markedly enhanced plant nutrition at later growth stage only.

Javaid and Mahmood (2010) conducted a field experiment to investigate the effect of a symbiotic nitrogen fixing bacterium *Bradyrhizobium japonicum* and a commercial EM (effective microorganisms) on growth and yield of soybean (*Glycine max* L.) in soils amended either with farmyard manure or *Trifolium alexandrinum* L. green manure @ 20 t/ha each. In green manure amendment, Effective microorganisms (EM) inoculation significantly enhanced number and biomass of nodules resulting in a significant increase of 27, 65 and 55% in shoot biomass and number and biomass of pods, respectively. As a result a significant increase of 45 and 47% in shoot biomass and number of pods was recorded respectively.

Ghoname *et al.* (2010) reported that the study was conducted in two successive season of 2008 and 2009 to investigate and compare the enhancing effects of three different biostimulation compounds on growth and production of sweet pepper plants (*Capsicum annuum* L.) cv. California Wonder. Transplanting plants were sprayed with any of the individual three solutions of Stimufol (multi nutrients solution) (1, 2 and 3 g/l), Chitosan (2, 4 and 6 cm /l); and Yeast (1, 2 and 3 g/l). Results showed that all 3 applied solutions promoted plant vegetative growth i.e. plant height, number of leaves and branches, fresh and dry weights. Individual fruit weight and number of fruits were also improved. Fruit quality in terms of Total Soluble Solids (TSS) showed also similar positive responses compared to untreated ones. Stimufol was superior in its effect compared to all other treatments followed by Chitosan and the lowest effect was recorded with yeast treatments.

Mohan (2008) conducted a field experiment at srinivasan rural training center, Hosur, India during the period of (2005-2006) to evaluate the influence of organic growth promoters on yield of dry land vegetable crops. Two vegetable crops were used Brinjal (*Solanum melonogena*) and tomato (*Lycopersicon esculentum*). Treatment were T_0: Control, T_1: Panchagavya (3%, diluted in water), T_2: Panchagavya (5% diluted in water), T_3: Amrit Pani (3% diluted in water), T_4: Amrit Pani (5% diluted in water), T_5: Bokashi (750 kg/ha) and T_6: Bokashi (1250 kg/ha). Results showed that in brinjal the effect of growth related data was given highest at T_5 and T_6 by the treatment with T_1 and T_2. Plant height (97.2±0.2cm) and leaves per branch (13.3±0.1) was highest at T_5. Number of flower/plant (158.5±0.1), Fruit/plant (121.0±0.3) and yield/plant (4.3±0.0 kg) was highest at T_6. In tomato plant height (97.2±0.2cm) and number of leaves/branch (13.3±0.1) was highest at T_5. Number of flower/plant (158.5±0.1), number of fruit/plant (121.0±0.3) and yield/plant (4.3±0.0 kg) was highest at T_6. Significant difference was found between the control and the various treatments.

Idris *et al.* (2008) conducted field experiments at Research Farm in Wad Medani, University of during 2004-05 to find out 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/plant, number of fruits/cluster and total yield.

Khaliq *et al.* (2006) reported an experiment was conducted at research field of Soil Science Department, University of Agriculture, Faisalabad, Pakistan during the period of 1999 to 2000 to find out the effects of integrated use of organic and inorganic nutrient source with EM on growth and yield of cotton. Treatments were as follows T_0: Control, T_1: Organic matter (OM), T_3: Effective microorganisms (EM), T_4: Mineral NPK (170:85:60 kg), T_5: ½ NPK + EM, T_6: ½ NPK + OM + EM and T_7: NPK + OM + EM. Results showed that T1 and T_2 did not increase yield and yield attributing components significantly but T_3 resulted in 44% increase over control. T_7 resulted the highest seed cotton yield (2470 kg/ha), T_6 yielded (2091 kg/ha) similar to the yield (2165 kg/ha) obtained from T_4.

Javaid (2006) carried out an experiment to evaluate the effect of foliar and soil application of beneficial microorganisms on growth and yield of pea (*Pisum sativum* L.). Soil amended NPK fertilizer; farmyard maure and green manure were used with foliar application of EM. Results showed that foliar application of significantly increased shoot biomass by 70% in NPK treated soil. Similarly foliar application of EM increased the number of pods and pod biomass by 157% and 266%; 126% and 145% in NPK fertilizers and green manure amended soil.

Hu and Qi (2003) reported that long term effective microorganisms application promote growth and increase yield of wheat in china, study was conducted at Qu-Zhon experimental station, China Agricultural University, Hebei, China in 1993. Three treatments were used control: No soil amendments, Traditional compost: 60% straw, 30% livestock dung, 5% cottonseed-pressed trash, and 5% bran (15 t/ha) and Compost with EM: 50 kg traditional composts+ 200ml concentrated effective microorganisms + 1 kg red sugar. The results revealed that long-term application of EM compost gave the highest values for the measured parameters and the lowest values in the control plot. Application of EM in combination with compost significantly increased wheat plant height (67.20 cm), reproductive spike (474.81), grain per spike (29.87) and grain yield (6.12 t/ha) compared with traditional compost and control treatment. Plant height, reproductive spike, grain per spike and grain yield was significantly higher in compost soils than in untreated soil. This study indicated that application of EM significantly increased the efficiency of organic nutrient sources that affect the plants growth and yield.

Yadav (2002) conducted 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.

Shah *et al.* (2001) reported that the study was conducted at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan during the period of autumn 1998. Objective of the study was to investigate the effect of different fertilizers and EM on growth, yield and quality of maize. Nine treatments were applied as follows T_0: (Control), T_1: (12.5 t FYM + 60 L/ha EM), T_2: (75 kg N + 60 L/ha EM), T_3: (37.50 kg P + 60 L/ha EM), T_4: (75 kg N + 37.50 P + 60 L/ha EM), T_5: (25 t FYM + 30 L/ha EM), T_6: (150 kg N + 30 L/ha EM), T_7: (75 kg P + 30 L/ha EM) and T_8: (150 kg N + 75 kg P +30 L/ha EM). Results showed that Plant height (244.5 cm) at T_5 and (243.50 cm) at T_8 are statistically similar. No. of grain/cob (572.40) and grain yield (4.72 t) are highest at $T_{8.}$ Increase of yield was recognized to increased leaf number and more number of grains per cob.

Xu *et al.* (2001) conducted an experiment to investigate the effects of applications of bokashai and chiken manure as well as EM inoculation to bokashi and chicken manure on photosynthesis, fruit and quality of tomato. Six treatments used as follows T1: Chicken manure, T2: Chicken manure with EM, T3: Anaerobic Bokashi, T4: Anaerobic Bokashi with EM, T5: Chemical fertilizer and T6: Chemical fertilizer + 80 ml EM. Fruit no per plant (10.1 ± 0.3) and yield per plant (1012 ± 30) was highest at T_6 treatment.

Xu (2001) observed the effects of EM and organic fertilizer on the growth, photosynthesis and yield of sweet corn (*Zea mays* L.). An organic fertilizer consisting of a mixture of oilseed mill sludge, rice husk and bran and fish processing waste was inoculated and fermented with EM as the microbial inoculant. The organic fertilizer and chemical fertilizer were then applied to respective pots to compare the growth, yield and physiological response of sweet corn plants. EM applied with the organic fertilizer was shown to promote root growth and activity and to enhance photosynthetic efficiency and capacity which resulted increased grain yield. This was attributed largely to a higher level of nutrient availability facilitated by EM application over time.

Iwaishi (2001) carried out an experiment at the Agricultural Experiment Station, International Nature Farming Research Center, Matsumoto, Japan to evaluate the effect of Effective microorganisms (EM) on growth, yield and quality of rice. Experiment was designed as completely randomized block design (RCBD) and total four treatments were used. Treatments as follows T_1: OF + EM at 18.7 kg/a, T_2: OF at 18.7 kg/a, T_3: OF + EM at 27.5 kg/a, T_4: OF at 27.5 kg/a. Result showed that EM inoculation increased kernel enlargement after the panicle formation stage and also increased ear number and length and kernel number. The yield of brown rice from EM inoculation was higher for the standard fertilizer rate and lower for the higher rate of organic fertilizer.

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) 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.

Hussain *et al.* (1999) conducted an experiment to investigate the effect of effective microorganism (EM) on rice and wheat production. Four treatments (Control), (NPK fertilizer), (Green manure) and (Farmyard manure) with and without EM were used. Results showed that Em has effect on growth and yield related parameter in rice. Plant height (102 cm), Tillers no (298 m^{-2}) and grain yield (5.19 t/ha) of rice highest at T_2 with EM. Wheat production result showed no significant effect on plant height, tiller no and grain yield.

Daly *et al.* (1999) conducted an experiment at organic farms in Canterbury, New Zealand during 1994-1995 to evaluate 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) conducted 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) conducted many field and greenhouse experiments in Pakistan since 1990 to evaluate 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.

Chowdhury *et al.* (1994) reported that a series of four experiments was conducted at experiment field of Rice Research Institute, Joydebpur, Gazipur and Institute of Postgraduate Studies in Agriculture (IPSA), Salna, Gazipur to evaluate the effect of organic amendments and Effective Microorganisms (EM) on crop production. Four crops (string bean, rice, red pepper and Indian spinach) and four treatments T_1: control, T_2: recommended chemical fertilizer application, T_3: cow dung at 10 t/ha, T_4: rice straw at 10 t/ha used. EM was used with treatment. Result showed that for string bean T_4 with EM give highest Fruit per plant (21.7), Yield (12.1 t/ha) and yield increase (146%) than the control. For rice plant height (71 cm) at T_4 with EM and yield (4.2 t/ha) at T_2 with EM was highest. For red pepper Fruit per plant (75.7), fruit weight (76.7 g) and yield increase (73%) at T_4 with EM. For Indian spinach EM showed no significant effect on Harvested shoots/plant, leaves/plant, weight of stems/plant (g) and yield (t/ha).

Sharifuddin *et al.* (1993) conducted 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) conducted 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 fulctescens* L.) was at pot. Four treatment 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-P-K 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.

CHAPTER 3

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in conducting the experiment. It includes a short description of experimental site, climate, soil and materials that uses in the experiment, treatments, data collection and statistical analysis.

Experimental Site

The experiment was conducted at the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from September 2019 to March 2020. It situated within the $23^0$46´ N latitude and $90^0$22´ E longitudes with an elevation 8.24 meter from the sea level.

Climate

The experimental area was located on the sub tropical monsoon climatic zone. Heavy rainfall occurs during the months from April to September and low rainfall occurs during the rest period of the year. Details of the weather data for the study period were collected from the Meteorological Department of Bangladesh, Dhaka-1207

Soil

The soil of the experimental site located on the agro ecological region of "Madhupur tract" (AEZ No: 28). Top soil of the region is olive gray with common fine to medium distinct dark yellowish brown mottles and clay in texture. Soil PH ranged from 6 to 6.6 and organic matter content 0.84%. Soil sample was collected from experimental field 0-15 cm depths and analyzed by Soil Resources and Development Institute (SRDI), Dhaka. Physiochemical properties were present in the soil appropriately.

Planting material

Four tomato varieties were used in this experiment. Seeds were collected from the Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur.

Treatments of the experiment

Two factors were used in the experiment. Four tomato varieties and three level of clybio application.

Factor A: Four varieties of tomato coded as

BARI Tomato-14 (V_1)

BARI Tomato-17 (V_2)

BARI Tomato-18 (V_3)

BARI Tomato-21 (V_4)

Factor B: Clybio was applied as three different treatments coded as

Treatments:

Control (C_0)

Clybio 2ml/L (C_1)

Clybio 4ml/L (C_2)

There were 12 treatment combinations as follows:

V_1C_0, V_1C_1, V_1C_2, V_2C_0, V_2C_1, V_2C_2, V_3C_0, V_3C_1, V_3C_2, V_4C_0, V_4C_1, V_4C_2,

Compositions of Clybio:

Clybio is one kind of Effective microorganisms (EM). That contains 5 families, 10 genera and 80 species of coexisting microorganisms. Mostly contain microorganisms like *Lactobacilli* bacteria, Lactic acid bacteria, *Bacillus natto* bacteria, yeast, actinomycetes and fungus (plate 1 a).

Design and Layout of the experiment

The experiment was laid out in the randomized completely block design (RCBD) with three replications. An area of 29.1 m x 10 m was divided into three blocks. The treatments were randomly allotted in each block. Each block consisted of 12 plots and total 36 plots were in three replications. The size of a unit plot was 2 m x 1.8 m. The distance maintained between two plots and two blocks were kept 0.5 m and 1 m respectively. The layout of the experiment is shown in figure 1.

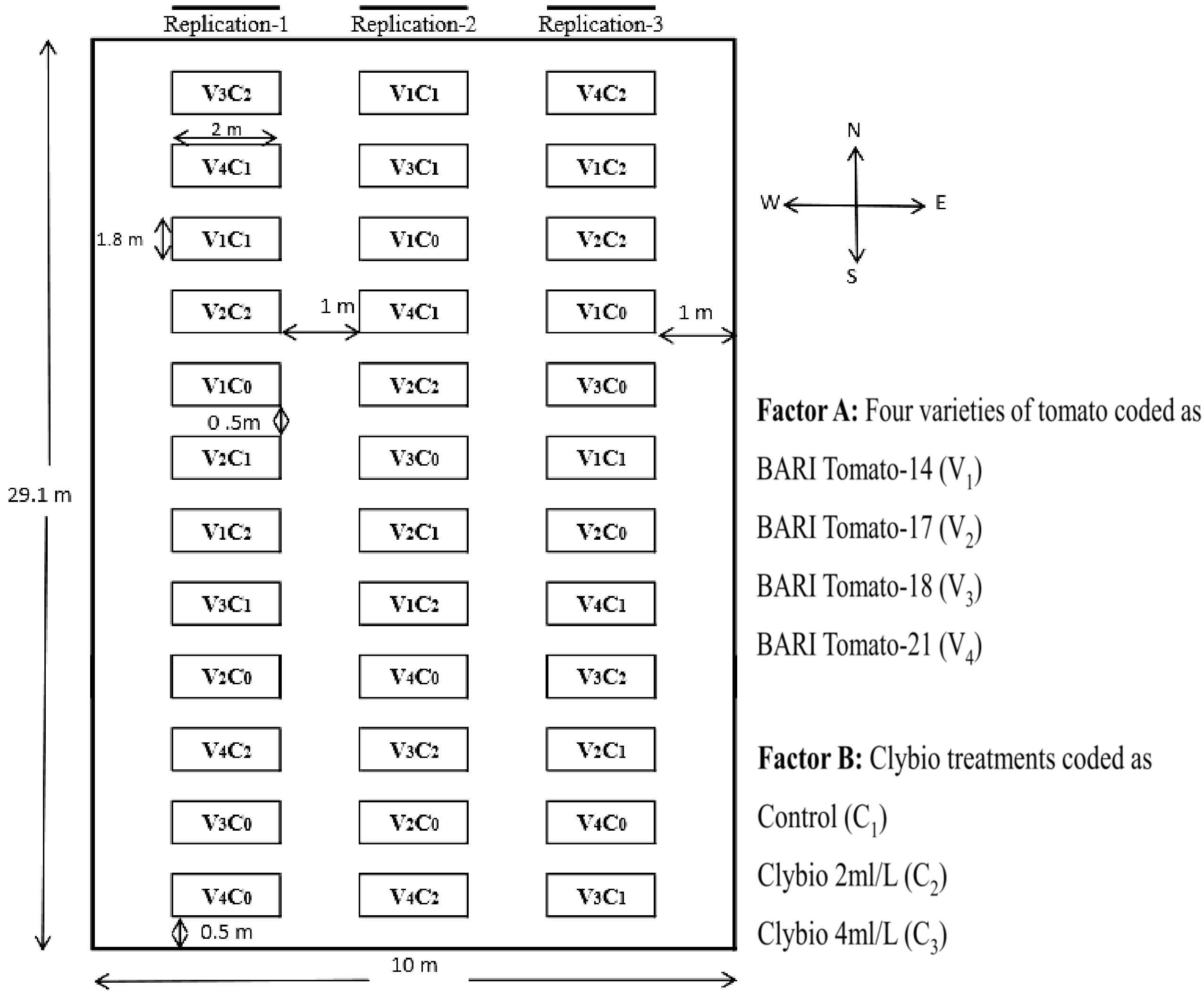

Fig. 1. Field layout of the experimental plot

Seed bed preparation and raising of seedlings

Seed bed was prepared for the raising of seedlings. The size of the seedbed was 2m x 1m. The soil was well ploughed and converted into loose friable and dried mashes to obtained good tilth, weeds, stubbles and dead roots were remove from the seedbed. The soil was treated with seven 50 wp @5 kg/ha to protect the young seedling from the attack of mole cricket, ants and cutworms.

Twenty grams of seed were sown in seedbed. The seeds were sown on 30 September, 2019. Seeds were then covered with light soil and shading was provided by polythene sheet to protect the seedling from the scorching sunlight and rainfall. Seeds were germinated after 4 days of sowing. Weeding, mulching and light watering were done as and when needed.

Land preparation

The selected land for the experiment was first opened on first week of October, 2019. The land was well prepared by several ploughing and cross ploughing. All weeds and stubbles were removed and land the land was finally prepared through addition of basal doses of manures and fertilizers. Then the area was divided into plots of 2 m x 1.8 m as per the design.

Manure and fertilization application

During final land preparation total amount of cow dung and triple super phosphate (TSP) were applied in the pot. Half Urea and half murate of potash (MoP) were applied in the plot after three weeks of transplanting. Remaining urea and murate of potash (MoP) were applied after five weeks of transplanting. Dose of manure and fertilizers used in the study are showing in (Table 1).

Table 1. Manures and fertilizer with BARI (2019) recommended dose

Manures/Fertilizers	Recommended dose
Cow dung	10 t/ha
Urea	180 kg/ha
TSP	150 kg/ha
MoP	80 kg/ha

Application of clybio

Clybio stock solution was used in this study. From Clybio stock solution 2 ml was added to 1 liter of water to make treatment (C_1) and 4ml was added to one liter of water to make treatment (C_2). Clybio was sprayed on the plant and soil surface of clybio at 15 days interval was done at four times after transplanting (Plate 1 b).

Transplanting of seedlings

Healthy and uniform size 18 days old seedlings were taken from the seedbed and transplanted into the main experiment field at the afternoon of 21 October, 2019. There 60 cm x 50 cm plant spacing was maintained. The seedlings were watered regularly till the seedlings were considered to be settled. Shading was provided using banana leaf sheath for few days. Some seedlings were planted around the boarder side of the field for gap filling.

Intercultural operation:

Gap filling

Gap filling was done in the place of dead and wilted seedlings in the field after few days of transplanting. Previously planted border area seedling of the same variety was used in gap filling.

Weeding

Weeding was done to keep the field clean and free from weeds for the better plant growth. Three times weeding were done during the cropping period.

Staking

When the plants were well established, each plant was staked with bamboo stick with rope to keep the plant erect. As the plants were grown up within a few days of staking, other cultural operations were carried out.

Irrigation

Seedlings were properly irrigated after transplanting. Flood Irrigation was provided after each top dressing of urea. Final irrigation was given when plants reached to active fruiting stage.

Pest and disease control

To protect the plant from the leaf hopper, cutworm and fruit borer Malathion 57 EC was applied @ 2ml/L. The insecticide application was made fortnightly for a week after transplanting to a week before first harvesting. Furadan 10G was applied at the final land preparation as a soil insecticide.

Harvesting

Harvesting of fruits were done on the basis of horticultural maturity, size, color and age being determined for the purpose of consumption as the fruit grew rapidly and soon get beyond the marketable stage (Plate 1.d.). Throughout the harvesting period frequent picking was done. Harvesting was started from 25 January 2020 and was completed by 23 February 2020.

Data collection

Data were collected in respect of the following parameter:

Plant height (cm)

Plant height was measured from the bottom part to the apex of the plant using the meter scale (Plate 1 c). The height was recorded from the sample plant and mean was determined by dividing the total height by the number of the plant. Plant height was recorded 20, 40, 60 days after transplanting to observe the growth rate.

Number of leaves per plant

Leaves number was manually counted from the selected plants at 20 days interval and their average were taken. Number of leaves was recorded 20, 40, 60 days after transplanting to observe the growth rate of plant.

Number of branch per plant

Branch number of per plant was counted manually at certain day interval from the selected plant. The average was computed and expressed as average number of branch.

Number of flower cluster per plant

Flower clusters were counted manually from the sample plant after certain day's interval of transplanting. The average was computed and expressed as the number of the cluster per plant.

Number of flower per cluster

The number of flower per cluster was counted manually from every cluster of the selected plant. The average was computed by dividing the total flower number and the total flower cluster number and expressed an average number of flowers per cluster.

Number of flower per plant

Total numbers of the flower was counted from the selected plants and their average was expressed as the numbers of flower per plant.

Number of fruit cluster per plant

The number of clusters bearing fruits was counted from the sample plants and the average number of fruit clusters produced per plant was recorded and calculated at the final harvest.

Number of fruit per cluster

Number of fruits in every cluster was counted manually from the five selected plants and the average number of fruit produced per cluster was recorded.

Number of fruit per plant

Total number of fruit was counted manually from the five selected plant and the average number of fruit produced per plant was recorded (Plate 1 d).

Single fruit weight (g)

Except first and last harvest fruits were considered to take individual fruit weight. Fruit weight was measured using electronic precision balance in gram. Total fruit weight of each plot was obtained by addition of individual fruit weight and mean fruit weight was acquired from division of total fruit weight by total number of fruits (Plate 1 e).

Fruit length and Diameter (mm)

The length and diameter of fruit were measured using Digital Calipars-515 (DC-515) in millimeter (Plate 1 f).

Yield per plant (kg)

It was calculated from weight of total fruits divided by total number of plants.

Yield per hectare (t)

Yield per hectare was calculated from the yield obtained from each of the experimental plot and was expressed in tones per hectare.

Chlorophyll percentage

Chlorophyll of leaf was measured by using SPAD-502 plus (Plate 1 g). The chlorophyll was measured from three portion of leaf and average was calculated. Chlorophyll content was expressed in percentage.

Brix percentage

Brix was measured by refractometer (ERMA, Tokyo, Japan) at room temperature (Plate 1 h). At first every single fruit was blended and juice extract was collected to measure brix and expressed in percentage. Mean was calculated from the each treatment.

Statistical analysis

The data obtained from different yield and yield components statistically analyzed to find out the significance of the difference among the treatments. The mean values were evaluated to measure the analysis of variance by the F (variation ratio) following MSTAT–C computer packaging program. The difference between treatments was accessed by Least Significant Difference (LSD) test 0.05% level of significance (Gomez and Gomez 1984).

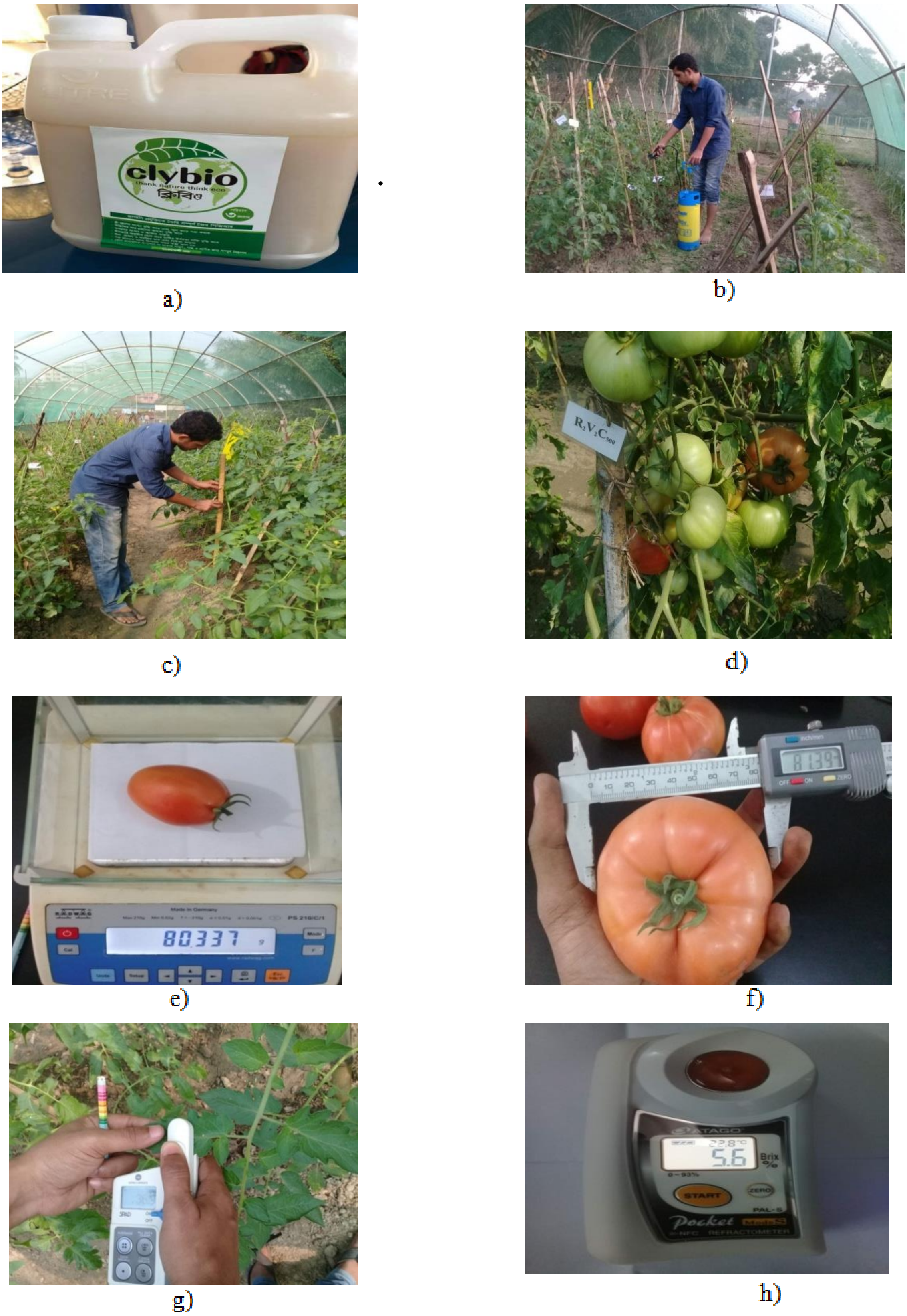

Plate 1. Picture of different methodological works, equipments and data collection process. a. Clybio stock solution, b. Foliar application of clybio, c. Measurement of plant height, d. Fruit in plant, e. Measurement of single fruit weight, f. Measurement of fruit diameter, g. Measurement of chlorophyll percentage, h. Measurement of Brix percentage

CHAPTER IV

RESULT AND DISCUSSION

This experiment was conducted to evaluate the effect of clybio on growth and productivity of four tomato varieties. All data of different parameter were recorded and findings of research work have been presented and discussed in this chapter. Results of different parameter have been presented and discussed with the help of tables and figures. Summary of analysis of variance (ANOVA) of different parameter have been arranged in appendix. The results have been presented, discussed and possible interactions are given under the following headings.

Plant height

Plant height is one of the most important parameters, which has positive correlation with the yield of tomato. Significant dissimilarity was found among the tomato varieties performance in terms of plant height (Appendix I). Plant height of tomato varieties V_1, V_2, V_3 and V_4 exposed statistically significant inequality at 20, 40, 60 and 80 days after transplanting (Appendix I). Tallest plant (128.0 cm) was found at V_3 and lowest (95.2 cm) was found at V_2 at 80 DAT (Fig. 2.). Significant increase in plant height was observed from 40-60 DAT in all the varieties which then slowed down at 60-80 DAT because indicating it reaching it maturity.

Plant height of tomato varieties exposed statistically significant disparity among different treatments. Tallest plant was found from C_2 treatment; i.e. 37.9 cm, 53.4 cm, 97.6 cm and 117.6 cm at 20, 40, 60 and 80 DAT respectively and shortest was found from control (C_0) 31.8 cm at 20 DAT,46.7 cm at 40 DAT, 87.3 cm at 60 DAT and 104.7 cm at 80 DAT (Fig. 3.).

Combined effect of different tomato varieties and different treatments in terms of plant height also exposed significant dissimilarity (Appendix I). Plant height exposed significant disparity among combination of tomato and clybio treatments at 20 DAT, 40 DAT, 60 DAT and 80 DAT. Tallest plant (136.7 cm) was obtained from V_3C_2 and lowest (90.4 cm) was obtained from V_2C_0 at 80 DAT (Table 2). Idris *et al.* (2008) reported similar findings in tomato.

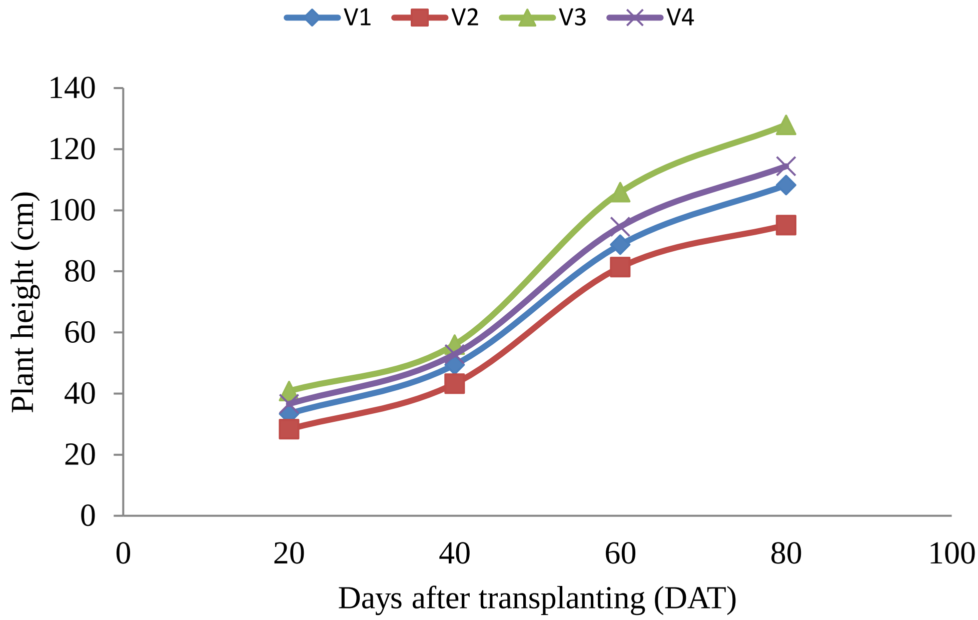

Fig. 2. Performance of four tomato varieties on plant height; i.e. BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4).

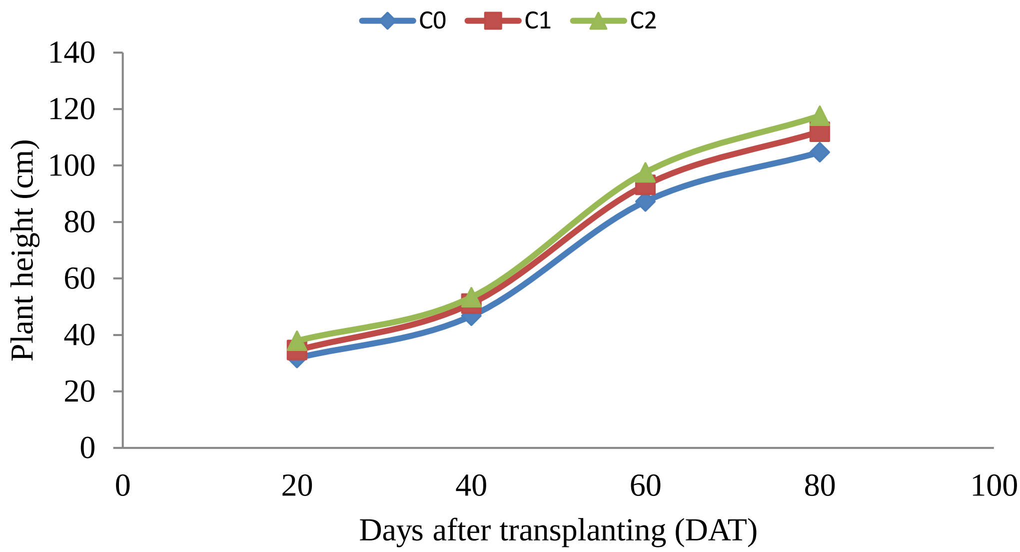

Fig. 3. Effect of clybio treatments on plant height; i.e. control (C_0), Clybio 2ml/L (C_1), Clybio 4 ml/L (C_2).

Table 2. Combined effect of varieties and clybio treatments on plant height at different days after transplanting of tomato

Treatment combinations [xx]	Plant height (cm) [x]			
	20 DAT	40 DAT	60 DAT	80 DAT
V_1C_0	29.7 fg	45.2 f	83.8 i	101.8 g
V_1C_1	33.2 e	49.9 d	88.9 g	108.6 f
V_1C_2	37.3 cd	53.1 c	93.5 f	114.3 e
V_2C_0	25.6 h	39.4 g	75.5 j	90.4 j
V_2C_1	28.6 g	44.7 f	82.5 i	96.1 i
V_2C_2	30.7 f	45.6 f	86.1 h	99.1 h
V_3C_0	37.7 c	53.5 c	102.2 c	119.0 d
V_3C_1	40.3 b	56.6 b	105.4 b	128.2 b
V_3C_2	44.4 a	58.1 a	110.1 a	136.7 a
V_4C_0	34.3 e	48.7 e	87.6 g	107.6 f
V_4C_1	36.2 d	53.3 c	95.5 e	115.3 e
V_4C_2	39.3 b	56.6 b	100.8 d	120.4 c
CV%	8.00	4.43	3.02	2.45
LSD (0.05%)	1.36	1.09	1.37	1.33

[x] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

[xx] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4) ; Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

Number of leaves per plant

Leaves number was significantly affected by Tomato varieties (Appendix II). Leaf number of tomato V_1 (10.8; 25.8) and V_4 (10.1; 26.4) exposed statistically similar at 20 and 40 DAT respectively. Difference was found among four tomato varieties (V_1, V_2, V_3 and V_4) at 60 and 80days after transplanting (Fig. 4.). Number of leaves was found highest at V_4 (73.1) and lowest was found at V_2 (58.0) at 80 DAT.

Leaves number of tomato varieties exposed statistically significant inequality among different clybio application. Leaves number of tomato has gradually increased with the application of clybio. Maximum leaf number was counted in C_2 treatment; i.e. 10.8, 27.0, 50.8 and 71.1 at 20, 40, 60 and 80 DAT respectively and minimum was counted from C_0 treatment; i.e. 8.0, 19.9, 39.1 and 60.3 at 20, 40, 60 and 80 DAT respectively (Figure 5).

Combined effect of different tomato varieties and clybio treatments in terms of leaf number of tomato also exposed significant variation (Appendix II). Leaf number of different tomato varieties had exposed statistically significant inequality among treatments at 20, 40, 60, 80 DAT (Table 3). In combination highest leaf number (75.7) was found at V_1C_2 which is statistically similar at V_4C_2 and lowest (53.3) was found at V_2C_0 at 80 DAT (Table 3). Similar results obtained by Karunarathna and Seran (2016).

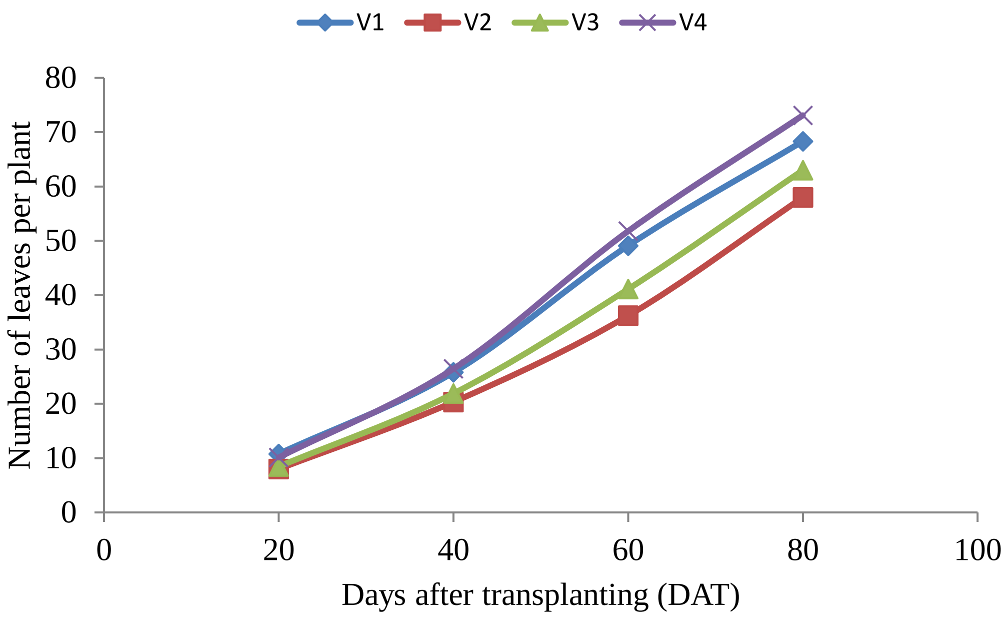

Fig. 4. Performance of four tomato varieties on number of leaves per plant; i.e. BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4).

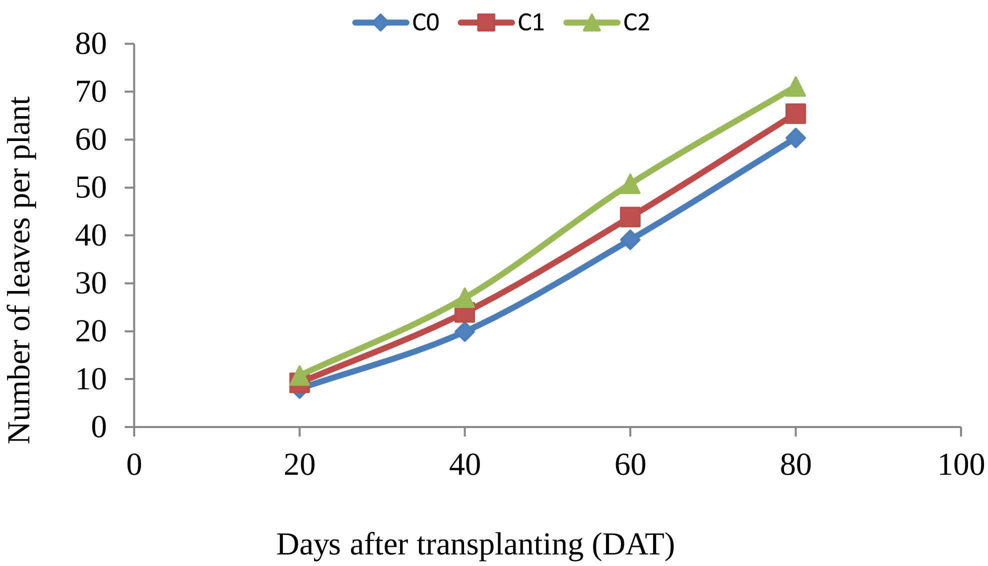

Fig. 5. Effect of clybio treatments on number of leaves per plant; i.e. control (C_0), Clybio 2 ml/L (C_1), Clybio 4 ml/L (C_2)

Table 3. Combined effect of varieties and clybio treatments on number of leaves Per plant at different days after transplanting of tomato

Treatment combinations [xx]	Number of leaves per plant [x]							
	20 DAT		40 DAT		60 DAT		80 DAT	
V_1C_0	8.3	d	20.7	g	41.7	e	61.3	f
V_1C_1	10.3	b	25.0	de	47.3	d	68.0	d
V_1C_2	13.7	a	31.7	a	58.3	a	75.7	a
V_2C_0	6.7	f	16.7	i	31.7	h	53.3	h
V_2C_1	8.0	de	21.3	g	36.0	f	57.0	g
V_2C_2	9.3	c	23.0	f	41.0	e	63.7	e
V_3C_0	7.7	e	18.0	h	34.7	g	56.0	g
V_3C_1	8.3	d	22.3	f	40.7	e	63.3	e
V_3C_2	9.3	c	25.3	d	48.0	d	69.7	c
V_4C_0	9.3	c	24.3	e	48.3	d	70.7	c
V_4C_1	10.3	b	27.0	c	51.3	c	73.3	b
V_4C_2	10.7	b	28.0	b	55.7	b	75.3	a
CV%	11.68		6.98		5.30		4.11	
LSD(0.05%)	0.53		0.81		1.15		1.32	

[x] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

[xx] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4); Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

Number of branches per plant

Branch number of tomato per plant exposed statistically significant variation among four tomato varieties V_1, V_2, V_3 and V_4 (Appendix III). The maximum number of branches (6.89) was found in V_1 which is statistically identical with V_4 (6.67) and minimum number of branches (5.00) was found in V_3 which is also similar with V_2 (5.33) (Table 4).

Significant inequality was found on branch number of tomato varieties among different treatment of clybio. Branch number was significantly influenced by clybio application (Appendix III). Maximum number of branches (6.83) was found at C_2 and minimum number of branches (4.92) was found at C_0 (Table 5).

The combinations of tomato varieties and clybio influenced significantly on branch number of tomato. In combination highest number of branches (8.00) was found at V_1C_2 and lowest (4.33) at V_3C_0 which is statistically similar with V_2C_0 (Table 6).

Chlorophyll percentage

Chlorophyll content of leaves showed significant dissimilarity among four tomato variety. Maximum chlorophyll content (47.28) was found at V_4 and minimum (40.57) was found from V_2. Second lowest percentage of chlorophyll (42.03) was found from V_3 which are statistically similar with V_1 (43.61) (Table 4).

Chlorophyll content of leaves (SPAD reading) showed statistically significant inequality among clybio treatment; (C_0, C_1 and C_2) (Appendix III). Maximum chlorophyll content (44.47) was found at C_2 which is statistically similar with C_1 (43.45) and minimum (42.20) was found at C_0 (Table 5).

In terms of chlorophyll percentage combined effect of tomato variety and clybio treatments disclosed significant dissimilarity (Appendix III). Highest chlorophyll content (47.73) at V_4C_2 which is similar to V_4C_1 and lowest (39.33) was recorded from V_2C_0 (Table 6). This result is in agreement with the findings of Iriti *et al.* (2019).

Table 4. Performance of four tomato varieties on number of branch per plant and chlorophyll percentage [Y]

Variety [X]	Number of branch/plant	Chlorophyll percentage
V_1	6.89 a	43.61 b
V_2	5.33 b	40.57 c
V_3	5.00 b	42.03 bc
V_4	6.67 a	47.28 a
CV%	9.18	3.90
LSD (0.05%)	0.54	1.65

[X] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 5. Influence of clybio treatments on number of branch per plant and Chlorophyll percentage [Y]

Treatments [X]	Number of branch/plant	Chlorophyll percentage
C_0	4.92 c	42.2 b
C_1	6.17 b	43.45 ab
C_2	6.83 a	44.47 a
CV%	9.18	3.90
LSD(0.05%)	0.46	1.43

[X] Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 6. Combined effect of varieties and clybio treatments on number of branch per plant and chlorophyll percentage [Y]

Treatment combinations [XX]	Number of branch/plant	Chlorophyll percentage
V_1C_0	5.33 f	42.20 f
V_1C_1	7.33 b	43.40 d
V_1C_2	8.00 a	45.23 c
V_2C_0	4.33 h	39.33 h
V_2C_1	5.33 f	40.57 g
V_2C_2	6.33 d	41.80 f
V_3C_0	4.33 h	40.43 g
V_3C_1	5.00 g	42.57 ef
V_3C_2	5.67 e	43.10 de
V_4C_0	5.67 e	46.83 b
V_4C_1	7.00 c	47.27 ab
V_4C_2	7.33 b	47.73 a
CV%	9.18	3.90
LSD (0.05%)	0.27	0.83

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

[XX] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4); Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

Number of flower cluster per plant

Tomato varieties showed significant difference in terms of number of flower cluster per plant (Appendix IV). Maximum number of flower cluster (8.00) was found at V_3 which is statistically similar with V_4 and minimum number of flower cluster (5.22) was found at V_2 (Table 7).

Number of flower cluster per plant significantly influenced by clybio treatments (Appendix IV). Highest number of flower cluster (7.58) was recorded at C_3. Lowest number of cluster (6.50) was at C_0 (Table 8).

Combined effect of tomato varieties and clybio treatments disclosed statistically significant difference in number of flower cluster per plant (Appendix IV). Maximum number of flower cluster (8.67) was found in V_3C_2 and minimum number of flower cluster (4.67) was found in V_2C_0 (Table 9).

Number of flower per cluster

Significant difference was found among the four tomato varieties in terms of the number of flower per cluster (Appendix IV). Number of flower per cluster exposed significant dissimilarity among the four tomato varieties (V_1, V_2, V_3 and V_4). Maximum number of flower (8.57) was recorded at V_1 which is similar to V_4 and minimum number of flower (7.12) was recorded at V_3 (Table 7).

Significant variation was found in terms of clybio treatments (Appendix IV). Flower number per cluster show statistically significant difference among C_0, C_1 and C_2. Highest number of flower (8.34) was recorded at $C_{2,}$ which is statistically similar with C_1 (8.01) and lowest (7.65) was at C_0 (Table 8).

Combined effect of four tomato varieties and clybio treatments in terms of flower number per cluster also exposed significant difference (Appendix IV). Maximum number of flower per cluster (8.90) was found at V_4C_2 and minimum number of flower per cluster (6.89) was found at V_3C_0 which is statistically similar to V_3C_1 (7.04) (Table 9).

Table 7. Performance of four tomato varieties on the number of flower cluster per plant, number of flower per cluster and number of flower per plant [Y]

Variety [X]	Number of flower cluster/plant		Number of flower/cluster		Number of flower/plant	
V_1	7.00	b	8.57	a	59.89	b
V_2	5.22	c	7.85	b	40.78	d
V_3	8.00	a	7.12	c	56.89	c
V_4	8.00	a	8.46	ab	67.44	a
CV%	7.96		8.59		2.00	
LSD (0.05%)	0.55		0.67		1.10	

[X] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 8. Influence of clybio treatments on the number of flower cluster per plant, number of flower per cluster and number of flower per plant [Y]

Treatments [X]	Number of flower cluster/plant		Number of flower/cluster		Number of flower /plant	
C_0	6.50	c	7.65	b	49.42	c
C_1	7.08	b	8.01	ab	56.50	b
C_2	7.58	a	8.34	ab	62.83	a
CV%	7.96		8.59		2.00	
LSD(0.05%)	0.48		0.58		0.95	

[X] Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 9. Combined effect of variety and clybio treatments on the number of flower cluster per plant, number of flower per cluster and number of flower per plant [Y]

Treatment combinations [XX]	Number of flower cluster/plant		Number of flower/cluster		Number of flower /plant	
V_1C_0	6.33	g	8.30	d	52.33	h
V_1C_1	7.00	f	8.76	ab	61.33	e
V_1C_2	7.67	d	8.64	abc	66.00	c
V_2C_0	4.67	j	7.45	f	34.33	l
V_2C_1	5.33	i	7.69	ef	40.67	k
V_2C_2	5.67	h	8.42	cd	47.33	j
V_3C_0	7.33	e	6.89	g	50.33	i
V_3C_1	8.00	c	7.04	g	56.33	g
V_3C_2	8.67	a	7.41	f	64.00	d
V_4C_0	7.67	d	7.95	e	60.67	f
V_4C_1	8.00	c	8.53	bcd	67.67	b
V_4C_2	8.33	b	8.90	a	74.00	a
CV%	7.96		8.59		2.00	
LSD (0.05%)	0.27		0.34		0.55	

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

[XX] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4); Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

Number of flower per plant

Significant variation was found among the varieties of tomato in terms of number of flower per plant (Appendix IV). Number of flower per plant disclosed statistically significant difference among the four varieties of tomato (V_1, V_2, V_3 and V_4). Highest number of flower (67.44) was counted in V_4 and lowest number of flower per plant (40.78) was counted in V_2 (Table 7).

In terms of flower number per plant was significantly influenced by the clybio treatment. Flower number per plant showed significant dissimilarity among C_0, C_1 and C_2 treatment (Appendix IV). Maximum number of flower per plant (62.83) was counted in C_2 and lowest number of flower (49.42) was counted in C_0 (Table 8).

Flower number per plant disclosed significant variation among the combination of different varieties of tomato and clybio treatments (Appendix IV). Highest number of flower (74.00) was counted in V_4C_2 and lowest (34.33) was counted in V_2C_0 (Table 9). This result is in agreement with the findings of Mohan (2008) in tomato plants.

Number of fruit cluster per plant

Analysis of variance showed that less significant variation among the varieties of tomato in terms of number of fruit cluster per plant (Appendix V). The highest fruit cluster (6.11) was shown from V_3 which is identical to V_1 and V_4. Lowest fruit cluster (3.67) was shown in V_2 (Table 10).

There was no significant variation among the treatments in respect of number of fruit cluster per plant (Appendix V). All three treatments showed statistically similar data; i.e. 5.67, 5.17 and 5.00 at C_0, C_1 and C_2 respectively.

Combined effect of tomato varieties and treatments in terms of number of fruit cluster per plant exposed significant dissimilarity (Appendix V). Number of fruit cluster per plant of different tomato varieties showed significant variation among different treatments. Highest number of fruit cluster (6.67) was found at V_3C_0 and lowest (3.33) was found in V_2C_2 (Table 12).

Number of fruit per cluster

Analysis of variance showed that significant variation among the varieties of tomato in terms of number of fruit per cluster (Appendix V). Number of fruit per cluster disclosed statistically significant difference among the four tomato varieties V_1, V_2, V_3 and V_4. Maximum fruit number per cluster (6.48) was found at V_1 and minimum number of fruit per cluster (4.18) was found at V_2. V_3 and V_4 showed statistically similar in terms of fruit number per plant.

Fruit number per cluster was significantly affected by the application of clybio (Appendix V). Fruit number of tomato showed significant difference among C_0, C_1 and C_2 treatment. Highest number of fruits per cluster (6.07) was reported at C_2 which is statistically similar with C_1 and lowest (4.61) was reported at C_0 (Table 11).

Combined effect of tomato varieties and treatments in terms of number of fruits per cluster also exposed significant dissimilarity (Appendix V). Number of fruit per cluster of different tomato varieties showed significant variation among different treatments. Highest number of fruit per cluster (7.27) was found at V_1C_2 and lowest (3.46) was found in V_2C_0 (Table 12). This result supported the findings of Idris *et al.* (2008) in tomato.

Number of fruit per plant

Analysis of variance showed significant dissimilarity of number of fruit per plant (Appendix V). Number of fruit per plant exposed statistically significant difference among four tomato varieties V_1, V_2, V_3 and V_4. From the table it was found that the highest number of fruits per plant (34.22) was counted from variety V_1 and lowest (14.33) was found from variety V_2 (Table 10).

Fruit number of tomato plant showed significant variation among C_0, C_1, and C_2 treatment. Highest number of fruits per plant (30.08) was found in C_2 and lowest (26.08) was found in C_0 (Table 11).

Combined effect of tomato varieties and treatments in terms of number of fruits per plant disclosed significant difference (Appendix V). Number of fruit per plant of different tomato varieties exposed significant inequality among different treatments. Maximum number of fruits per plant (36.33) was counted in V_1C_2 and minimum (13.33) was counted in V_2C_0 (Table 12).

Table 10. Performance of four tomato varieties on the number of fruit cluster per plant, number of fruit per cluster and number of fruit per plant [Y]

Variety [X]	Number of fruit cluster/plant	Number of fruit/cluster	Number of fruit/plant
V_1	5.33 a	6.48 a	34.22 a
V_2	3.67 b	4.18 c	14.33 d
V_3	6.11 a	5.28 b	31.67 c
V_4	6..00 a	5.60 b	32.78 b
CV%	15.44	16.60	2.20
LSD (0.05%)	0.80	0.87	0.61

[X] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 11. Influence of clybio treatments on the number of fruit cluster per plant, number of fruit per cluster and number of fruit per plant [Y]

Treatments [X]	Number of fruit cluster/plant	Number of fruit/cluster	Number of fruit/plant
C_0	5.67 a	4.61 b	26.08 c
C_1	5.17 a	5.47 a	28.58 b
C_2	5.00 a	6.07 a	30.08 a
CV%	15.44	16.60	2.20
LSD (0.05%)	0.69	0.76	0.53

[X] Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 12. Combined effect of varieties and clybio treatments on the number of fruit cluster per plant, number of fruit per cluster and number of fruit per plant [Y]

Treatment combinations [XX]	Number of fruit cluster/plant	Number of fruit/cluster	Number of fruit/plant
V_1C_0	5.67 cd	5.68 d	32.00 g
V_1C_1	5.33 de	6.49 b	34.33 c
V_1C_2	5.00 e	7.27 a	36.33 a
V_2C_0	4.00 f	3.46 g	13.33 l
V_2C_1	3.67 fg	4.00 f	14.33 k
V_2C_2	3.33 g	5.08 e	15.33 j
V_3C_0	6.67 a	4.32 f	28.67 i
V_3C_1	5.67 cd	5.75 cd	32.33 f
V_3C_2	6.00 bc	5.78 cd	34.00 d
V_4C_0	6.33 ab	4.97 e	30.33 h
V_4C_1	6.00 bc	5.65 d	33.33 e
V_4C_2	5.67 cd	6.17 bc	34.67 b
CV%	15.44	16.60	2.20
LSD (0.05%)	0.40	0.44	0.30

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

[XX] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4); Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

Fruit length

Significant dissimilarity was found for fruit length among four tomato varieties (Appendix VI). Maximum fruit length (61.27 mm) was recorded at V_2 and minimum (55.93 mm) was recorded at V_1 (Table 13).

Fruit length showed significant difference with clybio treatments (Appendix VI). Highest fruit length (60.55 mm) was recorded at C_2 and lowest (56.15 mm) was recorded at C_0 (Table 14).

In terms of fruit length combined effect of four tomato varieties and clybio treatments also showed significant difference (Appendix VI). Longest fruit (63.14 mm) was found in V_2C_2 and shortest (52.84 mm) was found from V_1C_0 (Table 15). This result supported the findings obtained by Karunarathna and Seran (2016) in capsicum.

Fruit diameter

Significant variation was observed for fruit diameter among six tomato varieties V_1, V_2, V_3 and V_4 (Appendix VI). Maximum fruit diameter (79.52 mm) was recorded from V_2 and minimum (50.69 mm) was recorded from V_4 (Table 13).

Fruit diameter showed significant variation among treatments (C_0, C_1 and C_2) (Appendix VI). Fruit diameter recorded highest (63.16 mm) from C_2 minimum (59.27 mm) was recorded from C_0 (Table 14).

Combined effect of different varieties and treatment in terms of fruit diameter exposed significant variation (Appendix VI). The widest fruit diameter (81.15 mm) was found at V_2C_2 and lowest (48.13 mm) was found at V_4C_0 (Table 15). Similar result was obtained by Karunarathna and Seran (2016) in capsicum.

Table 13. Performance of four tomato varieties on fruit length, fruit diameter and brix percentage [Y]

Variety [X]	Fruit length (mm)		Fruit diameter (mm)		Brix percentage	
V_1	55.93	d	57.65	b	4.47	c
V_2	61.27	a	79.52	a	3.87	d
V_3	57.15	c	57.49	b	4.67	b
V_4	60.06	b	50.69	c	5.38	a
CV%	1.55		2.98		1.49	
LSD (0.05%)	0.89		1.79		0.07	

[X] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 14. Influence of clybio treatments on fruit length, fruit diameter and brix percentage [Y]

Treatments [X]	Fruit length (mm)		Fruit diameter (mm)		Brix percentage	
C_0	56.15	c	59.27	c	4.43	c
C_1	59.11	b	61.6	b	4.62	b
C_2	60.55	a	63.16	a	4.73	a
CV%	1.55		2.98		1.49	
LSD (0.05%)	0.77		1.55		0.06	

[X] Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 15. Combined effect of variety and clybio treatments on fruit length, fruit diameter and brix percentage [Y]

Treatment combinations [XX]	Fruit length (mm)		Fruit diameter (mm)		Brix percentage	
V_1C_0	52.84	k	56.21	f	4.27	g
V_1C_1	56.44	i	57.77	e	4.50	f
V_1C_2	58.50	ef	58.98	d	4.63	e
V_2C_0	58.12	fg	77.57	c	3.77	j
V_2C_1	62.55	b	79.86	b	3.88	i
V_2C_2	63.14	a	81.15	a	3.97	h
V_3C_0	55.67	j	55.17	g	4.53	f
V_3C_1	57.03	h	58.00	e	4.67	e
V_3C_2	58.77	ef	59.31	d	4.80	d
V_4C_0	57.97	g	48.13	j	5.17	c
V_4C_1	60.42	d	50.76	i	5.43	b
V_4C_2	61.78	c	53.18	h	5.53	a
CV%	1.55		2.98		1.49	
LSD (0.05%)	0.45		0.89		0.03	

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

[XX] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4); Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

Brix percentage

Significant variation was found among the varieties of four tomato in terms of brix percentage (Appendix VI). Highest percentage of brix (5.38%) was observed in V_4 and lowest percentage (3.87 %) was found in V_2 (Table 13).

Brix percentage was significantly affected by the clybio treatment (Appendix VI). Highest brix percentage (4.73 %) was recorded in C_2 and lowest (4.43 %) was recorded in C_0 (Table 14).

Combined effect of four tomato four varieties and treatments in terms of brix percentage also exposed significant variation (Appendix VI). Brix percentage of four tomato varieties exposed significant inequality among different treatments. Brix percentage was recorded highest (5.53 %) in V_4C_2 and lowest (3.77 %) was recorded in V_2C_0 (Table 15). The present result correlates with the outcome of Ghoname *et al.* (2010).

Single fruit weight

Significant variation was among the four varieties of tomato in terms of single fruit weight per plant (Appendix VII). V_2 tomato variety exposed highest single fruit weight per plant (152.8 g) while minimum (73.33 g) was obtained from V_4 (Table 16).

Single fruit weight per plant was significantly affected by treatments (Appendix VII). Single fruit weight per plant showed significant difference among C_0, C_1 and C_2 treatment. Maximum single fruit weight (100.5 g) was recorded in C_2 and minimum (94.28 g) was recorded from C_0 (Table 17).

Combined effect of tomato varieties and treatments in terms of single fruit weight per plant also exposed significant variation (Appendix VII). Single fruit weight per plant (156.2 g) was recorded maximum in V_2C_2 and lowest (70.56 g) was recorded in V_4C_0 (Table 18). Similar results obtained by Kodippili and Nimalan (2018).

Yield per plant

Yield per plant was significantly affected by tomato variety. Yield per plant of tomato exposed significant inequality among V_1, V_2, V_3 and V_4. (Appendix VII). Highest yield per plant (2.89 kg) was found at V_1 and lowest (2.19 kg) was at V_2 (Table 16).

Yield per plant was significantly affected by the clybio treatments. Yield per plant showed significant variation among C_0, C_1, and C_2 (Appendix VII). Maximum yield per plant (2.75 kg) was recorded in C_2 and lowest (2.23 kg) was recorded from C_0 (Table 17).

Combined effect of four tomato varieties and treatments in terms of yield per plant per plant also showed significant dissimilarity (Appendix VII). Yield per plant of different tomato varieties exposed significant variation among different treatments. Yield per plant (3.15 kg) was found highest at V_1C_2 and minimum (1.98 kg) was recorded in V_2C_0 (Table 18). Similar findings were obtained by Xu *et al.* (2001) in tomato.

Yield per hectare

Yield per hectare significantly influenced by four tomato varieties V_1 ,V_2 ,V_3 and V_4 (Appendix VII). Highest yield per hectare (96.39 ton) was found at V_1 and lowest (73.08 ton) was at V_2 (Table 16).

Yield per hectare was significantly affected by thetreatments. Yield per hectare showed significant dissimilarity among C_0, C_1 and C_2 treatment (Appendix VII). Maximum yield per hectare (91.74 ton) was recorded in C_2 and lowest (74.39 ton) was recorded from C_0 (Table 17).

Combined effect of four tomato varieties and treatments in terms of yield per hectare also showed significant difference (Appendix VII). Yield per hectare of different tomato varieties showed significant variation among different treatments. Yield per hectare (105.0 ton) was recorded highest at V_1C_2 and lowest yield per hectare (65.95 ton) was recorded at V_2C_0 (Table 18). These results are in agreement with those obtained Ncube *et al.* (2011) in tomato.

Table 16. Performance of four tomato varieties on single fruit weight, yield per plant and yield per hectare [Y]

Variety [X]	Single fruit weight (g)	Yield /plant(kg)	Yield/hectare(t)
V_1	84.39 b	2.89 a	96.39 a
V_2	152.80 a	2.19 d	73.08 d
V_3	79.80 c	2.54 b	84.44 b
V_4	73.33 d	2.41 c	80.26 c
CV%	0.61	2.70	2.69
LSD(0.05%)	0.59	0.07	2.20

[X] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 17. Influence of clybio treatments on single fruit weight, yield per plant and yield per hectare [Y]

Treatments [X]	Single fruit weight (g)	Yield /plant(kg)	Yield/hectare(t)
C_0	94.28 c	2.23 c	74.39 c
C_1	97.91 b	2.54 b	84.50 b
C_2	100.5 a	2.75 a	91.74 a
CV%	0.61	2.7	2.69
LSD(0.05%)	0.51	0.06	1.9

[X] Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

Table 18. Combined effect of varieties and clybio treatments on single fruit weight, yield per plant and yield per hectare [Y]

Treatment combinations [XX]	Single fruit weight (g)	Yield /plant(kg)	Yield/hectare(t)
V_1C_0	81.90 g	2.62 d	87.37 d
V_1C_1	84.58 e	2.91 b	96.80 b
V_1C_2	86.70 d	3.15 a	105.0 a
V_2C_0	148.40 c	1.98 j	65.95 j
V_2C_1	153.70 b	2.20 h	73.44 h
V_2C_2	156.20 a	2.39 g	79.84 g
V_3C_0	76.27 i	2.19 h	72.88 h
V_3C_1	79.74 h	2.58 e	85.93 e
V_3C_2	83.40 f	2.84 c	94.52 c
V_4C_0	70.56 l	2.14 i	71.34 i
V_4C_1	73.65 k	2.46 f	81.83 f
V_4C_2	75.8 j	2.63 d	87.60 d
CV%	0.61	2.70	2.69
LSD (0.05%)	0.29	0.03	1.10

[Y] Means in a column having similar letter (s) are statistically identical and those dissimilar letter (s) differ statistically as per 0.05 level of probability.

[XX] BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4); Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2)

V_1C_2 V_1C_1 V_1C_0

V_2C_2 V_2C_1 V_2C_0

V_3C_2 V_3C_1 V_3C_0

Plate 2. Pictorial presentation of varietal performance due to clybio application; here BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4), Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2).

V_4C_2 V_4C_1 V_4C_0

V4 V3 V2 V1

Plate 2. Pictorial presentation of varietal performance due to clybio application; here BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3), BARI Tomato-21 (V_4), Control (C_0), Clybio 2ml/L (C_1), Clybio 4ml/L (C_2).

CHAPTER V

SUMMARY AND CONCLUSION

In order to evaluate the effect of clybio on four tomato varieties and experiment was conducted during the period of October, 2019 to March, 2020 at Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka. It was two factorial experiments which was included four tomato varieties; i.e. BARI Tomato-14 (V_1), BARI Tomato-17 (V_2), BARI Tomato-18 (V_3) and BARI Tomato-21 (V_4) and three treatments Control (C_0), Clybio 2ml/L (C_1) and Clybio 4ml/L (C_2).with three replication. Experiment was outlined in a Randomized Complete Block Design (RCBD) with three replications. Collected data were statistically analyzed for the evaluation of performance of different treatments for selection of best tomato varieties grown in different plots. Summarized findings of the experiment described in this chapter.

In case of plant height maximum plant height (128.0 cm) was found at V_3 and minimum (95.2 cm) was found at V_2 at 80 DAT. In case of clybio treatments highest plant (117.6cm) was found at C_2 and shortest (104.7cm) was found at C_0.In case combination tallest plant (136.7 cm) was found at V_3C_2 and shortest (90.4 cm) was obtained from V_2C_0 at 80 DAT.

In terms of leaves number per plant highest number of leaves (73.1) was obtained from V_4 and lowest (58.0) was obtained from V_2 at 80 DAT. In case of clybio treatment maximum number of leaf (71.1) was found in C_2 and minimum (60.3) was found in C_0 at 80 DAT. In case of combinations maximum leaf number (75.7) was counted at V_1C_2 and minimum (53.3) was counted at V_2C_0 at 80 DAT.

In terms of number of branch per plant, maximum number of branches was found in V_1 (6.89) and minimum was counted in V_3 (5.00). In case of clybio treatments maximum number of branch was found at C_2 (6.83) and minimum was found at C_0 (4.92). In case of combinations highest number of branch was counted at V_1C_2 (8.00) and lowest at V_2C_0 (4.33).

In case chlorophyll%, highest chlorophyll content was recorded from V_4 (47.28) and lowest was recorded from V_2 (40.57). In case of clybio treatments maximum chlorophyll content was found at C_2 (44.47) and minimum was found at C_0 (42.20). In case of combination highest chlorophyll content was recorded at V_4C_2 (47.73) and lowest was recorded at V_2C_0 (39.33).

In case of number of flower cluster per plant, highest number of flower cluster was counted at V_3 (8.00) which is statistically similar with V_4 (8.00) and minimum number of flower cluster was counted at V_2 (5.22). In case of clybio treatments maximum number of flower cluster was found at C_2 (7.58) and minimum was found at C_0 (6.50). In case of combinations maximum flower cluster was recorded at V_3C_2 (8.67) and minimum was recorded at V_2C_0 (4.67).

In terms of number of flower per cluster maximum number of flower was recorded at V_1 (8.57) and lowest number was recorded at V_3 (7.12). In case of clybio treatments maximum number of flower was counted at C_2 (8.34) which is statistically similar with C_1 (8.01) and minimum was counted at C_0 (7.65) treatment. In case of combinations highest number of flower was found at V_4C_2 (8.90) and lowest number of flowers was found at V_3C_0 (6.89).

In case of flower number per plant maximum number of flower was found in V_4 (67.44) and minimum number of flower per plant was found in V_2 (40.78). In case of clybio treatment maximum number of flower per plant was recorded at C_2 (62.83) and minimum number of flower was recorded at C_0 (49.42). In case of combinations highest number of flower was counted at V_4C_2 (74.00) and lowest was counted at V_2C_0 (34.33).

In terms of number of fruit cluster per plant, maximum number of fruit cluster was counted at V_3 (6.11) which is statistically similar with V_1 (5.33) and V4 (6.00). Lowest number of fruit cluster was counted at V_2 (3.67). In case of clybio treatments C_0 (5.67), C_1 (5.17) and C_2 (5.00) gives statistically similar data. In case of combinations highest number of fruit cluster was found at V_3C_0 (6.67) and lowest was found at V_2C_2 (3.33).

In case of number of fruit per cluster, highest number of fruits per cluster was counted at V_1 (6.48) and lowest was counted at V_2 (4.18). In case of clybio treatments maximum number of fruits per cluster was found at C_2 (6.07) which is statistically similar with C_1 (5.47) and minimum was found at C_0 (4.61). In case of combinations highest number of fruits per cluster was recorded at V_1C_2 (7.27) and lowest was recorded at V_2C_0 (3.46).

In terms of number of fruit per plant, maximum number of fruits per plant was counted from V_1 (34.22) and minimum was counted from variety V_2 (14.33). In case of clybio treatments highest number of fruits per plant was found at C_2 (30.08) and lowest was found at C_0 (26.08). In case of combinations maximum number of fruits per plant was obtained in V_1C_2 (36.33) and minimum was obtained in V_2C_0 (13.33).

In terms fruit length, maximum fruit length was found at V_2 (61.27 mm) and minimum was found at V_1 (55.93 mm). In case of clybio treatments longest fruit length was recorded at C_2 (60.55 mm) and shortest was recorded at C_0 (56.15 mm). In case of combinations maximum fruit length was obtained from V_2C_2 (63.14 mm) and minimum was obtained from V_1C_0 (52.84 mm).

In terms of fruit diameter, highest fruit diameter was counted from V_2 (79.52 mm) and lowest was counted from V_4 (50.69 mm). In case of clybio treatments fruit diameter found maximum from C_2 (63.16 mm) and minimum was found at C_0 (59.27 mm). In case of combinations maximum was recorded at V_2C_2 (81.15 mm) and minimum was recorded at V_4C_0 (48.13 mm).

In terms of brix percentage, highest brix percentage was found from V_4 (5.38%) and lowest was found from V_2 (3.87%). In case of clybio treatments, highest brix percentage was found from C_2 (4.73%) and lowest was found from C_0 (4.43%). In case of combinations, highest brix percentage was found from V_4C_2 (5.53%) and lowest was recorded from V_2C_0 (3.77%).

In terms of single fruit weight, maximum fruit weight was obtained from V_2 (152.80 g) while minimum was obtained from V_4 (73.33 g). In case of clybio treatments maximum single fruit weight was found at C_2 (100.50 g) and minimum was found at C_0 (94.28 g). In case of combinations was recorded maximum in V_2C_2 (156.20 g) and minimum was recorded in V_4C_0 (70.56 g).

In case of yield per plant, maximum yield was found at V_1 (2.89 kg) and minimum was found at V_2 (2.19 kg). In case of clybio treatments maximum yield was recorded in C_2 (2.75 kg) and minimum was recorded in C_0 (2.23 kg). In case of combinations yield per plant was recorded maximum in V_1C_2 (3.15 kg) and minimum was recorded in V_2C_0 (1.98 kg).

In terms of yield per hectare, highest yield per hectare was recorded from V_1 (96.39 t/ha) and lowest was recorded from V_2 (73.08 t/ha). In case of clybio treatments maximum yield per hectare was found at C_2 (91.74 t/ha) and minimum was found at C_0 (74.39 t/ha). In case of combinations highest yield per hectare was recorded from V_1C_2 (105.0 t/ha) and lowest was recorded found from V_2C_0 (65.95 t/ha).

Conclusion:

From the above results it can be concluded that V_1 provide best result in terms of number of branches per plant, number of flower per cluster, number of fruit per cluster, number of fruit per plant, yield per plant, yield per hectare. V_2 provided best result in fruit length, fruit diameter and single fruit weight. V_3 provided best results in plant height, flower cluster per plant and fruit cluster per plant. V_4 provided best outcome in number of leaves per plant, flower per plant, chlorophyll percentage and brix percentage. In case of clybio treatment C_2 provide best results in terms of all parameter except fruit cluster per plant and C_0 provide worst result in case of all parameter. In case of combinations, V_1C_2 combination provide better performance in terms of number of branches per plant, number of flower per cluster, number of fruit per cluster, number of fruit per plant, yield per plant, yield per hectare over any other combinations. Looking upon the above circumstances it can be easily enunciated that V_1 was the most outstanding variety and C_2 was the most excellent treatment for growth, and yield attributes of tomato.

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APPENDICES

Appendix I: Analysis of variance on plant height at different days after transplanting of tomato and fruit diameter of tomato

Source of variance	Degree of freedom	Mean square for plant height (cm)			
		20 DAT	40 DAT	60 DAT	80 DAT
Factor A (Tomato varieties)	3	249.423*	271.633*	966.743*	1672.856*
Factor B (Clybio)	2	112.149*	136.595*	322.155*	504.473*
Interaction (A X B)	6	1.445*	2.338*	4.978*	10.297*
Error	22	7.732	4.985	7.831	7.439

*: Significant at 0.05 level of probability

Appendix II: Analysis of variance on number of leaves per plant at different days after transplanting of tomato

Source of variance	Degree of freedom	Mean square for leaf number			
		20 DAT	40 DAT	60 DAT	80 DAT
Factor A (Tomato varieties)	3	15.778*	72.296*	462.667*	385.222*
Factor B (Clybio)	2	22.75*	151.361*	413.028*	347.028*
Interaction (A X B)	6	2.639*	8.213*	14.139*	15.472*
Error	22	1.189	2.717	5.573	7.27

*: Significant at 0.05 level of probability

Appendix III: Analysis of variance on the number of branch per plant and Chlorophyll % of tomato			
Source of varience	Degree of freedom	Mean square of	
		Number of branch/plant	Chlorophyll %
Factor A (Tomato varieties)	3	8.028*	74.923*
Factor B (Clybio)	2	11.361*	15.468*
Interaction (A X B)	6	0.361*	0.893*
Error	22	0.301	2.856
*: Significant at 0.05 level of probability			

Appendix IV: Analysis of variance on the number of flower cluster per plant, number of flower per cluster and number of flower per plant of tomato.				
Source of varience	Degree of freedom	Mean square of		
		Number of flower cluster/plant	Number of flower per cluster	Number of flower per plant
Factor A (Tomato varieties)	3	15.444*	4.00*	1135.065*
Factor B (Clybio)	2	3.528*	1.45*	540.583*
Interaction (A X B)	6	0.083*	0.13*	1.731*
Error	22	0.316	0.473	1.265
*: Significant at 0.05 level of probability				

Appendix V: Analysis of variance on the number of fruit cluster per plant, number of fruit per cluster, number of fruit per plant on tomato.

Source of variance	Degree of freedom	Mean square of		
		Number of fruit cluster per plant	Number of fruit per cluster	Number of fruit per plant
Factor A (Tomato varieties)	3	11.444*	8.097*	784.546*
Factor B (Clybio)	2	1.444*	6.51*	49.000*
Interaction (A X B)	6	0.111*	0.197*	1.741*
Error	22	0.664	0.799	0.386

*: Significant at 0.05 level of probability

Appendix VI: Analysis of variance on the data of fruit length, fruit diameter and brix %.

Source of variance	Degree of freedom	Mean square of		
		Fruit length (mm)	Fruit diameter (mm)	Brix %
Factor A (Tomato varieties)	3	55.453*	1417.263*	3.47*
Factor B (Clybio)	2	60.357*	45.909*	0.276*
Interaction (A X B)	6	1.766*	0.781*	0.006*
Error	22	0.83	3.334	0.005

*: Significant at 0.05 level of probability

Appendix VII: Analysis of variance on the data of single fruit weight, yield per plant and yield per hectare of tomato.

Source of variance	Degree of freedom	Mean square of		
		Single fruit weight (g)	Yield per plant (kg)	Yield per hectare (ton)
Factor A (Tomato varieties)	3	12368.4*	0.774*	858.527*
Factor B (Clybio)	2	117.82*	0.819*	911.434*
Interaction (A X B)	6	1.976*	0.008*	8.9*
Error	22	0.36	0.005	5.057

*: Significant at 0.05 level of probability