INFLUENCE OF CLYBIO CONCENTRATION WITH APPLICATION FREQUENCY ON GROWTH AND YIELD OF BOTTLE GOURD

(*Lagenaria siceraria* L.)

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Most surely in the creation of the heavens and the earth and the alternation of the night and the day, there are signs for men who understand.

(Surah Al Zumar 3:190)

DEDICATED TO

MY BELOVED PARENTS

Department of Horticulture

Sher-e-**B**angla **A**gricultural **U**niversity

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Memo No.: Dated:

CERTIFICATE

This is to certify that the thesis entitled ***"INFLUENCE OF CLYBIO CONCENTRATION WITH APPLICATION FREQUENCY ON GROWTH AND YIELD OF BOTTLE GOURD (Lagenaria siceraria L.)"*** *submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in HORTICULTURE****, embodies the result of a piece of bona fide researchwork carried out by* ***MD. SHAHID HASSAN****, Registration No.* ***19-10172*** *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.

Dated: December, 2021 **Prof. Dr. A.F.M. Jamal Uddin**

Dhaka, Bangladesh **Supervisor**

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- The author

INFLUENCE OF CLYBIO CONCENTRATION WITH APPLICATION FREQUENCY ON GROWTH AND YIELD OF BOTTLE GOURD (*Lagenaria siceraria* L.)

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ABSTRACT

An experiment was conducted to evaluate the influence of Clybio concentration with application frequency on growth and yield of Bottle gourd at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, during the period from January to June 2020. The experiment was consisted of seven treatments namely, T_0: Control; T_1: @ 1.0 ml/L+10 days interval; T_2: @ 1.0 ml/L+15 days interval; T_3: @ 1.0 ml/L+20 days interval; T_4: @ 2.0 ml/L+10 days interval; T_5: @ 2.0 ml/L+15 days interval; T_6: @ 2.0 ml/L+20 days interval. The single factorial experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. Among the treatments the maximum vine length (162.5cm, 360.6cm and 511.4cm at 30, 45, 60 DAT respectively), SPAD value (58.5), number of fruits (11.3/plant), fruit length (45.7cm), fruit diameter(15.5cm), individual fruit weight(3.3kg), yield per plant (38.3kg), yield (95.7t/ha) was found in case of T_4 treatment. On the other hand, minimum vine length (104.1cm, 292.1cm and 383.9cm at 30, 45, 60 DAT respectively), SPAD value (50.3), number of fruits (8.6/plant), fruit length (35.3cm), fruit diameter (10.8cm), individual fruit weight (2.4kg), yield per plant (21.1kg), yield (52.8 t/ha) was found in case of T_0 treatment. Considering the effect of applied treatments on growth and yield related results it can be concluded that T_4(@ 2ml+10 days interval) treatment showed the best performance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF PLATES

LIST OF ABBREVIATIONS AND ACRONYMS

AEZ	=	Argo-Ecological Zone
ANOVA	=	Analysis of Variance
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
CV%	=	Percent of coefficient of Variation
DAT	=	Days After Transplanting
Df	=	Degrees of freedom
et al	=	and others
Hort.	=	Horticulture
Kg/ha	=	Kilogram/hectare
J.	=	Journal
i.e.,	=	That is
Int.	=	International
LSD	=	Least Significant Difference
M.S.	=	Master of Science
ml/L	=	Milliliter per liter
RCBD	=	Randomized Complete Block Design
SAU	=	Sher-e-Bangla Agricultural University
spp.	=	species
t/ha	=	ton/hectare
%	=	Per cent

CHAPTER I

INTRODUCTION

INTRODUCTION

The bottle gourd (*Lagenaria siceraria* L.) is a popular and extensively grown vegetable of the Cucurbitaceae family, with chromosome number 2n =22, and belongs to the order Cucurbitales, class Magnoliopsida (Bose and Som, 1986). It's a useful gourd with a wide range of applications, and it's widely grown in the tropics and subtropics for its tasty fruits. Lau is the local name for bottle gourd. Birdhouse gourd, trumpet gourd, calabash gourd, and white-flowered gourd are some of the other names for it. Due of its monoecious nature, it is mostly cross-pollinated. Cross pollination occurs in 60 to 80 percent of cases (Chowdhury, 1979). In Bangladesh, it is a popular vegetable. Tender fruits are used as a vegetable as well as for making sweets and pickles, particularly in the highlands. The bottle gourd is said to have originated in Africa and spread worldwide in pre-Columbian times, maybe via floating on the oceans. The white blooms and distinctive fruit, seed, and leaf forms differentiate the bottle gourd from other pumpkin kinds (Cutler and Whitaker, 1967).

The bottle gourd is a large-leaved annual climbing vine with a rich look. Tendrils run up the stem, allowing the vine to climb. When crushed, the leaf is enveloped in soft hairsand has a strong musky odor. Because of the small hairs on the underside of the leaves, they have a velvety touch. The blossoms are lovely and white. The background is either bright or dark green in coloration. The dark green coloration might appear as a single color, regular or irregular stripes or an unstructured patch. In a pale green pulp, the brownish seeds are abundant. Each seed has grooved folds towards the connected end andis about rectangular in form.

Bottle gourd has an 86 percent edible component. Due to its great keeping quality, bottle gourd has the most minerals of all the cucurbit vegetables (Rashid, 1993). It has a variety of medicinal and medical characteristics. Iron, Vitamin C and B complex are all present. People with digestive difficulties, diabetics, and medical details benefit from regular digestion of this vegetable.

It is beneficial to those who suffer from problem that may arise and indigestion (Thamburaj and Singh, 2003). Per 100g of edible part, fruit comprises 96.1g water,2.5g carbs,0.22g protein, 0.1g fat, 0.5g minerals, 0.6g fiber, and 12kcal energy. Per 100g of edible part, there are 87.9g water, 6.1g carbs, 2.3g protein, 0.7g fat, 1.7g minerals, 1.3g fiber, and 39kcal energy (Gopalan *et al.*, 1982). It is quickly gaining popular among health-conscious urban elites, who have supported year-round growth of this potentially vital cucurbitaceous vegetable, with the exceptionof severely cold winter locales. It covers over 16835 acres in Bangladesh, with a total output of 31126 tons (BBS, 2020). The average output per hectare is about 35 to 40 tons, which is quite low when compared to other tropical countries. On the other hand, the rapid pace of population expansion is putting further strain on the region of vegetable production. Bottle gourd may be cultivated in a homestead area for a lower cost and without the need for more land.

In Bangladesh, farmers utilize chemical fertilizer on a considerably larger scale than is recommended. Farmers believe that spraying more insecticides on crops kills more insects, resulting in increased yield. It decreases soil fertility and production, kills soil microorganisms and poses a health risk to humans. It has a harmful influence on the environment as well. Excessive use of chemical fertilizers degrades the quality of vegetables and introduces heavy metals that have a long-term influence on human health.

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 (Uddin *et al.*, 2019). The use of organic fertilizer increases plants vegetative growth and yield (Rakibuzzaman *et al*., 2019b).

Clybio is the unique and complex microbe that contains bacteria like Lactobacilli bacteria, Lactic acid bacteria, Bacillus natto bacteria, yeast fungus and Lactic acid bacteria (Shrestha *et al.*, 2014), Bacillus bacteria (Tiwari *et al.*, 2019), Yeast (El-Tarabily and Sivasithamparam, 2006) are a fruitful factor to maintain ecology, efficient bio- fertilizer that increases soil fertility, bio-control agent against bacterial diseases and have bio stimulating effect to promote growth, yield and obviously for quality.

Alternative technology selection is a solution to this problem that can improve plant nutrient availability and absorption by plants. Professor Teruo Higa of the University of the Ryukyus in Okinawa, Japan, has created an Effective Microorganism idea and technology (EM). It is made up of a mixture of microorganisms that are found in nature (bacteria, fungi, actinomycetes and yeast) (Higa, 1988). The major goal of Effective Microorganism is to preserve soil ecological balance by suppressing dangerous pathogensand improving soil quality (EM). Microorganisms aid plant nutrition absorption by breaking down complicated nutrient sources. It also improves crop quality and increases agricultural output by boosting photosynthetic efficiency. EM can also be used to treat some diseases.

Plant hormones, useful bioactive compounds, and antioxidants were generated by microorganisms found in EM, while nutrients were solubilized (Higa,1988). Yeast generates bioactive phyto hormones and enzymes that help cells divide more effectively. Actinomycetes create antimicrobial properties from amino acids, which reduced dangerous soil microorganisms (Conder *et.al*., 2007). Many vegetable crops benefit from EM in terms of growth and productivity (Chowdhury *et.al.*, 1994; Javed 2006; Khaliq *et.al.*,2006). It increases crop health and productivity by enhancing photosynthetic rate and hastening soil organic matter breakdown for plant nutrient release (Hussain *et.al.*,1999).

In Bangladesh, EM is not available. Many EM brands are manufactured all over the world. Clybio is one of them, and it is made by the Japanese company Aqua Company Ltd. Clybio is composed to microorganisms from five families, ten genera and 80 species. Lactobacillus bacteria, yeast fungus, Bacillus natto bacteria, actinomycetes, and fungus are the most common microorganisms found. It is capable of enhancing crop growth, quality and yield parameters.

In view of the findings, the current study was designed to assess the impact of Clybio onBottle gourd output.

The objective of the study was as follows:

1.To evaluate the Clybio concentration on growth and yield of Bottle gourd.

2. To evaluate the application frequency on growth and yield of Bottle gourd.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Any scientific research must begin with a thorough and critical examination of previous studies. It gives not just knowledge of previous field work, but also insight into methodologies and processes. It also serves as a foundation for operational definitions of key topics. Relevant reviews also back up the study's findings and discussion.

Bottle gourd (*Lagenaria siceraria* L.) is an important vegetable cultivated in Bangladesh,but a few works have been done for the improvement of this crop in Bangladesh and other countries in the world. Research effort on the variability of its genetic resources, diversity on genetic and molecular level, correlation, path coefficient analysis, heritabilityand genetic advance seems to be meager. However, information available in these aspectsof bottle gourd and some other cucurbit crops have been reviewed and presented in this section.

In Sher-e Bangla Agricultural University, Husna A. (2009) performed an experiment with thirty-one bottle gourd genotypes. She discovered that the mean sum for leaf length was 29.721, which was very significant related to bottle gourd genotypes, indicating that there was a significant difference in this characteristic. With a mean value of 18.70, the maximum leaf length was found to be 25.03 in BD-4583 and the minimum was found to be 12.97 in BD-8949.

Nahar (2014), observed considerable variations among 20 genotypes of pumpkinfor leaf length. She stated significant mean sum of square for leaf length (16.882) indicated considerable variation among the genotypes. The highest leaf length measured in G_4 (BD 246) was 21.17, while the shortest was 12.50 in G_1 (BD 4587), with a mean value of 16.59. The phenotypic variance (5.80) was somewhat larger than the genotypic variance (5.54), indicating that the environment had less effect on the expression of the gene controlling this feature.

Gaffar (2008) experimented with fifteen different sponge gourd genotypes. He discovered that the leaf length genotypic and phenotypic variations were 24.13 and 25.55, respectively. The GCV (20%) was somewhat lower than the PCV (20%). (20.58 percent). This trait's heritability was 97 percent, with moderate genetic advance (9.83) and significant genetic 11 advance in percent of mean (40.03), indicating that apparent variance was related to genotypes.

For days to the first female flower opening in bottle gourd, Sharma and Dhankhar (1990) obtained nearly identical estimations of GCV and PCV (13.54 and 14.00). They also discovered that the bottle gourd has a high heritability (93.47%) and a significant genetic progress (26.99) for days to flowering. Mannan (1992) found significant variation in the days to initial male flower (66.7-81.6 days) and female flower (72.80-85.67 days) opening among eight bitter gourd lines.

Ramchandran and Gopalkrishnan (1979), also reported significant variability among 25 diverse genotypes of bitter gourd. Studied heritability of yield components in watermelon and reported that heritability for number of days to flowering was 94%.

Bose and Som (1986), stated that the first male and female flowers in bottle gourd after 40-45 days and 60-65 days of planting seedling, respectively. Days to flower was observed to be markedly influenced by the environment as was indicated by much higher environmental variance compared to the low genetic variance (Srivastava and Srivastava, 1976 and Singh *et al.*, 1977).

Rahman *et al.* (1991); reported that male flower was earlier than female flower in several genotypes of bottle gourd. Islam (1993), also reported that the male flowering was earlier than female flowering in several genotypes of bottle gourd.

Sureshbabu (1989), studied 50 genotypes of pumpkin and observed considerable variability for days to first male flower anthesis (41.0-73.0 days) and days to first female flower opening (41.0-84.5 days). Lowest PCV was observed for days to first male flower anthesis (13 .08).

At the farm of the Olericulture Division, Quamruzzaman *et al.* (2008) studied the genetic divergence among thirty genotypes of ridge gourd (*Luffa acutangula*). During the summer of 2005, I worked at HRC and at several BARS, BARI. RGN05, RGN06, RGN07, RGN08, RGN13, RGN17, RGN18, RGN27, RGN29 had the highest cluster mean values for days to first male flower open (56.0 days) and single fruit weight (141.0g), while RGNO3. RGN12 had the lowest mean values for days to first female flower open (27.0 days) and single fruit weight (141.0g), (85.0g). Days to first male flower opening, days to first female flower opening, fruit diameter, single fruit weight, and fruit number all have a role in PCA, indicating their significance in genetic divergence.

Rahman *et al.* (1986); noted the value of genotypic and phenotypic variances for number of fruits per vine per plant in bottle gourd (1.43 and 3.10), whereas Prasad and Singh (1989), Abusaleha and Dutta (1990), Mangal *et al.* (1981); reported the value in ribbed gourd (202.26 and 475.98), muskmelon (1.71 and 1.90), cucumber (1.15 and 1.24) and bitter gourd (9.02 and 10.45).

Husna A. (2009), reported in bottle gourd that mean performance of days to first male flowering showed maximum duration (90.33) to first flowering was produced by BD-8949 and that minimum duration (57.00) by BD-4580 with mean value 73.78.

Husna A. (2009), conducted an experiment on bottle gourd and maximum number of fruits per plant was found 20.0 in BD-4560 and the minimum was recorded 5.00 in BD-4598 with mean value 10.42 and also conducted an experiment on bottle gourd and founded maximum fruit length 16.03 in BD-8948 and the minimum recorded 7.03 in BD-4580 with mean value 12.29.

Saha *et al.* (1992); observed high GCV and PCV for fruit length (30.34 and 31.76) and low for fruit diameter (8.87 and 10.23) in pumpkin. They estimated high h2 for both length (11.17%) and diameter (75.07%). They also found high genetic advance for fruit length (59.72) but low for fruit diameter (15.82). Significant variation for fruit length and diameter were noticed in bitter gourd (Srivastava and Srivastava, 1976; Mangal *et al.*, 1981), sponge gourds (1983; Prasad and Singh, 1990), ribbed gourd and bottle gourd (Rahman *et al.*, 1991).

Rahman *et al.* (1986), indicated high GCV and PCV for both length (31.73 and 33.75) and diameter (39.23 and 41.96) of fruits in bottle gourd. They also observed minimum difference between GCV and PCV. Characters having high GCV indicate high potentiality for effective selection.

For fruit weight in pumpkin, Saha *et al.* (1992) observed high GCV and PCV (39.55 and 41.00); Doijode and Sulladmath (1986) reported high GCV and PCV (30.2 and 36.4). In pumpkin, Rana *et al.* (1986) found a high value for this characteristic. Mannan (1992) found a little difference between GCV and PCV for this feature in bitter gourd, indicating that the character is less influenced by the environment.

Doijode and Sulladmath (1986) observed high heritability combined with genetic progress for average fruit weight in pumpkin (82.9 percent and 49.6); Saha *et al.* (1992) observed (93.03 and 78.58).Similar findings were achieved in snake gourd and cucumber by Prasad and Singh (1990). On the other hands low heritability (45.1%) and very high genetic advance (133.05) was recorded for this trait in ribbed gourd noted low GCV and PCV for fruit weight in 16 water melon (0.28 and 0.41) and musk melon (0.01 and 0.02) respectively, whereas Mangal *et al.* (1981) found high value (291.89 and 318.47) in bitter gourd.

The variation for yield per plant was recorded in bottle gourd (Rahman *et al.*, 1991), water melon (Chezhiyan, 1984), musk melon (Swamy *et al.*, 1984) and pumpkin (Rana *et al.*, 1986; Saha *et al.*, 1992; Mangal *et al.*,1981) found high value (47759.63 and 55149.80) in bitter gourd while low GCV and PCV were recorded for this character in water melon (0.44 and 1.15) and musk melon (0.04 and 0.07) by Vashistha *et al.* (1983) and Vijay (1987). Prasad and Singh (1989) and Saha *et al.* (1992) recorded high GCV and PCV for yield per plant in pointed gourd (46.50 and 64.10) and pumpkin (28.82 and 31.21). High h2 associated with high genetic advance for yield per plant was reported by Saha *et al.* (1992). The use of inorganic and synthetic chemicals has increased, providing a danger to human health and the environment. The goal of this study was to see how an organic bio- stimulator affected strawberry growth and yield parameters. T_0: Control; T_1: Neem oil; T_2: Bordeaux mixture; T_3: Clybio; T_0: Control; T_1: Neem oil; T_2: Bordeaux mixture;T_3: Clybio; T_0: Control; T_1: Neem oil; T_2: Bordeaux mixture; T_3: Clybio; T_0: Control; T_1: Neem oil; T_2: Bordeaux mixture; T_3: Clybio; T_0: Control; T_0: Control The impacts on vegetative growth, yield parameters, and fruit quality (Brix percent) were examined, and substantial variance was found.

Strawberry fruit color (fruit skin and flesh) was also quantified and represented using the CIELab scale, which included L* (lightness), a* and b* (two Cartesian coordinates), as well as C* and hab (Chroma & Hue angle). Clybio (T_3) and Bordeaux mixture (T_2) treatments significantly improved vegetative growth (crown height, SPAD value, runner number) and yield attributes (flower number, fruit length); maximum fruit number (26.3), fruit weight (25.3g), Brix value (7.1) were recorded in T_3 treatment, and Clybio resulted in a greater improvement in fruit yield (69.6%) over control treatment. As a result, Clybio can be suggested as a bio-fertilizer with a bio-stimulating effect that improves vegetative development while also increasing yield.

Under laboratory and field circumstances, Abdel-Gawad *et al.* (2019) researched and observed the impact of soil treatments with three *Bacillus pumilus* isolates on black root rot disease of strawberry plants caused by *R. solani*, *F.solani*, and *Pythium sp*. On the ‘Festival’ strawberry cultivar. Each seedling was dipped in bacterial cell solution at 1108 colony- forming units/ml of each unique bacterial isolate for 30 minutes before being combined with 5 percent Arabic gum to improve bacterial adherence and dispersion on the roots. These three fungi's growing area was dramatically decreased by the *B. pumilus* isolates examined. For *R. solani*, *F. solani,* and *Pythium sp*., the two bacterial isolates Nos. 2 and3 decreased the growth area by more than 85.2, 83.6, and 89.0 percent, respectively. Similarly, the three bacterial isolates significantly ($P \leq 0.05$) inhibited the disease under field conditions.

Anuradha *et al*. (2020) carried out an experiment to study the co-inoculation effect of effective rhizospheric bacteria on growth, yield and quality of strawberry cv. Chandler. They treated the strawberry plants with rhizospheric bacteria i.e., Pseudomonas strains namely, CP109 and CPS67 and Bacillus strains namely HCA61, RCA3 and SYB101, whereas untreated soil served as control. The growth, yield and quality of fruits were significantly influenced by rhizospheric bacteria. Among different treatment, treatment T_4 (CP109+ HCA61) recorded the significantly highest fruit yield per plant (257.92g). The growth parameters, viz. plant height (14.11cm), number of leaves per plant (12.34), crown diameter (13.21mm), fresh weight (45.89g) and dry weight (13.11g) of plant maximum in treatment combination CP109+HCA61. However, with respect to TSS (%),Ascorbic acid and anthocyanin content (mg 100g-1) of fruits Bacillus HCA61+Pseudomonas CP109 was found best. The co-inoculation with Bacillus and Pseudomonasstrains could be an ecofriendly and cost-effective technology for improving the growth, yield and quality of strawberry.

Al-Karawi *et al.* (2018) conducted a study on the effect of spraying dry yeast (*Saccharomyces cerevisiae*) and boron and their interaction on the growth and productionof the strawberry plant. The study included 9 treatments: spraying the plants with two concentrations of dry yeast (1, 2g L^{-1}) in addition to distilled water only with three concentrations of boron (0, 2, 4 g.L^{-1}). The results showed that spraying the plants with dry yeast led to a significant increase in the plant height and the number of leaves at the concentration of (1 g.L^{-1}), while the spraying treatment with concentration (2 $g.L^{-1}$) gave a significant increase in the dry weight of the total vegetative, the leaves content of chlorophyll and the fruits content of Total sugars, the average production of one plant. The spraying with boron showed a significant increase in the traits of vegetative growth and of the yield traits at a concentration of (2 $g.L^{-1}$).

Borah (1997) discusses his research on how soil yeasts interact with biotic and abiotic variables in their environment. Soil yeasts may have a role in the development of soil aggregates and the preservation of soil structure, in addition to affecting microbial and plant growth. Soil yeasts contribute to critical ecological processes such as the mineralization of organic matter and the dissipation of carbon and energy across the soil ecosystem by serving as a nutrition supply for bacterial, faunal, and protistan predators. Some soil yeasts have the potential to solubilize insoluble phosphates, making it more easily accessible to plants, and may play a role in both the nitrogen and sulfur cycles. Recently, the potential of soil yeasts as plant growth promoters and soil conditioners has been studied with the goal of using them in the field of sustainable agriculture.

Abdel-Gawad and Youssef (2019) reported that an experiment was conducted at Experimental Farm, Faculty of Agriculture, Al-Azhar University, Egypt during the winterseason 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 (10g/L) increased growth and yield significantly.

In constrained environmental conditions, Iriti *et al*. (2019) found that effective microorganisms (EM) treatments had an influence on leaf chlorophyll content, yield, and micronutrient content of bean plants cultivated in various substrates (nutrient rich substrate vs. nutrient low sandy soil). Two weeks longer than control plants, EM treated plants maintained maximum leaf photosynthetic performance and increased yield.

The study was conducted in Hunumulla agricultural farm, Gampaha District, Sri Lanka, according to Kodippili and Nimalan (2018), to evaluate the effect of homemade EM combined with compost on chilli growth and yield characteristics (*Capsicum annuum*). The experiment was designed using three replications in a Randomized complete block design (RCBD). The following were the treatments: T_1: Control, T_2: Compost, and T_3: EM+Compost (T_3). The EM+Compost treated crops had significantly higher 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 no significant differences in pod length, pod width, or total chilli pod weight per crop were observed between the EM+compost and compost treatments. 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.

At the Crop farm, Eastern University, Sri Lanka, Karunarathna and Seran (2016) evaluated the effect of effective microorganisms (EM) in combination with cow dung on capsicum (*Capsicum annum* L.) growth and yield. A Randomized Complete Block Design was used to organize six treatments with three replications. 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, T_6: Cattle manure 20 t/ha + EM, T_7: Cattle manure 20t/ha+EM, T_8: Cattle manure 20t/ha+EM Up to 20 DAT, the data indicated no significant change in canopy height across the treatments At 10, 20, and 30 DAT, there were significant differences in the number of leaves per plant, as indicated by P values of 0.197, 0.700, and 0.075, and chi-square values of 7.33, 3.00, and 10.00, respectively. In majority of the treatments, the diameter of the pod was increased until the third plucking, after which it was reduced. The number of pods per plant rose when cow manure was increased from T_3 to T_4. T_4 had high fresh pod weights, number of seeds per pod, and dried pod and seed weights.

The effect of plant growth enhancing microorganisms on cucumber was examined by Kang *et al.* (2015). Treatments included Rhizobacteria spheroids, Lactobacillus plantarum, and Saccharomyces cerevisiae bacteria. Treatment with all three bio- inoculants boosted shoot length, root length, shoot fresh weight, shoot dry weight, and chlorophyll content via secreting IAA and organic acids, according to the results. Inoculation with R. spheroids had a more favorable effect on plant growth than inoculation with L. plantarum or S. cerevisiae, since it increased gibberellin levels while lowering abscisic acid levels.

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) studied the influence of organic manure and complex chemical fertilizer (NPK) with or without effective microorganism (EM) on the agronomic performance of spinach crop in a two-year pot experiment at Gomal University from 2009 to 2011 Bio-Aab, a commercial product, was employed as an EM source. T_1 (no N or EM), T_2 (FYM applied at 10 t/ha), T_3 (press mud applied at 20t/ha), T_4 (compost applied at 0.7t/ha), and T_5 (poultry manure applied at 5t/ha) were the treatments. In 2009-10, the use of EM in combination with Press mud at a rate of 20t/ha resulted in greater average spinach plant height (35cm), number of leaves (16.4), fresh foliage yields (330g/pot), and dry foliage yields (32g/pot) and leaf length (40.5cm) 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.

Tomic *et al*. (2015) investigated the effects of biofertilizer and cultivar on the vegetative potential, leaf mineral composition, yield potential, fruit features, and chemical attributes of Clery, Joly, and Dely strawberry plants' fruits. Biofertilizer 1 (inoculums of a mixture of liquid bacteria cultures from the genera Azotobacter, Derxia, and Bacillus) and Biofertilizer 2 (inoculums of a mixture of liquid bacteria cultures from the genera Azotobacter, Derxia, and Bacillus) were used (inoculums of liquid culture of diazotrophic bacteria belonging to the genus Klebsiella). The biofertilizers used had a substantial influence on the leaf's vegetative potential, as well as the contents of several macro and microelements, as well as the values of titratable acidity, vitamin C, total anthocyanins, total phenolic content, and total antioxidant capacity.

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.

Research was done in a dedicated greenhouse within the boundaries of the Experimental Station of the Faculty of Horticulture and Landscape Architecture of the University of Life Sciences in Poznan, Poland, according to Kleiber *et al.* (2013). The goal of the study was to see how the chemical composition of nutrient solutions (NS I, NS II), seed inoculation with Effective Microorganisms (EM), and assimilation illumination (AI) of plants affected lettuce (*Lactuca sativa* L.) growth, development, and nutritional status in hydroponic cultivation, as well as microbiological changes in the medium. The following measurements were made: number of leaves per plant (LQ), surface area of the largest leaves (SBL), relative chlorophyll content (SPAD units), and 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 growthand 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 7 (3cm/L), AG_1 (1cm/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 (15.69t/ha).

A total of 60 random samples of fresh chicken burger, fillet, and luncheon (20 of each) were collected from markets at Tanta city. The average total yeast counts (cfu/g) in burger, fillet, and luncheon samples were 2.7×106±1.1×106, 2×105±0.9×105, and 1.4×107±0.7×107, respectively. A total of 158 yeast isolates of 23 species were isolated and identified. *Candida, Cryptococcus, Debaromyces, Issatchenkia, Pichia, Rhodotorula, Saccharomyces, Trichosporon* and *Yarrowia* species were recovered from the examined samples of fresh chicken meat products in varying percentages ranging from 5% to 50%. The tested plant extracts of cinnamon, clove and thyme revealed a potent anti-yeast activity against *C. albicans, D. hansenii* and *S. cerevisiae* at 20% concentration, and a moderate inhibitory activity against these yeast strains at 10% concentration, while garlic extract had a lesser inhibitory effect on the yeast strains tested at the same concentration. Moreover, thyme, cinnamon and clove extracts had a completeinhibitory effect on chicken fillet inoculated with Candida albicans when incubated at 5°C and 25°C.

To explore the potential relevance and practical application of rhizophagy, Lonhienne *et al*. (2014) investigated brewers' yeast (*Saccharomyces cerevisiae*), a waste product of the brewing industry, for its role as biofertilizer. The addition of live or dead yeast to fertilized soil substantially increased the nitrogen (N) and phosphorus (P) content of rootsand shoots of tomato (*Solanum lycopersicum*) and young sugarcane plants. Yeast additionto soil also increased the root-to-shoot ratio in both species and induced species-specific morphological changes that included increased tillering in sugarcane and greater shoot biomass in tomato plants. These findings support the notion that brewers' yeast is a cost- effective biofertilizer that improves not only plant nutrition but also plant vigor duringthe early growth phase.

The capacity to solubilize phosphate and to produce indole compounds Indole Acetic Acid type, was evaluated in 15 strains isolated from castor bean lignocellulosic residues (*Ricinus communis*). To determine the solubilizing activity of phosphates a qualitative test by using Pikovskaya culture medium was employed and for the evaluation of the production of indole compounds (IAA) a Salkowsky colorimetric analysis technique was applied. Among the microorganisms tested, the *Bacillus pumilus* GIBI 206 demonstrated capacity to solubilize phosphates and Bacillus subtilis GIBI 200 showed of capacity to solubilize phosphates and to produce Indoleacetic Acid (IAA).

To determine the effect of the *Bacillus* subtilis strain on germination and growth promotion, tomato seeds (*Solanum lycopersicum* ‘Santa Clara’) were inoculated; the inoculation of the seeds along with the microorganism revealed statistically significant differences, during the germination stage compared to the control treatment. Nevertheless, it revealed a positive influence on the development of tomato plants, originating a significant increase on the mass and length ofits stem and root. The results of this research offer the possibility of using the Bacillus subtilis as a growth promoter in tomato seedlings and in the formulation of bio-products. Keywords: biotechnology, indole, PGPB, seedlings, tomato.

A field experiment was conducted at Nalanda College of Horticulture during summer 2017 to assess the effect of complementary and sole applicationsof organic and inorganic fertilizers on the growth and yield of bottle gourd under okra- cabbage-bottle gourd crop sequence. The experiment consists of seven treatments viz., T-Chemical fertilizers1(120Kg N: 60 Kg P_2O and 40 Kg K_2O); T- 252-250% NPK through inorganic fertilizer+50% N through FYM; T -50% N through FYM+50% 3N through VC; T-1/3 of N through FYM +4VC + Neemcake; T-50% N through FYM+5PSB + Azotobacter; T-T +PSB + Azotobactor 63 and T-T +PSB + Azotobacter. These 74 treatments were replicated thrice in Randomized Block Design. Results revealed that T-50% NPK through inorganic 2fertilizer+50% N through FYM recorded-1238.9q/ha fruit yield, which was statistically at par with rest of the fertilizer sources, -1except T (173.4 q/ha). Although, T-RDF5 1-1recorded maximum (247q/ha).

Ncube *et al.* (2011) conducted a field experiment during the 2004-2005 summer season toevaluate 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 8 tomato plants at T_5 resulted in 33.3% increase in the number of fruited plants relative to the T_1. Highest Yield (36.3t/ha) was at T_4 and lowest yield (17.5t/ha) at T_7.

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 20t/ha, *Trifolium alexandrinum* green manure at 20t/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.

Sood *et al*. (2018) undertaken a study to monitor the interactive effects of bio-fertilizers and plant growth regulators on performance of strawberry. Three different bio-fertilizers viz. Azotobacter (10kg/ha), PSB (6kg/ha) and VAM (12kg/ha) and three plant growth regulators viz. GA3 (100ppm), Triacontanol (5ppm) and NAA (50ppm) were tested individually and in combinations. The combined application of bio-fertilizers and growth regulators (i.e., PSB@6 kg/ha + GA3 @ 100ppm) helped to improve the plant growth with least time to produce first flower. The physical characteristics, anion and cation content of strawberry fruit were positively affected by treating the plants with PSB@6 kg/ha) + Triacontanol @ 5ppm. The plants treated with PSB (6kg/ha) + Triacontanol (5ppm) registered a 33.0% higher yield compared to control treatment. An appropriate combination of bio-fertilizers and plant growth regulators (e.g., PSB@ 6kg/ha) + Triacontanol @ 5 ppm) significantly improved the fruit yield and quality of strawberry.

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 t/ha) was added to the soil and urea (0.10 t/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 10 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.

Rueda *et al.* (2016) carried out an investigation with isolated and identified *Azotobacter* spp. and *Azospirillum* spp. through macromorphologically and micromorphologically in order to assess its effect on growth and yield of strawberry (*Fragaria vesca*) in hydroponic system. The inoculation and coincubation of bacterial culture were performed in combination with three nitrogen levels (50, 100 and 150ppm). It was observed that in T_8 (co-inoculation in100 ppm N) group showed significantly increase in plant height (18.57cm), chlorophyll content (48.57 Soil Plant Analysis Development-SPAD), fresh root weight (25.82g) and dry root weight (5.93g), while in treatment group T_5 (*Azotobacter* spp. 100ppm of Nitrogen) and T_6 (*Azotobacter* spp. 150ppm of Nitrogen) showed significant increase in root length, leaf area, dry and fresh weights of aerial parts. Azotobacter and Nitrogen treatment has growth related benefits in strawberries under hydroponic system.

Pii (2018) *et al*. conducted research to evaluate and compare the effects of beneficial microorganisms, supplied either as pure culture (*Azospirillum brasilense*) or as a commercial mixture (Effective Microorganisms - EM), on the growth and quality of strawberry fruits. PGPR can stimulate plant growth, increase plant resistance to abiotic and biotic stresses and thus have a positive effect on fruit quality. Strawberry frigo-plants were hydroponically grown either in a complete nutrient solution or in a nutrient solution inoculated with *A. Brasiliense* or with EM for 10 weeks. Fruits obtained from PGPR- inoculated plants also had a higher sweetness index in comparison to control fruits. The concentration of flavonoids and flavanols was higher in fruits harvested from A. Brasiliense-inoculated plants. In addition, PGPRs also influenced the uptake and allocation of nutrients in fruits, in particular increasing the concentration of micronutrients.

Singh *et al*. (2007) conducted a field experiment to study the response of nitrogen fixing bacteria with chemical fertilizers in conjunction with plant bioregulators on growth, yield and nutrient status of strawberry cv. Sweet Charlie. The maximum growth in terms of plant height, number of leaves, leaf area, crowns/plant and total biomass were observed in the treatment consisting of Azotobacter + Azospirillium + 60kg N ha-1 + 100ppm GA_3. This treatment also contains highest chlorophyll content in leaves. Highest fruitset, yield and optimum fruit quality was recorded in plants inoculated with Azotobacter and Azospirillum along with 60 kg N ha-1 (50% N of the standard dose) and 100ppm GA 3. The plant nutrient status was much influenced by combined use of biofertilizer and bioregulators.

Verma *et al*. conducted a field experiment during 2014-15 to study the performance of different levels of inorganic fertilizers with combination of bio-fertilizers. It comprised application of different level of inorganic and bio-fertilizers with thirteen treatments. Among these, overall minimum plant height was obtained (14.18cm) at 90 days after transplanting in T_1 - Control and maximum plant height (18.67cm) in T_2 - (100 kg N ha-1+ Azotobacter). The maximum number of leaves was recorded highest (18.67) in T_2 - (100 kg N ha-1+ Azotobacter) with followed by (17.67) in T_4 - (75 kg N ha-1 + Azotobacter). The minimum spreading of plant in North- South direction (15.63 cm) was recorded in case of control. The highest yield per plant observed in T_2 (173.42g). Among the thirteen treatments T_2 - (100 Kg N ha-1+ Azotobacter) showed best performance in terms of maximum fruit yield of strawberry.

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 manure 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-Zhong 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 kgred 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 (67.20cm), 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 11 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 valley, 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 a greater number of grains per cob.

Xu *et al.* (2001) conducted an experiment to investigate the effects of applications of bokashi and chicken manure as well as EM inoculation to bokashi and chicken manure onphotosynthesis, fruit and quality of tomato. Six treatments used as follows T_1: Chicken manure, T_2: Chicken manure with EM, T_3: Anaerobic Bokashi, T_4: Anaerobic Bokashi with EM, T_5: Chemical fertilizer and T_6: 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 levelof 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 effectof 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 18.7kg/a, T_2: OF at 18.7kg/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 foliarapplication 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 13.4cm and 83.0cm to 13.1cm and 79.8cm. Maximum root length, plant height, number of branch (29.13) 13 and weight (198.1gm) were at T_3, while minimum number of branch (21.3) and weight (144.4gm) 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 (102cm), 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 offoliar 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 since1990 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: 14 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, Jadavpur, 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 at10 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 EMusing 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 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, T4: RecommendedN-P-K fertilizer rate). The highest onion yield (7.2 t/ha) was obtained by T_2 with EM andwas 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 III

MATERIALS AND METHODS

MATERIALS AND METHODS

The study was conducted at Horticultural farm of the Sher-e-Bangla Agricultural University, Dhaka, from January to June 2020 to look at growth and yield contributing parameters in bottle gourd. The location of the experimental site, soil qualities, climate, materials, layout, and design of the experiment are all briefly described. The following are the procedures for land preparation, manuring and fertilizing, seedling transplantation, intercultural operations, harvesting, data recording, economic and statistical analysis and so on.

3.1. Experimental site

During the months of January to June 2020. The experiment was conducted in the Horticultural farm of Sher-e-Bangla Agricultural University in Dhaka-1207.

3.2 Geographical location

At a height of 8.6 meters above sea level, the experimental area was located at 23°74'N latitude and 90°35'E longitude (Anon, 2004). The experimental field is located in AEZ-28, The Madhapur Tract's agro-ecological zone. This was a complicated topography and soils region built over the Madhapur clay, where floodplain sediments covered the Madhapur Tract's dissected borders, leaving little hillocks of red soils as 'Islands' surrounded by floodplain. In Appendix I, the trial location was depicted on a map of Bangladesh's AEZ.

3.3 Climate

The climate of the area is subtropical, with high temperatures, high relative humidity, and little rainfall in combination with somewhat low temperatures.

3.4 Characteristics of soil

The soil at the trial site is classified as Shallow Red Brown Terrace Soils in the Tejgaon Series. The top soils were olive-gray in color, with fine to medium noticeabledark yellowish-brown mottles. The pH of the soil ranged from 5.47

to 5.63, with 0.82 percent organic matter. The experimental area was flat, with an irrigation and drainage system in place, and it was above flood level. Soil samples were taken from the experimental field at depths ranging from 0 to 15 cm. Soil Resource and Development Institute (SRDI) Dhaka conducted the analyses. Appendix II contains the soil's physicochemical characteristics.

3.5 Experimental materials

3.5.1 Clybio preparation

Clybio is an example of a useful microbe (EM). There are five families, ten genera, and 80 species of coexisting microorganisms in this area. Lactobacillus bacteria, yeastfungus, Bacillus natto bacteria and fungus are the most common microorganisms found.

3.5.2 Planting materials

The seedlings of bottle gourds BARI LAU 4 were used in this study. Disease free and vigours seedlings were collected from the nursery and had 2-3 leaf per plant.

3.5.3 Treatments of the experiment

The single factorial experiment was conducted to evaluate the growth and yield of bottle gourd and clybio concentration with application frequency.

Treatment:

T_0; Control (no Clybio)

T_1; 1ml/L+10 Days interval

T_2; 1ml/L+15 Days interval

T_3; 1ml/L+20 Days interval

T_4; 2ml/L+10 Days interval

T_5; 2ml/L+15 Days interval

$T_{6;}$ 2ml/L+20 Days interval

3.5.4 Application of Clybio

Foliar application as well as root zone application of Clybio was done to the bottle gourd field soil along with the leaf and the whole plant. First application was done at 10 days after transplanting and treatment frequency maintained. No pesticides and fungicides were used on this experiment.

3.5.5 Design and layout of the experiment

The experiment was laid out Randomized Complete Block Design (RCBD) with threereplications. The distance maintained spacing pit to pit 2 m.

3.5.6 Spacing and pot size

Row to row distance was 2 m and plant to plant distance 2 m.

3.6 Production technology

3.6.1 Land preparation

In the first week of January 2020, the trial plot was prepared by ploughing and cross ploughing, followed by laddering and harrowing with tractor and power tiller to get good tilth. Weeds and other things were carefully removed from the experimental areabefore it was leveled.

3.6.2 Application of manure and fertilizers

During final land preparation, all cow dung, half of TSP, and one third of MoP

Table: Doses of manure and fertilizers used in the study Fertilizer Recommended Doses (BARI)

Fertilizer	Recommended Doses (ha)
Cow dung	10 t
TSP	125 kg
Urea	125 kg
MOP	150 kg
Gypsum	75 kg
Zn fertilizer	10 kg

were put in the field. One week before transplantation, the remaining TSP, one-third MoP, entire gypsum, zinc oxide, and one-third urea were applied in the pit.

3.6.3 Transplanting of seedlings

Germination of seeds took only ten days, and seedlings of several accessions were put in the hole on January 20, 2020. Two seedlings were put in each pit, and the earth surrounding them was firmly crushed by hand. After a few days, an entresol was built, and intercultural operations including as mulching, thinning and gap filling were carried out.

3.6.4 Harvesting

It takes around 7-10 days after pollination for the fruit to reach commercial stage. Fruits were chosen for eating based on horticultural maturity, size, color and age. Because the fruit grew quickly and quickly passed the marketable stage, regular picking was done during the harvesting period. Fruits were plucked with a sharp knife while taking care not to injure the planted fruits of various shapes after harvesting.

3.7 Parameters of the experiment

Data were collected in respect of following parameters:

1. Growth related parameters

- **a.** Plant height (cm)
- **b.** Days to first female flowering (DAT)
- **c.** Days to first harvest (DAT)

2.Physiological parameters

- **a.** SPAD value

3.Yield attributing parameters

- **a.** No. of fruits plant^{-1}
- **b.** Fruit length (cm)
- **c.** Fruit diameter (cm)
- **d.** Individual Fruit weight (kg)

e. Yield plant^{-1}(kg)
f. Yield ha^{-1}(t)

3.8 Data recording

Data were recorded on following parameters from the studied plants during the experiment. The details of data recording are given below on individual plant basis.

3.8.1 Plant characteristics

3.8.1.1 Vine length (cm)

From the ground level to the tip of the longest leaf, the vine length of each sample plant was measured in centimeters, and the mean value was computed and expressed in centimeters.

3.8.1.2 Days to first female flowering (DAT)

Three replications were tallied independently for the number of days necessary for the first female flower to blossom, and the mean value data was recorded.

3.8.2 Physiological parameter

3.8.2.1 SPAD value

At 55 days after transplanting, the amount of chlorophyll in the leaves was measured (DAT). All of the mature leaves (fourth leaves from the top) were measured at all times. Using a portable SPAD-502 (Minolta, Japan), three mature plants from each plot were assessed, and an average SPAD value for each plot at each sample period was computed. SPAD-502 is a simple and portable diagnostic equipment for determining the greenness of leaves or their relative chlorophyll content.

3.8.3 Fruit characteristics

3.8.3.1 Fruit length (cm)

Fruit length was measured in cm in three to five fruits from each plant during fruit harvest for vegetable consumption and the mean value data was recorded.

3.8.3.2 Fruit breadth (cm)

Fruit diameter was measured in centimeters in three to five fruits, then split by two in middle portion and mean value data was recorded during fruit harvest for vegetable consumption.

3.8.3.3 Fruit weight (kg)

During the harvest for vegetable consumption, the weight of three fruits on each plant was measured in kilograms.

3.8.3.4 Yield per plant(kg)

The weight of chosen fruits from each plant was measured in kilograms.

3.8.3.5 Fruit yield(t/ha)

Following harvest, the weights of healthy fruits and the total yield under each treatment was converted to yield (t/ha).

3.9 Statistical analysis

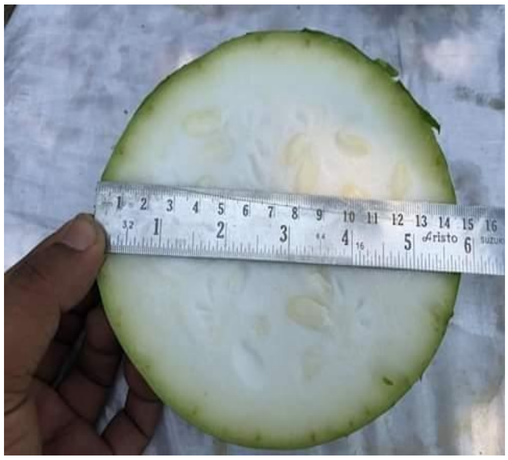
The data was statistically evaluated using the Statistix 10 computer software tool. The mean for all treatments was computed, and F-test was used to do analysis of variance for each of the characters (Variance Ratio). Finally, at a significance level of 0.05 percent, the difference between treatments was analyzed using the Least Significant Difference (LSD) test.

(a) (b)

(c) (d)

Plate 1: Pictorial presentation of different methodological works and equipment. (a) Transplanting, (b) spraying Clybio, (c) female flower with fruit and (d) harvesting time of bottle gourd.

(e)



(f)

(g)

(h)

Plate 2: Pictorial presentation of different equipment and data collection. (e) Fruit length, (f) fruit diameter, (g) individual fruit weight, (h) taking SPAD value.

CHAPTER IV

RESULT AND DISCUSSION

RESULT AND DISCUSSION

The goal of the experiment was influence of clybio concentration with application frequency on growth and yield of bottle gourd. Data was collected on many growth and other parameters, as well as yield. The results of the data analyses of variance (ANOVA) on various parameters are reported in the Appendix section. The findings were presented in the form of graphs and tables, with various interpretations listed under the sections below.

4.1 Vine length (cm)

Vine length (cm) is a visible growth metric in bottle gourd yield and the growing parameters impacted this attribute significantly. Due to the application of Clybio at different concentration levels and at different frequencies, statistically significant variation in vine length was found 30 days after transplanting (DAT) of bottle gourd plants. Highest vine length at 30 DAT was found in case of T_4 (162.5cm) which was followed by T_5 (155.6cm), T_1 (148.6cm), T_2 (141.1cm), T_6 (133.3cm), and T_3 (126.3cm). On the other hand, lowest vine length at 30 DAT was found in case of T_0 (104.1cm) (Fig.1).

Due to the application of Clybio concentrations with frequency levels, statistically non-significant variation in vine length was found 45 days after transplanting (DAT) of bottle gourd plants. T_4 (360.6cm) had the highest vine length at 45 DAT, followed by T_5 (347.2cm), T_1 (338.3cm), T_2 (328.3cm), T_6 (321.4cm), and T_3 (313.8cm). T_0, on the other side, had the shortest vine length at 45 DAT (292.1cm) (Fig.1).

Due to the application of Clybio concentrations with frequency levels, statically non-significant variation was observed in bottle gourd plants 60 days after transplanting (DAT). T_4 (511.4cm) had the longest vine length at 60 DAT, followed by T_5 (497.9cm), T_1 (488.8cm), T_2 (475.3cm), T_6(467.7cm), and T_3 (460.6cm). T_0, on the other hand, had the shortest vine length at 60 DAT (383.9cm) (Fig.1).

Vine length showed significant variation with Trichoderma treatments. Uddin *et al*. (2016) found the higher plant height in tomato with Trichoderma treatments. Baker (1991) similar opinion was put forwarded in tomato, bean and cucurbits. This may be due to enhanced nutrition uptake activity to the plants.

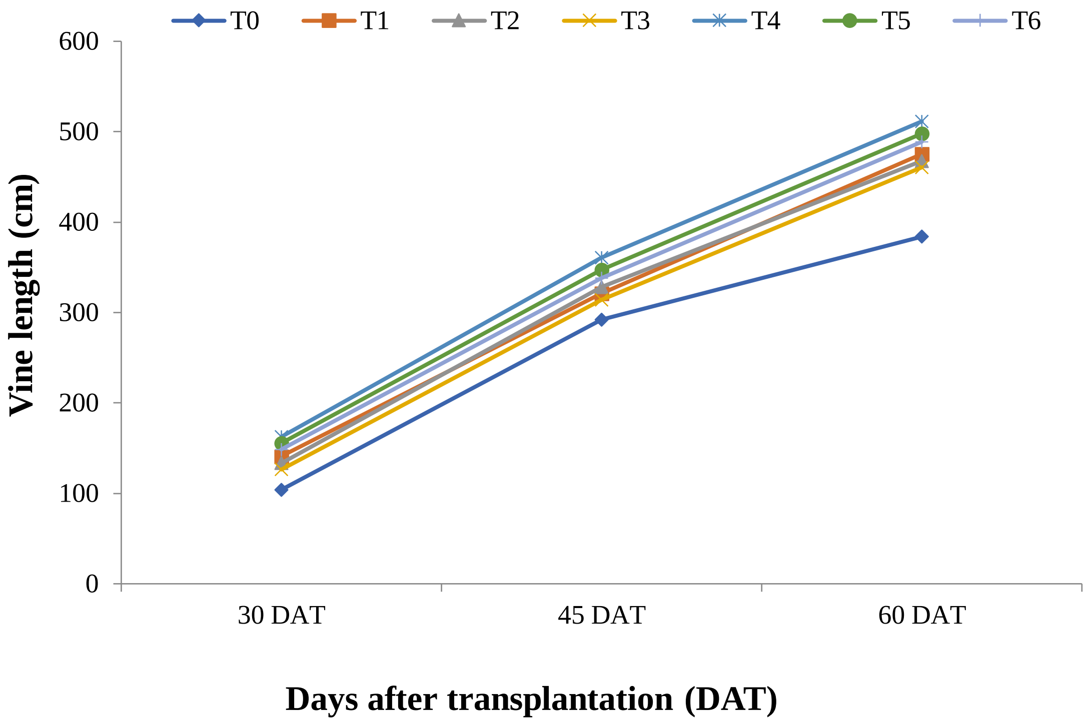


Fig.1. Effect of Clybio concentration and application frequency on vine length of bottle gourd

(Here T_0=Control, T_1=1ml/L+10 days interval, T_2=1ml/L+15 days interval, T_3=1ml/L+20 days interval, T_4=2ml/L+10 days interval, T_5=2ml/L+15 days interval, T_6=2ml/L+20 days interval.)

The vegetative and reproductive growth potential of plants is responsible for superior plant height and root length. Furthermore, the probable reason could be that the optimum amount of Clybio application resulted in increased physiological growth of spinach and more established root growth, which enhanced the plant competency for light, water, and nutrients resulting in more established plants. Similar findings reported by Fahad *et al.* (2016), showed that exogenously applied growth regulators enhance the plants morpho-physiological growth. Height of the plant studied significant variation applied bio-fertilizers (Doifode and Nandkar, 2014). The foliar application of combination of vermiwash with neem oil, increased the brinjal plant growth (Tiwari and Singh, 2015).

4.2 Days required to first female flowering (DAT)

For different concentrations of Clybio spray, the days required for first female flowering significant differences (Table 1). The lowest days required to first female flowering (38.3) was observed in T_4 (2ml/L+10 days interval) treatment, while the maximum day to first female flowering (44.6) was recorded in T_0 (Control) treatment due to the application of different concentrations of Clybio. This seems as if the Clybio treatment enhanced the plant's reproductive growth.

Due to the use of vermicompost, the plant produces early flowering (Chamani *et al.,* 2008). According to Nath and Singh (2012), all concentrations of various combinations of animal, agro, and kitchen wastes have a substantial early start in flowering and increase crop yields.

In different genotypic trials, bottle gourd needed a minimum of 48.17 days and a maximum of 60.67 days (Harika *et al.,* 2012). Kumar *et al.* (1999) and Sirohi *et al.* (1988) found variance in the initial female and male appearance in different bottle gourd genotypes.

4.3 Days required to first fruit harvest (DAT)

Days required for the first fruit harvest of bottle gourd were shown to vary significantly depending on Clybio concentrations (Table 1). The lowest days necessary to harvest the first fruit (54.3) were recorded in the T_4 (2ml/L+10 days interval) treatment, while the maximum days required to harvest the first fruit (61.6) were reported in the T_0 (Control) treatment.

Table 1. Effect of Clybio at different concentration with frequency on bottle gourd at first female flowering (DAT) and days to first harvest (DAT)

Treatment	First female flowering (DAT)	Days to first harvest (DAT)
T_0	44.6 a	61.6 a
T_1	40.6 de	56.6 d
T_2	42.3 bc	58.3 c
T_3	43.3 b	60.0 b
T_4	38.3 f	54.3 e
T_5	39.6 e	56.3 d
T_6	41.6 cd	58.3 c
CV %	1.3	0.9
LSD (0.05%)	1.0	0.9

(Here T_0=Control, T_1=1ml/L+10 days interval, T_2=1ml/L+15 days interval, T_3=1ml/L+20 days interval, T_4=2ml/L+10 days interval, T_5=2ml/L+15 days interval, T_6=2ml/L+20 days interval.)

4.4 SPAD value

Due to the treatment of Clybio at different concentrations with different frequency levels, there was statistically significant fluctuation in the SPAD value of bottle gourd at 55 DAT. T_4 (58.5%) had the highest SPAD value, followed by T_5 (57.1), T_1 (56.1), T_2 (54.6), T_6 (53.3), and T_3 (51.8).

In the case of T_0 (50.3), on the other hand, the lowest SPAD value was discovered (Fig.2). The trend of SPAD value of fruit observed due to application of Clybio at different concentrations with frequency level to bottle gourd plant is $T_4 > T_5 > T_1 > T_2 > T_6 > T_3 > T_0$, according to these findings.

Clybio made of yeast and yeast promotes different essential amino acids, vitamins, and phytohormones that led to the growth and improve the chlorophyll content (Taha *et al.*, 2020).

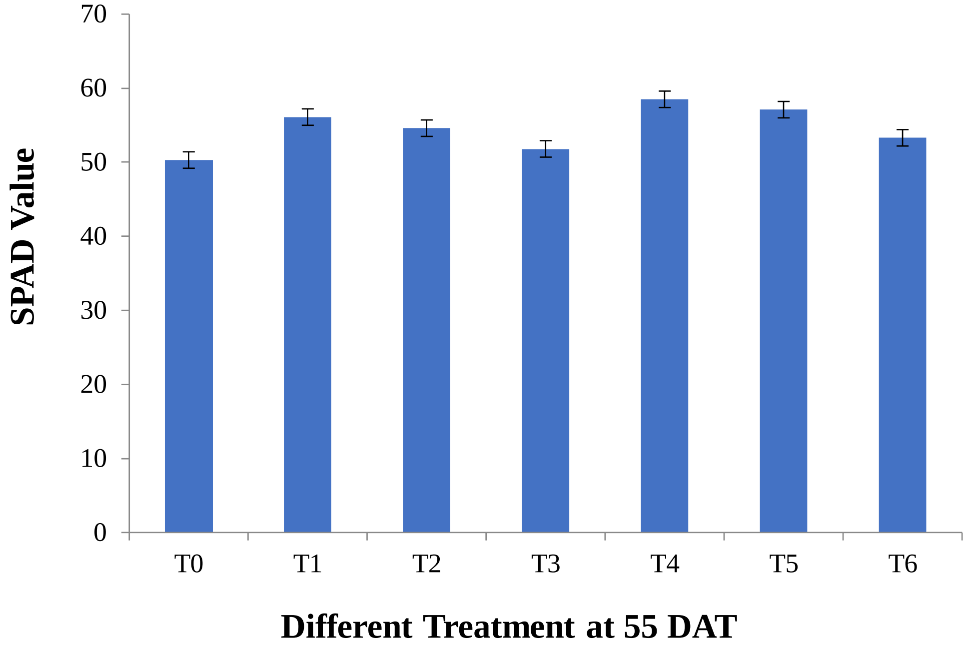


Fig.2. Effect of clybio concentration with application frequency on SPAD value of bottle gourd at 55 (DAT)

(Here T_0=Control, T_1=1ml/L+10 days interval, T_2=1ml/L+15 days interval, T_3=1ml/L+20 days interval, T_4=2ml/L+10 days interval, T_5=2ml/L+15 days interval, T_6=2ml/L+20 days interval.)

4.5 Fruit length (cm)

Because of different Clybio concentrations at different growth stages, fruit length varied dramatically (Table 2). T_4 (2ml/L+10 days interval) had the longest fruit length (45.7cm), followed by T_5 (43.4cm), T_1 (41.3cm), T_2 (40.5cm), T_6 (39.6cm), and T_3 (37.3cm), with T_0 (control) having the shortest fruit length (35.3cm).

Harika *et al.* (2012) found that maximum fruit length 58.92cm and minimum 9.18cm among twenty-five genotypes.

4.6 Fruit diameter (cm)

Different concentrations of Clybio with frequency had a significant impact on the fruit diameter of bottle gourds (Table 2). The highest fruit diameter (15.5cm) was recorded from T_4 (2ml/L+10 days interval) treatment, which was significantly different from the others, which were T_5 (14.4cm), T_1 (13.3cm),

T_2 (12.6cm), T_6 (12.5cm) and T_3 (11.8cm), with T_0 (control) treatment having the lowest fruit diameter (10.8cm).

It showed that fruit diameter of bottle gourd increased with the increase of concentration of Clybio. This result is similar with the findings of Nuruzzaman *et al.* (2015). Fruit diameter ranges was observed from 16.3cm to 6.47cm and this range was found from different genotype of bottle gourd (Harika *et al.*, 2012)

4.7 Individual fruit weight (kg)

There was significant variation on individual fruit weight of bottle gourd influenced by Clybio concentration with frequency. It was observed that the highest individual fruit weight (3.3kg) was achieved from T_4 (2ml/L+10 days interval) treatment which was followed by T_5 (3.2kg), T_1 (3.2kg), T_2 (2.9kg), T_6 (2.8kg), and T_3 (2.6kg) whereas the lowest individual fruit weight (2.4kg) was achieved from T_0 (Control) treatment (Table 2).

The result obtained are in agreement with Samadia (2002) and Sharma and Dhankar (1999).

Table 2. Effect of Clybio at different concentration with frequency on bottle gourd fruit length, fruit diameter and individual fruit weight

Treatment	Fruit length (cm)	Fruit diameter (cm)	Individual fruit weight (kg)
T_0	35.3f	10.8e	2.4e
T_1	41.3c	13.3c	3.2b
T_2	40.5cd	12.6cd	2.9d
T_3	37.3e	11.8d	2.6d
T_4	45.7a	15.5a	3.3a
T_5	43.4b	14.4b	3.2b
T_6	39.6d	12.5cd	2.8cd
CV%	1.2	4.3	3.2
LSD (0.05%)	0.8	1.0	0.1

(Here T_0=Control, T_1=1ml/L+10 days interval, T_2=1ml/L+15 days interval, T_3=1ml/L+20 days interval, T_4=2ml/L+10 days interval, T_5=2ml/L+15 days interval, T_6=2ml/L+20 days interval.)

4.8 Number of fruits/plant

In terms of the number of fruits per plant, there were highly significant variances among bottle gourds. T_4 (11.3) produced the most fruits per plant, whereas T_0 produced the fewest (8.6). Because to the increased number of flowers per plant, the high fruit set percentage, the maximum number of fruits per plant and the number of fruits per plant has grown.

These results are in agreement with those obtained Prema *et al*. (2011) and Singh *et al*. (2013). Fruit number varied with organic fertilizers treatment (Mehraj *et al*., 2014) and botanical extract like neem leaf (Azad *et al.*, 2012).

Bacillus OSU 142 and Pseudomonas BA-8 were previously selected as a biological control agent for the management of some plant diseases and more recent studies showed that OSU 142 was able to fix N_2 a symbiotically and promote plant growth and yield in barley, sugar beet, tomato, pepper and apricot (Cuppels *et al.*, 1999; Kotan *et al.*, 1999; Sahin *et al.*, 2000; Cakmakci *et al.*, 2001; Esitken *et al.*, 2005; Orhan *et al.*, 2006; Aslantas *et al.*, 2007; Pirlak *et al.*, 2009). In addition, the preliminary studies have demonstrated that Bacillus OSU-142, Burkholderia OSU-7, Pseudomonas BA-8, and Bacillus M-3 produce IAA and solubilization P (Aslantas *et al.*, 2007).

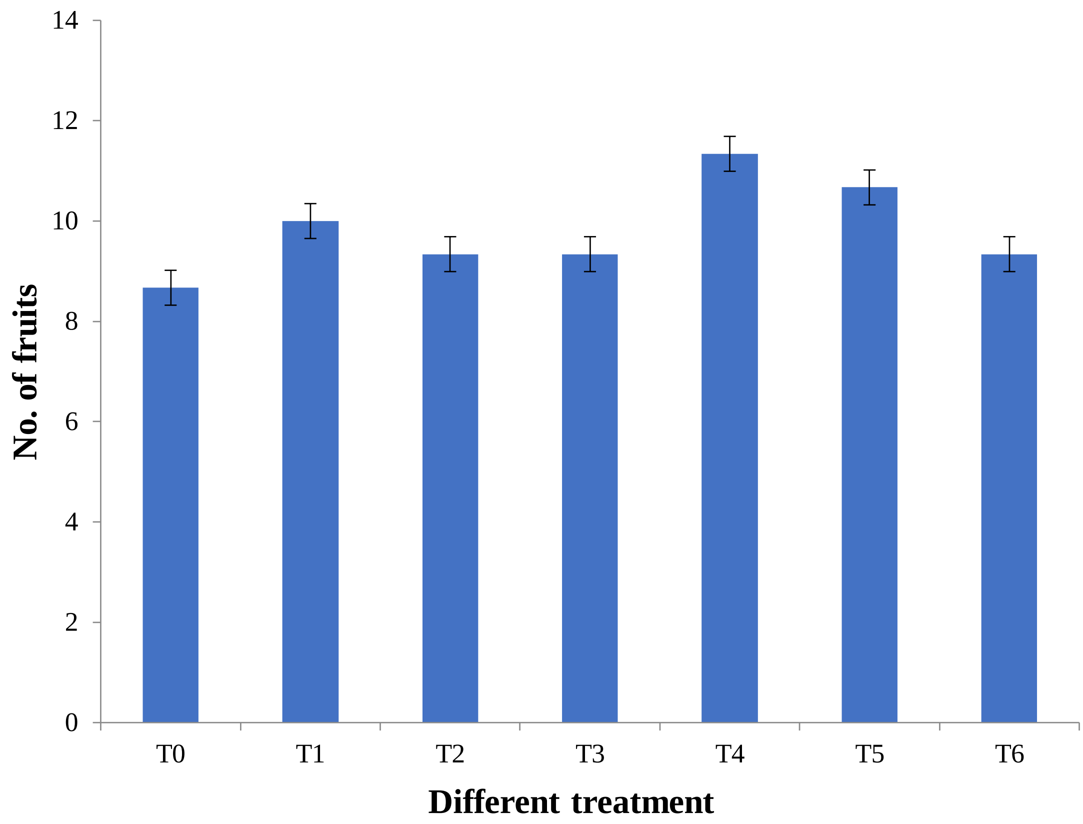


Fig.3. Effect Clybio concentration with application frequency in No. of fruits of bottle gourd

(Here T_0=Control, T_1=1ml/L+10 days interval, T_2=1ml/L+15 days interval, T_3=1ml/L+20 days interval, T_4=2ml/L+10 days interval, T_5=2ml/L+15 days interval, T_6=2ml/L+20 days interval.)

4.9 Yield per plant (kg)

The yield per plant of bottle gourd varied significantly depending on the concentration of Clybio (Table 3). The T_4 (2ml/L+10 days interval) treatment produced the maximum yield per plant (38.3kg), while the T_0 (control) treatment produced the lowest yield per plant (21.1kg).

Increased production of Clybio and other organic bio-stimulator applications. Clybiois a unique and complicated microorganism that comprises bacteria such as Lactic acid bacteria, Bacillus natto bacteria, and yeast fungus, as well as a growing and developing plant. Lactobacillus bacteria, for example, aid in nitrogen fixation and the buildup of auxin and cytokinin, which stimulate plant growth during the flowering stage (Higdon *et al.*, 2020).

Table 3. Effect of different Clybio concentration with frequency on bottle gourd yield/plant and yield/ha

Treatment	Yield/plan (kg)	Yield/ha(ton)
T_0	21.1e	52.8e
T_1	26.9d	67.3d
T_2	27.6d	68.9cd
T_3	26.2d	65.5d
T_4	38.3a	95.7a
T_5	35.0b	87.5b
T_6	29.8c	73.9c
CV%	4.0	3.9
LSD (0.05%)	2.1	5.1

(Here T_0=Control, T_1=1ml/L+10 days interval, T_2=1ml/L+15 days interval, T_3=1ml/L+20 days interval, T_4=2ml/L+10 days interval, T_5=2ml/L+15 days interval, T_6=2ml/L+20 days interval.)

Bacillus solubilizes soil P, improves nitrogen fixation, and produces siderophores that promote growth (Hashem *et al.,* 2019); yeast stimulates plant hormones such as auxins, gibberellins, cytokines, vitamin synthesis, antifungal and antibiotic compounds, and the ability to solubilize minerals such as phosphorus and othernutrients that improve plant growth and photosynthesis (Hashem *et al.,* 2019). (Agamy *et al.,* 2013).

4.10 Fruit yield per hectare (t)

Fruit yield per plot of bottle gourd was shown to vary significantly when varied amounts of Clybio were used (Table 3). The T_4 (2 ml/L+10 days interval) treatment produced the maximum fruit production per hectare (95.79t), whereas the T_0 (control) treatment produced the lowest fruit yield per hectare (52.83t).

This larger yield per plant is attributed to more flowers per plant, a higher fruit set percentage, and the maximum number of fruits per cluster and per plant, as well as taller plants, which improve photosynthetic activity and, as a result, yield per plant. These findings are in line with those of Prema *et al.* (2011) and Singh *et al.* (2013). The use of plant growth promoting bio-fertilizers enhanced the efficiency of organic manure usage and had the ability to stimulate strawberry growth and yield (Karlidag *et al.*, 2009).

CHAPTER V

SUMMARY AND CONCLUSION

SUMMARY

The study took place from January to June 2020 at the Horticultural Farm of Sher-e- Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka, Bangladesh, to see how varying concentrations and numbers of Clybio sprays affected bottle gourd growth and yield**.** The experiment consists of single factors; different concentration of Clybio viz. T_0= Control, T_1= 1ml/L+10 days interval, T_2=1ml/L+15 days interval, T_3=1ml/L+20 days interval, T_4=2ml/L+10 days interval, T_5=2ml/L+15 days and T_6=2ml/L+20 days interval. Levels of single factors made 7 treatment and the numbers of plots were twenty-one. The single factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Vine length, days to first female flower, days to first fruit harvest, SPAD value, fruit length, fruit diameter, number of fruits harvested, individual fruit weight, yield per plant, and yield per hectare were all measured. Statistix 10 was used to statistically evaluate the gathered data on various criteria.

There was significant variation in vine length between different concentrations of Clybio at 30 DAT (Days After Transplanting) of bottle gourd. However, substantial difference in vine length was detected at 45 and 60 DAT, with T_4 (2ml/L+10 days interval) having the longest vine length (162.5cm, 360.6cm, and 511.4cm). At 30, 45 and 60 days after transplant, the lowest vine (104.1cm, 292.1cm, and 383.9cm) was seen in the T_0 (control) group.

Due to the application of Clybio concentrations with frequency levels, the SPAD value of bottle gourd at 55 DAT was observed. In the context of T_4, the highest SPAD value was recorded (58.5). In the context of T_0, on the other hand, the lowest SPAD value was recorded (50.3). These findings show that the application of Clybio concentrations at different frequency levels to bottle gourd plants produced an increase in the SPAD value of the fruit. T_0 treatment had the highest number of days necessary for first female flowering (44.6 DAT), whereas T_4 treatment had the lowest number of days required for first

female flowering (38.3 DAT). T_0 treatment had the highest number of days to first fruit harvest (61.6 DAT), whereas T_4 treatment had the lowest number of days to first fruit harvest (54.3 DAT).

The highest fruit length (45.7cm) was discovered in the T_4 treatment, whereas the shortest fruit length (35.3cm) was obtained in the T_0 treatment. The largest fruit diameter (15.5cm), which was substantially different from the others, was recorded from T_4, whereas the lowest fruit diameter (10.8cm) was observed from T_0 treatment. T_4 treatment resulted in the highest individual fruit weight (3.3kg), whereas T_0 treatment resulted in the lowest individual fruit weight (2.4kg). T_4 treatment resulted in the highest number of fruits harvested per plant (11.3), whereas T_0 treatment resulted in the lowest number of fruits harvested per plant (8.6). T_4 treatment produced the maximum yield per plant (38.3kg), whereas T_0 treatment produced the lowest yield per plant (21.1kg). T_4 treatment produced the maximum output per hectare (95.7tons), whereas T_0 treatment produced the lowest yield per plot (52.8tons).

CONCLUSION

Based on the findings of this experiment, the following conclusions and suggestions may be made:

1. Clybio @ 2ml/L surpassed the others in the trial.

2. The number of sprays had a significant impact on bottle gourd growth and yield.

3. In general, the 10-day period performed better than the other intervals. T_4 (Clybio @ 2ml/L with a 10-day interval) had the highest potentiality of 95.7 t/ha.

Considering the situation of the present experiment, further study might be conducted in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performances. However, the experiment was conducted in one season only and hence the results should be considered as a tentative. It is imperative that similar experiment should be carried out with more variables to reconfirm the recommendation.

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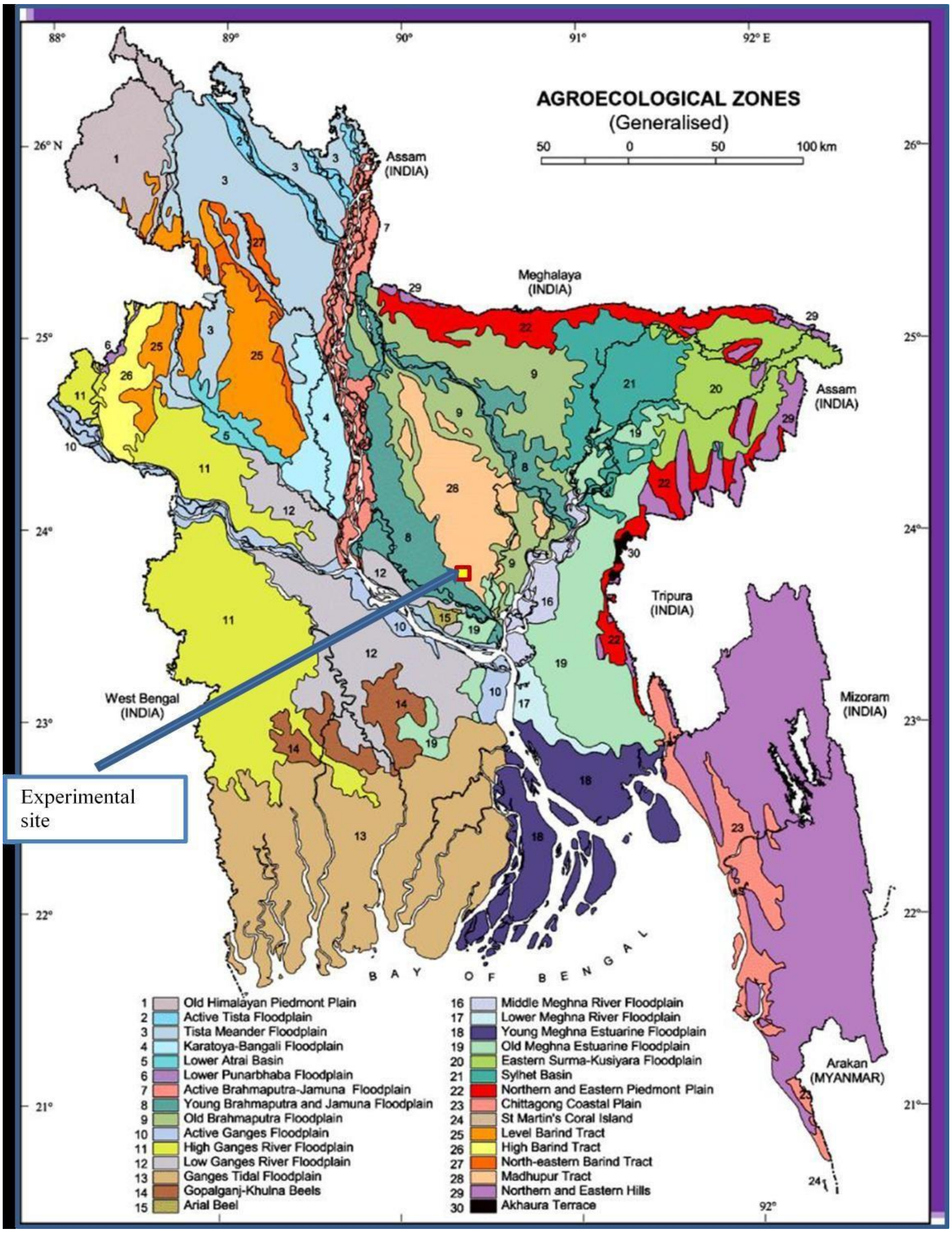
APPENDICES

APPENDICES

Appendix I. Map showing the experimental site



Appendix II: Characteristics of Sher-e-Bangla Agricultural University soil is analyzedby Soil Resources Development Institute (SRDI), Khamar Bari, Farmgate, Dhaka.

a) Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Sher-e-Bangla Agricultural
AEZ	Madhupur Tract (28)
General soil type	Shallow Red Brown Terrace Soil
Land Type	High land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Fellow-Tomato

b) Physical and chemical properties of initial soil

Characteristics value	**Partial Size Analysis**
% Sand	27
% Silt	43
% Clay	30
Textural Class	
PH	5.47 – 5.63
Organic carbon (%)	0.46
Organic matter (%)	0.83
Total N (%)	0.05
Available P (ppm)	20.00
Exchangeable K (me/100 gm soil)	0.12
Available S (ppm)	46

Appendix III: Analysis of variance of the data on vine length at different days after transplanting (DAT) of bottle gourd.

Source of variation	Degree of freedom	Mean Square		
		Vine Length (cm) at different Days After Transplanting (DAT)		
		30DAT	45DAT	60DAT
Replication	2	116.99	259.51	1337.30
Treatment	6	1171.36*	1536.19	5191.05
Error	12	22.88	327.31	757.98
CV%		3.45	5.50	5.87
LSD (0.05%)		8.5087	32.185	48.978

***:** Significant at 0.05 level of probability

Appendix IV: Analysis of variance on SPAD value at 55 Days After Transplanting(DAT) of Bottle gourd.

Source of variation	Degree of freedom	Mean Square
		SPAD value at 55 DAT
Replication	2	0.0005
Treatment	6	26.2141*
Error	12	0.0394
CV%		0.36
LSD (0.05%)		0.3530

***:** Significant at 0.05 level of probability

Appendix V: Analysis of variance of the data on day required to First Female Flowering in Bottle gourd.

Source of variation	**Degree of freedom**	**Mean Square**
		First Female Flowering (DAT)
Replication	2	0.3333
Treatment	6	14.0952*
Error	12	0.3333
CV%		1.39
LSD (0.05%)		1.0271

***:** Significant at 0.05 level of probability

Appendix VI: Analysis of variance of the data on Days to First Harvest in Bottle gourd.

Source of variation	**Degree of freedom**	**Mean Square**
		Days to First Harvest (DAT)
Replication	2	0.1905
Treatment	6	17.8254*
Error	12	0.3016
CV%		0.95
LSD (0.05%)		0.9770

***:** Significant at 0.05 level of probability

Appendix VII: Analysis of variance of the data on No. of fruits per plant in Bottle gourd.

Source of variation	Degree of freedom	Mean Square
		No. of fruits per plant
Replication	2	0.33333
Treatment	6	2.53968*
Error	12	0.27778
CV%		5.37
LSD (0.05%)		0.9376

***:** Significant at 0.05 level of probability

Appendix VIII: Analysis of variance of the data on fruit length (cm), fruit diameter andindividual fruit weight (cm) of bottle gourd.

Source of variation	Degree of freedom	Mean Square		
		Fruit Length (cm)	Fruit Diameter(cm)	Individual Fruit Weight (cm)
Replication	2	166.630	27.2176	0.00066
Treatment	6	37.280*	7.4138*	0.35151*
Error	12	0.250	0.3160	0.00912
CV%		1.24	4.31	3.22
LSD (0.05)		0.8895	1.0000	0.1699

***:** Significant at 0.05 level of probability

Appendix IX: Analysis of variance of the data on yield per plant (kg), and yield perhectare (t) of bottle gourd.

Source of variation	Degree of freedom	Mean Square	
		Yield Per Plant (kg)	**Yield Per Hectare(ton)**
Replication	2	2.6440	13.908
Treatment	6	99.4659*	620.914*
Error	12	1.3902	8.367
CV%		4.02	3.95
LSD (0.05%)		2.0975	5.1459

***:** Significant at 0.05 level of probability