INFLUENCE OF CLYBIO AND ECOAGRA CONCENTRATION ON GROWTH AND YIELD OF STRAWBERRY

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DHAKA-1207

JUNE 2021

INFLUENCE OF CLYBIO AND ECOAGRA CONCENTRATION ON GROWTH AND YIELD OF STRAWBERRY

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Reg. No. 14-06277

A Thesis Submitted to
The Department of Horticulture, Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka-1207
In partial fulfillment of the requirements
For the degree of

MASTER OF SCIENCE (MS)
IN
HORTICULTURE

SEMESTER: JANUARY-JUNE 2021

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CERTIFICATE

This is to certify that the thesis entitled **"INFLUENCE OF CLYBIO AND ECOAGRA CONCENTRATION ON GROWTH AND YIELD OF STRAWBERRY"** submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE**, embodies the result of a piece of *bona fide* research work carried out by **KAYNAT BHUIYAN,** Registration No. **14-06277** 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: JUNE 2021
Dhaka, Bangladesh

Prof. Dr. A. F. M. Jamal Uddin
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Our lord! Forgive me and my parents, and (all) the believers on the day when the reckoning will be established – Quran 14:41

DEDICATED TO

MY BELOVED PARENTS

ACKNOWLEDGEMENTS

*All praises to the **"Almighty Allah"** who enables me to complete a piece of research work and prepare this thesis for the degree of Master of Science (M.S.) in Horticulture.*

*I feel much pleasure to express my gratefulness, sincere appreciation and heartfelt liability to my venerable research supervisor **Professor Dr. A F M Jamal Uddin**, Department of Horticulture, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh for his scholastic guidance, support, encouragement, valuable suggestions and constructive criticism throughout the study period.*

*I am also indebted to my co-supervisor **Prof. Mohammad Humayun Kabir, Ph.D,** Department of Horticulture, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 for his heartiest co-operation and supports throughout the study period.*

*It is also pleasure for me to express my cordial appreciation and thanks to the Chairman **Prof. Dr. Md. Jahedur Rahman,** Department of Horticulture, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 for her encouragement and co-operation to this research work.*

*I am grateful to all my **honorable teachers** of the Department of Horticulture, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 for their valuable teaching, indirect advice and enormous inspiration throughout the research work.*

I deeply acknowledge the profound dedication to my beloved family members for their moral support, steadfast encouragement and continuous prayer in all phases of academic pursuit from the beginning to the completion of study successfully.

Finally, I wish to thank all my fellow Horticulture Innovation lab. BD. members for being there in all the hard work and sharing my joys and sorrows. To them I say, "You make the bad times good and the good times unforgettable."

The Author

Influence of Clybio and Ecoagra Concentration on Growth and Yield of Strawberry

BY

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ABSTRACT

An experiment was carried out to evaluate the influence of different concentrations of Clybio and Ecoagra on growth and yield of strawberry at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2019 to February 2020. The experiment was consisted of nine treatments namely T_0 : Untreated (control); T_1 : Clybio @ 1.0 ml/L; T_2 : Clybio @ 2.0 ml/L; T_3 : Ecoagra @ 1.0 ml/L; T_4 : Ecoagra @ 2.0 ml/L; T_5 : Clybio @ 1.0 ml/L + Ecoagra @ 1.0 ml/L; T_6 : Clybio @ 1.0 ml/L + Ecoagra @ 2.0 ml/L; T_7 : Clybio @ 2.0 ml/L + Ecoagra @ 1.0 ml/L; T_8 : Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L. All the treatments were applied to the soil of strawberry field along with leaves and crowns of strawberry plants. The single factorial experiments were laid out in Randomized Complete Block Design with three replications. Among the treatments maximum number of fruits (50.6/plant), fruit length (5.1 cm), fruit diameter (4.7 cm), single fruit weight (40.5 g), yield (22.3 t/ha), brix percentage (7.8) was found in case of T_8 treatment. On the other hand minimum number of fruits (17.6/plant), fruit length (4.2 cm), fruit diameter (3.7 cm), single fruit weight (24.3 g), yield (5.1 t/ha), TSS content (6.2) was found in case of T_0 treatment. In view of overall performances, T_8 treatment that implies Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L provided the best result for growth and yield attributes.

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ABBREVIATIONS AND ACRONYMS

SAU	: Sher-e-Bangla Agricultural University
TSS	: Total Soluble Solid
CV.	: Cultivars
AEZ	: Agro-Ecological Zone
ANOVA	: Analysis of Variance
df	: Degrees of freedom
CV%	: Percentage of Coefficient of Variation
FAO	: Food and Agriculture Organization of United Nations
UNDP	: United Nations Development Programme
SRDI	: Soil Resources and Development Institute
RCBD	: Randomized Complete Blocked Design
LSD	: Least Significance Difference
et al.	: and others
spp.	: species

CHAPTER I

INTRODUCTION

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INTRODUCTION

The common cultivated strawberry (*Fragaria* × *ananassa* Duch.) is a widely grown hybrid plant resulting from the breeding between two American species, *Fragaria chiloensis* and *Fragaria virginiana*. Strawberry is a member of the Rosaceae family and one of the most popularly consumed berries in the world. Strawberry is one of the most delicious and nutritious soft fruits of the world (Singh *et al*., 2007). In the West it is considered as the "queen of the fruit". It is the fourth most consumed fruit after apples, oranges, and bananas (Virginie, 2010). Strawberries are produced commercially both for immediate consumption and for processing as frozen, canned, or preserved berries or as juice, pies, ice creams, milkshakes, and other desserts.

Botanically, the strawberry is an aggregate accessory fruit (not a berry indeed), meaning that the fleshy part is derived not from the ovaries of the flower but from the receptacle, that holds the ovaries. Each apparent seed (properly named achene) on the outside of the fruit is actually one of the ovaries of the flower, with a seed inside it. The plant comprises a shorten stem or crown from which arises leaves, runners, roots, auxiliary crowns and inflorescences (Maas, 1998; Bowling, 2000 and Darnell *et al*., 2003).

Strawberry is new fruit crop and its commercial production is possible in wide climatic range (Barney, 1999) including subtropical areas like Bangladesh. Weather of Bangladesh is suitable for the production of high quality strawberries though it is normally produced in countries having cold weather particularly in West. In Bangladesh strawberry cultivation area is increasing gradually. Here, strawberry can be grown during the month of October to April. Screening of strawberry variety is needed for suitable variety for continuous production and some varietal screening has already done in Bangladesh (Hossan *et al*., 2013; Nuruzzaman *et al*., 2011). Three varieties of strawberry have been developed in Bangladesh. Around 6,500 bighas of land have been brought under strawberry cultivation throughout the country during the year of 2016 (Bangladesh

Strawberry Association). Rajshahi district is ahead of other districts in farming the fruit.

Strawberries have numerous health benefits as they are highly nutritious loaded with vitamin C, potassium, folic acid and powerful antioxidant. According to World Health Organization (WHO), Bangladesh is a nutrient-deficient country and promoting the fruit will help overcome this deficiency, such as by reducing the risk of heart attacks, as studies suggest (Meher Yaseen, 2016). It also boost up immunity, maintain healthy vision, ward off cancer, regulate blood pressure, defence against Type 2 diabetes, improve skin elasticity and resilience.

The Environmental Working Group (EWG) has released the 2021 version of its annual Dirty Dozen list. Unfortunately, strawberry continues to top the list of 12 different vegetables and fruits that have been found to contain the highest traces of pesticides used in commercial farming. EWG Suggest that people should buy organic strawberries to reduce the risk of pesticide exposure.

But, farmers of our country have a tendency to use chemical fertilizers and pesticides undeliberate to increase the production of strawberry that is not safe for us. Sweetness of strawberry is a major problem in Bangladesh. Organically grown strawberry increase total soluble solids (TSS) content, hence produce high quality fruit with sweeter in taste, longer shelf life (by thickening fruit peel) and better flavour (Reganold *et al*., 2010). Organic fertilizer is an excellent source of nutrients and it could maintain high microbial population activities. Fruits harvested from plant receiving organic fertilizers were compact, lower acidity, attractive color and fruit yield with better quality (Singh *et al*., 2010; Islam, 2003).

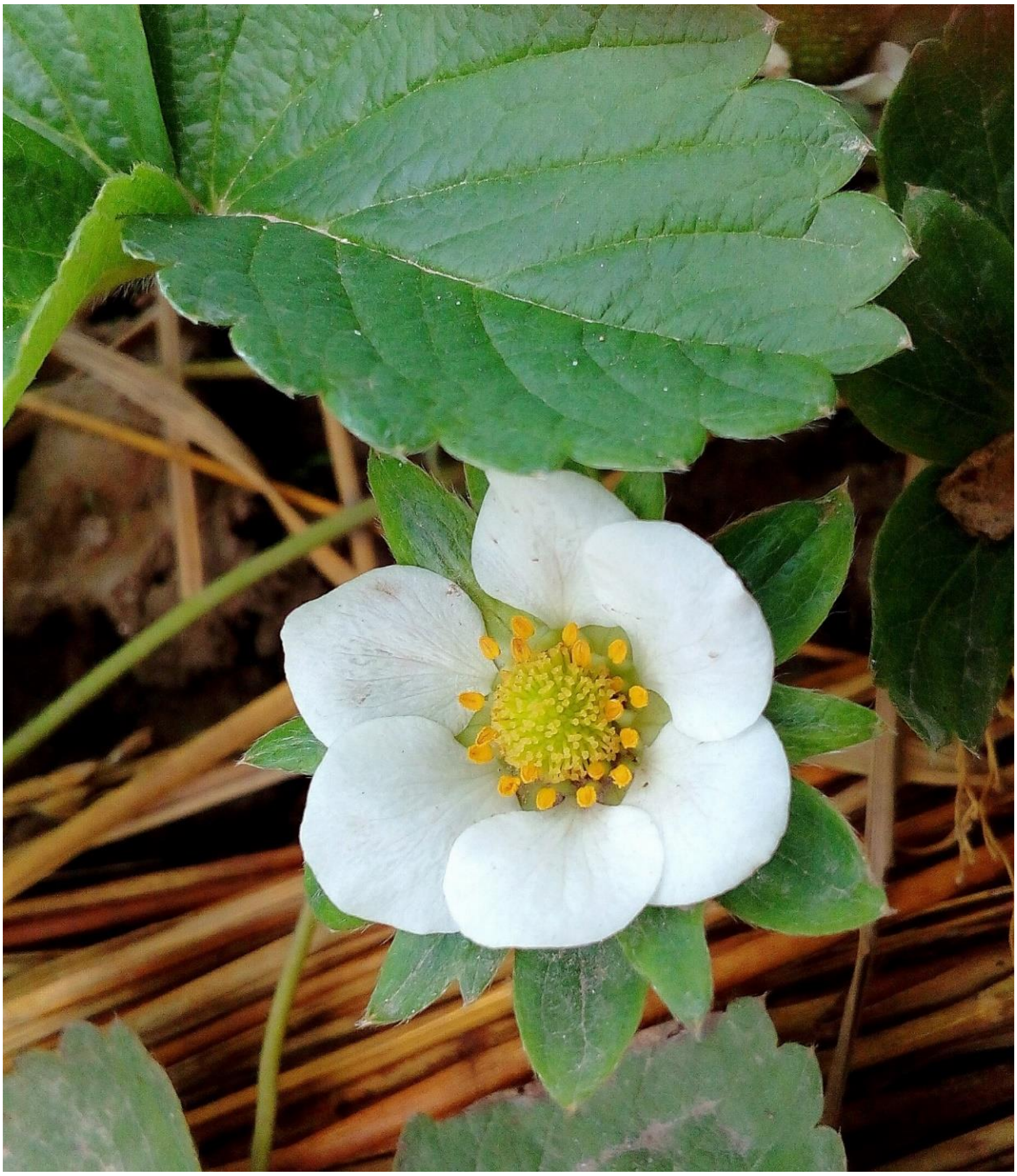
Modern day intensive crop cultivation results with the huge application of chemical fertilizers which are not only in short supply but also expensive and pollute the environment, soil and water too. Nitrogen fixing bacteria and phosphate solubilizers are main bio-fertilizers for horticultural crops. These micro-organisms are either free living in soil or symbiotic with plants and contribute directly or indirectly towards nitrogen and phosphorus nutrition of plants. They also produce hormones, vitamins and other growth factors required for the growth and development of plants.

Clybio is a complex microorganism whose quality is controlled by the technology developed by Ehime prefecture Industrial Technology Centre. It is composed of three food ingredients; these are *Lactobacilli, Bacillus Natto* and Yeast fungus. So unquestionably, Clybio is safe and secure. Using Clybio in field will serve as an energy drink for indigenous microorganisms. Through interaction of those three ingredients and power of enzyme, Clybio plays remarkable benefits on plants such as improvement of soil, promotion of growth, increases leaf microorganisms, reduced pesticide cultivation, promotion of compost, suppression of fungal diseases etc. *Bacillus Natto* has been known to have potent antibacterial function, and was used for the treatment of bacterial infectious diseases (Senbon *et al*., 1940). The main effective component identified in natto is dipicolinic acid (DPA, 2,6-pyridinedicarboxylic acid) produced by natto bacteria during fermentation. This is effective against a variety of microorganisms such as *Aspergillus oryzae*, *Penicillium* spp., pathogenic colon bacillus, Escherichia O-157, and yeasts (Sumi *et al*., 1999). There is a growing interest in using *Lactobacillus* species as a biological control agent to prevent bacterial and fungal crop disease and to enhance plant growth (Symsoil, 2020). Yeast is a cost-effective biofertilizer that improves not only plant nutrition but also plant vigor during the early growth phase (Lonhienne *et al*., 2014). Yeasts also have potential for the biological control of diseases caused by soil-borne fungal plant pathogens, as is evident in reports of certain yeasts in suppressing some soil-borne fungal plant pathogens.

Ecoagra is a foliar sprayed growth stimulant, suitable for all crops and plants. 100 percent from plant extract means no harmful chemicals. The nutrient content of Ecoagra eA300: total solid 0.37%, total nitrogen 0.33%, phosphorus <0.1%, iron <2.5mg/Kg, magnesium <2.5mg/Kg, potassium <2.5mg/Kg, sodium 1.3mg/L. Applied via either the irrigation system or sprayer, Ecoagra will stimulate the plants' growth hormones, better root growth, increase photosynthesis, thus reduction in fertilizer use, improvement of plant health and better quality produce. It also improves the size and sweetness of fruits and vegetables through increased BRIX levels and crop value. Considering the above facts and present situation, the study has been undertaken the following objectives:

1. To evaluate the influence of Clybio on growth and yield of strawberry
2. To evaluate the influence of Ecoagra on growth and yield of strawberry
3. To evaluate the combine effect of Clybio and Ecoagra on growth and yield of strawberry

CHAPTER II
REVIEW OF LITERATURE



CHAPTER II

REVIEW OF LITERATURE

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

Strawberry (*Fragaria annanasa*) is one of the most popular fruit in the world. Though strawberry is an exotic fruit but it has an opportunity to grow commercially in Bangladesh. Now-a-days, strawberry is not only used as fruit but also as raw materials in different industries. Strawberry fruits harvested from plant receiving organic fertilizers are compact, lower acidity, attractive color and fruit yield with better quality. Adoption of organic farming has been increased which have a reduced impact on environment. However, some of the important and informative works in relation to organic fertilizers and micronutrients so far been done in home and abroad are presented below:

Abd-L-Kareem *et al*. (2021) examined and observed the impact of soil treatments with 3 *Bacillus pumilus* isolates on black root rot disease of strawberry plants caused by *R. solani*, F., and *Pythium* sp. under laboratory and field conditions on the 'Festival' strawberry cultivar. To increase the bacterial adhesion and distribution on the roots, each seedling was dipped in bacterial cell suspension at 1 × 108 colony-forming units/ml of each separate bacterial isolate for 30 min then mixed with 5% Arabic gum. The tested *B. pumilus* isolates significantly reduced the growth area of these 3 fungi. The two bacterial isolates Nos. 2 and 3 reduced the growth area by more than 85.2, 83.6, and 89.0% for *R. solani, F. solani*, and *Pythium* sp., respectively. Likewise, the 3 bacterial isolates significantly ($P \leq 0.05$) inhibited the disease under field conditions.

The use of agricultural waste is of great interest to sustainable agriculture. Ahmed *et al*. (2019) carried out an investigation to evaluate the effects of compost and compost tea made from agricultural waste rice straw on the yield and quality of strawberry. In strawberry experiment, six treatments were considered which were T1: 100% soil (as a control), T2: 80% soil + 20% compost, T3: 60% soil + 40% compost, T4: 40% soil + 60% compost, T5: 20% soil + 80% compost & T6: 100% compost. Results revealed that number of fruit, fruit yield and total sugar (%) was increased with the increasing level of compost up to 80% after that decreased at 100% compost. The treatment T5: 20% soil + 80% compost gave the best results among the treatments to grow strawberry with good yield (185.3 g/plant) and sweetness (total sugar 5.19%).

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 T4 (CP109 + HCA61) recorded the significantly highest fruit yield per plant (257.92 g). The growth parameters, viz. plant height (14.11 cm), number of leaves per plant (12.34), crown diameter (13.21 mm), fresh weight (45.89 g) and dry weight (13.11 g) of plant maximum in treatment combination CP109 + HCA61. However, with respect to TSS (%), ascorbic acid and anthocyanin content (mg 100 g^{-1}) of fruits *Bacillus* HCA61+ *Pseudomonas* CP109 was found best. The co-inoculation with *Bacillus* and *Pseudomonas* strains could be an ecofriendly and cost effective technology for improving the growth, yield and quality of strawberry.T_1

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 production of the strawberry plant. The study included 9 treatments: spraying the plants with two concentrations of dry yeast (1, 2 $g.L^{-1}$) 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}).

Beer *et al.* (2017) carried out a study the effect of organic, inorganic and bio-fertilizer on vegetative growth, flowering and yield of strawberry cv. Chandler. study the effect of organic, inorganic and bio-fertilizer on vegetative growth, flowering and yield of strawberry cv. Chandler. Plant height, number of leaves per plant, runners per plant and number of crown per plant was found maximum in treatment T14 where the plants treated with vermicompost (25 ton/ha) + *Azotobacter* (6 kg/ha) + NPK (70:80:80). Maximum number of flowers per plant, number of fruit set per plant and duration of harvesting and fruiting characteristics and quality parameters were found superior in treatment (T_{13}) where plants were treated with Vermicompost (25 ton ha^{-1}) + *Azotobactor* (6 kg ha^{-1}) + NPK (70:80:80 kg ha^{-1}).

Botha (2011) focuses on his study about the interactions of soil yeasts with biotic and abiotic factors in their environment. Soil yeasts not only affect microbial and plant growth, but may also play a role in soil aggregate formation and maintenance of soil structure. Serving as a nutrient source for bacterial, faunal and protistan predators, soil yeasts contribute to essential ecological processes such as the mineralization of organic material and dissipation of carbon and energy through the soil ecosystem. Some soil yeasts may also play a role in both the nitrogen and sulphur cycles and have the ability to solubilize insoluble phosphates making it more readily available for plants. 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.

David Eddy (2020) conducted a research under bio stimulants on strawberry (BG 6-30214). He explained that introducing beneficial microbes and organic or inorganic compounds can enhance the soil structure, promote root and plant growth, improve crop health, reduce salt and drought stress, prevent the loss of nutrients, increase the uptake of nutrients and water, and protect against pests and diseases. Other than the untreated control, all other products were administered on top of the grower standard fertility program. Perhaps the biggest take-away from the study is that the treatments boosted the size of the plants and the marketable yields over the grower standard across the board.

A study was conducted by Dara (2020) in an experimental strawberry field at the Shafter Research Station to evaluate the potential of different biostimulant materials on strawberry growth, health, and fruit yields. No pre-plant fertilizer application was made in this non-fumigated field which had both *Fusarium oxysporum* and *Macrophomina phaseolina* infections in previous year's strawberry planting. While biostimulants can help plants under some stresses, providing sufficient macro- and micro-nutrients seems to be critical for higher fruit yields.

Daranas *et al*. (2018) conducted a research to study the use of lactic acid bacteria (LAB) to control multiple pathogens that affect different crops namely, *Pseudomonas syringae* pv. *actinidiae* in kiwifruit, *Xanthomonas arboricola* pv. *pruni* in Prunus and *Xanthomonas fragariae* in strawberry. The antagonistic activity of 55 strains was first tested in vitro and the strains *Lactobacillus plantarum* CC100, PM411 and TC92, and *Leuconostoc mesenteroides* CM160 and CM209 were selected because of their broad-spectrum activity. The biocontrol efficacy of the selected strains was assessed using a multiple-pathosystem approach in greenhouse conditions. *L. plantarum* PM411 and TC92 prevented all three pathogens from infecting their corresponding plant hosts. In addition, the biocontrol performance of PM411 and TC92 was comparable to the reference products (*Bacillus amyloliquefaciens* D747, *Bacillus subtilis* QST713, chitosan, acibenzolar-S-methyl, copper and kasugamycin) in semi-field and field experiments.

Derkowska *et al*. (2014) conducted a study to assess the growth and development of plants of three strawberry cultivars fertilized with selected biofertilizers under greenhouse conditions during 2013-2014. Plants of three strawberry cultivars, ‘Elsanta’, ‘Honeoye’ and ‘Elkat’, were planted in rhizoboxes and grown under the following fertilization regimes: 0-control (no fertilization), NPK control, Micosat F (bacterial-mycorrhizal substrate), manure, Humus UP, and Vinassa. Applications of humus UP resulted in beneficial effects on plant height, leaf surface area, leaf fresh and dry weight, the degree of mycorrhizal colonization in the roots, and on the number of spores of arbuscular mycorrhizal fungi in the rhizosphere plants. Biopreparations humus UP and Vinassa also had a positive influence on the size of the root system, the total number of bacteria, including spore-forming bacteria, and the total number of filamentous fungi in the rhizosphere soil, compared with mineral NPK fertilization under greenhouse conditions.

Esitken *et al*. (2008) conducted a study on the effects of plant growth promoting bacteria (PGPB) on the fruit yield, growth and nutrient element content of strawberry cv. Fern under organic growing conditions. Three PGPB strains (*Pseudomonas* BA-8, *Bacillus* OSU-142 and *Bacillus* M-3) were used alone or in combination as biofertilizer agent in the experiment. Data through 3 years showed that the use of PGPB significantly increased fruit yield, plant growth and leaf phosphorous and Zinc contents. Root inoculation of M-3 and floral and foliar spraying of OSU-142 and BA-8 bacteria stimulated plant growth resulting in significant yield increases. M-3 + BA-8, BA-8 + OSU-142, M-3, M-3 + OSU-142 and BA-8 applications increased cumulative yield by 33.2%, 18.4%, 18.2%, 15.3% and 10.5%, respectively. Number of fruits per plant significantly increased by the applications of M-3 + BA-8 (91.73) and M-3 (81.58) compared with the control (68.66).

Humic acid is an organic acid obtained from humus and other natural resources with hormonal effects and improving nutrient absorption, increasing root and shoot biomass. Eshghi *et al*. (2015) investigated the effect of foliar and soil drench applications of humic acid on growth responses of strawberry. After the establishment of plants, Greenhum (13.5% humic acid) was sprayed at 300, 600, 900, and 1200 mg L^{-1} and soil drench was applied at 300, 450, 600, and 750 mg L^{-1} (250 ml pot-1). Results showed that foliar application at 600 and 900 mg L^{-1} produced the highest dry mass of shoot and root. Total acid of fruit in 750 mg L^{-1} soil application and in 300 mg L^{-1} foliar application were significantly higher than untreated control plants. The greatest vitamin C and TSS were obtained from 900 and 600 mg L^{-1} foliar application treatments, respectively. The highest flower numbers and yield were produced in 900 mg L^{-1} foliar application. In general, foliar application of Greenhum, especially at 600 and 900 mg L^{-1}, significantly increased most evaluated parameters.

Helaly and Hanan (2017) recommended that supplementations of K_2SiO_3 to the saline irrigation water accompanied with spraying yeast extract four times, 4 weeks intervals, from the middle of April induced salt tolerance and productivity of Williams banana plants, irrigated with pumped saline water. Potassium silicate at 3% combined with yeast at 20 g/l gave the best results with regard growth, flowering as well as yield and fruit quality. Yeast extract showed additive effects to the potassium silicate in this respect.

Harman *et al*. (2004) conducted a study to evaluate the *Trichoderma* spp. On plant that common in soil and root ecosystems. Recent discoveries show that they are opportunistic, avirulent plant symbionts, as well as being parasites of other fungi. They produce or release a variepathogenicity to plants. These root-microorganism associations cause substantial changes to the plant proteome and metabolism. It was highly remarkable that plants are protected from numerous classes of plant pathogen by responses that are similar to systemic acquired resistance and rhizobacteria induced systemic resistance. Therefore, root colonization by *Trichoderma* spp. also frequently enhances root growth and development, crop productivity, resistance to abiotic stresses and the uptake and use of nutrients.

538 yeast strains were isolated from dark chestnut soil collected from under the plants of the legume family (Fabaceae). Among the 538 strains of yeast 77

(14.3%) strains demonstrated the ability to synthesize IAA. 15 strains were attributed to high IAA-producing yeasts (above 10 μg/ml). The most active strains were YA05 with 51.7 ± 2.1 μg/ml of IAA and YR07 with 45.3 ± 1.5 μg/ml. In the study Ignatova, L.V. *et al*.(2015) observed the effect of incubation time on IAA production the maximum accumulation of IAA coincided with maximum rates of biomass: at 120 h for YR07 and at 144 h for strain YA05. 10 strains demonstrated the ability to inhibit the growth and development of phytopathogenic fungi. YA05 and YR07 strains formed the largest zones of inhibition compared to the other strains – from 21.6 ± 0.3 to 30.6 ± 0.5 mm. Maximum zone of inhibition was observed for YA05 against *Phytophtora infestans* and YR07 strains against *Fusarium graminearum*.

Jimenez-Gomez *et al*. (2017) conducted research and said that plant probiotics are bacteria capable of improving crop yields reducing or even eliminating chemical fertilizers. Studies show that many of these bacteria can improve not just production, but also food quality, through the increase of some nutrients as well as some plant bioactive compounds, which are beneficial to human health.

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

Karlidag *et al*. (2010) conducted a study which aim to evaluate possible effects of three plant growth promoting rhizobacteria (PGPR) strains as biofertilizer on growth, yield and ionic composition of leaves of strawberry plants. The application treatments included the control (without bacteria inoculation and mineral fertilizers), mineral fertilizers, and plant growth promoting rhizobacteria species [*Bacillus cereus*, (N2- fixing), *Brevibacillus reuszeri* (phosphate solubilizing), and *Rhizobium rubi* (N2-fixing and phosphate solubilizing)]. Data suggest that root inoculation of strawberry plants with PGPR strains tested increased root weight, shoot weight, ionic composition of leaves of strawberry and yield. The results of the study show that PGPR application may increase organic manure use efficiency and have capacity to stimulate strawberry growth and yield.

Khalil and Agah (2017) carried out an experiment in order to study the effect of fertilizer combinations included mineral fertilizers, foliar application, organic and Bio-fertilizers on the growth and production of strawberry, *Fragaria* x *ananassa* Duch Var. Festival. The results indicated that organic and bio-fertilizers with 50% of recommended mineral fertilizer can be used as an alternative to 100% recommended mineral fertilizers for increasing the growth, productivity and quality of strawberry plant. Organic and bio-fertilizer types Provide soil with essential mineral elements for plant growth as well as the promotion substance that enhanced plant growth.

Kumar *et al*. (2015) carried out an experiment on growth and quality parameters of strawberry to evaluate the effect organic manure (Farm Yard Manure, vermicompost and press mud) and biofertilizers (*Azotobacter*, phosphate solubilizing bacteria and *Azospirillum*). Each treatment combination has shown significant effects on most of the parameters, but the combination of vermicompost and PSB showed highest plant height (23.59 cm), leaves plant^{-1} (12.67), primary branches plant^{-1} (10.50), secondary branches plant-1 (27.35), first flowering (61.06 days), flowers plant^{-1} (15.33), first fruit setting (72.80 days) and fruits plant-1 (8.33). Similarly, the treatments combination of vermicompost and PSB significantly affected the Total Soluble Solids.

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 roots and shoots of tomato (*Solanum lycopersicum*) and young sugarcane plants. Yeast addition to 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 during the early growth phase.

Lovaisa *et al*. (2017) explored the impacts of intensive strawberry monocropping during five years on the fruit-yield and on the microbial soil activity and composition. Field trials were performed in two plots: P1 (a soil with five years of consecutive strawberry cropping), and P2 (a soil with just one year of strawberry cropping). Fruit-yield was quantified; total microorganisms and four functional groups (cellulolytics, nitrogen-fixers, phosphate solubilizers, and siderophores producers) were quantified, isolated and characterized in both plots. According to the results, the intensive cultivation of strawberry for several years in the same field exerted a negative impact on the soil quality, affecting the native microbial population, which might be linked to the fruit yield decline. It may well be that the decline in organic matter content (substrate limitation) was the main cause of the lower microbial biomass and activity observed in P1. The addition of compost had positive effects on the soil nutritional status, microbial community structure, and enzyme activity in different stages of barley cultivation.

Mishra and Tripathi (2015) conducted an experiment during 2008-09 and 2009-10 to study the influence of Azotobacter and PSB (Phosphate Solubilizing Baceria) alone and in combination on vegetative growth, flowering, yield and quality of strawberry cv. Chandler. The result clearly showed that combined application of Azotobacter and PSB (each at 6 Kg/ha) significantly increased the height of plant (19.29 cm), number of leaves (64.31), crowns (7.17), runners (5.26), number of flowers(67.27) and fruits set (37.88) per plant. Maximum duration of harvesting (70.90 days) and minimum number of days taken to produce first flower(56.69 days) and fruit set (6.12 days) with significantly more yield (322.17 g/plant) were also observed in Azotobacter and PSB (each at 6

Kg/ha) fertilized plants. So far as the quality characters of fruits are concerned, plants fertilized with Azotobacter and PSB (each at 6 Kg/ha) also produced fruits with maximum length (4.63 cm), width (2.64 cm), weight (8.48 g), volume (6.14 cc), TSS (10.300 Brix), total sugars (9.54%), ascorbic acid (57.55 mg/100g edible material) with minimum titratable acidity (0.548 %) contents in comparison to untreated plants.

Negi *et al*. (2021) carried out a study to elucidate the effects of organic manures (FYM, vermicompost and forest litter) and biofertilizers (*Azotobacter chroococcum* and *Pseudomonas fluorescens*) on plant growth, yield and fruits quality of strawberry (cv. Chandler) under field conditions. Among Sixteen treatments, treatment T_{13} (50 % FYM + 50 % vermicompost + azotobacter + pseudomonas) was found most effective to enhance plant height, plant spread, leaf area per plant, and induced early flowering. Maximum increase in yield per plant and yield per plot were achieved by the application of 50 % FYM + 50 % vermicompost + pseudomonas (T_{12}), which was at par of T_{13}. However, fruit quality parameters including ascorbic acid, total sugar, total phenolic content, and antioxidant capacity were found significantly higher in T13. Higher availability of nutrients in soil was also recorded in this treatment. The combination of manures and biofertilizers has shown potential to increase crop yield and its nutritive properties under field conditions.

Newsham (2011) suggested that plant relationships with root endophytic fungi can become beneficial when organic nutrients are present in soil, owing to the ability of fungi to saprotrophically break down complex organic molecules and mobilize sequestered nutrients.

Pii (2018) *et al*. conducted a 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. brasilense 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 flavonols was higher in fruits harvested from A. brasilense-inoculated plants. In addition, PGPRs also influenced the uptake and allocation of nutrients in fruits, in particular increasing the concentration of micronutrients.

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 coinoculation of bacterial culture was performed in combination with three nitrogen levels (50, 100 and 150 ppm). It was observed that in T8 (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 T5 (*Azotobacter* spp. 100 ppm of Nitrogen) and T6 (*Azotobacter* spp. 150 ppm 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.

Rashid (2019) conducted an experiment at the Landscaping section and Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh for optimisation of growth, yield and quality of strawberry cultivars through organic farming during the period from October 2017 to March 2018. . The experiment comprised eight organic manures viz., control, cowdung, mustard oilcake (MOC), poultry manure, cowdung+MOC, cowdung+poultry manure, MOC+poultry manure, cowdung+MOC+poultry manure. The experiment showed that combined application of cowdung+MOC+poultry manure gave the maximum yield (19.14 t/ha) than the other treatments.

Robert M. Harveson (2019) conducted an experiment in which five different products were tested for at least 2 years each and were compared with two commercially available copper compounds (Kocide and MasterCop). The new alternatives included two growth-promoting chemicals (Ecoagra A300, WakeUP Summer), and three contact sanitizers (Goldshield 5, SaniDate, and OxiDate). Treatments with SaniDate and Ecoagra A300 more consistently produced higher yields than other treatments. The experiment resulted that Kocide and Ecoagra A300 produced significantly higher yields after harvest than any other treatment. However, yields for Ecoagra A300 increased more than 400 ka/ha compared with the MasterCop treatment or almost 300 ka/ha compared with the nontreated control. Again, two specific products (SaniDate and Ecoagra A300) more consistently produced higher yields than other treatments. The Ecoagra A300 product apparently enhances vigor and plant growth, allowing improved total seed yields.

Shih-Feng F *et al*. (2016) used yeasts as plant growth-promoting (PGP) agents in their study. In this study, yeast isolates from the phyllosphere and rhizosphere of the medicinally important plant *Drosera spatulata* Lab. were assessed for their PGP traits. All isolates were tested for indole-3-acetic acid-, ammonia-, and polyamine-producing abilities, calcium phosphate and zinc oxide solubilizing ability, and catalase activity. Furthermore, the activities of siderophore, 1-aminocyclopropane-1-carboxylate deaminase, and fungal cell wall-degrading enzymes were assessed. The antagonistic action of yeasts against pathogenic *Glomerella cingulata* was evaluated. The cocultivation of *Nicotiana benthamiana* with yeast isolates enhanced plant growth, indicating a potential yeast–plant interaction.

Shternshis (2014) the influence of *Bacillus* spp. on strawberry Gray-moldcausing agent and host plant resistance to disease. Bacterial strains *B. subtilis*, *B. amyloliquefaciens*, and *B. licheniformis* suppress the development of the phyto pathogenic fungus *B. cinerea* in vitro and in vivo. In addition to the antifungal action, bacterial strains show positive effect on the growth and development of strawberry plants, indicating multifunctional properties of Siberian strains *Bacillus* spp.

Shokouhian (2019) *et al*. conducted an experiment at the aim of investigating the effects of nitrogen application with Urea fertilizer source and bio-fertilizer EM (Effective Microorganisms) on nutrient uptake by leaf and yield of strawberry Parous cultivar. EM contains selected species of microorganisms, including dominant populations of lactic acid bacteria and yeasts, and a small number of photosynthetic bacteria, octanomists that are compatible with each other. Treatments consisted of nitrogen as urea fertilizer at three levels (50, 100 and 150 $kg.ha^{-1}$ pure nitrogen) and EM bio-fertilizer using two methods of application (foliar and soil with irrigation water) at concentrations of 0, 1, 2 and 3%. The result concluded that application of EM bio-fertilizer with both spraying and soil methods can improve plant growth, yield and nutrient uptake by roots of strawberries. The best and the most suitable nitrogen concentration in terms of fruit yield and leaf elements were 100 kg / ha.

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 + 60 kg N ha^{-1} + 100 ppm GA 3. This treatment also contains highest chlorophyll content in leaves. Highest fruit set, 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 100 ppm GA 3. The plant nutrient status was much influenced by combined use of biofertilizer and bioregulators.

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 (10 kg/ha), PSB (6 kg/ha) and VAM (12 kg/ha) and three plant growth regulators viz. GA3 (100 ppm), Triacontanol (5 ppm) and NAA (50 ppm) were tested individually and in combinations. The combined application of bio-fertilizers and growth regulators (i.e. PSB@6 kg/ha + GA3@100 ppm) 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@5 ppm. The plants treated with PSB (6 kg/ha) + Triacontanol (5 ppm) registered a 33.0% higher yield compared to control treatment. An appropriate combination of bio-fertilizers and plant growth regulators (e.g. PSB@ 6 kg/ha) + Triacontanol@ 5 ppm) significantly improved the fruit yield and quality of strawberry.

Subraya *et al*. carried out a study to evaluate the effect of integrated nutrient management on yield and quality of strawberry (*Fragaria* x *ananassa* Duch.) under naturally ventilated polyhouse condition during the year of 2014-2015 that involved ten treatments. Yield components and quality parameters like per cent fruit set, number of fruits per plant, number of fruits per cluster, fruit characters, yield per plant (304.73 g plant-1), non reducing sugars, total sugars, sugar to acid ratio, TSS and ascorbic acid content were found maximum under the treatment 100% RDF + Azospirillum + PSB whereas, the maximum fruit weight (15.68 g), fruit length (3.61 cm) and reducing sugars (5.02%) with moderate yield per plant (299.95 g) were recorded in the treatment 75% RDF + Azospirillum + PSB. Application of 60:40:40 kg NPK ha^{-1} along with Azospirillum and PSB found ideal to get high yields with good quality, thereby saving 25 per cent of inorganic fertilizers.

Tomic *et al*. (2015) carried out a study to evaluate the impact of biofertilizer and cultivar on vegetative potential, leaf mineral composition, yield potential, fruit characteristics, and chemical traits in the fruits of Clery, Joly and Dely strawberry plants. Two types of biofertilizer were applied: Biofertilizer 1 (inoculums of the mixture of liquid bacteria cultures of the genera Azotobacter, Derxia and Bacillus) and Biofertilizer 2 (inoculums of liquid culture of diazotrophic bacteria belonging to the genus Klebsiella). The applied biofertilizers made a significant impact on the parameters of vegetative potential and contents of some macroelements and microelements in the leaf, as well as the values of titrable acidity, vitamin C, total anthocyanins, total phenolic content and total antioxidant capacity.

Uddin *et al*. (2020) carried out a pot experiment to study the efficacy of Eco-Agra comprising three treatments (i) No Eco-Agra application (E0), (ii) Eco-Agra 2ml/L (E1) and (iii) Eco-Agra 4ml/L (E2); at 20 days interval on organic cherry tomato production. Data on growth and productivity were taken. The results showed that Eco-Agra 4ml/L application had a synergistic effect on growth attributes positively and influenced to produce 89.0% higher yield compared to control treatment. Eco-Agra 4ml/L application also revealed an increase in Brix percentage and maximum (7.2) recorded.

Uddin *et al*. (2017) conducted a study during January 2015 to April 2015, to evaluate the performance Trichoderma on growth and yield of strawberry. Four concentrations of trichoderma, viz. T0, control; T1, 100 g/m2; T2, 200 g/m2 and T3, 300 g/m2 were applied. Number of runner, number of stolon, chlorophyll percentage, plant survival percentage (%), number of fruits/plant, fruit length (mm) , fruit diameter (mm), fruit weight (g), total fruit weight (g/plant) were showed significant variation among all treatments. Results showed that highest fruit yield/plant found in T1 (702.9.0 g), whereas minimum (220.05g) from T2. Rate of survival ability of strawberry plants observed highest (79.5) in T1 (100 g/m2) and lowest (42.7) was in Control.

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 (14.18 cm) at 90 days after transplanting in T_1 - Control and maximum plant height (18.67 cm) 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.

A new approach to farming is often referred to as sustainable agriculture and it seeks to introduce friendlier agricultural practices to the environment and maintains the long term ecological balance of the soil ecosystem. Hence Wani *et al*. (2013) carried out investigations to develop nutrient management for strawberry cultivar Sweet Charley subjected to various treatment combinations of organic and inorganic fertilizers. Traits such as plant growth characteristics (leaves/plant and plant spread), yield characteristics (flower buds, fruits per plant and fruit yield tons/ha) and quality characteristics (juice content, total sugar content, vitamin C and specific gravity) were observed. However the manure fertilizer combination under treatment (75% Organic Fertilizers + 25% inorganic Fertilizers) was found to be the best treatment with regard to integrated and combined application of nutrient resources for strawberry cultivation in India.

CHAPTER III
MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The present study regarding the evaluation of the the influence of Clybio and Ecoagra concentrations in strawberry cultivation has been conducted during November 2019 to March 2020 at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. Laboratory studies were done in the Horticulture Innovation Lab of Horticulture department, Sher-e-Bangla Agricultural University. This chapter contains a brief description of location of the experimental site, climatic condition and soil, materials used for the experiment, treatment and design of the experiment, production methodology, intercultural operations, data collection procedure and statistical analysis etc. which are presented as following headings:

3.1. Site of the experimental field

The experiment was accomplished in the Horticultural farm of SAU, Dhaka situated at 23.74' N latitude and 90.35' E longitudes with an elevation of 8.2 meter from sea level (Anon.,1989) in Agro-Ecological Zone of Madhupur Tract (AEZ No. 28).

3.2. Climate of the experimental area

The experiment site was located in the subtropical monsoon climatic zone, set aparted by heavy rainfall during the months from April to September (Kharif season) and scanty of rainfall during the rest of the year (Rabi season). In addition, under the sub-tropical climatic, which is individualized by high temperature, high humidity and heavy precipitation with seasonal unexpected winds and relatively long in Kharif season (April- September) and sufficient sunlight with moderately low temperature, intensity of humidity and short day period of during Rabi season (October-March). The information of weather regarding the atmospheric temperature, relative humidity, rainfall, sunshine 22 hours and soil temperature persuaded at the experimental site during the whole period of observation (Appendix I).

3.3. Soil of the experimental field

The experimental soil belongs to the Modhupur Tract under AEZ No. 28 (UNDP-FAO, 1988). The land which selected was medium high and the soil series was Tejgaon. The soil characteristics of experimental plot were analyzed in the Soil Resources and Development Institute (SRDI), Khamarbari, Dhaka and the experiment field primarily had a pH of 6.5 and organic matter content 0.84%. Physiochemical properties were present in the soil appropriately.

3.4. Experimental materials

3.4.1. Planting material

Healthy, disease free, well established plantlets (propagated through tissue culture technique) of strawberry of Festival variety was collected from nearby nursery. Plantlets were of 30 days .

3.4.2. Treatments

Comparative effectiveness of the following eight treatments in growth and yield of strawberry were evaluated in the experiment :

T_1= Clybio @ 1.0 ml/L

T_2= Clybio @ 2.0 ml/L

T_3= Ecoagra @ 1.0 ml/L

T_4= Ecoagra @ 2.0 ml/L

T_5= Clybio @ 1.0 ml/L + Ecoagra @ 1.0 ml/L

T_6= Clybio @ 1.0 ml/L + Ecoagra @ 2.0 ml/L

T_7= Clybio @ 2.0 ml/L + Ecoagra @ 1.0 ml/L

T_8= Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L

T_0= No application of Clybio and Ecoagra

3.4.3. Treatment application

All the treatments were prepared properly. Treatments were applied to the soil of strawberry field along with leaves and crowns of strawberry plants with the help of a hand sprayer. First application was done after five days of transplanting. Treatments were applied ten times in total at 10 days interval.

3.5. Design and layout of the experiment

The single factorial experiment was laid out in a Randomized Complete Block Design (RCBD) with three replication. The experiment comprised of 27 plots.

3.6. Spacing and plot size

The size of each plot was 1.8m × 0.8m. The distance between two blocks was 1.5 m. Row to row distance was maintained 45 cm and plant to plant distance was 55 cm.

Production methodology

3.7. Land preparation

The soil was well prepared and good tilth was ensured for commercial crop production. The land of the experimental field was ploughed with a power tiller. Later on the land was ploughed three times followed by laddering to obtain desirable tilth. The corners of the land were spaded and larger clods were broken into smaller pieces. After ploughing and laddering, all the stubbles and uprooted weeds were removed and then the land was ready. The field layout and design of the experiment were followed immediately after land preparation.

3.8. Manure and fertilizer

Soil was well prepared and then well-decomposed cowdung was exerted to each plots @5.0 kgplot-1. Chemical fertilizers were not used on the experiment.

3.9. Collection of plantlets of strawberry

The healthy plantlets (30 days old seedlings) of strawberry were collected from nearby nursery. Collected healthy plantlets were sprayed with water by a hand sprayer.

3.10. Plantlets transplanting

The 30 days old healthy plantlets were transplanted on 14th November, 2019 in the experimental plots. During planting, the growing point of the plant was allowed just above the soil surface. Also, the plantlets are allowed at 30 degrees angle to the west for maximize the utilization of sunlight. After transplanting, immediate irrigation was done unless the plantlets might be dried out.

3.11. Tagging of plants

Plants were tagged on 20^{th} November, 2019 using cards.

3.12. Intercultural operation

Following operations were done:

3.12.1. Weeding

Weeding was necessary to keep the plant free from weeds. The newly emerged weeds were uprooted carefully from the field when necessary.

3.12.2. Irrigation:

Frequency of watering depended upon soil moisture status by observing visually. However, avoided water logging as it is detrimental to plants.

3.12.3. Placing of Yellow sticky trap:

On 13 Dec 2019, yellow sticky traps were placed in the experimental plot to catch flying insects like fungus gnats, white flies, leaf miner, aphids etc.

3.12.4. Straw mulch application:

A layer of rice straw was applied on 25 December, 2019 which helped to retard weed growth and to keep dirt off fruits.

3.12.5. Removal of old leaves:

Keeping 10 to 15 leaves per plant, excess and old leaves were removed to ensure better growth and yield.

3.12.6. Harvesting of fruit:

Harvesting was done preferably daily after fruits reached at maturity stage. Based on firmness, surface color, sensory attributes, fully matured fruits of strawberry were harvested. Fruits were harvested from first week of January 2020 to last week of February 2020.

3.13. Parameters of the experiment

Data were collected in respect of following parameters:

A. Growth related parameters

1. Plant height
2. Leaf number
3. Crown number
4. Crown height
5. Days to first flowering

B. Physiological parameters

1. Chlorophyll content (SPAD value)

C. Yield attributing parameters

1. Flower per plant
2. Fruit per plant
3. Fruit length (cm)
4. Fruit diameter (cm)
5. Single fruit weight (g)
6. Yield per plant (g)

D. Quality attributing parameters

1. Brix percentage (%)

3.14. Data collection

For data collection three plants per plot were randomly selected and tagged. Data collection was started at vegetative stage to final fruit harvest. Data have been collected on the basis of four attributed like- growth related parameters, physiological parameters, yield attributing parameters and quality attributes parameters. The following parameters were considered during data collection.

3.14.1. Plant height (cm)

Plant height of each sample plant was measured in centimeter from the ground level to the tip of the longest leaf and mean value was calculated and expressed in cm.

3.14.2. Number of leaf per plant

The number of leaves per plant was counted from the selected plants and their average mean was taken as the number of leaves per plant. It was recorded during different days at 15, 25, 35 days after transplanting.

3.14.3. Crown height (cm)

Crown height of each sample plant was measured in centimeter from the ground level to the tip of the crown and mean value was calculated and expressed in cm. This data was collected 65 days after transplanting.

3.14.4. Crown number per plant

Crown number per plant was counted from the selected plants and their average mean was taken as the number of crown per plant.

3.14.5. Days to first flowering

Days required to first flowering were recorded from the selected plants and expressed in term of number of days.

3.14.6. SPAD value

SPAD value of leaves was measured at 55 and 70 days after transplanting. Mature leaves were measured all time. Three mature plant of each plot were measured by using portable Chlorophyll Meter (SPAD-502, Minolta, Japan) and then calculated an average SPAD value for each plot. (SPAD-502) is a simple and portable diagnostic tool that measures the greenness or the relative chlorophyll concentration of leaves (Kariya *et al.*, 1982).

3.14.7. Number of flower per plant

The number of flower per plant was recorded manually from selected plants and the average was computed and as expressed in average number of flower per plant.

3.14.8. Fruit length (cm) and fruit diameter (cm)

Fruit length and diameter were measured by using Digital slide caliper-515 (DC515) in centimeter (cm) and mean was calculated.

3.14.9. Weight of single fruit (g)

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

3.14.10. Fruit per plant

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

3.14.11. Brix percentage (%)

Brix was measured by refractometer (ERMA, Tokyo, Japan) at room temperature (Plate 2; d). 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.

3.15. Calculation

3.15.1. Yield of strawberry

Yield of strawberry (t/ha) was calculated from yield of strawberry per plot as follows:

$$\text{Yield of strawberry (t/ha)} = \frac{\text{Yield of strawberry per plot (kg/decimal)}}{1000} \times 247$$

3.16. Statistical analysis

Collected data were statistically analyzed using MSTAT-C computer package program. Mean for every treatments were calculated and analysis of variance for each one of characters was performed by F–test (Variance Ratio). Duncan's multiple range test (DMRT) at 5% level of probability (Gomez and Gomez, 1984) was used to determine the levels of significant differences among the application of Clybio and Ecoagra solution at different concentration levels.

A

b

C

d

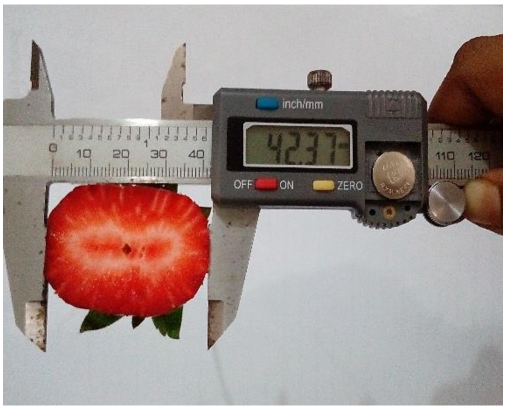
E

f

Plate 1. Experimental activities a) Preparation of land b) Transplantation of Plantlets c) Placement of tag d) Application of treatment e) Application of mulch f)Placement of yellow Sticky Trap

a   b

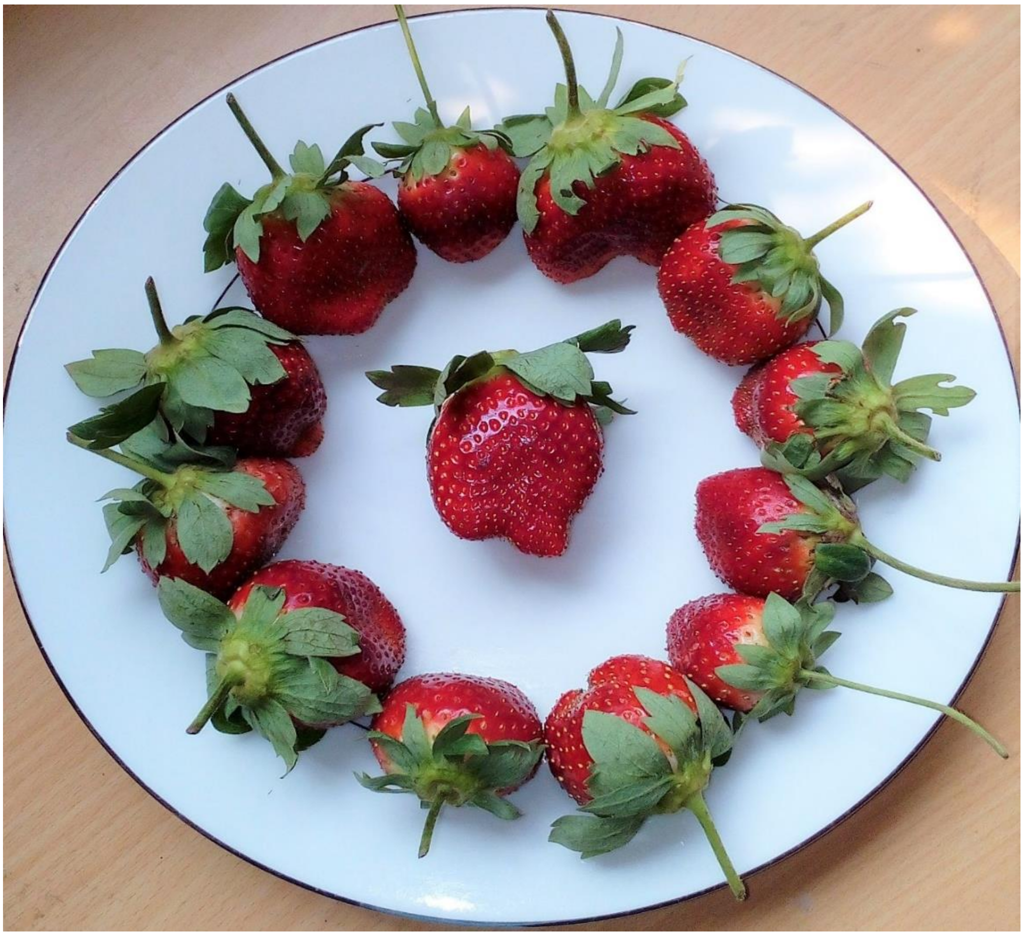
c   d



e   f

Plate 2. Experimental activities a) Measuring plant height b) Measuring SPAD value c) Harvested fruits d) Measuring Brix percentage e) Measuring fruit weight f) Measuring fruit diameter

CHAPTER IV
RESULTS AND DISCUSSIONS



CHAPTER IV

RESULT AND DISCUSSION

The present experiment was conducted to evaluate the influence of Clybio and Ecoagra concentration on growth and yield of strawberry. The analysis of variance (ANOVA) of the data on different yield contributing characters of strawberry plants are given in Appendix III-VIII. The results have been presented and discussed, and possible interpretations have been given under the following sub-headings:

4.1. Number of leaf per plant

Leaves are the important organ which helps to physiological processes, photosynthesis and transpirations. Thus it influenced the growth of a plant very much and enhances the yield of a plant. Statistically no significant variation was found in number of leaf per plant at 15 days after transplanting (DAT) of strawberry plant due to influence of Clybio and Ecoagra concentration except T_0.

But there was significant variation in number of leaf per plant at 30 DAS due to the influence of Clybio and Ecoagra concentration under present trial. Highest number of leaf per plant at 30 DAS was found in case of T_8 (12.3) which was was followed by T_7 (12.1), T_6 (11.8), T_5 (11.8), T_3 (11.5) and T_2 (11.0). On the other hand, lowest number of leaf per plant at 30 DAS was found in case of T_0 (9.8) which was followed by T_1 (10.5) and T_4 (10.5) (table 1). From these results it is revealed that the trend of the number of leaf per plant was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_3 > T_2 > T_4 > T_1 > T_0$. Hossain (2007) observed highly significant variation in respect of number of leaves per plant in Raton tomato variety.

Table 1. Number of leaf per plant due to the influence of Clybio and Ecoagra concentration in strawberry production**

Treatment*	Number of leaf per plant		
	15 DAT	30 DAT	45 DAT
T_0	7.8 b	9.8 c	13.6 d
T_1	8.0 ab	10.5 bc	17.6 c
T_2	8.8 ab	11.0 abc	18.6 bc
T_3	9.0 a	11.5 abc	18.3 c
T_4	8.3 ab	10.5 bc	18.0 c
T_5	8.8 ab	11.8 ab	21.3 ab
T_6	8.6 ab	11.8 ab	22.3 a
T_7	9.0 a	12.1 ab	22.3 a
T_8	8.8 ab	12.3 a	22.6 a
LSD value	1.04	1.71	2.86
CV (%)	7.02	8.81	8.51

*Here, T_0 : No application of Clybio and Ecoagra; T_1 : Clybio @ 1.0 ml/L; T_2 : Clybio @ 2.0 ml/L; T_3 : Ecoagra @ 1.0 ml/L; T_4 : Ecoagra @ 2.0 ml/L; T_5 : Clybio @ 1.0 ml/L + Ecoagra @ 1.0 ml/L; T_6 : Clybio @ 1.0 ml/L + Eco agra @ 2.0 ml/L; T_7 : Clybio @ 2.0 ml/L + Ecoagra @ 1.0 ml/L; T_8 : Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L

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

Statistically significant variation was found in number of leaf per plant at 45 DAS due to the influence of Clybio and Ecoagra concentration under present trial. Highest number of leaf per plant at 45 DAS was found in case of T_8 (22.6) which were followed by T_7 (22.3), T_6 (22.3) and T_5 (21.3). On the other hand, lowest number of leaf per plant at 45 DAS was found in case of T_0 (13.6) which was significantly lower from all other treatments (table 1). From these results it is revealed that the trend of the number of leaf per plant was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_2 > T_3 > T_4 > T_1 > T_0$.

4.2. Plant height (cm)

Plant height (cm) is obviously important growth parameters in strawberry which is positively correlated with yield and the growing conditions significantly influenced this trait. Statistically significant variation was found in plant height at 15 days after transplanting (DAT) due to the influence of Clybio and Ecoagra concentration to strawberry plant. Highest plant height at 15 DAT was found in case of T_8 (19.0) which was followed by T_7 (18.3), T_2 (18.1), T_5 (18.0), T_1 (18.0), T_6 (17.9) and T_4 (17.6). On the other hand, lowest plant height at 15 DAT was found in case of T_0 (16) which was followed by T_7 (17.5) (table 2). From these results it is revealed that the trend of plant height was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_2 > T_5 > T_1 > T_6 > T_4 > T_3 > T_0$.

Table 2. Effect on Plant height, Crown height and Crown per plant of strawberry production due to the influence of Clybio and Ecoagra concentration in strawberry plant****

Treatment*	Plant Height (cm)		Crown height (cm) at 65 DAT	Crown per plant
	at 15 DAT	at 25 DAT		
T_0	16.0 c	17.8 b	3.2 d	3.6 c
T_1	18.0 ab	21.5 a	3.9 c	4.3 bc
T_2	18.1 ab	21.7 a	3.9 c	5.0 ab
T_3	17.5 b	20.5 a	3.9 c	4.6 abc
T_4	17.6 ab	19.8 ab	4.0 bc	5.0 ab
T_5	18.0 ab	21.5 a	4.5 ab	5.3 ab
T_6	17.9 ab	20.8 a	4.2 abc	5.3 ab
T_7	18.3 ab	21.8 a	4.6 a	5.6 a
T_8	19.0 a	21.9 a	4.6 a	5.6 a
LSD value	1.47	2.18	0.49	1.26
CV (%)	4.74	6.06	6.88	14.77

*Here, T_0 : No application of Clybio and Ecoagra; T_1 : Clybio @ 1.0 ml/L; T_2 : Clybio @ 2.0 ml/L; T_3 : Ecoagra @ 1.0 ml/L; T_4 : Ecoagra @ 2.0 ml/L; T_5 : Clybio @ 1.0 ml/L + Ecoagra @ 1.0 ml/L; T_6 : Clybio @ 1.0 ml/L + Eco agra @ 2.0 ml/L; T_7 : Clybio @ 2.0 ml/L + Ecoagra @ 1.0 ml/L; T_8 : Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L

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

Statistically significant variation was found in plant height at 25 days after transplanting (DAT) of strawberry plant due to the influence of Clybio and

Ecoagra concentration. Highest plant height at 25 DAT was found in case of T_8 (21.9) which was followed by T_7 (21.8), T_2 (21.7), T_5 (21.5), T_1 (21.5), T_6 (20.8) and T_3 (20.5). On the other hand, lowest plant height at 25 DAT was found in case of T_0 (17.8) (table 2). From these results it is revealed that the trend of plant height was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_2 > T_5 > T_1 > T_6 > T_3 > T_4 > T_0$.

Plant height showed significant variation with Trichoderma treatments. Uddin *et al*. (2016) found the higher plant height in tomato with trichoderma treatments. Similar opinion was put forwarded by Baker (1991) in tomato, bean and cucurbits. This may be due to enhanced nutrition uptake activity to the plants. Glinicki *et al*. (2011), revealed that NPK fertilization with single microbial inoculation applied to strawberry plants can withstand the positive effect on strawberry plant growth. Growth of strawberry plant was significantly influenced by organic and biofertilizer with or without synthetic mineral fertilizer (Hassan, 2015).

4.3. Crown height (cm)

Statistically significant variation was found in crown height at 65 days after transplanting (DAT) of strawberry plant due to the influence of Clybio and Ecoagra concentration. Highest crown height at 65 DAT was found in case of T_8 (4.6) and T_7 (4.6) which was statistically similar with T_5 (4.5) and T_6 (4.2). On the other hand, lowest crown height at 65 DAT was found in case of T_0 (3.2) (table 2) which was statistically different from all other treatments. From these results it is revealed that the trend of crown height was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_5 > T_6 > T_4 > T_2 > T_1 > T_3 > T_0$.

4.4. Crown per plant

Statistically significant variation was found in crown per plant of strawberry plant due to the influence of Clybio and Ecoagra concentration to strawberry plant. Highest crown per plant was found in case of T_8 (5.6) and T_7 (5.6) which was statistically similar with T_6 (5.3), T_5 (5.3), T_4 (5.0), T_2 (5.0) and T_3 (4.6). On the other hand, lowest crown per plant was found in case of T_0 (3.6) (table 2). From these results it is revealed that the trend of crown per plant was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_2 > T_4 > T_3 > T_1 > T_0$. Strawberry, CV. Festival organically cultured fertilized mineral nutrition showed a significant increase in a number of leaves, leaf area, and number of crowns per plant. (Khalil, 2014)

4.5. Days to first flowering

Statistically significant variation was found in days to first flowering of strawberry plant due to the influence of Clybio and Ecoagra concentration. Days to first flowering was highest in case of T_0 (38.3) and T_3 (38.3). On the other hand, days to first flowering was lowest in case of T_8 (29.8) (table 3). From these results it is revealed that the trend of days to first lowering was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_0 > T_3 > T_6 > T_1 > T_4 > T_5 > T_7 > T_2 > T_8$. Early flowering was initiated due to application of clybio and Ecoagra. It made the nutrient readily available for the plant and accelerated to early flowering. Plant produce early flowering due to incorporation of vermicompost (Chamani *et al.* 2008). Nath and Singh (2012) notified that all concentrations of different combinations of animal agro and kitchen wastes have significant early start in flowering and enhance the productivity of crops.

4.6. Flowers per plant

Number of flower is the most prominent parameter for attributing yield. Statistically significant variation was found in flowers per plant of strawberry plant due to the influence of Clybio and Ecoagra concentration. Highest flower per plant was found in case of T_8 (55.6) which was followed by T_7 (51.0). On the other hand, lowest number of flower per plant was found in case of T_0 (19.3) (table 3) which was statistically different from all other treatments. From these results it is revealed that the trend of flower per plant was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 >$

T_6> T_5> T_4 > T_1>T_2> T_3 >T_0. Availability of plant growth influencing substances such as hormones and humates produced by microorganisms during vermicomposting, probably contributed to increased flowering (Arancon et al., 2008).

Table 3. Influence of Clybio and Ecoagra concentration on days to first flowering, flowers per plant and fruits per plant in strawberry production**

Treatment*	Days to first flowering	Flowers per plant	Fruits per plant
T_0	38.3 a	19.3 d	17.6 d
T_1	32.3 c	38.3 bc	35.6 bc
T_2	29.9 cd	37.3 bc	37.3 bc
T_3	38.3 a	35.6 c	32.6 c
T_4	32.0 bc	39.3 bc	34.3 c
T_5	31.6 bc	41.6 bc	39.6 bc
T_6	33.6 b	51.0 ab	38.6 ab
T_7	30.3 d	51.0 ab	46.3 ab
T_8	29.8 e	55.6 a	50.6 a
LSD value	2.765	13.73	11.54
CV (%)	5.07	19.78	17.91

*Here, T_0 : No application of Clybio and Ecoagra; T_1 : Clybio @ 1.0 ml/L; T_2 : Clybio @ 2.0 ml/L; T_3 : Ecoagra @ 1.0 ml/L; T_4 : Ecoagra @ 2.0 ml/L; T_5 : Clybio @ 1.0 ml/L + Ecoagra @ 1.0 ml/L; T_6 : Clybio @ 1.0 ml/L + Eco agra @ 2.0 ml/L; T_7 : Clybio @ 2.0 ml/L + Ecoagra @ 1.0 ml/L; T_8 : Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L

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

4.7. Fruits per plant

Statistically significant variation was found in fruits per plant of strawberry plant due to the influence of Clybio and Ecoagra concentration. Highest number of fruits per plant was found in case of T_8 (50.6) which was statistically similar with T_7 (46.3) and T_6 (38.6). On the other hand, lowest number of fruits per plant was found in case of T_0 (17.6) (table 3) which was statistically different from all other treatments. From these results it is revealed that the trend of fruits per plant was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_2 > T_1 > T_4 > T_3 > T_0$. Positive effects on yield and growth of foliar and root inoculation with PGPR (Plant Growth Promoting Bacteria) are not known sufficiently in strawberry. 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 N2 asymbiotically 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*., 2003, 2006; Orhan *et al*., 2006; Aslantas *et al*., 2007; Pirlak *et al*., 2007). In addition, the preliminary studies have demonstrated that Bacillus OSU-142, Burkholderia OSU-7, Pseudomonas BA-8, and Bacillus M-3 produce IAA and solubilizate P (Aslantas *et al*., 2007).

4.8. Fruit length (cm)

Statistically significant variation was found in fruit length (cm) of strawberry due to the influence of Clybio and Ecoagra concentration. Highest fruit length (cm) was found in case of T_8 (5.1) which was statistically similar with T_7 (5.0), T_6 (4.9), T_5 (4.6), T_2 (4.7), T_4 (4.4), T_3 (4.4) and T_1 (4.3). On the other hand, lowest fruit length (cm) was found in case of T_0 (4.2) (table 4). From these results it is revealed that the trend of fruit length (cm) was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_2 > T_4 > T_3 > T_1 > T_0$.

4.9. Fruit diameter (cm)

Statistically significant variation was found in fruit diameter (cm) of strawberry due to the influence of Clybio and Ecoagra concentration. Highest fruit diameter (cm) was found in case of T_8 (4.7) which was followed by T_7 (4.6). On the other hand, lowest fruit diameter (cm) was found in case of T_0 (3.7) (table 4). From these results it is revealed that the trend of fruit diameter (cm) was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_2 > T_5 > T_1 > T_4 > T_3 > T_0$.

Table 4. Influence of Clybio and Ecoagra concentration on fruit diameter (cm), fruit length (cm), weight of single fruit (g) and yield of fruit (t/ha) in strawberry production**

Treatment*	Fruit length (cm)	Fruit diameter (cm)	Weight of single fruit (g)	Yield of fruit (t/ha)
T_0	4.2 b	3.7 b	24.3 c	5.1 d
T_1	4.3 ab	4.1 ab	30.1 abc	14.5 bc
T_2	4.7 ab	4.4 ab	35.3 ab	14.8 bc
T_3	4.4 ab	3.9 ab	29.2 bc	11.1 c
T_4	4.4 ab	3.9 ab	30.9 abc	13.4 bc
T_5	4.6 ab	4.2 ab	35.6 ab	15.4 bc
T_6	4.9 ab	4.5 ab	36.2 ab	17.3 ab
T_7	5.0 ab	4.6 ab	37.2 ab	22.1 a
T_8	5.1 a	4.7 a	40.5 a	22.3 a
LSD value	0.97	0.97	10.69	5.4
CV (%)	13.86	12.01	18.55	20.91

*Here, T_0 : No application of Clybio and Ecoagra; T_1 : Clybio @ 1.0 ml/L; T_2 : Clybio @ 2.0 ml/L; T_3 : Ecoagra @ 1.0 ml/L; T_4 : Ecoagra @ 2.0 ml/L; T_5 : Clybio @ 1.0 ml/L + Ecoagra @ 1.0 ml/L; T_6 : Clybio @ 1.0 ml/L + Eco agra @ 2.0 ml/L; T_7 : Clybio @ 2.0 ml/L + Ecoagra @ 1.0 ml/L; T_8 : Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L

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

4.10. Weight of single fruit (g)

Statistically significant variation was found in single fruit weight (g) of strawberry due to the influence of Clybio and Ecoagra concentration. Highest single fruit weight (g) was found in case of T_8 (40.5) which was statistically similar with T_7 (37.2), T_6 (36.2), T_5 (35.6), T_2 (35.3), T_4 (30.9) and T_1 (30.1). On the other hand, lowest single fruit weight (g) was found in case of T_0 (24.3) (table 4). From these results it is revealed that the trend of single fruit weight (g) was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_2 > T_4 > T_1 > T_3 > T_0$.

4.11. Yield of fruit (t/ha)

Statistically significant variation was found in yield of fruit (t/ha) of strawberry due to the influence of Clybio and Ecoagra concentration. Highest yield of fruit (t/ha) was found in case of T_8 (22.3) which was followed by T_7 (22.1). These treatments were statistically similar with T_6 (17.3). On the other hand, lowest yield of fruit (t/ha) was found in case of T_0 (5.1) (table 4). From these results it is revealed that the trend of yield of fruit (t/ha) was observed due to application of Clybio and Eco Agra at different concentration level to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_2 > T_1 > T_4 > T_3 > T_0$. This increased yield per plant is due to increased number of flower per plant, high fruit set percentage and maximum number of fruits per cluster and per plant, taller plants which intern increases the photosynthetic activity and ultimately leads to higher yield per plant. These results are in agreement with those obtained Prema *et al*., (2011) Singh *et al*., (2013). Plant growth promoting bio-fertilizer application increased organic manure use efficiency and have the capacity to stimulate strawberry growth and yield (Karlidag *et al*., 2009).

4.12. SPAD value of fruit

Statistically significant variation was found in SPAD value of strawberry at 55 DAT due to the influence of Clybio and Ecoagra concentration. Highest SPAD value was found in case of T_8 (48.3) which was followed by T_5 (48.3), T_7 (48.2), T_6 (48.2), T_4 (48.2), T_3 (48.1) and T_2 (48.1). On the other hand, lowest SPAD value was found in case of T_0 (46.7) (table 5). From these results it is revealed that the trend of SPAD value of fruit was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_5 > T_7 > T_6 > T_4 > T_3 > T_2 > T_1 > T_0$.

Statistically significant variation was found in SPAD value of strawberry at 70 DAT due to the influence of Clybio and Ecoagra concentration. Highest SPAD value was found in case of T_8 (51.3) which was followed by T_6 (50.3), T_7 (50.2), T_5 (48.9), T_2 (48.9), T_1 (48.8), T_4 (48.7) and T_3 (48.4). On the other hand, lowest SPAD value was found in case of T_0 (45.1) (table 5). From these results it is revealed that the trend of SPAD value of fruit was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_6 > T_7 > T_5 > T_2 > T_1 > T_4 > T_3 > T_0$. Through spraying of Clybio and Ecoagra enhances photosynthesis of leaves through increased biomass, increases plant ability to fight pest and diseases.

Table 5. Influence of Clybio and Ecoagra concentration on SPAD value and brix percentage (%) of fruit in strawberry production**

Treatment*	SPAD Value		Brix percentage (%)
	At 55 DAT	At 70 DAT	
T_0	46.7 c	45.1 b	6.2 d
T_1	47.7 b	48.8 a	7.1 bc
T_2	48.1 ab	48.9 a	7.6 ab
T_3	48.1 ab	49.4 a	6.8 c
T_4	48.2 a	49.7 a	7.2 abc
T_5	48.3 a	48.9 a	7.6 ab
T_6	48.2 a	50.3 a	7.6 ab
T_7	48.2 a	50.2 a	7.6 ab
T_8	48.3 a	51.3 a	7.8 a
LSD value	0.43	2.23	0.61
CV (%)	0.52	2.63	4.88

*Here, T_0 : No application of Clybio and Ecoagra; T_1 : Clybio @ 1.0 ml/L; T_2 : Clybio @ 2.0 ml/L; T_3 : Ecoagra @ 1.0 ml/L; T_4 : Ecoagra @ 2.0 ml/L; T_5 : Clybio @ 1.0 ml/L + Ecoagra @ 1.0 ml/L; T_6 : Clybio @ 1.0 ml/L + Eco agra @ 2.0 ml/L; T_7 : Clybio @ 2.0 ml/L + Ecoagra @ 1.0 ml/L; T_8 : Clybio @ 2.0 ml/L + Ecoagra @ 2.0 ml/L

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

4.13. Brix percentage (%) of fruit

Statistically significant variation was found in Brix percentage (%)of strawberry due to the influence of Clybio and Ecoagra concentration. Highest Brix percentage (%) of strawberry was found in case of T_8 (7.8) which was followed by T_7 (7.6), T_6 (7.6), T_5 (7.6), T_2 (7.6) and T_4 (7.2). On the other hand, lowest Brix percentage (%) of strawberry was found in case of T_0 (6.2) (table 5). From these results it is revealed that the trend of Brix percentage (%) of strawberry fruit was observed due to the influence of Clybio and Ecoagra concentration to strawberry plant is $T_8 > T_7 > T_6 > T_5 > T_2 > T_4 > T_1 > T_3 > T_0$. Root application of PGPR had significant negative effect on vitamin C. The effect of PGPR applications on total and reducing sugar were found to be important whose are increased with root application as compared to control (Pirluk *et al*. 2009). Kumar *et al*. (2015) indicated that treatments combination organic manure + Biofertilizers has shown significant effects on most of the vegetative growth parameters, fruit setting and Total Soluble Solids in strawberry plants.

4.14. Relationship between number of flowers and number of fruits per plant

Significant relationship was found between number of flowers and number of fruits per plant when correlation was made between these two parameters. Highly significant (p<0.01), very strong (R2=0.99) and positive (slope= 0.90) correlation was found between number of flowers and number of fruits per plant, i.e. number of fruits per plant increases with the increase of number of flowers per plant (Figure 02).

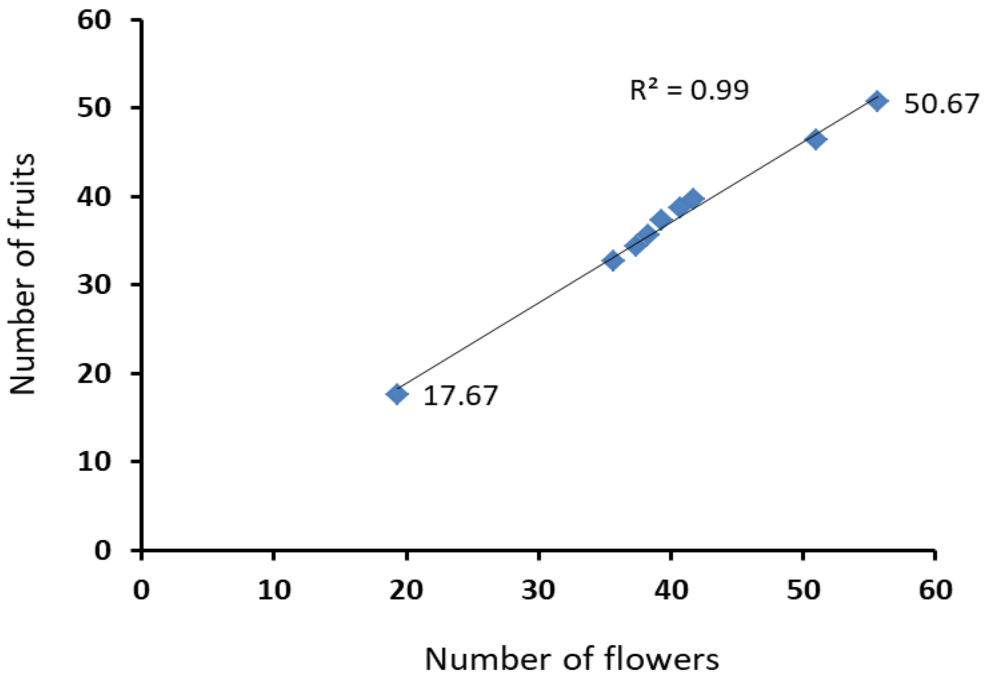


Figure 01: Relationship between number of flowers and number of fruits per plant

4.15. Relationship between number of fruits per plant and yield (t/ha) of fruits

Significant relationship was found between number of fruits per plant and yield (t/ha) of fruits when correlation was made between these two parameters.

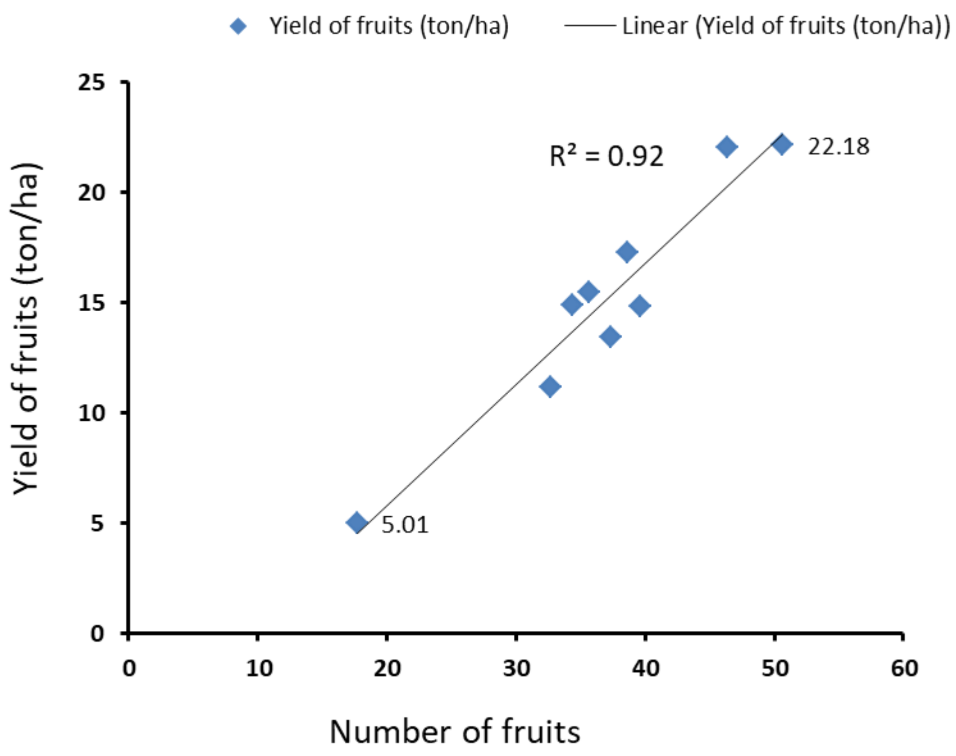


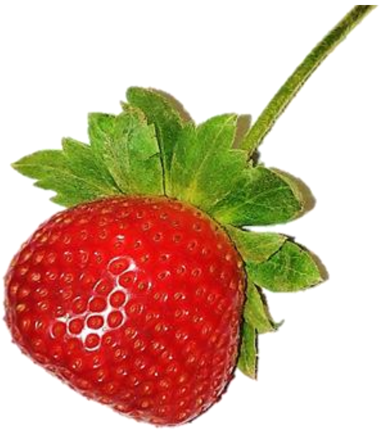
Figure 02: Relationship between number of fruits per plant and yield (t/ha) of fruits

Highly significant ($p<0.01$), very strong (R2=0.92) and positive (slope= 0.54) correlation was found between number of fruits per plant and yield (t/ha) of fruits, i.e. yield (t/ha) of fruits increases with the increase of number of fruits per plant (Figure 03).

T_1

T_2

T_3



T_4

T_5

T_6

Plate 3: Pictorial presentation of Strawberry; Clybio @ 1.0 ml/L (T_1), Clybio @ 2.0 ml/L (T_2), Ecoagra @ 1.0 ml/L (T_3), Ecoagra @ 2.0 ml/L (T_4), Clybio @ 1.0 ml/L+ Ecoagra @ 1.0 ml/L (T_5), Clybio @ 1.0 ml/L+ Ecoagra @ 2.0 ml/L (T_6)

T_7

T_8

T_0

Plate 3: Pictorial presentation of Strawberry; Clybio @ 2.0 ml/L+ Ecoagra @ 1.0 ml/L (T_7), Clybio @ 2.0 ml/L+ Ecoagra @ 2.0 ml/L (T_8), Untreated control (T_0)

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

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Statistically no significant variation was found in number of leaf per plant at 15 days after transplanting (DAT) of strawberry plant due to the influence of Clybio and Ecoagra concentration except T_0. But at 30 DAT highest number of leaf per plant was found in case of T_8 (12.3) which was followed by T_7 (12.1), T_6 (11.8), T_5 (11.8), T_3 (11.5) and T_2 (11.0). On the other hand, lowest number of leaf per plant at 30 DAS was found in case of T_0 (9.8) which was followed by T_1 (10.5) and T_4 (10.5). At 45 DAT highest number of leaf per plant was found in case of T_8 (22.6) which were followed by T_7 (22.3), T_6 (22.3) and T_5 (21.3). On the other hand, lowest number of leaf per plant at 45 DAT was found in case of T_0 (13.6) which was significantly lower from all other treatments.

At 15 DAT highest plant height of strawberry plant was found in case of T_8 (19.0) due to the influence of Clybio and Ecoagra concentration which was followed by T_7 (18.3), T_2 (18.1), T_5 (18.0), T_1 (18.0), T_6 (17.9) and T_4 (17.6). On the other hand, lowest plant height at 15 DAT was found in case of T_0 (16) which was followed by T_7 (17.5). But at 25 DAT highest plant height was found in case of T_8 (21.9) which was followed by T_7 (21.8), T_2 (21.7), T_5 (21.5), T_1 (21.5), T_6 (20.8) and T_3 (20.5). On the other hand, lowest plant height at 25 DAT was found in case of T_0 (17.8).

Highest crown height (cm) at 65 DAT was found in case of T_8 (4.6) and T_7 (4.6) which was statistically similar with T_5 (4.5) and T_6 (4.2). On the other hand, lowest crown height at 65 DAT was found in case of T_0 (3.2) which was statistically different from all other treatments. Highest crown per plant was found in case of T_8 (5.6) and T_7 (5.6) which was statistically similar with T_6 (5.3), T_5 (5.3), T_4 (5.0), T_2 (5.0) and T_3 (4.6). On the other hand, lowest crown per plant was found in case of T_0 (3.6).

Days to first flowering was highest in case of T_0 (38.3) and T_3 (38.3). On the other hand, days to first flowering was lowest in case of T_8 (29.8). Highest flower per plant was found in case of T_8 (55.6) which was followed by T_7 (51.0). On the other hand, lowest number of flower per plant was found in case of T_0 which was statistically different from all other treatments.

Highest number of fruits per plant was found in case of T_8 (50.6) which was statistically similar with T_7 (46.3) and T_6 (38.6). On the other hand, lowest number of fruits per plant was found in case of T_0 (17.6) which was statistically different from all other treatments. Highest fruit length (cm) was found in case of T_8 (5.1) which was statistically similar with T_7 (5.0), T_6 (4.9), T_5 (4.6), T_2 (4.7), T_4 (4.4), T_3 (4.4) and T_1 (4.3). On the other hand, lowest fruit length (cm) was found in case of T_0 (4.2). Highest fruit diameter (cm) was found in case of T_8 (4.7) which was followed by T_7 (4.6). On the other hand, lowest fruit diameter (cm) was found in case of T_0 (3.7). Highest single fruit weight (g) was found in case of T_8 (40.5) which was statistically similar with T_7 (37.2), T_6 (36.2), T_5 (35.6), T_2 (35.3), T_4 (30.9) and T_1 (30.1). On the other hand, lowest single fruit weight (g) was found in case of T_0 (24.3).

Maximum yield of fruit (t/ha) was found in case of T_8 (22.3) which was followed by T_7 (22.1). These treatments were statistically similar with T_6 (17.3). On the other hand, lowest yield of fruit (t/ha) was found in case of T_0 (5.1).

At 55 DAT highest SPAD value was found in case of T_8 (48.3) which was followed by T_5 (48.3), T_7 (48.2), T_6 (48.2), T_4 (48.2), T_3 (48.1) and T_2 (48.1). On the other hand, lowest SPAD value was found in case of T_0 (46.7). At 70 DAT highest SPAD value was found in case of T_8 (51.3) which was followed by T_6 (50.3), T_7 (50.2), T_5 (48.9), T_2 (48.9), T_1 (48.8), T_4 (48.7) and T_3 (48.4). On the other hand, lowest SPAD value was found in case of T_0 (45.1).

Highest brix percentage (%) of strawberry was found in case of T_8 (7.8) which was followed by T_7 (7.6), T_6 (7.6), T_5 (7.6), T_2 (7.6) and T_4 (7.2). On the other hand, lowest Brix percentage (%) of strawberry was found in case of T_0 (6.2).

Findings of the experiment reveal that the combined effect of Clybio and Ecoagra gives better result on growth and yield related attributes of strawberry. So considering the more yield, availability of Clybio and Ecoagra, easy preparation and application process, combination of Clybio and Ecoagra at 2ml/L of water may be recommended for application to increase Strawberry production.

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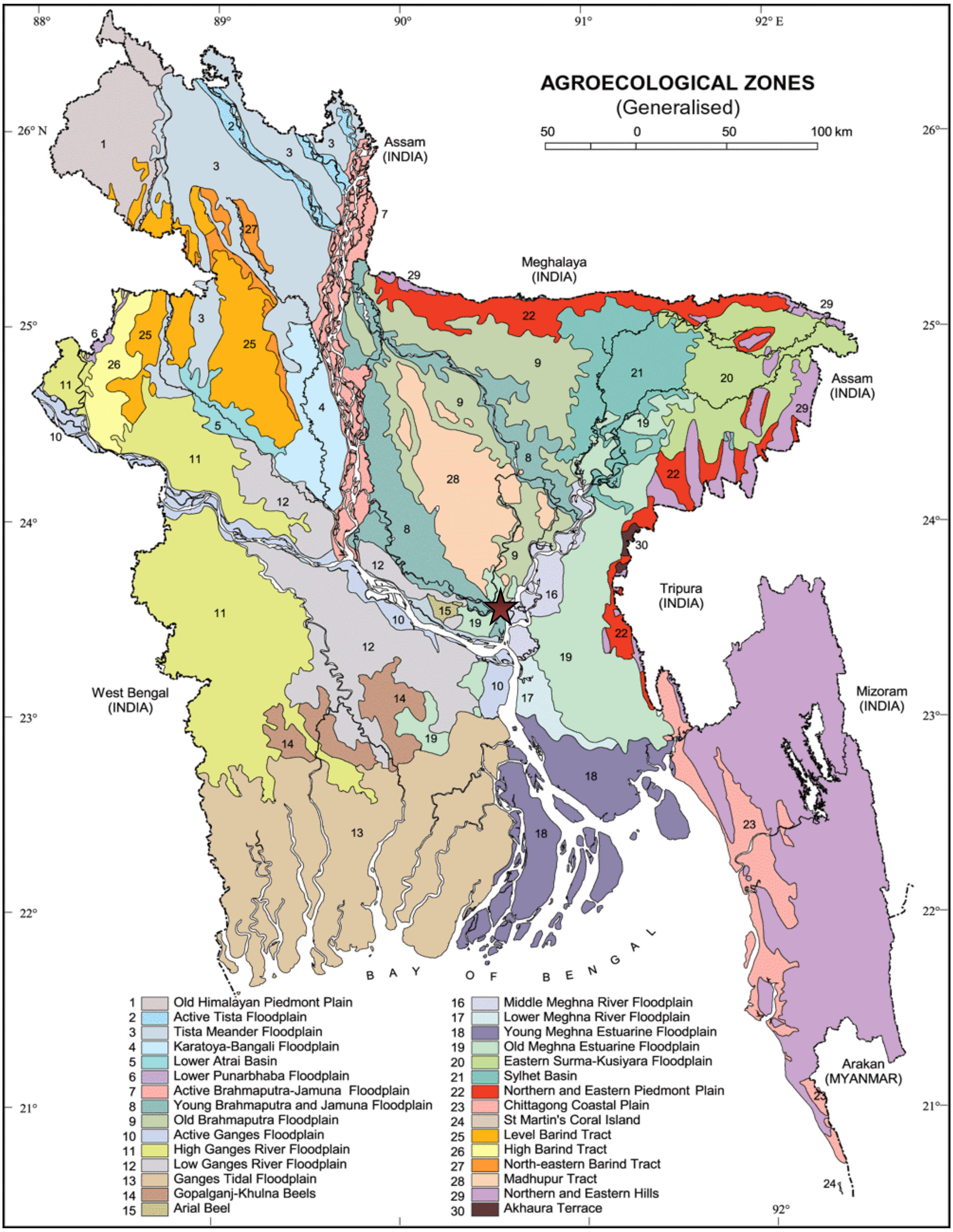
APPENDICES

Appendix 01. Experimental area showing in maps



*Mark showing experimental land area

Appendix 02. Monthly record of air temperature, relative humidity, rainfall and sunshine hour at experimental site during the period of experiment in field					
Month	*Air temperature (ºc)		*Relative Humidity (%)	Total Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
October, 2019	26.5	19.4	81	22	6.9
November, 2019	25.8	16.0	78	00	6.8
December, 2019	22.4	13.5	74	00	6.3
January, 2020	24.5	12.4	68	00	5.7
February, 2020	27.1	16.7	67	30	6.7
March, 2020	31.4	19.6	54	11	8.2

* Monthly average

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka –1212

Appendix 03. Analysis of variance on the number of leaves per plant at differentdays after transplanting of strawberry				
Sources of variation	Degrees of freedom	Mean square for number of leaves at		
		15 DAT	30 DAT	45 DAT
Factor A (Treatment)	8	0.56*	2.22*	26.66*
Error	16	0.36	0.98	2.73
CV value		7.02%	8.81 %	8.51%
*: Significant at 0.05 level of pobability				

Appendix 04. Analysis of variance on plant height at different days after transplanting of strawberry			
Sources of variation	Degrees of freedom	Mean square for plant height at	
		15 DAT	25 DAT
Factor A (Treatment)	8	2.48*	5.03*
Error	16	0.72	1.59
CV value		4.74%	6.06 %
*: Significant at 0.05 level of pobability			

Appendix 05. Analysis of variance on crown number at 65 DAT, crown height at 55 DAT and days to first flowering of strawberry			
Sources of variation	Degrees of freedom	Mean square of	
		Crown number at 55 DAT	Crown height at 65 DAT
Factor A (Treatment)	8	1.28*	0.61*
Error	16	0.53	0.08
*: Significant at 0.05 level of pobability			

Appendix 06. Analysis of variance on days to first flowering, on number of flower per plant and number of fruits per plant of strawberry				
Sources of variation	Degrees of freedom	Mean square of		
		days to first flowering	number of flower per plant	number of fruits per plant
Factor A (Treatment)	8	79.09*	334.66*	278.83*
Error	16	2.55	62.94	44.44
*: Significant at 0.05 level of pobability				

Appendix 07. Analysis of variance on SPAD value at different days after transplanting of strawberry				
Sources of variation	Degrees of freedom	Mean square of		
		SPAD value at 55 DAT	SPAD value at 70 DAT	Brix (%)
Factor A (Treatment)	8	1.28*	0.77*	0.85*
Error	16	0.53	0.06	0.12
*: Significant at 0.05 level of pobability				

Appendix 08. Analysis of variance on fruit length (cm), fruit diametre (cm), weight of single fruit (g) and yield of fruits (t/ha) of strawberry					
Sources of variation	Degrees of freedom	Mean square of			
		fruit length (cm)	fruit diametre (cm)	weight of single fruit (g)	yield of fruits (t/ha)
Factor A (Treatment)	8	0.37*	0.35*	74.16*	83.72*
Error	16	0.31	0.34	38.12	10.02
*: Significant at 0.05 level of pobability					