INFLUENCE OF ORGANIC LEACHATES ON GROWTH AND YIELD OF BLACK CHERRY TOMATO

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This is to certify that the thesis entitled ***"INFLUENCE OF ORGANIC LEACHATES ON GROWTH AND YIELD OF BLACK CHERRY TOMATO"*** *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* ***MD. RAKIBUL HASSAN,*** *Registration No.* ***11-04466*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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"A single tear caused by the remembranceof ALLAH brings a comfort to the heart that nothing in the Dunya can match"

DEDICATED TO

My Beloved Father & Mother

The person who taught me

"*Always Trust Your Struggle*"

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ABSTRACT

The experiment was performed at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, during the period from October 2015 to March 2016. Five treatments *viz*. only cowdung (CD) as basal dose (T_1), cowdung with BARI fertilizer dose (basal) + cowdung leachate as top dressing (T_2), cowdung with BARI fertilizer dose (basal) + vermicompost leachate as top dressing (T_3), cowdung with BARI fertilizer dose (basal) + MOC leachate top dressing (T_4), cowdung with BARI fertilizer dose (basal) (T_5) were studied in this experiment. These treatments were arranged in Randomized Complete Block Design with three replications. Significant variation was observed at different growth and yield parameters with different treatments. Maximum fruit number (117.0/plant), fruit weight (9.80 g), yield/plant (1.12 kg) and total yield (46.77 t/ha) were found from T_3 whereas minimum (108.0/plant, 8.50 g/fruit, 0.92 kg/plant and 38.20 t/ha respectively) from T_1 treatment. This study suggests that T_3 treatment acts as a potential source of plant nutrients for suitable black cherry tomato production.

CONTENTS

List of Table

List of Plate

List of Figure

List of Appendices

ABBREVIATIONS AND ACRONYMS

SAU	---	Sher-e-Bangla Agricultural University
SAURES	---	Sher-e-Bangla Agricultural University Research System
TSS	---	Total Soluble Solid
SG	---	SAU Germplasm
CD	---	Cowdung
PM	---	Poultry Manure
VC	---	Vermicompost
CF	---	Chemical Fertilizer
FYM	---	Farmyard Manure
FCD	---	Farm Cowdung
FVW	---	Farm Vegetable Waste
FCVW	---	Farm Cow Dung and Vegetable Waste
NAA	---	Naphthalene Acetic acid
IAA	---	Indole Acetic Acid
GA_3	---	Gibbrellic Acid
pH	---	Negative logarithm of hydrogen ions concentration
ppm	---	parts per million
DM	---	Dry matter
cv.	---	Cultivars
EC	---	Electrical Conductivity
AEZ	---	Agro-Ecological Zone
ANOVA	---	Analysis of Variance
df	---	Degrees of freedom
CV(%)	---	Percentage of Coefficient of Variation
FAO	---	Food and Agriculture Organization
r	---	Linear correlation
EC	---	Emulsifiable Concentrates
LSD	---	Least Significant Difference
MSTATC	---	Computer based statistical software package

CHAPTER I

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) comes from Aztec word “tomatl” which belongs to the family Solanaceae. Due to its versatile species this family is also known as nightshade. Tomato was first originated in Peru and Northern-Chile (Salunkhe *et al*., 1987). It is the world’s largest vegetable category, representing 16%. Global tomato production is currently around 130 million tons, of which 88 million are destined for the fresh market and 42 million are processed. Top 5 largest tomato producing countries are: China, EU, India, US and Turkey. They account for 70% of global production. In Bangladesh, about 1,26,648 MT tomatoes produced from 17721 acres land (BBS, 2005) and it is considered as the second consumed vegetable next to potato in Bangladesh (FAOSTAT, 2011).

Cherry tomato (*Lycopersicon esculentum* var. *cerasiforme*) is regarded as a botanical variety of the cultivated tomato which is round in shape, similar to a cherry juicy and meaty berry, bigger than 1.5 cm in diameter (Silva & Giordano, 2000). Various colorful cherry tomatoes were found like Red, Black, Green, Bi-Color, White, Stripped, Yellow-Orange and Pink cherry tomato. Black cherry tomatoes are preferred for eating fresh or in salad, though they also lend themselves to being flash grilled or roasted. In addition, market value of the black cherry tomato is, on average, two to three times higher than other varieties (Araujo *et al*., 2013), which causes great interest from greenhouse producers (Soares *et al*., 2005) being a growing and promising market in Brazil (Pinheiro, 2016).The color of black cherry tomato is an indicator of the fruit’s stage of maturity. At its first sign of ripeness, the tomato will have a signature mahogany-brown coloring with green shoulders and it will be firm to touch, with a blend of sweet and tart flavors. As it ripens, the green deepens to brown, the flesh becomes slightly tender, and the flavor richens. At the peak of their maturity, black cherry tomatoes are low in acidity and they develop a smoky and sweet flavor. It produces large clusters of the one-inch round tomatoes on vigorous, tall, indeterminate plants that are easy to grow and can be grown in the greenhouse or outdoors in a sunny spot. Black cherry tomato fruits have good post-harvest life 10-14 days in room temperature. It has an excellent consumer acceptance due to its high sweetness (Preczenhak *et al.,* 2014) among other organoleptic characteristics superior to the traditional tomato fruits (Pinheiro, 2016). Black cherry tomatoes are good source for providing disease resistance and adaptability to fruit set even at high temperature (Prema *et al*., 2011). In conventional agriculture, heavy doses of inorganic fertilizers are often used to improve the yield black cherry tomato to meet out the increasing higher demand. Inorganic fertilizers have high nutrient contents and are rapidly taken up by plants. However, the use of excess fertilizer can result in a number of problems, such as nutrient loss, surface water and groundwater contamination, soil acidification or basification, reductions in useful microbial communities, and increased sensitivity to harmful insects. In addition, usage of inorganic fertilizer causes health hazard to the person who handle it. Moreover, chemical fertilizers are relatively inexpensive that they are out of reach of small and marginal farmers. In this regard, to reduce and eliminate the adverse effects of inorganic fertilizers, new agricultural practices have been developed in the so- called organic agriculture, ecological agriculture or sustainable agriculture. As the mode of release of essential nutrients from organic fertilizer is quite slow, suitable substitute or technique to improve the efficacy is required. Use of organic leachate from the same sources can be the answer. The application of organic leachate from cowdung, vermicompost and mustard oil cake results in higher growth, yield and quality of black cherry tomato. They supplies essential macro and micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Palekar, 2006). Overall, application of organic leachate in crop production is a new technique in Bangladesh and in case of cherry tomato production it would be promising one independent of inorganic fertilizer use.

Keeping above points in view, present investigation has been undertaken with the objectives to study the influence of different organic leachate on growth and yield of black cherry tomato.

CHAPTER II

REVIEW OF LITERATURES

Tomato is one of the most frequently consumed vegetable around the world as well as in Bangladesh. A wide range of cultivars present in Bangladesh, among them black Cherry Tomato also known as "Table Tomato" is the most promising one. Consumer interest for Organic Fruits and vegetables are rising from last several consecutive decades. Some of significant research work which have been done in home or abroad related to this experiment have been presented (yearly wise) in this chapter.

An experiment was conducted by Álvarez-Solís *et al*. (2016) to evaluate the effect of Bokashi and Bokashi amended with Vermicompost Leachate (VL) on the growth, yield and quality of jalapeño pepper (*Capsicum annuum* L.) and onion (*Allium cepa* L.) in monoculture and intercropping cultures. Bokashi significantly increased the number of leaves and plant height in onion (37 and 62%) and jalapeño pepper pepper (133 and 94%) compared with the control plants. In jalapeño pepper and onion, the content of capsaicin and soluble solids was 41 and 42% higher with the application of Bokashi plus VL, respectively. In onion, Bokashi increased the polar and equatorial diameters and bulb weight by 28, 69 and 269%, respectively and its yield increased from 6.4 to 21.0 t ha^{-1}.
Ávila-Juárez *et al*. (2015) conducted an experiment with tomato and the objective of this research was to incorporate vermicompost leachates (VCLs) into an irrigation system during tomato (*Solanum lycopersicum* cv. *Rafaello*) cultivation to evaluate their effects on the lycopene, β-carotene, and phenolic content of tomatoes and on the physical and chemical soil variables. They used three types of substrates to create VCLs: mushroom waste (MSHW), leaf-cutting ant waste (LCAW), and cow compost (CC). A total of 0.1 L of leachate per plant was added as a supplement to a nutrient solution (NS) and applied once weekly, twice weekly, or every fifteen days to three different treatments for each leachate. Results revealed that all VCLs had a positive effect on the production of lycopene; the best results were obtained by the application of the

MSHW (78 mg kg^{-1} fresh weight). The VCL decreased the presence of ions phytotoxic to plants by 99% and improved the soil structure by increasing the amount of organic matter and the hydraulic conductivity. However, the VCL had no effect on the physiological variables.

Four combinations of two solid organic fertilizers (Monterra Malt and chicken manure) were applied before planting strawberry and two liquid organic fertilizers (broad bean and Pioner Hi-Fruit/K-Max) given through drip irrigation (fertigation) and was compared with inorganic fertilization regarding growth, yield, nutrient concentration, and fruit quality of strawberries. Broad bean fertigation combined with Monterra Malt resulted in a similar fruit yield as inorganic fertilizer and a higher yield than Monterra Malt combined with Pioner; however, total soluble solids, firmness, and titratable acid were improved with Pioner fertigation, although these parameters were more affected by harvest time than the applied fertilizers. The concentrations of most nutrients in fruits and leaves were higher in inorganically fertigated plants. The reductions in fruit yield in three of four treatments and fruit weight in all organic treatments may be due to a combination of the following conditions in the root zone: (1) high pH and high NH_4^+/NO_3^- ratio; (2) high EC and/or high NaCl concentration; (3) cation imbalance; and (4) nutrient deficiency (Pokhrel *et al*., 2015).

Pot experiment was conducted by Kumar *et al*. (2015) to evaluate the effect organic manure (Farm Yard Manure, vermicompost and press mud) and biofertilizers (*Azotobacter*, phosphate solubilizing bacteria and *Azospirillum*) on growth and quality parameters of strawberry. The experiment was tested in Complete Randomized Design (CRD) with three replications and consisted of ten treatments namely T_1 (FYM + Azotobacter), T_2 (FYM + PSB), T_3 (FYM + Azospirillum), T_4 (Vermicompost + Azotobacter), T_5 (Vermicompost + PSB), T_6 (Vermicompost + Azospirillum), T_7 (Pressmud + Azotobacter), T_8 (Pressmud + PSB), T_9 (Pressmud + Azospirillum) and T_{10} (Control). 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 (TSS) (10.75° Brix), titrable acidity (0.82), vitamin C (57.24 mg/100gm fruit), total sugars (5.95 %) and juice content (79.50 %).

The best quality lettuce is assured by adequate fertilizing, steady supply of water and cool temperature. Most of the farmers are using inorganic fertilizers for lettuce in open fields and in hydroponics. However, there is an increasing demand for organically produced fruits and vegetables. Peiris *et al*. (2015) found fresh weight in T_3 (Glliricidia leaf extract) where the average EC and average pH were maintained at 0.43 dS/m and 5.85, respectively throughout the growing period. The highest NL and *LA* were also found in T_3, resulting a higher production of photosynthetic tissues; where the lowest *NL* and *LA* were observed in T_1 (Compost tea liquid). The highest *DW*, partitioned to leaves (*LDW*) and roots (*RDW*) were recorded in T_3. T_1 and T_2 (Poultry manure liquid) showed significantly lower dry matter partition to leaves and roots even though the highest EC (0.77dS/m) during the study period was recorded in T_2. The study revealed that *Glliricidia* leaf extract as the most favorable organic based liquid fertilizer for best growth performance of leaf lettuce while Compost tea liquid was the lowest. Poultry manure was an intermediate performer in case of vegetative growth in leaf lettuce.

Ali *et al*. (2014) observed the potential of vermicompost and mustard oil cake leachate as foliar organic fertilizer with reference to the growth, yield and TSS status of BARI hybrid tomato 8 and then examined their effects on different parameters. Treatments of the experiment were: No foliar application; foliar application of leachate from vermicompost and foliar application of leachate

from 1 2 mustard oil cake. The experimental data revealed significant increase in growth; yield and TSS on BARI hybrid tomato 8 due to foliar application of vermicompost and mustard oil cake. All parameters performed better results with the foliar application of the leachate from vermicompost which was very close the mustard oil cake. However, maximum number of fruits (30.9/ plant), yield (14.3 kg plot^{-1}) and TSS (4.7%) were found from the foliar application of leachate from vermicompost which was followed by mustard oil cake (28.4 plant^{-1}, 12.7 kg /plot and 4.2% respectively) whereas minimum from control.
In a study, organic and conventional fertilizer was tested on yield and nitrate reductase activity in saladette tomato. Tomato plants were grown under controlled greenhouse conditions and treated with either organic or conventional fertilizer. There were five treatments: F_1, sand + inorganic fertilizer; F_2, sand + vermicompost tea; F_3, 1:1 mixture of sand: compost + vermicompost tea; F_4, 1:1 mixture of sand: vermicompost + vermicompost tea; and F_5, 2:1:1 mixture of sand: compost: vermicompost + vermicompost tea. The evaluated variables were yield, fruit size, number of fruits, fruit quality, chlorophyll content, and in vivo nitrate reductase enzyme activity. Fertilizer type strongly influenced the yield, fruit size, and fruit quality. The best organic fertilizer for tomatoes was sand + vermicompost tea. Tomatoes in this treatment group produced the second highest yield, the best NO3- assimilation, the greatest nitrate reductase enzyme activity and the second highest organic foliar nitrogen content. (Márquez-Quiroz *et al*., 2014).

Melek Ekinci *et al*. (2014) carried out an experiment to determine the effects of nanotechnology liquid fertilizer on the plant growth and yield of cucumber (*Cucumis sativus* L.). The doses of 2.0, 3.0 and 4.0 L ha^{-1} of Nanonat and Ferbanat were used as fertilizer source. The plant leaves were sprayed with Nanonat and Ferbanat suspension until becoming wet at ten day intervals for three times during plant growth. The results showed that the fertilizer treatments significantly improved the yield compared to control. The highest yield (149.17 t ha^{-1}) occurred in Ferbanat 4.0 L ha^{-1} application. As a result, this study suggested that the foliar applications of liquid fertilizer could improve the plant growth and yield of cucumbers.

Mehdizadeh *et al*. (2013) conducted an experiment to evaluate the vegetative growth yield quantity of tomatoes as affected by different organic fertilizers. The results showed that addition of organic fertilizers at rate of 20 ton ha^{-1} significantly increased tomato growth and yield compared to control (no fertilizer application). Also obtained results proved that tested treatments could be arranged in decreasing order as follows: municipal waste compost>poultry manure>cow manure>sheep manure>no fertilizer. Compost and poultry manure had a synergistic effect on both fresh and dry weights of tomato shoots and roots and compared to other treatments. As a general result using of organic fertilizers especially in composted form had positive effect on soil health and fertility, which consequent increase yield in long term can be expected.

Hibiscus esculentus was allowed to grow in the medium of vermicompost and urea to evaluate the effect of vermicompost and urea on the growth and yield. There were 3 treatments viz., control, vermicompost (T_1) and urea (T_2). The germination percentage, shoot length and yield of the plant were recorded on 20th, 40th and 60th days. From the study, maximum plant height (19.8 ± 2.9 cm), number of flower (21.3±0.36), number of fruit (15.0), fruit weight (10.3 g), total fruit weight (185.0 g) and fruit length (12.3 cm) was observed from application of vermicompost on *Hibiscus esculentus*. This study revealed that vermicompost seems to be maintained the soil which is ideal for growth of the plant. The highest yield of *Hibiscus esculentus* was found in vermicompost treatment (T_1) followed by urea (T_2) and lowest in control. Application of vermicompost increased the vegetative growth and yield of *Hibiscus esculentus* (Vanmathi and Selvakumari, 2012).

An experiment was carried out by Lamo *et al*. (2012) to find the effect of different organic nutrient sources on seed quality and yield characters of radish. Thirteen treatments comprising of organic manures, bio-fertilizers, inorganic and control (no treatment) were used. The observations were recorded on pod length (cm), number of seeds per pod, seed yield per plant and per plot (g), 1000-seed weight (g), seed germination (%) and vigor index. Analysis of variance showed highly significant difference among treatments. Among organic manures vermicompost was found comparatively better.

The potential of vermicompost was investigated as one of the substrate constituent on yield indexes of three strawberry cultivars. For this, four substrates consisted of (0%, 5%, 15% and 25% vermicompost indicated by S_1, S_2, S_3 and S_4 respectively) and three cultivars (Camarosa, Mrak and Selva) were used. The results of the experiment indicated that highest of diameter of crown, fruit length and yield were obtained in interaction of Mrak and S_2 (19.45 mm, 4.47 cm and 264.143 g respectively). The interaction of Selva and S_3 had more fruit number (26.63) than other treatments. Selva cultivar in S_4 had the highest of mean of fruit weight (12.33 g) also Mrak in S_4 had 44 more number of inflorescence than other treatments. Camarosa in S_1 had lower fruit length (2.66 cm) and mean of fruit weight (8.27 g) than other treatments also Selva in this substrate had the lowest of yield (140.79 g). The lowest of inflorescence number was observed in interaction of Camarosa and S_3. Selva in S_4 had the lowest of new diameter crown (13.47 mm) and fruit number (13.34 g) (Atefe *et al.*, 2012).

An investigation was accomplished by Attarde *et al.* (2012) on growth and nutrient status of *Abelmoschus esculentus*(okra plant). Various combinations of fertilizers such as Vermicompost (VC), Chemical Fertilizer (CF) and Farmyard Manure (FYM) were applied by followings, T_1: Control, T_2: (FYM 100%), T_3: (VC 100%), T_4: (CF 100%), T5: (VC 75% + CF 25%), T_6: (VC 75% + FYM 25%), T_7: (VC 50% +FYM 50%) and T_8: (VC 50% + CF 50%). The study indicated that that with the use of inorganic fertilizers plants physical characteristics were enhanced compared to other treatments whereas nutrient status of okra fruit was recorded maximum in treatment T_3 (VC 100%) and followed by T_6 (VC 75% + FYM 25%). Although, treatment T_4 has shown high potential for rapid growth of plant comparatively similar results in the growth of plant were observed in treatment T_5 (VC 75% + CF 25%). Thus combination of organic fertilizer along with inorganic fertilizer is beneficial for the physical growth of okra plant while nutrient content of okra fruit are dependent only on organic fertilizer dose.

An experiment was executed by Lamo *et al*. (2012) to find the effect of different organic nutrient sources on seed quality and yield characters of radish. 13 treatments consist of bio-fertilizers, organic manures, control (no treatment) and inorganic were used. The observations were recorded on pod length (cm), number of seeds per pod, seed yield per plant and per plot (g), 1000-seed weight (g), seed germination (%) and vigor index. Analysis of variance revealed highly significant differences among treatments. Among all organic manures vermicompost was found comparatively better.

Okra fruit production can be alternatively supported with application of organic manures, to reduce the use of chemical fertilizers. Experiments were conducted to assess the growth and yield of okra (Variety: NH47-4) with cowdung (CD) and poultry manure (PM). Plants were generally taller at 6 and 8 weeks after planting (WAP) with PM and CD. Application of the treatments provided the tallest plants of 34 cm with CD and 83 cm with PM at 8 WAP. Okra pod yields were lower with PM relative to CD. 10 tha^{-1} PM gave the highest yield of 640 kg ha-1while the highest of 1297 kg ha^{-1}, with 15 t ha-1 was got with CD. Poultry manure supports more of vegetative growth of okra while cowdung gives higher fruit yields have been traced by Makinde and Ayoola (2012).

Uddin *et al.* (2015) stated the performance of strawberry as affected by different organic manure. The experiment was conducted with 13 treatments and 3 replications. The treatment T_4 (RDF + Vermicompost 5 t/ha + Neem Cake 4 t/ha) was found significantly superior compared to other treatment combinations, which recorded highest mean value of plant height (21.20cm), plant spread (26.62 cm^2), number of leaves per plant (16.23), petiole length (13.93cm), number of fruits per plant (4.20) and average fruit weight (19.51g). The highest yield per plant (286.56g) and yield per hectare (17.19 t/ha) were also obtained from treatment T_4 (RDF + Vermicompost 5 t/ha + Neem Cake 4 t/ha) followed by T_3 (RDF + Vermicompost 5 t/ha + Neem Cake 2 t/ha) and lowest yield was obtained from T_0 (control).

An experiment was carried out to determine the effects of vermicompost on growth and productivity of cymbidium plants (*Cymbidium* sp.). Cymbidium was grown in a container medium including 50% pumice, 30% charcoal, 10% vermiculite and 10% peat moss, which was basic plant growth medium substituted with 10%, 20%, 30% and 40% (by volume) vermicompost besides control consisted of container medium alone without vermicompost. Greatest vegetative growth was recorded from substitution of container medium with 30% and 40% vermicompost and lowest growth was in potting mixtures containing 0% vermicompost. Most flower buds and inflorescences occurred in potting mixture containing 30% and 40% vermicompost and also causes most and greatest number of flower, greatest length of inflorescences in 30% vermicompost. Some of cymbidium growth and productivity enhancement, resulting from substitution of container medium with vermicompost, may be explained by nutritional factors; however, other factors, such as plant-growth regulators and humus might have also been involved since all plants were supplied regularly with all required nutrients (Hatamzadeh and Masouleh, 2011).

Vermicompost is a very important biofertilizer produced through the artificial cultivation of worms i.e., vermiculture. Vermicompost is enriched with all beneficial soil bacteria and also contain many of the essential plant nutrients like N, P, K and micronutrients. It increases soil aeration, texture and tilt. Plant grown in vermicompost pretreated soil exhibited maximum increase in all morphological parameters such as root length, shoot length, number of root branches, number of stem branches, number of leaves, number of flowers, number of pods and number of root nodules in four months sampling in comparison to untreated, FYM treated and DAP treated soils in *Pisum sp.* and *Cicer sp.* (Sinha *et al*., 2010). Furthermore, in vermicompost pretreated soil, number of N_2 fixing bacterial colony were maximum and showed highest diversity indices (1.6 and 0.99 and 2.0 and 0.99 for *Cicer sp.* and *Pisum sp.* respectively) than FYM, DAP and untreated control.

The pot experiments were carried out by Deore *et al*. (2010) with five doses (1% - 5%) of novel organic leachate along with untreated control plants. Observation of growth performance of capsicum revealed the consistent and significant results due to application of novel organic liquid fertilizer. Out of five different treatments, the 3% treatment resulted in maximum plant height; number of branches per plant; leaf number; leaf area; fresh and dry weight of the plant; number of fruits per plant and total yield compared to other doses.

Though organic fertilizers release nutrients slowly than mineral fertilizer results in decreased S and P concentration in plants leaves, which in turn limits growth and yield. However, leachates treatment easily accesses their nutrient composition for the plants. Nileema and Sreenivasa (2010) evaluated the influence of liquid organic manures *viz.*, panchagavya, jeevamruth and beejamruth on the growth, nutrient content and yield of tomato in the sterilized soil. Significantly highest plant growth and root length was recorded with the application of RDF + Beejamruth+Jeevamruth+Panchagavya and it was found to be significantly superior over other treatments. The application of Beejamruth+ Jeevamruth + Panchagavya was next best treatment and resulted in significantly highest yield as compared to RDF alone. The N, P and K concentration of plants was significantly highest in the treatment given RDF + Beejamruth + Jeevamruth + Panchagavya.

Rakesh and Adarsh (2010) reported that soil and 45% cowdung + vermicompost increase various growth and yield parameters of tomato like mean stem diameter, mean plant height, yield/plant, marketable yield/plant, mean leaf number, total plant biomass were recorded for each treatment. The efficacy of Seaweed leachate of different concentrations obtained from green seaweed *Ulva lactuca* was assessed on the growth, pigments, total chlorophyll, total protein, total carbohydrate and total lipid and the yield of a flowering plant *Tageteserecta*. The combined effect of 1.0% SLF of *U. lactuca* with different proportions of recommended rate of chemical fertilizers was also made on the test plant. Among the concentrations, plants that received 1.0% SLF and 50% recommended rate of chemical fertilizers showed a maximum growth characteristic, total number of flower and fresh weight of flowers (Sridharand Rengasamy, 2010).

A study was accomplished by Thirumaran *et al*. (2009) to observe the effect of Seaweed Liquid Fertilizer of *Rosenvi geaintricata* with or without chemical fertilizer on seed germination, growth, yield, pigment content and soil profile of *Abelmoschus esculentus.* From his study it is clear that 20% SLF with or without chemical fertilizer shows the higher growth, yield, chlorophyll pigment and soil profile compared to other concentration.

Rasool *et al*. (2008) obtained that vermicompost at rate of 15 t/ha significantly increased growth, yield of tomato compared to other treatments (0, 5, 10 t/ha). It also increased EC of fruit juice and percentage of fruit dry matter up to 30 and 24%, respectively. The content of K, P, Fe and Zn in the plant tissue increased 55, 73, 32 and 36% compare to untreated plot respectively.

Manatad and Jaquias (2008) evaluated growth and yield performance of vegetables as influenced by the application of different rates of vermicompost. Data on plant height, number of fruits/plant, length of fruits, diameter of fruits, fruits weight/plant and yield were gathered and analyzed. Findings of their study exposed the following: Chemical analysis of vermicompost used in the experiment has 26.32% organic matter (DM); 2.09% N; 2.57% P; 0.44% K; 1.04% Ca; 0.45% Mg; 73.50 ppm Cu; 118.75 ppm Zn; 1055 ppm Mn; and 3257.5 ppm Fe. It has a pH of 6.9. In watermelon, fruit length, diameter, weight of fruits/plant and yield were significantly influenced by vermicompost application except for the length of vines and number of fruits. In eggplant, all parameters were markedly influenced by the application of the different rates of vermicompost except for the fruit length and diameter. In tomatoes, different rates of vermicompost generated significant variation on the fruit length and diameter, weight of fruits and fruit yield. In sweet pepper, all parameters significantly increased, regardless of the amount of vermicompost applied. The application of vermicompost significantly lowered the severity of bacterial wilt incidence in sweet pepper while in eggplant and tomatoes infestation was slightly reduced by statistically comparable in all treatments.

Federico *et al*. (2007) executed an experiment to evaluate growth, productivity and chemical characteristics of tomatoes (*Lycopersicum esculentum*) in a greenhouse condition. Five treatments were applied combining vermicompost and soil in proportions of 0:1, 1:1, 1:2, 1:3, 1:4 and 1:5 (v/v). Addition of vermicompost increased plant heights significantly, but had no significant effect on the numbers of leaves or yields 85 days after transplanting. Yield of tomatoes were significantly greater when the relationship of vermicompost:soil was 1:1, 1:2 or 1:3, 100 days after transplanting. Addition of sheep-manure vermicompost decreased soil pH, titratable acidity and increased soluble and insoluble solids in tomato fruits compared to those harvested from plants cultivated in unlamented soil. Sheep-manure vermicompost as a soil supplement increased tomato yields and soluble, insoluble solids and carbohydrate concentration.

Vermicompost applications in strawberries can increase beneficial microbial populations, which enhance production of plant growth hormones auxin, gibberellin, cytokinin and humic acid. Several experiments in strawberry have indicated that these hormones and acids may improve plant growth, leaf area, shoot biomass, number of flowers and runners (Arancon *et al.*, 2004) and yield (Arancon *et al*., 2004; Singh *et al*., 2008). According to Arancon *et al*. (2006) vermicompost applications are known to increase microbial biomass N and protect fruit marketability through reduction in physiological disorders and fruit disease.

Kannan *et al*. 2006 reported that application of recommended quantities of vermicompost to different field crops has been reported to reduce the requirement of chemical fertilizers without affecting the crop yield. Application of 100% nitrogen as vermicompost registered the higher plant height and number of branches per plant of tomato and it was significantly superior over supplementation of 100% N through urea and FYM similar trend was found in plant height of basmati rice at maturity with the application of vermicompost and it was on par with treatment receiving azolla at the rate 1.5 ton/ha. A progressive increase in plant height and leaf area index of soybean was observed with the conjunctive use of 75% N through vermicompost and remaining 25% N through chemical fertilizer and was found at par with 100% N through vermicompost alone. Additive benefit realized from vermicompost application (Govindan and Thirumurugan, 2005) might be ascribed to its higher nutrient contents and their availability to crop.

According to Nagavallemma *et al.* (2004) Vermicompost provides all nutrients in readily available form and also enhances uptake of nutrients by plants. Earthworms consume various organic wastes and reduce the volume by 40–60%. Each earthworm weighs about 0.5 g to 0.6 g eats waste equivalent to its body weight and produces cast equivalent to about 50% of the waste it consumes in a day. These worm castings have been analyzed for chemical and biological properties. The moisture content of castings ranges between 32% and 66% and the pH is around 7.0. The worm castings contain higher percentage of both macro and micronutrients than the garden compost. Soil available N increased significantly with increasing levels of vermicompost and highest N uptake was obtained at 50% of the recommended fertilizer rate plus 10 t ha-1 vermicompost. Vermicompost reduces C:N ratio and retains more nitrogen. The prolonged immobilization of soil nitrogen by the vermicomposted organic manures was attributed to the recalcitrant nature of its C and N composition. It increases macro pore space ranging from 50 to 500 μm, resulting in improved air-water relationship in the soil which favorably affects plant growth. The application of vermicompost favorably affects soil pH, microbial population and soil enzyme activities.

Arancon *et al.* (2004b) applied organic fertilizer produced commercially from cattle manure, market food waste and recycled paper waste to tomatoes *(Lycopersicon esculentum),* bell peppers *(Capsicum anuumgrossum),* and strawberries (*Fragaria* spp.). The result revealed that the marketable tomato yields in all vermicompost-treated plots were consistently greater than yields from the inorganic fertilizer-treated plots. Leaf areas, numbers of strawberry suckers, numbers of flowers, shoot weight and total marketable strawberry yields increased significantly in plots treated with vermicompost compared to those that received inorganic fertilizers only besides significant increases in shoot, leaf areas and total and marketable fruit yields of pepper plants from plots treated with vermicomposts. The author mentioned that improvement in plant growth and increases in fruit yield could be due to large increases in soil microbial biomass after vermicompost applications, leading to production of hormones or humates in the vermicompost acting as plant-growth regulators independent of nutrient supply.

Vermicomposting is a bio-oxidation and stabilization process of organic material that involves the joint action of earthworms and microorganisms. The earthworms are the agents which help for turning, fragmentation and aeration. It also raises N2 fixation by both nodular and free living N2 fixing bacteria and thus increase plant growth. Vermicompost has been proved as one of the cheapest source of nitrogen and other essential elements for better nodule formation and yield particularly in legumes. Such plants can meet their N needs through both biological nitrogen fixation (symbiosis) and native nitrogen in the soil (Parthasarthi and Ranganathan, 2002).

In a study, Nair *et al*. (1997) compared the microorganisms associated with vermicomposts with those in traditional composts. They found that the vermicomposts had much larger populations of bacteria (5.7 x 107), fungi (22.7 x 104) and actinomycetes (17.7 x 106) compared with those in conventional composts. The outstanding physiochemical and biological properties of vermicomposts make them excellent materials as additives to greenhouse container media, organic fertilizers or soil amendments for horticultural crops.
A large beneficial microbial population and biologically active metabolites, particularly gibberellins, cytokinins, auxins and B vitamins were observed with application of vermicompost alone or in combination with organic or inorganic fertilizers, so as to get better yield and quality of diverse crops (Tomati *et al*., 1983; Bano and Kale, 1987 and Bhawalker, 1991).

Subbaiah *et al*.(1985) conducted an experiment with tomato and brinjal to evaluate the effect of FYM and micronutrients under soil fertility status. The author concluded that the main reason for extended mean fruit weight and fruit yield by the application of FYM with NPK and vermicompost was attributed to solubilization effect of plant nutrients by the addition of vermicompost and FYM leading to increased uptake of NPK.

CHAPTER III

MATERIALS AND METHODS

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

3.1 Study area

The study was carried out during the period from October 2015 to April 2016 at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. It lies within the $23^0$74 N latitude and $90^0$35' E longitudes with an elevation of 8.2m from sea level (UNDP-FAO) in the Agro-Ecological Zone of Madhupur Tract (AEZ No. 28).

3.2 Climatic condition

Experimental site was located in the subtropical monsoon climatic zone, characterized by a heavy rainfall during the months from April to September (Kharif season) and a scantly rainfall during the rest of the year (Rabi season). Plenty of sunshine and moderately low temperatures prevail during October to March (Rabi season), which is suitable for black cherry tomato (the test plant) growing in Bangladesh.

Temperatures above 25ºC, when accompanied by high humidity and strong wind, result in reduced yield. Night temperature above 20ºC accompanied by high humidity and low sunshine lead to excessive vegetative growth and poor fruits production. High humidity leads to a greater incidence of pests and diseases and fruit rotting. Rabi season is therefore preferred for Black cherry tomato production.

3.3 Geology and Soil

The inherent soil character closely related to “The Modhupur Tract”, AEZ-28.

Upper layer of soil was silt clay in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and had organic carbon 0.45%. The area was well furnished with irrigation and drainage network and above level. The selected plot was medium high land.

3.4 Planting materials

In this experiment Black cherry tomato germplasm was used as experimental material which was collected from Takii Seed Company, Japan on October 2015. Planting materials contain 100 and 80 percentage purity and germination respectively. On the other hand, all of the organic fertilizers *viz.* cowdung, mustard oil cake, vermicompost and chemical fertilizer were collected form Krishibid Upokoron Nursery, Agargaon, Dhaka-1207.

3.5 Leachates preparation

Vermicompost, Cowdung and Mustard oil cake at the rate of 250g, 250g and 150g each respectively were place into a jar with 10 litter tap water. The mixture was stir continuously for thorough mixing. Then the mixture was kept in room temperature for about 48 hours to filtrate the liquid extract. The leachate extracts were then separated from the solution and applied in the soil as side dressing.

3.6 Experimental design and layout

Experiment was laid out in randomized complete block design (RCBD) with 3 replications. Whole field was divided into 3 homogenous blocks and individual plot size was $3m^2$. A distance of 0.5m from block to block and 60×40 cm^2 plant to plant was maintained. The seedlings were distributed randomly to each row in each block. Hypothetical field view is present in (Fig. 1).

3.7 Treatments of the experiment

The single factor experiment was conducted to observe the effects of organic leachate on growth and yield of black cherry tomato.

Treatments were as follow:

Treatment	Basal Application	Top Dressing at 15 days interval in 3 times
T_1	Cowdung (CD)	--
T_2	CD + BARI dose	Cowdung leachate
T_3	CD + BARI dose	Vermicompost leachate
T_4	CD + BARI dose	Mustard oil cake leachate
T_5	CD + BARI dose	--

3.8 Cultivation procedure

3.8.1 Seedbed preparation and raising seedling

Black cherry tomato seeds were sown in the seedbed at Horticulture Farm in 1st October, 2015. Before sowing, seeds were treated by Captan 75 WS @ 1.5 to 2.0 g a.i./litre for 5 minutes to protect seedlings from soil borne diseases. Twenty five days old seedlings were transplanted to the main field.

3.8.2 Main field preparation

Soil was well pulverized by power tiller and was exposed to sun about one week. Then several ploughing followed by cross ploughing, harrowing, spading and laddering done for uniform soil making. Weeds and stubbles were completely removed and soil was treated by little amount of lime (5kg/plot) to keep the soil free from pathogen. The plots were divided into several uniform blocks according to experimental design (mentioned earlier).

3.8.3 Application of manures and fertilizers

Manures and well decomposed organic matter were used @ 15 ton per hectare before terminating land preparation. The chemical fertilizers like Urea, TSP, MOP were mixed with soil as the source of nitrogen, phosphorus and potassium at the rate of 100, 200 kg and 90 kg per hectare respectively as basal application during final land preparation (BARI, 2011). Organic leachate *viz*., cowdung, vermicompost and mustard oil cake were applied at 15 day's interval in three times.

3.8.4 Transplanting of seedlings

Twenty five days old seedlings were transplanted in the main field and specific plots were tagged according to the treatments.

3.8.5 Intercultural operations

Irrigation

Surface irrigation was commonly practiced during the experimental period. Due to crops specific demands for high soil water content achieved with leaf wetting, trickle or drip irrigation has been successfully applied throughout the growing season.

Weeding

Weeding was done after transplanting to prevent competition between the plants and weeds. Weeding was done with a hoe three times during the study period. First weeding was carried out four weeks after transplanting and the second and third weeding were carried six and eight weeks respectively after transplanting.

Disease and pest control

In order to pest control Pest Exclusion Net (PEN) technology was used during the whole growing season.

3.9 Parameters of data recording

3.9.1 Plant height (cm)

Plant height was measured with a ruler. It was done by measuring the plant from the base at the ground level to the terminal growth point. The height was recorded for the sampled plants and the mean was determined by dividing the total heights with total number of plants.

3.9.2 Number of leaves per plant

This was determined by single counting the mature leaves per plants and average was taken.

3.9.3 Leaf area (cm^2)

Leaf area was measured by using CL-202 Leaf Area Meter (USA) in centimeter square. Mature leaves above 20 cm from the ground level were used for this purpose and expressed in cm^2. Then the mean was calculated.

3.9.4 SPAD value

SPAD value was determined by using the portable chlorophyll meter (SPAD-502, Minolta, Japan) from each of the treatments and expressed in percentage. Three mature leaves were randomly selected from each treatment and data were taken from three portions of each leaves randomly and then the mean values were calculated.

3.9.5 Days to first flowering

Each plot was daily observed to record the date of first flowering. The period from the transplanting date to the date of first flowering was recorded and expressed in term of number of days. The average values per line were calculated on plot basis.

3.9.6 Number of flower per plant

The numbers of flowers per plant were recorded from the tagged plant as per experimental treatments.

3.9.7 Days to first fruit setting

Days to first fruiting were recorded from transplanting date to the date of first fruiting of every entry.

3.9.8 Number of fruit per plant

The number of fruits harvested in maturity indices from three plants of each treatment was recorded. From this data total number of fruits per plant was calculated.

3.9.9 Fruit length and diameter

Fruit length and diameter were measured using Digital Caliper-515 (DC-515) in millimeter (mm). Mean value was determined for each treatment.

3.9.10 Fruit weight (g)

Fruit collect form three randomly tagged plants of each treatment were weighted with the help of an electric precision balance in gram. Total fruit weight of each plot was obtained by addition of individual fruit weight and mean fruit weight was acquired from division of total fruit weight by total number of fruits.

3.9.11 Brix %

Brix was measured by refractometer (ERMA, Tokyo, Japan) at room temperature. 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.

3.9.12 Days to first maturity

The data were recorded from the date of transplanting to fruit maturity of plants of each entry.

3.9.13 Yield/plant (kg)

Fruit yield/ plant were calculated from weight of total fruits divided by number of total plants.

3.9.14 Yield/ha (ton)

Yield/ ha was computed and expressed in ton per hectare.

3.10 Statistical analysis

The collected data as per specific parameters were statistically analyzed to find out the significant variation between different treatments. The mean values were evaluated to measure the analysis of variance by the "F" (Variation ratio) test following MSTAT-C computer packaging program. How these test results have statistically significant was estimated by the least significant difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

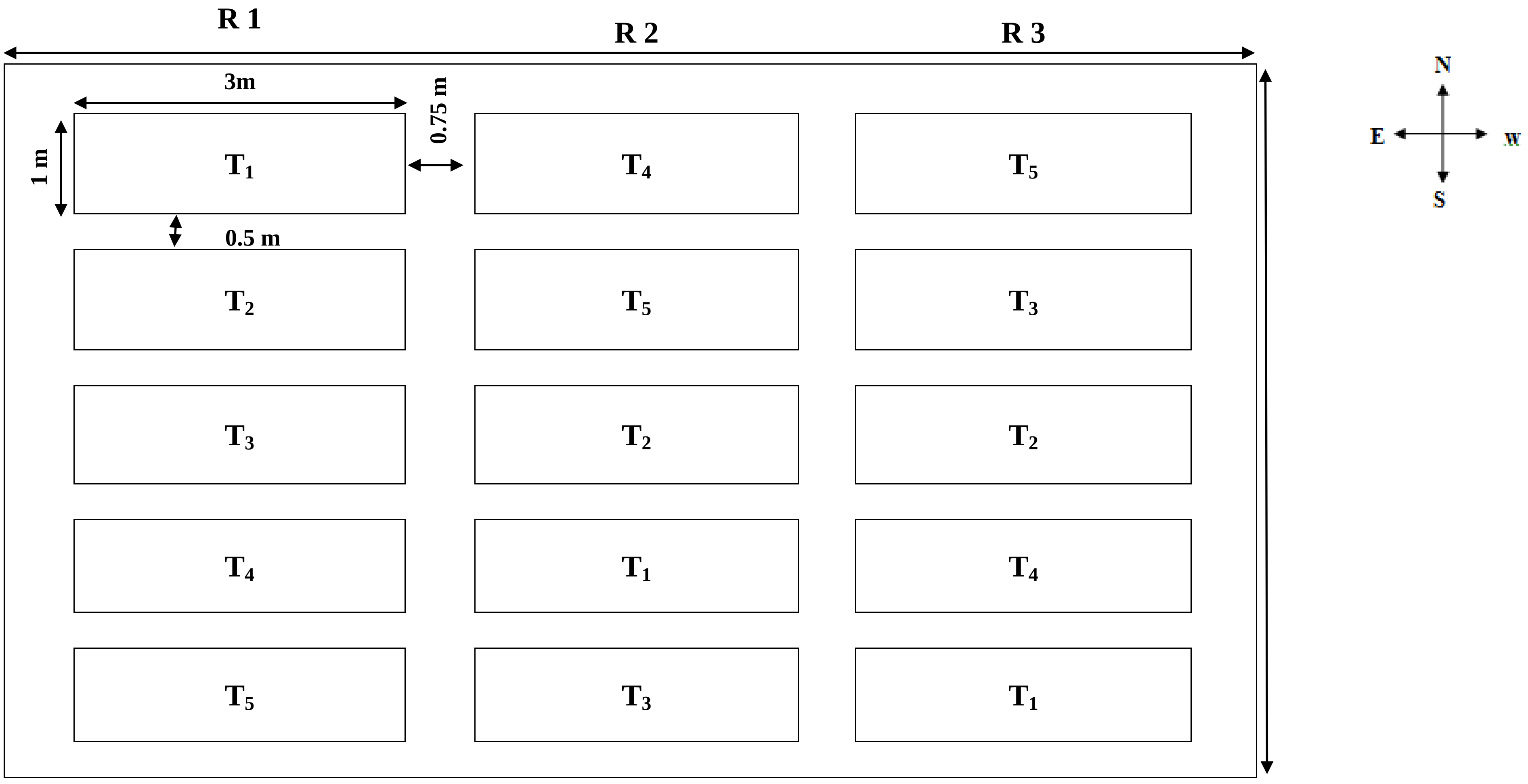


Fig. 1 Sketch of experimental plot

Plate 1. Different instrument used in data collection (a) Whole plant of cherry tomato plant (b) Plant height measuring by meter scale (c) Fruit weight measurement by using Electronic PrecisionBalance in gram (d) Slide caliper for fruit diameter (e) Refractometermeasuring Brix (%) (f) Leaf area measurement using CL-202 Leaf Area Meter (USA) in cm^2

CHAPTER IV

RESULT AND DISCUSSION

The experiment was performed to evaluate the vegetative growth of black cherry tomato and its yield performance against different organic leachate. Findings of the research work have been presented and discussed in this chapter. Illustration of this chapter has been focused by tables and figures to enhance their parallel and dissimilar character through discussion, comprehension and perceiving. A summary of the analysis of variances in regard to all parameters have been arrayed in appendix. Results have been presented, discussed and possible interpretations are given under the following headings.

4.1 Plant height

It is considered that plant height is the most influential parameter among others, which is positively correlated with the yield of black cherry tomato. Plant height was recorded at different days after transplanting (DAT) and at the final harvest period. Organic leachate influence plant height of black cherry tomato (Appendix I) and height of black cherry tomato exposed statistically significant inequality among control, cowdung, vermicompost and mustard oil cake leachate andchemical fertilizer at 30, 50, 60 and 90 DAT (Figure 1). The mean plant height ranged from 53.7 cm to 178.8 cm and maximum plant height was obtained at 90 days after transplanting. Tallest plant (176.4 cm) was observed in T_3 treatment whereas least height (150.6 cm) was in T_4 treatment at 90 DAT of black cherry tomato plantlets. Study referred that vermicompost increase plant height and judgment represents similar findings to Federico *et al.*(2007). They found that vermicompost leachate induced the largest increase in tomato plant heights and stem diameters in the 1:4 vermicompost:soil treatment. Microbes like fungi, bacteria, yeasts, actinomycetes, algae etc are capable of producing auxins, gibberellins etc in appreciable quantity during vermicomposting (Brown, 1995; Arancon *et al*., 2004), which affects plant growth appreciably (Tomati *et al*., 1987; Arancon *et al*., 2006). Rakesh *et al*.

(2010) also reported that mean plant height (cm) of tomato in treatments VC15 (Soil+15% VC), VC30 (Soil+30% VC), VC45 (Soil+45% VC) were 63cm, 63.4cm and 63.5 cm respectively, which were greater than mean plant height of 38cm reported in soil (control). Vermicompost was not so stimulatory or was inhibitory in the mineral soil which contained higher N, P and K than the peat medium. Changes in the physical properties of the medium may have also contributed to increase plant growth.

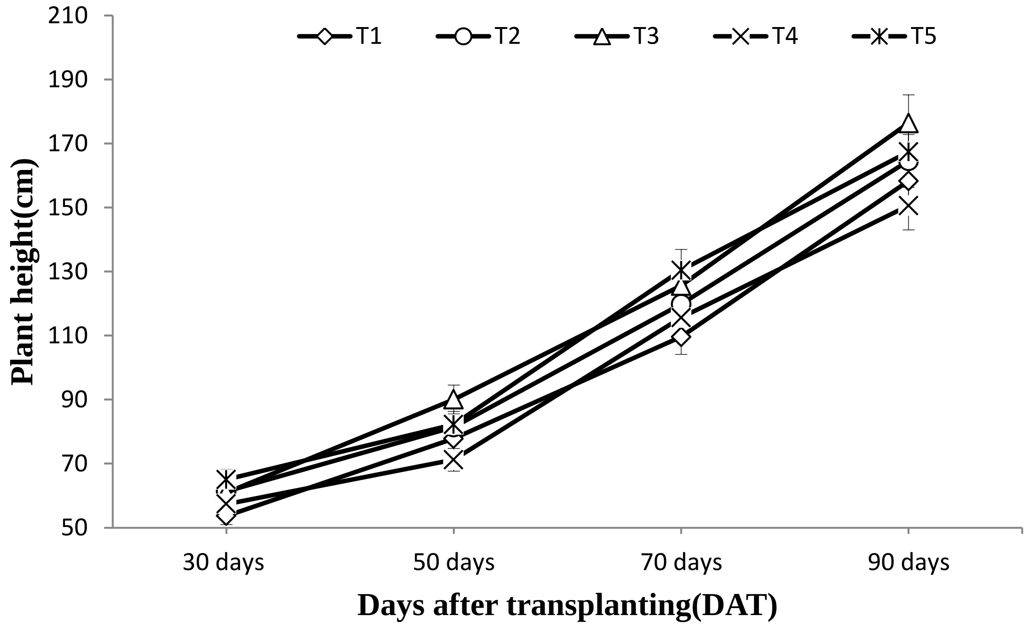


Fig. 2. Performance of black cherry tomato on plant height at different days after transplanting

T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

4.2 Number of leaves per plant

Leaves are important vegetative organ, as it assists plant in photosynthesis, transpiration and respiration process**.** Different nutrients have appreciated effect on the number of leaves per plant at different DAT. Higher leaf number indicates wholesome growth and development. Total number of leaves per plant showed significant influence on yield of black cherry tomato (Appendix II). The highest leaf per plant (123/plant) was recorded from T_3 treatment whereas T_1 treatment showed the lowest leaves (100/plant) (Figure 2) at 90 days after transplanting. Due to available nutrient in vermicompost leachate, plants grown with this treatment produce higher number of leaves. Result was supported by Yourtchi *et al*., (2013) and Bongkyoon *et al*., (2004) who mentioned that application of vermicompost performed the best response on leaf number of potato plant.

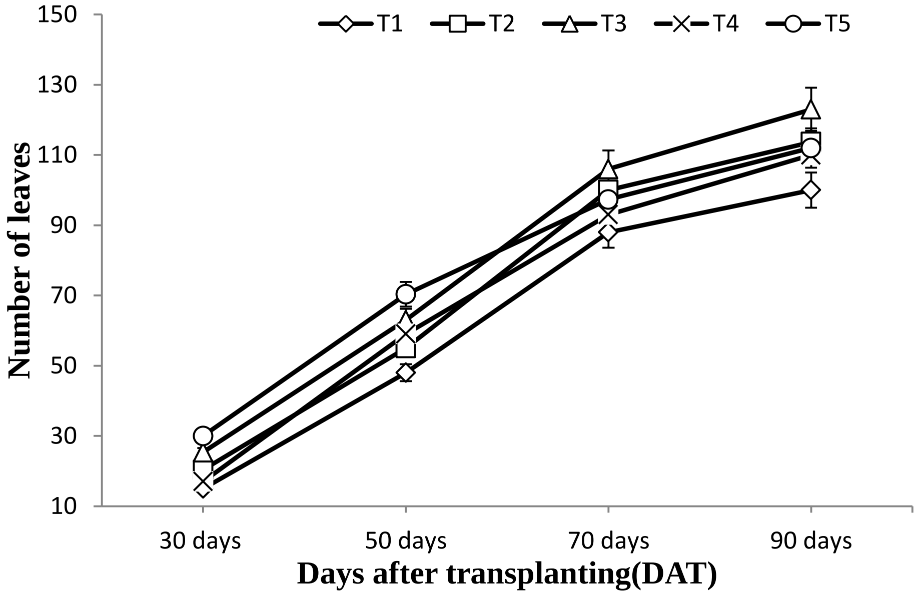


Fig. 3. Performance of black cherry tomato on leaf number at different days after transplanting.

T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

4.3 Leaf area (cm^2)

Black cherry tomato revealed statistically significant difference in case of leaf area with respect to different treatment (Appendix III). Maximum leaf area was found from T_3 (132.8 cm^2) and the minimum (104.1 cm^2) was T_5 (Figure 3). According to Wolk *et al*. 1983leaf area distribution in a tomato canopy is an important factor for maximizing plant photosynthetic capacity. Application of vermicomposts at rate of 15, 10 and 5 t ha^{-1} increase leaf area about 43, 35 and 18%, respectively in comparison to control (Azarmi *et al*., 2008). Aracon *et al*. (2004) also reported positive effect of vermicompost on the growth and yield in strawberry, especially increases leaf area.

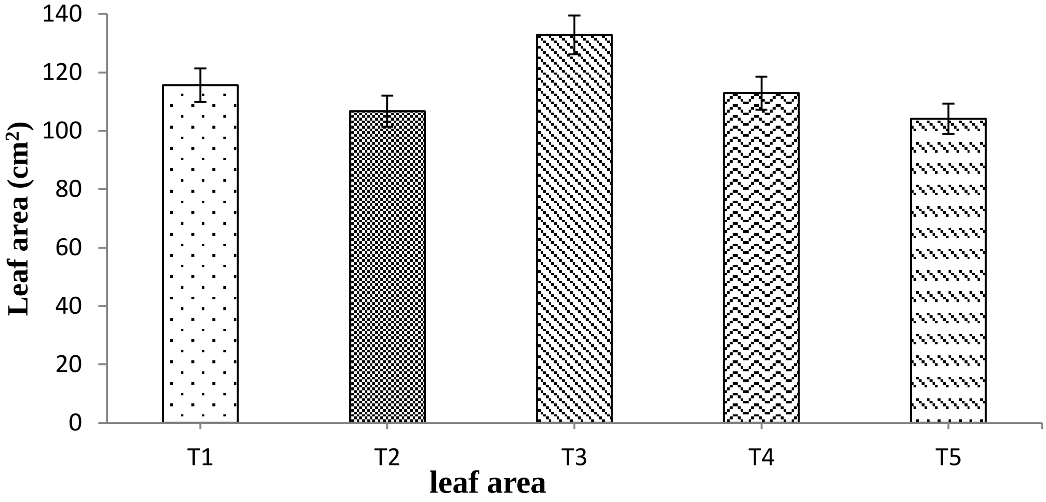
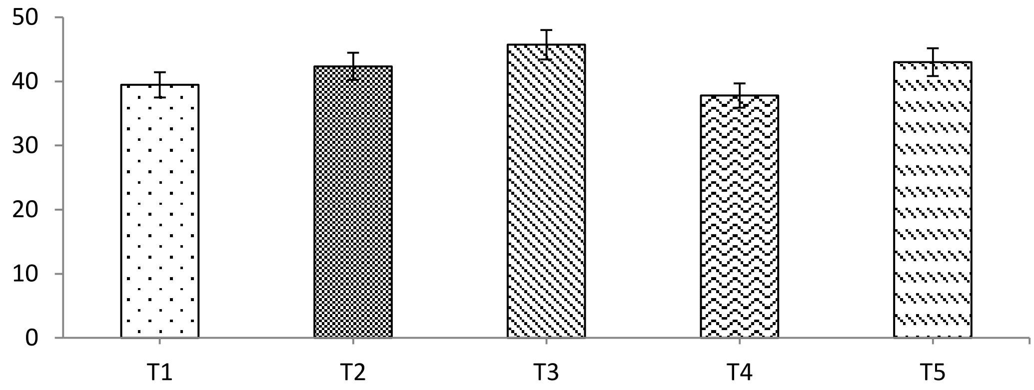


Fig. 4. Leaf area (cm^2) of black cherry tomato at different treatments

T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

4.4 SPAD value (%)

SPAD reading showed significant variation in black cherry tomato (Appendix III). Highest value was observed from T_3 (45.7%) which was statistically similar to T_2 and T_5. Whereas, lower SPAD value (37.8%) was found in T_4 (Figure 4). Vermicompost is ample source for nitrogen content. Chlorophyll contents are usually increased with the increase of N contents (Callistus and Anthony, 2014). Cimrin and Boysan (2006) also reported a significant relationship between organic matter (OM) and N content. Leaf chlorophyll content is often highly correlated with leaf N status, photosynthetic capacity and RuBP carboxylase activity (Evans, 1998; Seemann *et al.*,1987); a loss in chlorophyll coincides with development of grain filling. Whapham *et al*. (1993) observed that the application of SLF of *Ascophyllumn odosum* increased the chlorophyll levels of Cucumber cotyledons and tomato plants.



Cholorophyll %

Fig. 5.SPAD value (%) of black cherry tomato at different treatments

T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

4.5 Days to 1st flowering

Significant dissimilarity was found in days to first flowering due to different treatments (Appendix III). Earliest flowering (37.3 days) was observed in T_3 treatment while late flowering (43.0 days) was in T_2 Treatment (Table 1). Vermicompost produced from cattle and pigs manure as well as food wastes increased the rate of germination, growth and flowering of a range of ornamental and vegetable seedlings compared with vermicompost from other sources (Atiyeh *et al*., 2000). In an experiment involving vermicompost derived from water hyacinth (*Eichhornia crassipes* L.) on the growth and flowering of *Crossandraund ulaefolia* showed best performance. The amount of vermicompost had a significant effect on not only growth and flowering of the Marigold plants, but also on the plant shoot and root biomass, plant height and diameter of the flowers (Pritam *et al*., 2010). Such effects of vermicompost on flowering and fruiting of strawberry might be attributed to the fact that higher doses of vermicompost have resulted in to better growth of plants and consequently they took lesser days to flower and produced higher fruit yield than those receiving inorganic fertilizers only (Bulluck, 1995; Atiyeh *et al*., 2000, 2001; Arancon *et al*., 2004, 2006).

4.6 Number of flower cluster per plant

Number of flower cluster per plant was significantly varied in black cherry tomato with different treatment levels (Appendix IV). Flower cluster was the highest (15.0 cluster/plant) in T_3 treatment which was statistically similar to T_2 and T_5. The lowest (10.3 cluster/plant) was in T_1 treatment (Table 1). Present study notifies that application of vermicompost leachate to black cherry tomato increases number of flower cluster per plant which is alike to Nileemas and Sreenivasa (2011). Vermicompost pretreated soil enhance flower number in *Pisum sp.* and *Cicer sp*. (Sinha *et al*., 2010) also in *Hibiscus esculentus* (Vanmathi and Selvakumari, 2012).

4.7 Number of flower per cluster

The variation of flower number per cluster in black cherry tomato was observed due to divergence organic leachate sources (Appendix IV). The mean number of flower per cluster varies from 13.3 to 25. Higher flower number (25 flower/cluster) in a single cluster was found in T_3 treatment whereas the lowest (13.3 flower/cluster) in T_1 treatment (Table 1). Similar results were obtained by Arancon *et al*. (2008). Black cherry tomato plants from vermicompost treated soil had most and greatest number of flowers; reason may be explained as the availability of plant nutrient. However, other factors, such as plant growth-regulators and humates might have also been involved since all plants were supplied regularly with all required nutrients narrated by Hatamzadeh and Masouleh (2011). They found supreme number of flowers from vermicompost in *Cymbidium.*

Table 1. Influence of organic leachate on black cherry tomato related to days to 1st flowering, flower cluster per plant and number of flower per cluster[X]

Treatments[Y]	Day to 1st flowering	Flower cluster/plant	Flower/cluster
T_1	42.0 b	10.3 b	13.3 e
T_2	43.0 a	12.3 ab	17.0 c
T_3	37.3 e	15.0 a	25.0 a
T_4	40.0 c	11.7 b	15.0 d
T_5	39.0 d	13.3 ab	20.3 b
$Lsd_{0.05}$	0.5	3.3	1.3
CV %	0.6	14.1	3.7

[X]In a column, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.
[Y] T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

4.8 Days to 1st fruiting

Timing of first fruiting varied according to treatments (Appendix IV). Data reveals that early fruit setting (44.7 days) was in T_5 treatment which was statistically similar to T_3 treatment. Delay fruiting (49.0 days) was observed in T_4 treatment (Table 2).

4.9 Number of fruit per cluster

Highly notable dissimilarity was found in black cherry tomato with respect to number of fruits/cluster (Appendix V). The highest number of fruits/cluster (17.0 fruits/cluster) was recorded by T_3 treatment and lowest number of fruit/cluster (9.33 fruits/cluster) in T_1 treatment (Table 2). The increase in number of fruits/cluster might be due to highest flowers/cluster resulting higher fruit set percentage.

4.10 Number of fruit per plant

Different treatments remarkably influenced production of fruit per plant (Appendix V). Treatment T_3produced maximum number (117.0 fruit /plant) of fruits while minimum (108.00 fruit/plant) was obtained from T_1 treatment (Table 2). This finding is corresponding with Patil *et al*. (2004). He observed that significantly highest numbers of fruits (42.07 per plant) were recorded in the plants supplemented with 3 % of liquid organic fertilizers in tomato. Nanotechnology liquid fertilizer ferbam at applications increases 25–45% in the number of tomato fruit and flowers (Ferbanat, 2013). Vermicompost has larger populations of bacteria, fungi and actinomycetes compared with conventional composts also outstanding physico-chemical and biological properties (Nair *et al.,* 1997) can increase number of fruit.

Table 2. Performance of organic matter on black cherry tomato related to days 1st fruiting, numberof fruit/cluster and fruit/plant[X].

Treatments[Y]	Days to 1st fruiting	No of fruit/cluster	No of fruit/plant
T_1	47.00 ab	9.33 e	108.00 e
T_2	46.00 ab	13.33 c	113.00 c
T_3	45.00 b	17.00 a	117.00 a
T_4	49.00 a	11.00 d	110.00 d
T_5	44.67 b	15.00 b	114.00 b
$Lsd_{0.05}$	3.10	1.19	0.84
CV %	3.56	4.82	0.40

[X] In a column, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.
[Y] T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

T_1 **T_2**

T_3 **T_4**

T_5

Plate 2. Pictorial view of fruit of different treatments

T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

4.11 Fruit length (mm)

After application of different organic leachate showed conspicuous variations in fruit length (Appendix V). Longest fruit (41.6 mm) was found in T_3 treatment which was statistically similar to T_5 treatment (39.11 mm). Shortest (30.5 mm) was inT_1 treatment (Table 3). Nanotechnology liquid fertilizers significantly ($p < 0.001$, $p < 0.01$ and $p < 0.05$) affected the fruit length and dry matter statistically in cucumber (Melek *et al.*, 2014) like *Hibiscus esculentus* (Vanmathi and Selvakumari, 2012). Tadesse and Hiwot (2011) found similar result in Tomato, onion and pepper. Similar result was observed in radish pod length (Lamo *et al*., 2012); in tomatoes, sweet pepper, watermelon (Manatad and Jaquias, 2008) from vermicompost treatment.

4.12 Fruit diameter (mm)

Distinct diameter was noticed in each individual organic leachate application(Appendix VI). Maximum fruit girth (32.1 mm) was found from T_3 treatment and minimum fruit girth (26.9 mm) was found from T_1 treatment (Table 3).

4.13 Fruit weight (g)

Black cherry tomato fruit weight was varied significantly by the application of different organic leachate (Appendix VI). Maximum fruit weight (9.80 g) was found in T_3 treatment. Least significant variation was observed in T_5 treatment whereas lowest (8.50 g) in T_4 treatment (Table 3). In Bangladesh, single fruit weight to cherry tomato ranges from 7 to 14 g (Uddin *et al.*,2015). Deore *et al.*(2010) also found higher fruit yield in chilli (360.1 g/plant) in 3 % vermicompost treated plants, which might be due to increase in values of fresh weight of the fruits per plant. Similar result was also reported by Kondapa *et al*. (2009) (chilli), Singh *et al.*(2010)(tomato) and Mamta *et al*. (2012) (brinjal). Fruit weight of okra was also reported to increase due to the amplification of nutrient content through the application of vermicompost (Attarde *et al*., 2012).

Besides vermicompost reduces C:N ratio (Nagavallemma *et al*., 2004) which might be responsible for the maximum fruit weight.

Table 3. Influence of organic leachate on black cherry tomato related to fruit length, Fruit diameter and Fruit weight[X]

Treatments[Y]	Fruit length(mm)	Fruit diameter (mm)	Fruit weight (gm)
T_1	30.45 d	26.93 b	8.50 c
T_2	35.92 bc	29.39 ab	9.00 bc
T_3	41.75 a	32.13 a	9.80 a
T_4	32.45 cd	28.24 b	8.70 bc
T_5	39.11 ab	30.01 ab	9.40 ab
$Lsd_{0.05}$	4.17	3.11	0.72
CV %	6.17	5.63	4.22

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

[Y] T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

4.14 Brix(%)

Data regarding brix percentage are shown in (Appendix VI). Statistical analysis of the data showed that organic fertilizers leachate had significantly affected brix percentage. The highest percentage (3.64%) was observed in T_3 treatment and the lowest percentage (1.55%) was found in T_5 treatment which was statistically similar to T_1 treatment (Table 4). Treatment of vermicompost reduce pH level in soil, titratable acidity (Federico *et al*., 2007) and makes soil slightly acidic thus help to rise the sweetness of strawberry. Marquez and Cano (2005) reported values between 7.2 and 7.9 brix in cherry tomato produced organically under greenhouse conditions. Macronutrients are also liable for the sweetness of Tomato. Vermicomposts provided easy accessible of macro and micronutrients (Singh *et al*., 2010). Addition of vermicompost into soil helps to increase the density of microbes and also gives the vital macro nutrients *viz*., N, P, K, Ca, Mg (Amir and Ishaq, 2011; Giraddi, 1993) and micronutrients *viz*. Fe, Mo, Zn, Cu etc (Giraddi, 1993). Rakesh and Adarsh (2010) reported that soil+45% vermicompost has a positive effect on fruit sugar and similar finding was suggested by Davies and Winsor (1967).

4.15 Days to maturity

Variation in days to maturity was noticed in cherry tomato as per different treatments (Appendix VII). Early maturity (67.7 day) was found from T_2 treatment and delay maturity (81.3 days) was noted in T_3 treatment (Table 4).

4.16 Yield per plant (kg)

It was observed from the results that cherry tomato statistically differed by means of the total fruit weight per plant due to different treatments (Appendix VII). Maximum yield per plant (1.12 kg) of black cherry tomato was observed in T_3 treatment and it was analogous to T_5 treatment (1.11 kg) whereas lowest yield was found in T_1 treatment (0.92 kg) (Table 4). This findings is similar to Deore (2010) who reported that higher fruit yield in chilli was (360.14 g/plant) in 3 % organic liquid treated plants, which might be due to increase in values of fresh weights of the fruits per plant. Similar results were obtained by Kondapa *et al*.(2009) in chilli plants treated with organic fertilizers. 3.0 L ha^{-1} doses of Nanonat and Ferbanat applications have improved the yield of tomatoes (Ekinci *et al*., 2012) and in potatoes with 35–40% and in cabbages with 38–42% (Ferbanat, 2013). Such effects of vermicompost on flowering and fruiting of strawberry might be attributed to the fact that higher doses of vermicompost have resulted in to better growth of plants and consequently they took lesser days to flower and produced higher fruit yield than those receiving inorganic fertilizers only (Brown, 1995; Atiyeh *et al*.,2000, 2001; Arancon *et al*.,2006)

4.17 Yield/ha (t)

Significant variation was recorded for yield per hector among black cherry tomato with respect to different treatments (Appendix VII). The highest yield (46.8 t/ha) was found from T_3 treatment followed by T_5 treatment (45.7 t/ha) while the lowest result was found from T_1 treatment (38.2 t/ha) (Table 4).

Though organic fertilizers released nutrients more slowly than mineral fertilizers, resulting in decreased S and P concentrations in the leaves, which limit growth and yield, leachate treatment easily supplies their nutrient composition to the plants. So these treatments attributed to better vegetative growth, more number of fruits cluster per plant, highest average fruit weight, higher fruit set percentage and taller plants over.

Table 4. Effect of organic fertilizer on black cherry tomato related to brix percentage, Days of fruit maturity, Yield/plant and Yield/ha[X]

Treatments[Y]	Brix%	Days of fruit maturity	Yield/plant (kg/plant)	Yield/ha (ton/ha)
T_1	1.63 c	75.67 ab	0.92 c	38.20 d
T_2	3.06 b	67.67 b	1.02 b	42.53 b
T_3	3.64 a	81.33 a	1.12 a	46.77 a
T_4	2.94 b	72.67 ab	0.97 bc	40.50 c
T_5	1.55 c	77.33 ab	1.11 a	45.67 a
$Lsd_{0.05}$	0.42	9.80	0.06	1.59
CV %	8.69	6.95	1.55	1.97

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

[Y] T_1: only cowdung as basal, T_2: CD with BARI fertilizer dose (basal)+CD leachate, T_3: CD with BARI fertilizer dose(basal)+VC leachate, T_4: CD with BARI fertilizer dose(basal)+MOC leachate, T_5: CD with BARI fertilizer dose.

CHAPTER V
SUMMARY AND CONCLUSION

Summary

In order to evaluate the performance of liquid fertilizer on Black cherry tomato, an experiment was executed during the period of October, 2015 to March, 2016 at Horticultural farm, Sher-e-Bangla Agricultural University. Five treatments were used in this experiment and it was outlined in a Randomized Complete Block Design (RCBD) with three replications.

Collected data were statistically analyzed to evaluate the performance of different treatments. The findings of the experiment are summarized in this chapter.

The mean plant height ranged from 53.67 cm to 178.8 cm, the maximum plant height was at 90 days after transplanting. The tallest height (176.4 cm) was observed in T_3 treatment whereas least height (150.60cm) was in T_4 treatment at 90 DAT of black cherry tomato plantlets. The highest number of leaves (123 plant^{-1}) produced per plant by T_3 treatment whereas T_1 treatment showed lowest leaves number (100 plant^{-1}) at 90 days after transplanting. Maximum leaf area was found from T_3 (132.8 cm^2) and the minimum (104.1 cm^2) was in $T_{5.}$ The highest value was observed from T_3 (45.73%) which was statistically similar to T_2 and T_5 whereas, the lowest SPAD value (37.8%) was found in $T_{4.}$ The earliest flowering (37.3 days) was observed in T_3 treatment while late flowering (43.0 days) was in T_2 Treatment. Flower cluster was maximum (15.0 cluster/plant) in T_3 treatment which was statistically similar to T_2 and T_5. Lowest (10.33 cluster/plant) was reported from T_1 treatment. The mean number of flower per cluster varies from 13.3 to 25. Higher flower number (25 flower/cluster) in a single cluster was found in T_3 treatment whereas lowest (13.3 flower/cluster) in T_1 treatment. Data reveals that early fruit setting (44.7 days) was in T_3 treatment which was statistically similar to T_5 treatment. Delay fruiting (49.0 days) in T_4 treatment.

Highest number of fruit/cluster (17.0fruits/cluster) was recorded by T_3 treatment and lowest number of fruit/cluster (9.3fruits/cluster) in T_1 treatment.

Treatment T_3 produced maximum number (117.00 fruit /plant) of fruits while minimum (108.00 fruit/plant) was obtained from T_1 treatment. The longest fruit (41.8 mm) was found in T_3 treatment which was statistically to T_5 treatment (39.11mm). Shortest (30.5 mm) was in T_1 treatment. Maximum fruit girth (32.1 mm) was found from T_3 treatment and minimum fruit girth (26.9 mm) was found from T_1 treatment.

Maximum fruit weight (9.80 g) was found in T_3 treatment. Least significant variation was observed in T_5 treatment whereas lowest (8.50 g) in T_4 treatment. The highest percentage (3.6%) was observed in T_3 treatment but lowest percentage (1.6%) was found in T_5 treatment which was statistically similar to T_1 treatment. The earliest maturity (67.7 day) was found from T_2 treatment and delayed maturity (81.3 days) was noted in T_4 treatment. Maximum yield per plant (1.12 kg) of black cherry tomato was observed in T_3 treatment and it was analogous toT_5 treatment (1.11 kg) whereas lowest yield was found in T_1 treatment (0.92 kg). The highest yield (46.77 t/ha) was found from T_3 treatment followed by T_5treatment (45.67t/ha) while the lowest result was found from T_1 treatment (38.20t/ha).

Conclusion

Regard as the above summary, it can be concluded that vermicompost leachate performs as an excellent result among other treatments in terms for growth, yield and quality attributes of black cherry tomato. As the yield of black cherry tomato was higher in vermicompost application along with chemical fertilizer application than other organic fertilizer hence T_3 treatment can be used in replace to inorganic fertilizer.

Suggestion

Results are presented on the basis of one-year experiment; further trials are needed to substantiate the results.

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APPENDICES

Appendix I. Analysis of variance on plant height of Black cherry tomato at different days after transplanting

Source of Variation	Degrees of freedom (df)	Mean square of plant height			
		30 days	50 days	70 days	90 days
Factor A	4	55.9*	141.6*	200.1*	282.7*
Error	8	77.3	7.1	12.7	8.7

*: Significant at 0.05 level of probability

Appendix II. Analysis of variance on leaf number of Black cherry tomato at different days after transplanting

Source of Variation	Degrees of freedom (df)	Mean square of leaf number			
		30 days	50 days	70 days	90 days
Factor A	4	113.1*	211.1*	140.3*	203.6*
Error	8	0.4	0.8	2.3	8.1

*: Significant at 0.05 level of probability

Appendix III. Analysis of variance on leaf area (cm^2), chlorophyll % and days to 1st flowering of black cherry tomato at different treatments

Source of Variation	Degrees of freedom (df)	Mean square of		
		leaf area (cm^2)	chlorophyll %	days to 1st flowering
Factor A	4	380.8 *	28.9 *	15.6 *
Error	8	0.9	4.7	0.1

*: Significant at 0.05 level of probability

Appendix IV. Analysis of variance on Flower cluster/plant, Flower/cluster and Days to 1st fruiting of black cherry tomato at different treatments

Source of Variation	Degrees of freedom (df)	Mean square of		
		Flower cluster/plant	Flower/cluster	Days to 1st fruitng
Factor A	4	9.3 *	64.6 *	9.7 *
Error	8	3.1	0.5	2.7

*: Significant at 0.05 level of probability

Appendix V. Analysis of variance on no. of fruit/cluster, no. of fruit/plant and Fruit length of black cherry tomato at different treatments

Source of Variation	Degrees of freedom (df)	Mean square of		
		no. of fruit/cluster	no. of fruit/plant	Fruit length
Factor A	4	28.1 *	36.9*	64.6*
Error	8	0.4	0.2	4.9

*: Significant at 0.05 level of probability

Appendix VI. Analysis of variance on fruit diameter, fruit weight and brix% of black cherry tomato at different treatments

Source of Variation	Degrees of freedom (df)	Mean square of		
		fruit diameter	fruit weight	brix%
Factor A	4	11.4 *	6.4 *	2.6 *
Error	8	2.7	0.6	0.1

*: Significant at 0.05 level of probability

Appendix VII. Analysis of variance on Days to fruit maturity, Yield/plant and Yield/ha of black cherry tomato at different treatments

Source of Variation	Degrees of freedom (df)	Mean square of		
		Days to fruit maturity	Yield/plant	Yield/ha
Factor A	4	78.9*	0.2 *	8.1 *
Error	8	27.1	0.01	2.9

*: Significant at 0.05 level of probability

CHAPTER I

INTRODUCTION

CHAPTER II

REVIEW OF LITERATURE

CHAPTER III

MATERIALS AND METHODS

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER V

SUMMARY AND CONCLUSION