PERFORMANCE OF SWEET PEPPER IN RESPONSE TO DIFFERENT POTTING MEDIA AND *Trichoderma*

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PERFORMANCE OF SWEET PEPPER IN RESPONSE TO DIFFERENT POTTING MEDIA AND *Trichoderma*

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CERTIFICATE

This is to certify that the thesis entitled ***"PERFORMANCE OF SWEET PEPPER IN RESPONSE TO DIFFERENT POTTING MEDIA AND Trichoderma"*** *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* **MIR ARMAN HOSSAIN,** *Registration No.* ***13-05724*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: December, 2019
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DEDICATED TO-
My Beloved Parents and
Respected Research Supervisor

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The Author

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ABSTRACT

A pot experiment was accomplished in the Net House of Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka, during the period from October 2018 to march 2019. Two factors experiment was laid out in Complete Randomized Design with three replications. Factor A comprised with different potting media viz., M_0- soil (control), M_1- soil: coco peat (2:1 v/v), M_2- soil: vermicompost (2:1 v/v), and M_3- soil: coco peat: vermicompost (1:1:1 v/v) and factor B with different amount of *Trichoderma* viz., T_0- 0g/pot (control), T_1- 25g/pot and T_2- 50g/pot. The total treatment combinations were (3x4) 12. The result exhibited that different potting media significantly affected growth and yield of sweet pepper. The highest plant height (68.28cm), maximum number of fruits (12.44) and the highest fruit yield per plant (829.89 g), were recorded from M_3 (soil: coco peat: vermicompost (1:1:1 v/v)) treatment. In the *Trichoderma*, the highest plant height (67.64cm), maximum number of fruits (11.75) and the highest fruit yield per plant (765.25g) were found from T_2 (50g/pot) treatment. In respect of combination, the highest plant height (70.9cm), maximum number of fruits (14) and the highest fruit yield per plant (980g) were found from M_3T_2 treatment. So, among Different combinations, M_3T_2 showed better performance in terms of growth and yield of sweet pepper.

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LIST OF ABBREVIATIONS

BARI = Bangladesh Agricultural Research Institute

CRD = Complete Randomized Design

DAT = Day After Transplanting

cm = centimeter

mm = millimeter

g = gram

mg = milligram

LSD = Least Significant Difference

% = Percent

CV = Coefficient of Variance

MoP = Muriate of Potash

TSP = Triple Super Phosphate

hr = Hour

et al. = and others (at elli)

N = Nitrogen

Cr = Chromium

K = Potassium

P = Phosphorus

RSCEM = Rice Straw Compost with Effective Microorganism

SPAD = Soil Plant Analysis Development

CHAPTER I

INTRODUCTION

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Capsicum or sweet pepper (*Capsicum annuum*) is a flowering plant under the genus Capsicum and belongs to the family Solanaceae. It is relatively non-pungent with thick flesh and is the world's second most important vegetable after tomato (AVRDC, 1999). Tropical South America, especially Brazil is thought to be the original home of pepper (Shoemaker and Teskey, 1995). It is now widely cultivated in Central and South America, Peru, Bolivia, Costa Rica, Mexico, in almost all the European countries, Honkong and India. It is a popular fruit crop due to its combination of color, taste and heat (Howard *et al.,* 1994). It has high nutritive value and are rich source of vitamin C, bioflavonoid and 6-carotene (Jadczak *et al.,* 2010). Peppers are rich in capsaicin that may help works against inflammation, they have powerful antioxidant properties. Sweet peppers are used either green or red, come in a variety of different colors- range from green to yellow, red, orange, purple, and black. Red bell peppers are fully ripened with a milder, sweeter flavor. Other peppers include the red, heart- shaped; the pale green, slender and curved bull's horn which range in color from yellow to red and the sweet banana pepper which is yellow and banana shaped. Bell pepper is considered a minor vegetable crop in Bangladesh and its production statistics is not available (Hasanuzzaman, 1999). Economically it is the second most important vegetables crop in Bulgaria (Panajotov, 1998) and is thought to be the original home of pepper. It is now widely cultivated in America, Europe and some countries of the Asia-Pacific. It has great demand in Japan, Thailand, Philippines, Taiwan, Egypt and other countries even in Bangladesh. Small scale cultivation is found in peri-urban areas primarily for the supply to some city markets in Bangladesh (Saha and Hossain, 2001). The popularity of sweet pepper is increasing day by day in Bangladesh especially among the urban people because of its high nutritive value and possible diversified use in making different palatable foods. Generally it contains 1.29 mg protein, 11 mg calcium, 870 I.U. vitamin A, 17.5 mg ascorbic acid, 0.6 mg thiamin, 0.03 mg riboflavin and 0.55 mg niacin per 100 g of edible fruit (Joshi and Singh, 1975). In a survey on amount of vitamin C in fruits and vegetables, sweet peppers represented the highest fourth out of 42 choices (Frank *et al.,* 2001).

Soil or media is one of the major factors of sweet pepper production. It provides nutrients as well as physical support to the plant. Sweet pepper plant can be cultivated both in open field or a protected environment. In cities area there is lack of field for crop production. Here rooftop gardening are becoming more popular day by day. In rooftop gardening plants are grown in pot, drums, sack or container. As soil of cities area are poor in physical and chemical properties, potting media has become a headache of the owner of the garden. In additions coco peat, vermicompost and other organic compound can be used as potting media. Coco peat is a multipurpose growing medium made out of coconut husk. Its air-filled porosity and high water holding capacity makes it, an ideal growing medium for the plant crops. It is 100% organic and ecofriendly, free from soil borne pathogen and weed. It has a pH of 5.7 – 6.5, EC level <1 mS/cm is ideal for plant growth. In the contrary vermicompost, a by-product of earthworm mediated recycled organic waste which is rich in plant nutrients and growth promoting substances. It is a stable, fine granular organic manure, which increases soil quality by improving soil physical, chemical and biological properties. It also contains higher potassium and lower C: N ratio than cow dung and *Trichoderma* is a genus of fungi in the family Hypocreaceae. Many species in this genus are characterized as opportunistic avirulent plant symbionts and it helps to control soil borne disease and improve soil properties.

However, information regarding the effectiveness of different potting media and *Trichoderma* on growth and yield of sweet pepper cultivars isscanty. A detailed and systemic study is needed to find out the suitable potting media and *Trichoderma* dose to increase the yield of sweet pepper in Bangladesh.

Considering the above situation, the present experiment was conducted with the following specific objectives-

- To identify the suitable potting media for enhancing the fruit yield and quality of sweet pepper.
- To determine the optimum dose of *Trichoderma* for higher yield of sweet pepper.
- To find out the suitable combination of potting media and *Trichoderma* dose for ensuring the higher yield of sweet pepper.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Sweet pepper is one of the most widely grown vegetable in the world. Though it is a minor crops in our country, its popularity is raising day by day. People of our country is not so knowledgeable in regarding the procedure to increase the production of sweet pepper in pot by using suitable potting media. A few research works have been conducted in related to potting media and *Trichoderma* in Bangladesh. However, literature related to this regard were reviewed and will be contributed to a justification and for further use under following heading:

2.1 Coco peat on pepper production:

Coco peat is a multipurpose growing medium made out of coconut husk. The fibrous coconut husk is pre washed, machine dried, sieved and made free from sand and other contaminations such as animal and plant residue. Its air-filled porosity and high water holding capacity makes it, an ideal growing medium for the plant crops. It is 100% organic and ecofriendly, free from soil borne pathogen and weed. It has a pH of 5.7 – 6.5, EC level <1 mS/cm is ideal for plant growth.

Montejo *et al.* (2018) found that the yield of Bell Pepper fruit per plant (YFP) and number of fruit per plant (NFP) obtained in coconut fiber were 85% and 55% greater, respectively, than in soil.

Laurel *et al.* (2017) concluded an experiment on the application of used hydroponic substrate as soil amendment for crop production. In order to assess the effect of used hydroponic substrate in open field crop production, the experimental trial was conducted at the University of Mauritius Farm, using tomato (*Solanum lycopersicum* cv. Swaraksha). The treatments were applied at different growth stages and calculated on a weight basis as follows: 0% coco peat and 100% inorganic fertilizer (T1), 25% coco peat and 75% inorganic fertilizer (T2), 50% coco peat and 50% inorganic fertilizer (T3), 75% coco peat and 25% inorganic fertilizer (T4), and 100% coco peat and 0% inorganic fertilizer (T5) laid in a randomized block design with four blocks. The most significant difference in nitrogen content in the tomato plants was noted in T3, followed by T1 and T2; while T1 and T5 resulted in significant difference for

total plant phosphorus and total plant potassium ($p < 0.05$) as compared to control treatment.

Reshma, T. and Sarath, P.S. (2017) reported that the tomato variety Anagha grown in coco peat medium performed the best in terms of yield per plant (1.67 kg), average fruit weight (45.86g), plant height (69.36 cm), crop duration (85.73 days). They also found that the coco peat medium contained comparatively high amount of potassium (0.36 %) and also possessed high water holding capacity.

Kumarasinghe *et al.* (2016) observed the highest germination percentage 88%, the highest no. of leaves per seedling 6.1 and the maximum seedling heights 20.3cm of bell pepper in medium size particle (3 mm - 0.5 mm) of coco peat.

Kotur, S.C. (2014) investigated the Influence of fermented cocopeat on seedling vigor in some vegetables. He found Blending cocopeat:soil at 3:1 ratio caused some improvement compared to that with cocopeat alone or 1:1 and 1:3 blends of cocopeat:soil in tomato. Soil alone, placed in the pro-tray, also failed to equal the high seedling vigor produced by conventional raised bed method.

Charlo *et al.* (2011) opined that in coconut fiber under greenhouse condition the dry mass of the shoot of sweet pepper increased with time, following the experimental model exponential of first order, reaching a maximum of 451.5 g/plant and the production of dry mass of leaves, stem, root and fruit also increased over time reaching maximum values of 68.7, 65.8, 11.5 and 302.9 g/plant, respectively. The same occurred with the leaf area per plant, plant height and the absolute rate of growth, whose maximum values were 6.183,5 cm^2, 136.9 cm and 4.4 g/plant/day, respectively.

Torres *et al.* (2011) reported highest marketable fruit weight of sweet pepper in coconut coir in boxes along with Potting mix in pots, bags, and boxes, pine bark in bags.

Chul *et al.* (2009) observed that the water content in slab remained higher at coco peat than at rock wool. Sixty five percent water content in the slab was maintained by 112 mL/plant/time irrigation in coco peat and 150 mL/plant/time irrigation in rock wool. The EC change in slabs was more stable at coco peat with 3.0-5.0 ds/m than in rock

wool with 3.0-8.0 ds/m. The growth and fruit size were better and bigger at coco peat slab than at rock wool.

2.2 Vermicompost on pepper production:

Vermicompost, a by-product of earthworm mediated recycled organic waste which is rich in plant nutrients and growth promoting substances. It is a stable, fine granular organic manure, which increases soil quality by improving soil physical, chemical and biological properties. It is highly useful in raising seedling and for crop production.

Koshale *et al.* (2018) studied on the Effect of organic manure and inorganic fertilizer on growth, yield and physiological parameter of chilli *(Capsicum annum L.)* under 10 different treatment of T0 Control, T1 100% RDF of Inorganic, T2 100% FYM, T3 100% Poultry Manure, T4 100% Vermicompost, T5 25% RDF Inorganic + 75% FYM, T6 25% RDF Inorganic + 75% poultry manure, T7 25% RDF Inorganic + 75% Vermicompost, T8 33% FYM + 33% PM + 33% Vermicompost, T9, 25% RDF Inorganic + 25% FYM+ 25% poultry manure + 25% Vermicompost. The results showed significantly higher growth in plant height, number of leaves, number of branches, number of flower, number of fruit, fresh weight and dry weight per plant in treatment T6 (NPK+ poultry manure) in comparison to other treatments.

Nunes *et al.* (2018) accomplished an experiment on Vermicomposted tannery wastes in the organic cultivation of sweet pepper: growth, nutritive value and production. In this study, vermicomposted tannery wastes were applied in the organic cultivation of sweet pepper in a greenhouse. The effects of this organic matter addition on plant development and on the distributions of Cr (III) and Cr (VI) in plant tissues and organs were assessed. In a greenhouse, organic sweet peppers were cultivated adding vermicomposted tannery to the substrate (sample VRC) and the results were compared with the samples control (dYL; only soil) and reference (NPK; adding mineral fertilizer). The growth, nutritive value and fruit production were assessed to evaluate the plant development in different types of substrate. Besides evaluating the bio stimulant effect of vermicomposts, the distributions of Cr in plant tissues were also studied. It was found that the addition of vermicompost was bio stimulating to plants and positively influenced their development. Based on the Cr dynamics in the plants, since the Cr concentration was the same across all treatments, it demonstrated

that the addition of tannery residues to the vermicompost did not negatively influence the health benefits or food security of the produced fruits.

Alaboz *et al.* (2017) studied on the Effects of Different Vermicompost and Soil Moisture Levels on Pepper (*Capsicum annuum*) Grown and Some Soil Properties. In this study, vermicompost was applied to different levels (0%, 0.75%, 1.5%, 2.25% w/w) for a sandy loam soil. The irrigations were carried out at the levels of 80% PC and FC. Yield and some yield components were determined after 70 days from sowing. Effects of vermicompost were also, investigated on soil field capacity, wilting point and dispersion ratio. The differences found for plant height, weight, root weight, yield, leaf chlorophyll content were statistically significant. In addition, vermicompost applications provided to reduction of dispersion ratio.

Effects of Increasing doses of Vermicompost applications on P and K Contents of Pepper *(Capsicum annuum L.)* and Eggplant *(Solanum melongena L.)* was studied by Bellitürk *et al.,* (2017). The effects of the increasing doses of vermicompost implementation [0 (VC1), 3 (VC2), 5 (VC3), 7(VC4), %] on the P and K contents of pepper *(Capsicum annuum L.)* and eggplant *(solanum melongena L.)* have been investigated. The phosphorus and potassium contents of pepper plant were 0.0162% and 3.0454%, respectively, when the lowest dose (VC1) was considered, 0.0393% and 6.2519% respectively for the highest dose (VC4) application and the phosphorus and potassium contents of the eggplant plant were 0.0121% and 2.1462%, respectively, when the lowest dose (VC1) was considered, 0.0277% and 3.2843% respectively with the highest dose (VC4) application.

An experiment was carried out by Aminifard, M.H. and Bayat, H. (2016) to study the effect of vermicompost on fruit yield and quality of bell pepper. In this study effect of application of food waste vermicomposts to soil on antioxidant compounds, fruit yield and quality of sweet pepper (*Capsicum annum L.*) were investigated in field condition. Four vermicompost levels (0, 5, 10 and 15 t/ha) were applied to soil based on a randomized complete block design with three replications. The results showed that the highest (21.87 kg/m^2) and lowest (14.69 kg/m^2) fruit yield were achieved in plants treated with 5 t/ha vermicompost and control, respectively. Vermicompost treatments positively influenced fruit antioxidant compounds (antioxidant activity, total phenolic, carbohydrate content and total flavonoid). The highest antioxidant

activity (81%) and carbohydrate content were obtained in plants treated with 10 t/ha vermicompost, while their lowest values were recorded in the control plants. Fruit quality indices (pH, Titratable acidity, ascorbic acid and fruit firmness) were significantly influenced by vermicompost treatments. However, no significant difference was found for total soluble solids between treatments. There were 40, 61 and 56% increase in the amount of Titratable acidity, ascorbic acid content and fruit firmness following application of vermicompost (15 t/ha) when compared to their values in control, respectively. In conclusion, soil application of vermicompost can positively influence antioxidant compounds, fruit yield and quality of pepper.

Adhikari *et al.* (2016) studied the Effect of different sources of organic manure on growth and yield of sweet pepper. The treatments used were; Control, Chemical fertilizer, Vermicompost, Poultry manure, Farm yard manure, Goat manure and Commercial organic fertilizer. Effect of different treatments on growth and yield of sweet pepper was affected significantly. The results revealed better growth and yield performance by vermicompost followed by poultry manure over control and FYM. Chemical fertilizers, however, had similar yield as the previous mentioned treatments, but was slow in its flowering and fruiting behavior.

Kumar *et al.* (2016) studied on the Effect of Vermicompost, Cow Dung and Different Organic Manure Combination on Growth and Yield of Chili Crop *(Capsicum annuum L.).* The obtained results specified that the application of Vermicompost (Vermicompost @ 2.5 t ha^{-1}+ FYM @ 12.5 t ha^{-1}) show promising results in the cultivation of chili and better for obtaining the higher quality chili and further the cow dung and leave good growth and high yield of chili crop.

Ganeshnauth *et al.* (2015) found that Maximum chlorophyll level was present in the capsicum plants which treated with vermicompost and there were relatively high levels of pest and diseases in plants treated with chemical fertilizers, delayed flowering and fruiting period and high levels of leaf and fruit abscission as compared to plants treated with organic fertilizer (vermicompost).

A field experiment was conducted by Chandra, G. (2014) at the Agronomy research field, Sher-e-Bangla Agricultural University, Dhaka from November 01, 2014 to April 30, 2015 to find out the effect of 4 different vermicompost (Vm) levels *viz*., Vm1 - (control), Vm2 - (2 t ha^{-1}), Vm3 – (4 t ha^{-1}) and Vm4 – (6 t ha^{-1}) on growth,

yield and quality of 4 potato varieties. The results revealed that the yield of potato varieties were increased with increasing vermicompost levels and vermicompost 6 t ha^{-1} performed the best results.

Lari *et al.* (2014) conducted an experiment In order to evaluation of effect of coco peat and vermicompost bio fertilizers at different ratio's as media on qualitative traits of pepper, a factorial experiment in randomized completely block design with three replication in research greenhouse of 10 municipality of Tehran is done. Experimental treatments were: 1-vermicompost: perlite(1:1) 2-cocopeat: vermicompost (1:1) 3-coco peat: perlite: vermicompost (2:1:1) 4-coco peat: perlite:vermicompost (1:2:1) 5-coco peat: perlite: vermicompost(1:1:2) 6-coco peat: perlite(1:1)and the three varieties of Capsicum were as follows: *Capsicum annum var*. Alonso, Roxy, Baiela The result demonstrated that there are a significant difference in amount of Chlorophyll a in 1% and Chlorophyll b and Carotenoids was significant at the 5% level of significance. Different varieties have different answers to the substrates, so that chlorophyll a and b Alonso cultivar has highest average and in carotenoids Roxy has highest and Baiela least average. The results of vermicompost and perlite: coco peat (2:1:1) in characters Chlorophyll a and b, has the highest average. Finally The vermicompost: perlite: coco peat (1:1:2) was have highest average of carotenoids.

Ghimire *et al.* (2013) studied on the effects of organic manures and their combination with urea on sweet pepper production and found that the Weight per fruit was the highest (98.30 g) with FYM-50%+urea-50% followed by vermicompost-100% (94.52 g).

A field study was conducted by Lorraine, V.A. (2012) to compare four treatments [coffee VC, dairy compost, standard fertility (SFT) and no treatment (control)] for their effects on growth, yield and AA content of peppers. Coffee VC and dairy compost were applied at the rate of 22 t/ha and SFT was based on 212 kg/ha N. Yield, as well as AA content was not affected by the treatments evaluated; however, plant height and chlorophyll index were higher for VC and SFT treatments compared to dairy compost and the control.

Narkhede *et al.* (2011) found that increase in application of inorganic fertilizers in agriculture has detoriated the soil quality. Vermicompost as a soil conditioner has been emerging as a potential end use for maintaining soil productivity. The paper

examines the effect of chemical fertilizer and vermicompost on the growth of Capsicum annum crop. Initially analysis of soil was done in order to know its composition and lacking nutrients. Urea as chemical fertilizer was applied for the comparative study with vermicompost. Fertilizer at the rate of 0, 5, 10, 15 and 20% concentration was applied in the plot. Plant height, leaf length, number of leaves per plant, chlorophyll content in leaves, fresh weight, dry weight etc. were measured. Significant increase in plant height, leaf length and fruit yield of pepper plants was observed in plots treated with vermicompost. Maximum leaf chlorophyll content, 2.9% was estimated from the vermicomposting plot of 20%. Effective results were obtained after application of organic fertilizer as compared to the chemical fertilizer. Hence, in some fields if organic fertilizer applied at appropriate dose, it shows the potential to act as growth promoter for particular crop.

Berova *et al.* (2010) studied on Effect of organic fertilization on growth and yield of pepper plants *(Capsicum annuum L.)* and found that Nutrition with Lumbrical bio fertilizer produced by the Californian earthworm (*Lumbricus rubellus)* enhanced plant growth. The increased growth rate of the vegetative organs was accompanied by enhanced development of the generative ones.

Huerta *et al.* (2010) observed that the fruit production of Amashito pepper (*Capsicum annum var. glabriusculcum*) was significantly more in plants raised in vermicompost. Vermicompost significantly enhanced the highest weight (23.4g), height (26.7 cm) and production of leaves per plant (20.6 leaves per plant).

Catuiran *et al.* (2009) conducted an experiment on Performance of sweet pepper *(Capsicum annuum L.)* applied under different kinds of organic fertilizers under greenhouse condition. The treatments of the study were composed of the organic fertilizers: Sagana 100 (S100); ASU vermicompost (ASUV); Templonuevo vermicompost (TV); and rice straw compost with effective microorganism (RSCEM) and they found that the plants applied with S100 and TV comparably performed better than the ASUV and RSCEM in terms of number and weight of harvested fruits and number of marketable fruits per plant.

Azarmi *et al.* (2008) studied on the effect of vermicompost on growth, yield and nutrition status of tomato (*Lycopersicum esculentum*) with the different rates of

vermicompost (0, 5, 10 and 15 t ha^{-1}) which was incorporated into the top 15 cm of soil. The results revealed that addition of vermicompost at rate of 15 t ha^{-1} significantly (at $p<0.05$) increased growth and yield compared to control. Vermicompost with rate of 15 t ha^{-1} increased EC of fruit juice and percentage of fruit dry matter up to 30 and 24%, respectively.

Llaven *et al.* (2008) studied the effects of earthworm-processed sheep manure (vermicompost) on growth, productivity, and characteristics of bell pepper fruits (*Capsicum annum*) (Cv 'Ancho supremo') were investigated in a greenhouse experiment. Six treatments were applied combining vermicompost and soil in 0:1, 1:1, 1:2, 1:3, 1:4, and 1:5 (v/v) ratios. Plant characteristics were measured 21 and 90 days after transplanting. Addition of vermicompost increased plant size significantly with 8 cm in the 1:3 vermicompost: soil treatment compared to the unamended soil after 21 days, but no significant differences were found after 90 days. Seven more flowers were found in the 1:2 vermicompost: soil treatment and four in the 1:3 vermicompost: soil treatment compared to the unamended soil after 90 days. The number of marketable fruits per plant was significantly 1.5 and 1.9 times greater in the 1:2 and 1:3 vermicompost: soil treatments compared to plants cultivated in unamended soil after 90 days. The addition of vermicompost to soil increased soluble solids in pepper fruits > 2 Brix compared to fruits from plants cultivated in unamended soil while their pH was significantly lower. The nitrogen (N) content of the pepper fruits was significantly higher in the 1:4 vermicompost: soil mixture compared to the other treatments, whereas the fruits obtained from plants cultivated in the 1:3 and 1:4 vermicompost: soil treatments had higher titratable acidity values than in those from other treatments. It was found that amounts and characteristics of pepper fruits from plants cultivated in soil.

Arancon *et al.* (2002) studied on the Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries and they found that the marketable tomato yields in all vermicompost treated plots were consistently greater than yields from the inorganic fertilizer-treated plots. There were significant increases in shoot weights, leaf areas and total and marketable fruit yields of pepper plants from plots treated with vermicomposts compared to those from plots treated with inorganic fertilizer only. Leaf areas, numbers of strawberry suckers, numbers of flowers, shoot weights, and total marketable strawberry yields increased significantly

in plots treated with vermicompost compared to those that received inorganic fertilizers only. The improvements in plant growth and increases in fruit yields could be due partially to large increases in soil microbial biomass after vermicompost applications, leading to production of hormones or humates in the vermicomposts acting as plant-growth regulators independent of nutrient supply.

2.3 Review in relation to *Trichoderma*

The genus *Trichoderma* comprises a great number of fungal strains that colonize plants roots as a symbiont and have properties to stimulate plant growth and development. *Trichoderma* species have long been recognized as agents for the control of plant disease and for their ability to increase plant growth and development. It acts as a growth promoter and effective bio fertilizer for the crop production.

Kumar *et al.* (2019) reported that different isolates of *Trichoderma spp*. significantly influenced the root length, shoot length and number of leaves of chili at seedling stage. They found maximum root length and shoot length of 6.22 cm 7.33 cm respectively was recorded in seed treatment with *Trichoderma* isolate T2 [isolate from Rewa (Kuthulia)]. They also observed that maximum root length (6.84 cm), shoot length (62.19 cm), number of branches (5.82) was depicted in seed treatment coupled with its three foliar sprays of T2 isolate of *Trichoderma* by seed treatment coupled with three foliar sprays.

Delgadol *et al.* (2018) concluded an experiment on Effect of *Trichoderma* on Growth and Sporangia Production of *Phytophthora capsici.* In this study they evaluated the effects of three species of *Trichoderma*: *T. harzianum* (Th-7), *T. koningiopsis* (Tk NRRL50190) and *T. asperellum* (Ta NRRL50191) on two Mexican isolates of *P. capsici* (RDP-1 and RDP-2) obtained from commercial pepper fields in Aguascalientes, Mexico. The results suggest that Ta, Tk and Th could be used as potential bio control agents of *Phytopthora* root rot, however, further studies are necessary to test the in vivo protection of Ta, Tk and Th and their synergistic effects against *Phytophthora* root rot of chili peppers and other *P. capsici* susceptible solanaceous and cucurbitaceous crops such as tomatoes, squash, melons, and cucumbers.

Parra *et al.* (2017) concluded an experiment to estimate the potential of four native strains of *Trichoderma* as growth promoters of *Capsicum annuum L*. and as bio control against root knot nematode *Meloidogyne incognita*. They found that *T. atroviride* promoted greater height in the seedlings, while *T. atroviride, T. virens* and *T. harzianum*-C2 increased fresh weight in roots (60.14%) and both *T. atroviride* and *T. harzianum*-C2 produced up to 82.30% more dry root biomass. They also mentioned that the lowest galling indexes were estimated with all the *Trichoderma* strains (21.60% to 35%).

Olawumi *et al.* (2016) investigated the effectiveness of three *Trichoderma* species in controlling damping off disease caused by *Pythium aphanidermatum* in sweet pepper seedlings and to evaluate the contribution of the three *Trichoderma* species on overall growth performance. They reported that seedlings of sweet pepper treated with both *Trichoderma atroviride* and *Trichoderma harzianum* had higher emergence percentage than the un-treated seedlings, which was not significantly lower in emergence percentage from *Trichoderma koningii* treated pepper seedlings. They also mentioned that Presence of *Trichoderma* species enhance the growth of the developing plant root system *viz* the plant growth and yield through better nutrient uptake, production of growth promoting compounds and solubilization of phosphates, micronutrients and mineral cations like iron, manganese and magnesium necessary for plant metabolism.

Uddin *et al.* (2015) reported highest yield per plant of tomato (3.0 kg) obtained in T_1 *(Trichoderma* 100 g/m^2) treatment and lowest (1.4 kg) was in control. Their results also revealed that T_1 (87.1%) showed the higher seedling survival rate than the control (57.9%).

Haque *et al.* (2012) reported *Trichoderman* enriched bio fertilizers when supplemented with N fertilizer significantly boosted up the growth and yield of mustard and tomato. They found that application of 50% N fertilizer along with 50% *Trichoderma*-enriched bio fertilizers augmented 108 and 203% yields over control both in mustard and tomato, respectively.

Sriram *et al.* (2010) investigated on *Trichoderma* enriched coco peat for the management of *Phytophthora* and *Fusarium* diseases of chili and tomato in nurseries. In the study, coco peat enriched with *Trichoderma harzianum* was used for raising

tomato and chili seedlings to test the effect of the same on managing wilt caused by *Fusarium oxysporum* f. sp. *lycopersici* in tomato and damping off and root rot caused by *Phytophthora capsici* in chilies in nurseries. The enrichment with *T. harzianum*, resulted in reduced wilt incidence (5-7.5%) compared to control (38.75%) in tomato with increased plant growth parameters and there was reduction in *P. capsici* infection in chilies by up to 50% compared to coco peat without *Trichoderma* enrichment.

Altintas, S. and Bal, U. (2008) mentioned that *T. harzianum* significantly increased the marketable and total yield in bell pepper whereas the increase in early yield was not statistically significant. They found highest total and marketable yield plant^{-1} of 788 g and 685 g, respectively at 4.0 g m^{-2} dosage.

CHAPTER III

MATERIALS AND METHODS

Chapter III

MATERIALS AND METHODS

A pot experiment on Sweet pepper was accomplished with a view to study the influence of different potting media and doses of *Trichoderma* on growth and yield sweet pepper. In this chapter the description of different materials used and the methodology followed during the experimental period are presented:

3.1. Experimental site

The research was conducted at the Net House of "Field Laboratory of Plant Stress Management" at Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka-1207 during the winter season November 2018 to March 2019. The experimental field is located at 23°77′ N latitude and 90˚37′ E longitudes with an elevation of 8.24 m from the sea level.

3.2 Characteristics of soil used in pot

Soil was collected from the bank of the river Dhaleshwari, Hemayetpur, Savar which was alluvial in nature. The texture of the soil was sandy clay loam. The soil PH was 6.2 and electrical conductivity (EC) 2.0 ds/m. (Appendix I)

3.3 Weather and Climate

The experimental site belongs to sub-tropical climatic zone and characterized by heavy rainfall during the months of April to August and medium to low rainfall during the rest of the periods. The crop was grown in winter season when the day length (sunshine period) was reduced to 10.5-11.0 hours per day only. During the cropping period the Temperature ranged between 14.32°C and 34.58° C with generally 57.10 - 96.70 % humidity in the air.

3.4. Planting materials

Seeds of sweet pepper variety viz. KS 2201 was used as experimental materials. The seeds were collected from the Krishibid upokoron nursery. The seeds were healthy, well matured, vigorous, and free from other crop seeds and inert materials.

3.5 Experimental treatments and design

The experiment involved two factor completely randomized design with twelve treatment combination. The experimental pots were placed in ambient air at the net house premises of "Field Laboratory of Plant Stress Management lab." The treatments were as follows:

Factor A: Different potting media

M_0- Soil (control)

M_1- Soil: Coco peat (2:1 v/v)

M_2- Soil: vermicompost (2:1 v/v)

M_3- Soil: coco peat: vermicompost (1:1:1 v/v)

Factor B: *Trichoderma* powder

T_0- *Trichoderma* @ 0g/pot (control)

T_1- *Trichoderma* @ 25g/pot

T_2- *Trichoderma* @ 50g/pot

3.6 Seedbed preparation

Seedbed was prepared for raising seedlings of sweet pepper on 1 November 2018 and the size of the seedbed was 1m × 1m. The soil was well ploughed. Weeds and stubbles were removed from the seedbed. Cow dung was applied to the prepared seedbed @ 10 t/ha. The soil was treated by Sevin 50WP @ 5 kg/ha to protect the young plants from the attack of ants and cutworms. Seeds were treated by Vitavex-200 @ 5g/1kg seeds so that it can be protected from some seed borne diseases such as blight, anthracnose, etc.

3.7 Seeds sowing and raising of seedlings

Seeds were sown on 3 November, 2018 in the seedbed. 5 cm distance was maintained as spacing and seeds were sown at a depth of 2 cm and covered with a fine layer of soil followed by light watering by watering can. Thereafter, the beds were covered with polythene to maintain required temperature and moisture. Light irrigation and

weeding were done several times when needed. No chemical fertilizers were applied for raising of seedlings. Seedlings were not attacked by any kind of insect or disease.

3.8 Preparation of potting media and filling of pots

The size of the pot was 30 cm top diameter with a height of 25 cm. Thus, the surface area of an individual pot was 706.5 sq. cm. Plant parts, inert materials, visible insects and pests were removed from soil by sieving. Collected soil was dried under the sun. The dry soil was thoroughly mixed with coco peat (2:1 v/v) vermicompost (2:1 v/v) and coco peat and vermicompost (1:1:1 v/v) (Plate 1). Then the media were thoroughly mixed with *Trichoderma* powder as per treatment before filling the pot. The pots were placed in the net house with cover for seven days before transplanting the seedlings.

3.9 Application of fertilizer in the pot

The required amount of fertilizers (Urea- 250 kg/ha, TSP- 350 kg/ha, MOP- 250kg/ha and Gypsum- 110 kg/ha) was estimated on the basis of fertilizer recommendation from BARI (2014). As per such recommendation urea 9g, triple super phosphate (TSP) 12g, murate of potash (MOP) 9g per pot was applied. One third of urea and entire amount of TSP, MOP were mixed with the media in each pot before sowing. Rest of the urea was applied as side dressing at 30 and 60 days after transplanting.

3.10 Transplanting of seedling in the pot

Healthy and uniform 25 days old sweet pepper seedlings with 5-6 leaves were uprooted separately from the seed beds. To minimize damage of roots the seedlings were watered before uprooting. In the afternoon two seedlings were transplanted (Plate 1) to each experimental pot during the last week of November 2018. After transplanting light irrigation was given immediately by using watering can. During day time the newly transplanted young seedlings were shaded by polythene sheet to protect them from scorching sunshine up to a week. After seedling establishment one seedling was uprooted leaving one seedling in each pot.

3.11 Intercultural operations

For better growth and development of sweet pepper plant necessary intercultural operations were done properly in the pots. To keep the crop free from weeds, better

soil aeration and to break the soil crust weeding and mulching were accomplished as and when necessary.

3.11.1 Covering with net

The place where pots were kept was covered with mosquito net to protect the plant from insect infestation specially Aphid.

3.11.2 Staking

To protect the plant from damage caused by storm and strong wind the plants were stalked with bamboo sticks to keep them erect. Plastic ropes were used to tie the plants with bamboo sticks.

3.11.3 Weeding

The experimental pots were kept under careful observation. Weeding was done on when it necessary.

3.11.4 Irrigation

Light irrigation was provided to overcome water deficit to the individual pot immediately after transplanting. After establishment of seedlings, each pot was watered in alternate days to keep the soil moist for normal growth and development of the plants.

3.12 Pest and disease control

Insect infestation was a serious problem during the period of seeding establishment. Few young plants were damaged due to attack of mole cricket and cut worm. Cut worms were controlled both mechanically and spraying Darsban 29 EC @ 3%. The place where experimental pots were kept was covered with net to protect the plants from aphid infestation. As *Trichoderma* used as treatment there is no or less fungal infection. Few infected leaves were collected from the plants and removed from the place.

3.13 Harvesting the fruits

Harvesting of fruits was started at 85 DAT and continued up to final harvest based on the marketable size of fruits. Harvesting was done by hand picking.

3.14 Parameter Studied

Data on the following parameters were recorded:

Measurement of morphological characters

Plant height (cm)

Number of leaves/plant

Number of branches/plant

Stem diameter (mm)

Measurement of yield and yield contributing characters

Days from transplanting to first flowering

Number of flowers/plant

Number of fruits/plant

Length of fruit (cm)

Diameter of fruit (cm)

Pericarp thickness of fruit (mm)

Individual fruit weight (g)

Total fruit yield/plant (g)

Measurements of Biochemical parameters

Chlorophyll a content (mg/g)

Chlorophyll b content (mg/g)

Total chlorophyll content (mg/g)

Vitamin C (mg/100g)

3.14.1 Measurement of morphological characters

3.14.1.1 Plant height (cm)

Plant height of sweet pepper was measured from sample plants in centimeter from the ground level to the tip of the longest stem and mean value was calculated. Recording started from 30 days after transplanting (DAT) up to final harvest (120 DAT) at 30 days interval to investigate the vegetative growth rate of plants (Plate 2).

3.14.1.2 Number of leaves per plant

Total number of leaves of individual plants were counted at interval of 30 days from 30 days after transplanting (DAT) to final harvest (120 DAT) and the average number of leaves per plant was calculated.

3.14.1.3 Number of branches per plant

The branch number of individual plants was counted at final harvest and the average number of branches per plant were calculated.

3.14.1.4 Stem diameter (mm)

The diameter of stem of individual plants was counted at final harvest (120 DAT) with a Slide caliper and the average was calculated (Plate 2).

3.14.2 Measurement of yield and yield contributing characters

3.14.2.1 Days from transplanting to first flowering

Difference between the dates of transplanting to the date of first flower emergence of plants was counted and the average was calculated.

3.14.2.2 Number of flowers/plant

The number of flowers per plant was counted from each plant after flowering and there average were recorded.

3.14.2.3 Number of fruits/plant

The number of fruits of individual plant was recorded and the average number of fruits was recorded.

3.14.2.4 Length of fruit (cm)

The length of individual fruit was measured in one side to another side of fruit from 3 selected fruits with a Slide caliper and average of individual fruit length was recorded and expressed in centimeter (cm).

3.14.2.5 Diameter of fruit (cm)

The diameter of individual fruit was measured in several directions with a Slide caliper and the average of all directions was finally recorded and expressed in centimeter (cm).

3.14.2.6 Pericarp thickness (mm)

The pericarp thickness of individual fruit was measured in one side to another side of pericarp from three selected fruits with a Slide caliper and average of pericarp thickness recorded and expressed in millimeter (mm).

3.14.2.7 Individual fruit weight (g)

The weight of individual fruit was recorded in gram (g) by an electric balance from all fruits of selected three plants and converted individually.

3.14.2.8 Fruit yield/plant (g)

Fruit yield per plant was recorded in gram by multiplying individual fruit weight and number of fruits/plant by a digital weight machine.

3.14.3 Measurement of growth and fruit quality parameters

3.14.3.1 Chlorophyll contents

Leaf chlorophyll content from SPAD values were measured from the youngest fully-expanded leaf in the third position from the tip by a portable chlorophyll meter (SPAD-502, Konica Minolta, Japan). The SPAD-502 chlorophyll meter can estimate total chlorophyll amounts in the leaves of a variety of species with a high degree of accuracy and is a nondestructive method (Neufeld *et al.*, 2006). SPAD was recorded at flowering stage. By SPAD value chlorophyll a, chlorophyll b, total chlorophyll (a+b) and Nitrogen concentration was measured by the following formula:

Chlorophyll a (mg/g) = (0.0346×SPAD value) − 0.1933

Chlorophyll b (mg/g) = (0.0115×SPAD value) − 0.0936

Total chlorophyll = (Chlorophyll a + Chlorophyll b)

3.14.3.2 Measurement of Vitamin C

Oxidation Reduction Titration method was used for determination of vitamin C in sweet pepper juice. Extract of sweet pepper fruit juice was used for determination of Vitamin C content in per 100g of fruit sample. It has expressed as mg Vitamin C per 100gm of sweet pepper. Sweet pepper juice was prepared by blender and the volume was made with meta phosphoric acid up to 100 ml. 5 ml of standard L-ascorbic solution was taken in a conical flask. Then it was titrated with 2, 6 dichlorophenol indophenol taken in a burette. The end point was reached when the pink color lasts 10 seconds. Similarly, 5 ml of tomato juice was titrated with dye. It was measured in "Biotechnological and Horticultural Stress Management Lab," M.A.Wajed Miah Research Centre, SAU.

Calculation:

$$= \frac{0.5 \times \text{mean value of unknown solution reading} \times 100}{\text{mean value of known solution reading} \times 5} \text{ mg of L-ascorbic acid}$$

3.15 Analysis of data

The data in respect of growth, yield contributing characters were statistically analyzed to find out the statistical significance of the experimental results. The collected data on different parameters under this investigation were statistically analyzed by the software Statistix 10. The mean were compared by Duncan's Multiple Range Test (DMRT) at 5% level of probability.


Plate 1: Preparation of potting media and transplanting of seedling


Plate 2: Measuring plant height and measuring stem diameter

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The present study was therefore carried out to assess the influence of different potting media and different level of *Trichoderma* on plant performance and yield of sweet pepper that can help to find out suitable combination of potting media and *Trichoderma* doses. The experimental results obtained in this study are presented and discussed under following heads.

The mean data was recorded on plant height, number of branches per plant, flowering, number of fruits per plant, fruit diameter, fruit length, fruit weight, fruit yield per plant, SPAD meter reading were analyzed as per the Completely Randomized Design (CRD) adopted and mean squares are presented in appendix and an overview of sweet pepper growth performance and yield data are presented in different tables and graphs. The perusal of analysis of variance indicated that the treatments were highly significant for all the parameters studied.

4.1 Plant height

The plant height is one of the most important factors which affect the growth and yield of sweet pepper. Plant height of sweet pepper vary in different growing media. The data on plant height of sweet pepper plant as influenced by different potting media and *Trichoderma* doses is presented in the Table-1 and Figure-1 & 2.

Plant height of sweet pepper varied significantly for different potting media at 30, 60, 90 and (final harvest) 120 DAT (Appendix III). At final harvest, the tallest plant (68.28cm) was obtained from M_3 (Soil: coco peat: vermicompost, 1:1:1 v/v) treatment, while the shortest plant (62.63cm) was found from M_0 (control) treatment (Fig. 1 and Appendix III). It revealed that soil combined with vermicompost increased plant height.

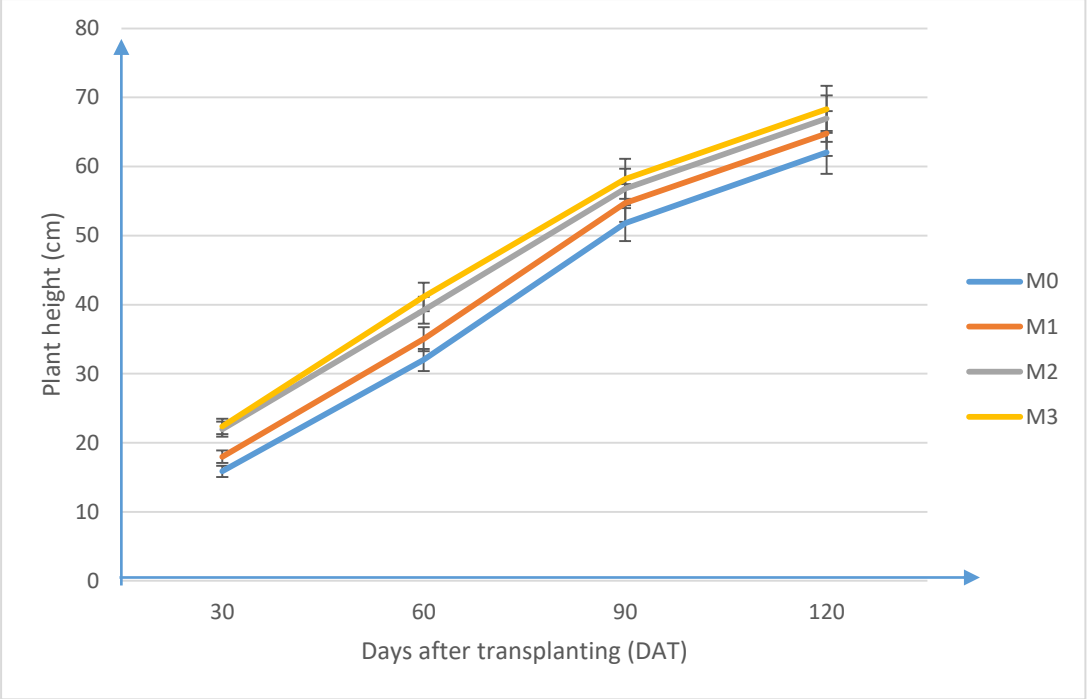

Fig. 1 Effect of potting media on plant height of sweet pepper [M_0: Soil (control), M_1: Soil: coco peat (2:1 v/v), M_2: Soil: vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v)]

Plant height of sweet pepper was significantly influenced by different doses of *Trichoderma* at 30, 60, 90 and (final harvest) 120 DAT (Appendix III). At final harvest, the tallest plant (67.64 cm) was obtained from T_2 (*Trichoderma* 50gm/pot) treatment, while the shortest plant (63.30 cm) was found from T_0 (control) treatment (Fig. 2 and Appendix III). It revealed that higher amount of *Trichoderma* improves plant height.

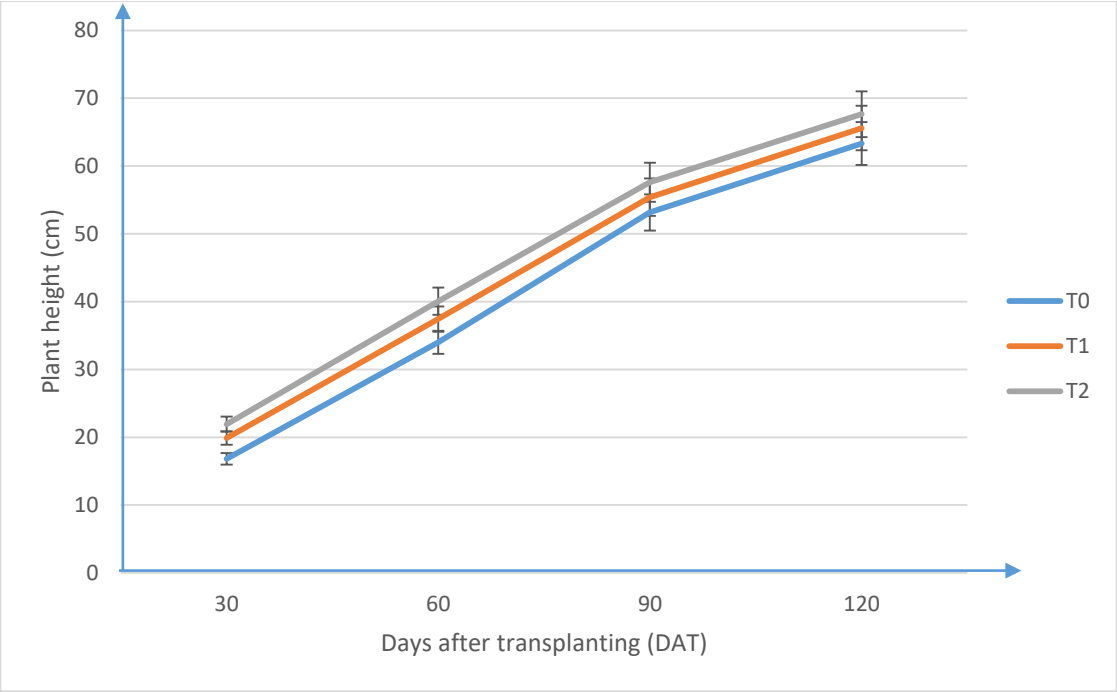

Fig. 2 Effect of *Trichoderma* on plant height of sweet pepper [T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

Significant variation was observed due to the combined effect of different potting media and *Trichoderma* doses in terms of plant height of sweet pepper at different days after transplanting (Table 1 and Appendix III). At final harvest (120 DAT) the tallest plant (70.90 cm) was observed from M_3T_2 treatment combination. On the other hand, the shortest plant (60 cm) was found from (control) M_0T_0 treatment combination.

Hence it may be concluded that the increase in plant height may be due to the effect on stem elongation by good physical properties of media, easy nutrient availability and less fungal infection. It was also supported by Adhikari P *et al.*, (2016) they stated that the growth and yield contributing characters were significantly differed due to effect of vermicompost. The highest plant height was obtained when soil and vermicimpost are combinedly used as growing media than others treatment.

Table 1. Combined effect of different potting media and *Trichoderma* on plant height of sweet pepper

Treatment combination	Plant height(cm) at different DAT			
	30	60	90	120
M_0T_0	15.07 h	30.01 i	50.08 g	60.05 f
M_0T_1	15.98 g	33.68 h	52.35 f	62.71 e
M_0T_2	16.50 fg	34.46 gh	53.01 ef	63.34 de
M_1T_0	15.91 g	32.96 h	52.24 f	62.51 e
M_1T_1	16.70 f	35.85 fg	53.99 de	63.99 de
M_1T_2	21.33 d	38.26 de	57.87 b	67.87 b
M_2T_0	18.07 e	36.08 fg	54.77 de	65.10 cd
M_2T_1	23.74 bc	39.18 cd	57.04 bc	67.27 bc
M_2T_2	24.07 b	42.34 b	58.66 b	68.45 b
M_3T_0	18.18 e	37.15 ef	55.53 cd	65.53 cd
M_3T_1	23.10 c	41.07 bc	58.22 b	68.42 b
M_3T_2	25.82 a	45.14 a	60.92 a	70.90 a
LSD(0.05)	0.6933	1.8953	1.9223	2.2713
CV (%)	3.62	3.26	2.28	1.57

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.[M_0: Soil (control), M_1: Soil: coco peat (2:1 v/v), M_2: Soil : vermicompost (2:1 v/v) , M_3: Soil: coco peat: vermicompost (1:1:1 v/v), T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

4.2 Number of branches per plant

Significant variation was recorded for different potting media of sweet pepper in terms of number of branches per plant at final harvest (120DAT) (Table 2. and Appendix IV). At final harvest, the maximum number of branches per plant (9.66) was recorded from M_3 (Soil: coco peat: vermicompost (1:1:1 v/v)) treatment, while the minimum number (6.77) was found from M_0 (control) treatment.

Table 2. Effect of potting media on total number of branch and plant stem diameter of sweet pepper

Treatment (Potting media)	Number of branches	Stem Diameter(mm)
M_0	6.77 d	11.00 d
M_1	7.44 c	11.77 c
M_2	8.88 b	13.22 b
M_3	9.66 a	13.88 a
LSD(0.05)	0.3774	0.4051
CV (%)	6.78	3.32

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) , M_2: Soil : vermicompost (2:1 v/v) , M_3: Soil: coco peat: vermicompost (1:1:1 v/v)]

Number of branches per plant of sweet pepper varied significantly for different level of *Trichoderma* at different days after transplanting (Table 3 and Appendix IV). At 120 DAT, the maximum number of branches per plant (8.91) was obtained from T_2 (*Trichoderma* 50gm/pot) treatment while the lowest (7.25) was found from T_0 (control) treatment. The result also indicated that the increasing amount of *Trichoderma* significantly increased the number of branches.

Table 3. Effect of *Trichoderma* on total number of branch and plant stem diameter of sweet pepper

Treatment (*Trichoderma*)	Number of branches	Stem Diameter(mm)
T_0	7.25 c	11.66 c
T_1	8.41 b	12.66 b
T_2	8.91 a	13.08 a
LSD(0.05)	0.3268	0.3508
CV (%)	6.78	3.32

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. [T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

Potting media and level of *Trichoderma* showed significant variation due to the combined effect on number of branches per plant of sweet pepper at final harvest (Appendix IV). The maximum number of branches per plant (11.0) was recorded from M_3T_2 treatment combination, where the minimum number of branches per plant (6.0) was found from M_0T_0 treatment combination (Table 4). In present study it was observed that plant growing media rich in organic matter increase number of branches per plant of sweet pepper. It can be said that plant growing media play a vital role in several morphological processes. Bio control agent *Trichoderma* has influence on plant morphological activity. This result is in agreement with the findings of Haque, *et al.,* (2012). They reported *Trichoderma* enriched bio fertilizers when supplemented with N fertilizer significantly boosted up the growth and yield of mustard and tomato.

Table 4. Combined effect of potting media and *Trichoderma* doses on total number of branch and stem diameter of sweet pepper

Treatment combination	Number of branch	Stem Diameter(mm)
M_0T_0	6.00 h	10.00 i
M_0T_1	7.00 g	11.33 gh
M_0T_2	7.33 fg	11.66 fgh
M_1T_0	7.00 g	11.00 h
M_1T_1	8.00 de	12.00 efg
M_1T_2	7.33 fg	12.33 def
M_2T_0	7.66 ef	13.00 cd
M_2T_1	9.00 c	13.33 bc
M_2T_2	10.00 b	13.33 bc
M_3T_0	8.33 d	12.66 cde
M_3T_1	9.66 b	14.00 b
M_3T_2	11.00 a	15.00 a
LSD(0.05)	0.6536	0.7017
CV (%)	6.78	3.32

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) , M_2: Soil : vermicompost (2:1 v/v) , M_3: Soil: coco peat: vermicompost (1:1:1 v/v), T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

4.3 Diameter of the stem

The diameter of the stem per plant was observed at 120 DAT (final harvest) among different treatments. Significant variation was recorded for different potting media of sweet pepper in terms of stem diameter. It was highest (13.88 mm) at M_3 (Soil:coco peat:vermicompost, 1:1:1v/v) treatment and lowest stem diameter (11 mm) was recorded at M_o (control) treatment (Table 2. and Appendix IV).

Diameter of stem was significantly different in case of treatment with Different doses of *Trichoderma* (Table 3).The highest value (13.08mm) was found in T_2 where lowest value (11.66mm) was recorded in T_0 (control) treatment.

Treatment combination of different potting media with *Trichoderma* doses showed significant difference in terms of plant stem diameter. Highest value (15 mm) was recorded at M_3T_2 treatment combination hence lowest value (10mm) was recorded at M_0T_0 treatment (Table 4 and Appendix IV)

4.4 Number of leaves per plant

As leaf is the main photosynthetic organ which has direct relation to yield of the plant the leaf number is the very important character for plant growth and development. Number of leaves per plant of sweet pepper showed statistically significant differences on different potting media at 30, 60, 90 and (final harvest) 120 DAT (Fig. 3 and Appendix V). At final harvest, the maximum number of leaves per plant (136) was recorded from M_3 (Soil:coco peat: vermicompost, 1:1:1v/v) treatment while the minimum number (119.33) was found from (control) M_0 treatment.

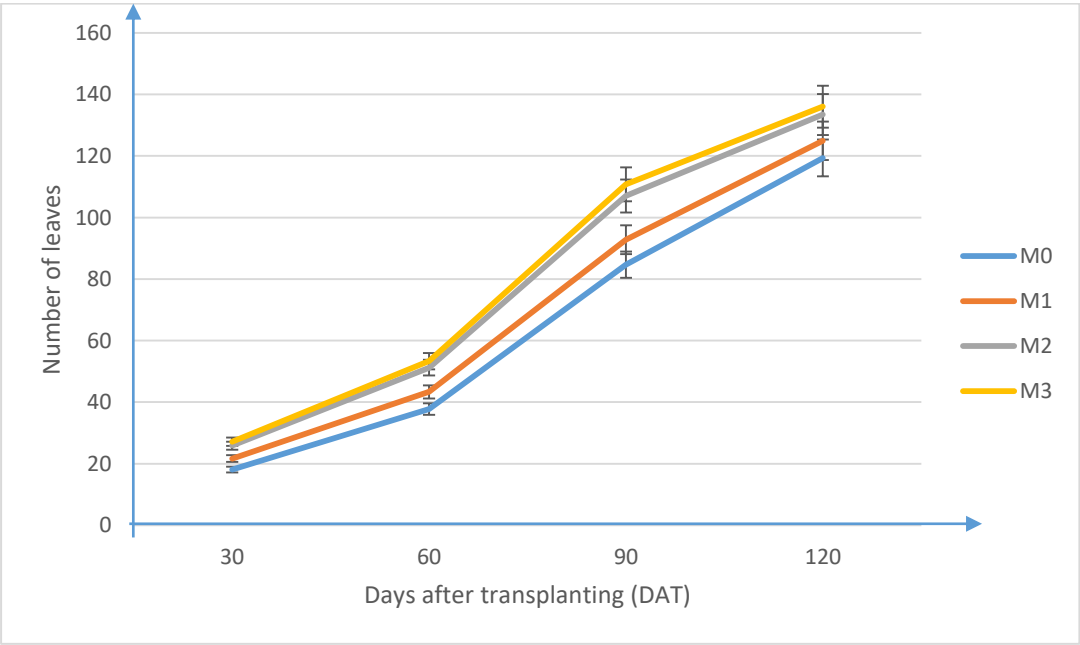

Fig. 3 Effect of different potting media on leaf number of sweet pepper per plant [M_0: Soil (control), M_1: Soil: coco peat (2:1 v/v) , M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v)]

Number of leaves per plant of sweet pepper was obtained statistically significant differences for different doses of *Trichoderma* at at 30, 60, 90 and (final harvest) 120 DAT (Fig. 4 and Appendix V). At final harvest, the maximum number of leaves per plant (133.42) was recorded from T_2 (*Trichoderma* 50gm/pot) treatment, while the minimum number (122.50) was obtained from T_0 (control) treatment (Fig. 5).

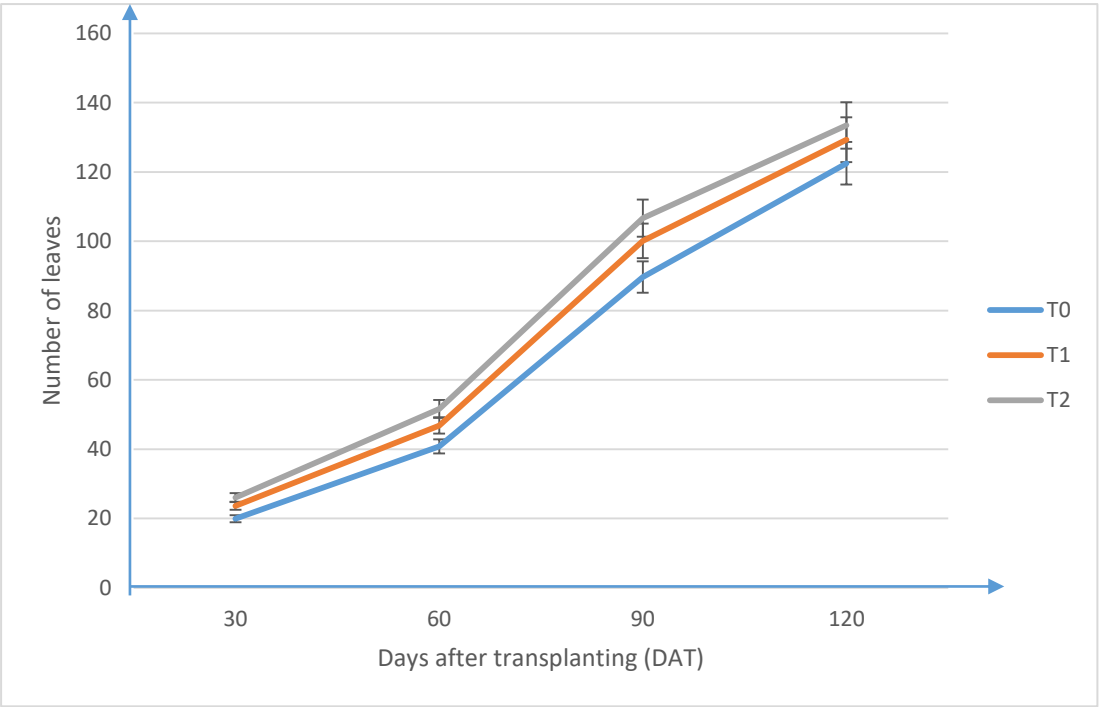

Fig. 4 Effect of *Trichoderma* on leaf number of sweet pepper [T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

Combined effect of different potting media and *Trichoderma* doses showed significant variation on number of leaves per plant of sweet pepper at 30, 60, 90, and 120 DAT (Appendix V). At 120 DAT, the maximum number of leaves per plant (141.0) was recorded from M_3T_2 treatment combination, whereas the minimum number of leaves per plant (115.0) was observed from M_0T_0 treatment combination (Table 5). From the results of the present study indicated that combined effect of soil:coco peat:vermicompost (1:1:1 v/v) with *Trichoderma* (50g/pot) combination might have induced better growing condition which ultimately led to the production of more leaves per plant.

Table 5. Combined effect of different potting media and *Trichoderma* on leaf number of sweet pepper per plant

Treatment combination	Number of leaves			
	30DAT	60DAT	90DAT	120DAT
M_0T_0	15.33 h	35.00 j	80.00 h	115.00 h
M_0T_1	18.00 g	38.33 i	86.00 g	120.00 g
M_0T_2	21.00 f	40.00 h	88.00 fg	123.00 f
M_1T_0	17.00 g	37.00 i	85.67 g	118.00 g
M_1T_1	23.00 e	43.00 g	90.33 f	125.33 ef
M_1T_2	25.00 d	50.00 e	102.33 d	131.33 d
M_2T_0	23.33 e	44.33 g	95.00 e	127.00 e
M_2T_1	26.33 c	52.00 d	110.00 c	135.00 c
M_2T_2	28.00 b	57.33 b	116.00 b	138.33 b
M_3T_0	24.00 de	47.00 f	98.00 e	130.00 d
M_3T_1	27.33 bc	54.00 c	114.00 b	137.00 bc
M_3T_2	30.000 a	59.00 a	120.33 a	141.00 a
LSD(0.05)	1.23	1.60	3.91	2.61
CV (%)	3.99	2.33	2.05	1.42

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [M_0: Soil (control), M_1: Soil: cocopeat (2:1 v/v) , M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: cocopeat: vermicompost (1:1:1 v/v), T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

4.5 Days from transplanting to 1st flowering

Significant variation was observed in terms of days from transplanting to 1st flowering of sweet pepper for different potting media. Minimum days from transplanting to 1st flowering 55.11 days was found in treatment M_3 [Soil: coco peat: vermicompost (1:1:1 v/v)] while maximum days from transplanting to 1st flowering was 59.88 days in treatment M_0 (control) (Table 6. and Appendix VI)

Table 6. Effect of different potting media on some yield contributing characters of sweet pepper

Treatment (Potting media)	Days from transplanting to 1st flowering	Number of flowers per plant	Number of fruits per plant
M_0	59.88 a	26.55 d	8.00 d
M_1	58.44 b	28.22 c	9.44 c
M_2	56.00 c	30.88 b	11.66 b
M_3	55.11 d	32.33 a	12.44 a
LSD(0.05)	0.72	1.17	0.51
CV (%)	1.28	4.18	3.72

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) , M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v)]

Days from transplanting to 1st flowering was significantly different in sweet pepper plant as influenced by different amount of *Trichoderma*. Minimum days from transplanting to 1st flowering (55.66 days) was found in T_2 (*Trichoderma* 50gm/pot) treatment and maximum days (59.25) was found in T_0 (control) treatment (Table 7. and Apendix VI).

Table 7. Effect of *Trichoderma* doses on some yield contributing characters of sweet pepper

Treatment (*Trichoderma*)	Days from transplanting to 1st flowering	Number of flowers per plant	Number of fruits per plant
T_0	59.25 a	27.50 c	8.91 c
T_1	57.16 b	29.33 b	10.50 b
T_2	55.66 c	31.66 a	11.75 a
LSD(0.05)	0.62	1.03	0.32
CV (%)	1.28	4.18	3.72

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

Significant variation was found on days after transplanting to 1st flowering as influenced by combination of different potting media and different amount of *Trichoderma*. Minimum days required (53.33) from transplanting to 1st flowering was found in treatment combination M_3T_2 while the maximum days required in treatment combination M_0T_0 (61.33) from transplanting to 1st flowering (Table. 8).

4.6 Number of flowers per plant

Due to the effect of different potting media number of flowers per plant of sweet pepper showed significant differences (Appendix VI). The maximum number of flowers per plant (32.33) was recorded from M_3 [Soil: coco peat: vermicompost (1:1:1 v/v)] treatment, whereas the minimum number (26.55) was obtained from M_0 (control) treatment (Table 6. and Appendix VI).

There was significant differences due to the effect of *Trichoderma* doses on total number of flower. In treatment T_2 maximum (31.66) flower and treatment T_0 lowest (27.50) flower was found (Table 7. and appendix VI).

Combined effect of different potting media and *Trichoderma* had influence on total number of flower. Maximum number of flower (35.33) was found in treatment M_3T_2

combination while the minimum number of flower (25) was found in treatment M_0T_0. (Table 8. and Appendix VI).

4.7 Number of fruits per plant

Different potting media significantly influenced on number of fruits per plant of sweet pepper (Appendix VI). The maximum number of fruits per plant (12.44) was found from M_3 (Soil: coco peat: vermicompost (1:1:1 v/v)) treatment while the minimum number (8) was recorded from M_0 (control) treatment (Table 6). Though M_3 and M_0 treatments were significantly different in fruiting number. This result is in agreement with the findings of Azarmi *et al.,* (2008) where he found that plants that grows in vermicompost has better yield capacity.

Application of different doses of *Trichoderma* showed significant variation on total number of fruits per plant (Appendix VI). The maximum number of fruits per plant (11.75) was obtained from T_2 treatment while the minimum number (8.91) was obtained from T_0 (control) treatment (Table 7).

Significant variation was observed due to the combined effect of different potting media and different amount of *Trichoderma* in terms of total number of fruits per plant (Appendix VI).The maximum number of fruits per plant (14.00) was recorded from M_3T_2 treatment combination, while the minimum number (7.00) was found from M_0T_0 treatment combination (Table 8).

Table 8. Combined effect of different potting media and *Trichoderma* on some yield contributing characters of sweet pepper

Treatment combination	Days from transplanting to 1st flowering	Number of flowers per plant	Number of fruits per plant
M_0T_0	61.33 a	25.00 h	7.00 j
M_0T_1	60.00 b	27.00 fgh	8.33 hi
M_0T_2	58.33 c	27.66 fg	8.66 gh
M_1T_0	61.00 ab	26.00 gh	8.00 i
M_1T_1	58.00 cd	28.00 efg	9.00 g
M_1T_2	56.33 ef	30.66 cd	11.33 d
M_2T_0	57.66 cd	29.00 def	10.00 f
M_2T_1	55.66 fg	30.66 cd	12.00 c
M_2T_2	54.66 g	33.00 b	13.00 b
M_3T_0	57.00 de	30.00 cde	10.66 e
M_3T_1	55.00 g	31.66 bc	12.66 b
M_3T_2	53.33 h	35.33 a	14.00 a
LSD(0.05)	1.2477	2.06	0.65
CV (%)	1.28	4.18	3.72

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) , M_2: Soil : vermicompost (2:1 v/v), M_3: Soil: coco peat: vermicompost (1:1:1 v/v), T_0: *Trichoderma* 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

4.8 Length of fruit

In terms of length of fruits different potting media showed significant variation (Table 9 and Appendix VII). The maximum length of fruit (7.90cm) was found from M_3 (Soil: coco peat: vermicompost (1:1:1 v/v)) treatment, where the minimum length (5.94cm) was found from M_0 (control) treatment. Plant growing media have possibility to increase fruit length.

Table 9. Effect of different potting media on some yield contributing characters of sweet pepper

Treatment (potting media)	Length of fruit (cm)	Diameter of fruit (cm)	Pericarp thickness (mm)	Individual fruit weight (g)
M_0	5.94 d	4.67 d	4.55 c	55.00 d
M_1	6.83 c	4.90 c	5.11 b	58.66 c
M_2	7.73 b	5.32 b	5.77 a	64.11 b
M_3	7.90 a	5.54 a	5.88 a	66.33 a
LSD(0.05)	0.12	0.08	0.4814	1.59
CV (%)	2.82	2.79	9.23	2.67

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) , M_2: Soil : vermicompost (2:1 v/v), M_3: Soil: coco peat: vermicompost (1:1:1 v/v)]

Different amount of *Trichoderma* showed significant variation for length of fruit (Table 10 and Appendix VII). The maximum length of fruit (7.71cm) was recorded from T_2 treatment (*Trichoderma* 50gm/pot), while the minimum length (6.46cm) was found from T_0 (control) treatment. From the results of the present study indicated that different amount of *Trichoderma* can affect the fruit quality.

Table 10. Effect of *Trichoderma* on some yield contributing characters of sweet pepper

Treatment (*Trichoderma*)	Length of fruit (cm)	Diameter of fruit (cm)	Pericarp thickness (mm)	Individual fruit weight (g)
T_0	6.46 c	4.80 c	4.91 b	57.50 c
T_1	7.12 b	5.12 b	5.25 b	61.33 b
T_2	7.71 a	5.80 a	5.83 a	64.25 a
LSD(0.05)	0.10	0.07	0.41	1.38
CV (%)	2.82	2.79	9.23	2.67

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [T_0:

Trichoderma 0gm/pot (control), T_1: *Trichoderma* 25gm/pot, T_2: *Trichoderma* 50gm/pot]

Significant variation was observed due to the combined effect of plant growth media and *Trichoderma* doses in terms of length of fruit (Appendix VII). The maximum length of fruit (8.36cm) was found from M_3T_2 treatment combination, while the minimum length (5.53cm) was found from M_0T_0 treatment combination (Table 11).

Table 11. Combined effect of potting media and *Trichoderma* doses on some yield contributing characters of sweet pepper

Treatment combination	Length of fruit (cm)	Diameter of fruit (cm)	Pericarp thickness (mm)	Individual fruit weight (g)
M_0T_0	5.53 h	4.50 h	4.33 e	53.00 i
M_0T_1	5.76 g	4.76 fg	4.33 e	55.33 ghi
M_0T_2	6.53 e	4.76 fg	5.00 cde	56.66 gh
M_1T_0	6.10 f	4.63 gh	4.66 de	55.00 hi
M_1T_1	6.73 e	4.83 f	5.00 cde	58.00 fg
M_1T_2	7.66 c	5.23 cd	5.66 abc	63.00 cd
M_2T_0	7.03 d	5.00 e	5.33 bcd	60.00 ef
M_2T_1	7.86 c	5.36 c	5.66 abc	65.00 bc
M_2T_2	8.30 ab	5.60 b	6.33 a	67.33 ab
M_3T_0	7.20 d	5.10 de	5.33 bcd	62.00 de
M_3T_1	8.13 b	5.53 b	6.00 ab	67.00 b
M_3T_2	8.36 a	6.00 a	6.33 a	70.00 a
LSD(0.05)	0.2184	0.17	0.8337	2.75
CV (%)	2.82	2.79	9.23	2.67

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) ,M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v), T_0: *Trichoderma* 0gm/pot (control),T_1: *Trichoderma* 25gm/pot,T_2: *Trichoderma* 50gm/pot]

4.9 Diameter of fruit

Significant variation was recorded for diameter of fruit of sweet pepper for different potting media (Appendix VII). The maximum diameter of fruit (5.54cm) was observed from M_3 (Soil: cocopeat: vermicompost (1:1:1 v/v)) treatment, while the minimum diameter (4.67) was observed from M_0 (control) treatment (Table 9).

Diameter of fruit varied significantly due to different amount of *Trichoderma* of sweet pepper (Table 10. and Appendix VII). The maximum diameter of fruit (5.80cm) was found from T_2 treatment (*Trichoderma* 50gm/pot), while the minimum diameter (4.80cm) was recorded from T_0 (control) treatment.

Different potting media and different amount of *Trichoderma* varied significantly due -to the combined effect in terms of diameter of fruit (Appendix VII). The maximum diameter of fruit (6.00cm) was observed from M_3T_2 treatment combination, while the minimum diameter (4.50cm) was recorded from M_0T_0 treatment combination.

4.10 Pericarp thickness

Pericarp thickness of sweet pepper varied significantly for different potting media (Table 9 and Appendix VII). The higher pericarp thickness (5.88mm) was recorded from M_3 (Soil: cocopeat: vermicompost (1:1:1 v/v)) treatment, while the lower thickness (4.55mm) was observed from (control) M_0 treatment.

Different amount of *Trichoderma* showed significant variation on pericarp thickness (Table 10 and Appendix VII). The maximum pericarp thickness (5.83mm) was recorded from T_2 treatment (*Trichoderma* 50gm/pot), while the minimum thickness (4.91 mm) was observed from T_0 (control).Though treatment T_1 was higher value than treatment T_0 but they were statistically identical.

Significant variation was observed due to the combined effect of different potting media and different amount of *Trichoderma* in terms of pericarp thickness (Appendix VII). The maximum pericarp thickness (6.33mm) was found from M_3T_2 treatment combination, while the minimum thickness (4.33mm) was recorded from M_0T_0 treatment combination (Table 11). Treatment combination M_3T_2 and M_2T_2 were statistically identical.

4.11 Individual fruit weight

Different potting media significantly influenced on individual fruits weight per plant of sweet pepper (Appendix VII). The maximum fruits weight (66.33g) was found from M_3 (Soil:coco peat: vermicompost (1:1:1 v/v)) treatment while the minimum fruit weight (55.00g) was recorded from M_0 (control) treatment (Table 9).

Significant variation was found on individual fruit weight for different level of *Trichoderma* (Table 10 and Appendix VII). The maximum weight of individual fruit (64.25g) was found from T_2 (*Trichoderma* 50gm/pot) treatment while the minimum weight (57.50g) was recorded from T_0 (control) treatment.

Significant variation was recorded due to the combined effect of different potting media and different amount of *Trichoderma* in terms of individual fruit weight (Appendix VII). The maximum weight of individual fruit (70.00g) was attained from M_3T_2 treatment combination, while the minimum weight (53.00g) was found from M_0T_0 treatment combination (Table 11).From the results of the present study indicated that combined effect different potting media and different amount of *Trichoderma* combination might have induced better growing condition which ultimately led to increase individual fruit weight per plant.

4.12 Yield per plant

Yield per plot of sweet pepper showed significant for different potting media (Table 9 and Appendix VII). The maximum yield per plant (829.89g) was recorded from M_3 (Soil: coco peat: vermicompost (1:1:1 v/v)) treatment while the minimum, yield per plant (441.44g) was found from M_0 (control) treatment (Fig. 5). Aminifard M.H and Bayat, H. (2016) reported that plant grown in vermicompost had significant effect on growth and yield attributes on sweet pepper.

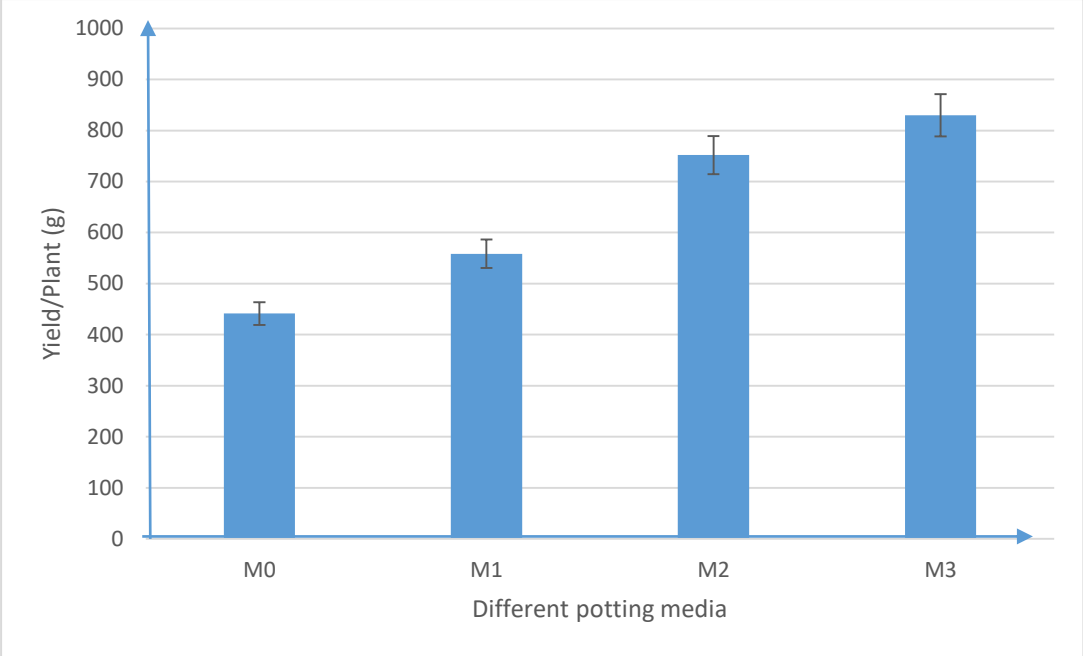

Fig. 5 Effect of different potting media on yield per plant of sweet pepper [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) ,M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v)] ($LSD_{0.05}$ =29.30)

Different level of *Trichoderma* showed significant variation on yield per plant (Appendix VII). The maximum yield per plant (765.25g) was observed from T_2 treatment (*Trichoderma* 50gm/pot), while the minimum yield per plant (518.08g) was recorded from T_0 (control) treatment (Table 10). This result is in agreement with the findings of Haque *et al.*, (2012) where he found that *Trioderma* enriched bio fertilizer increase the yield per plant of tomato.

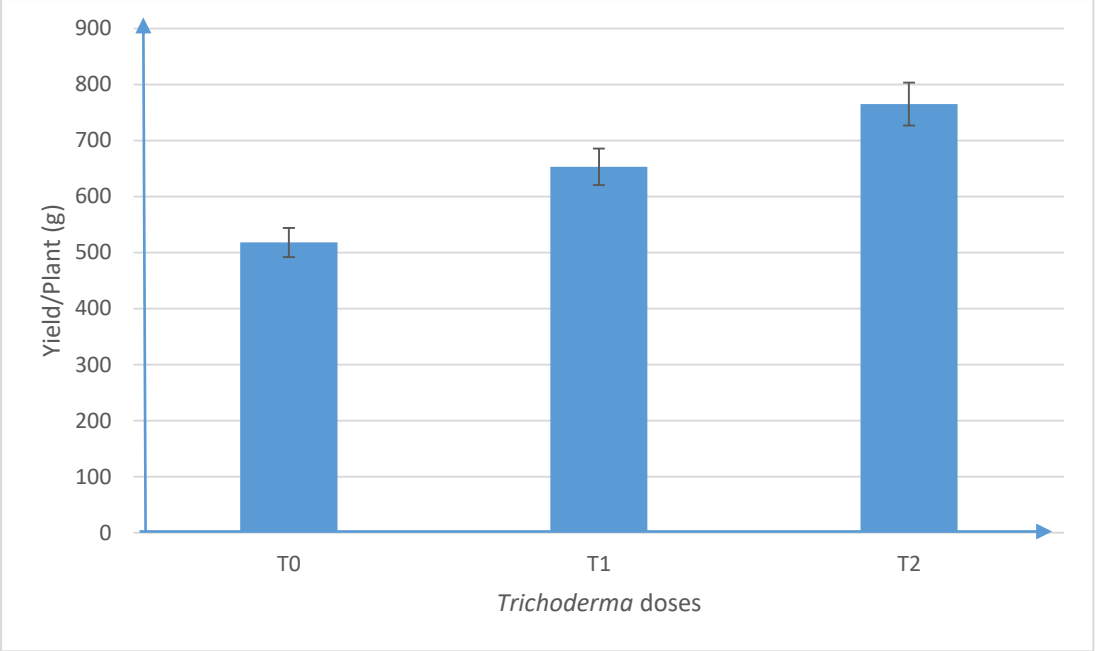

Fig. 6 Effect of *Trichoderma* on yield per plant of sweet pepper [T_0: *Trichoderma* 0gm/pot (control),T_1: *Trichoderma* 25gm/pot,T_2: *Trichoderma* 50gm/pot] ($LSD_{0.05}$ =25.381)

Combined effect of different potting media and *Trichoderma* varied significantly in terms of yield per plant (Appendix VII). The highest yield per plant (980g) was attained from M_3T_2 treatment combination, while the lowest yield per plant (371g) was found from M_0T_0 treatment combination (Fig. 7).

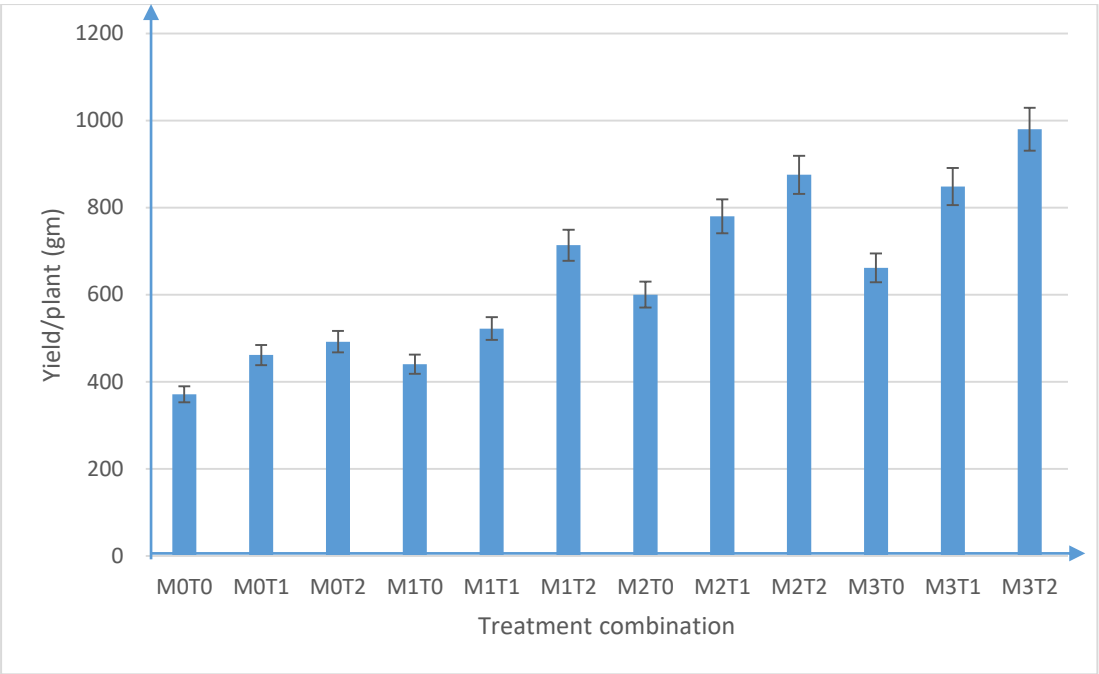

Fig. 7 Combined effect of potting media and *Trichoderma* doses on yield per plant of sweet pepper [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) ,M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v), T_0: *Trichoderma* 0gm/pot (control),T_1: *Trichoderma* 25gm/pot,T_2: *Trichoderma* 50gm/pot] ($LSD_{0.05}$ =50.76)

4.13 Chlorophyll content

Chlorophyll a

Significant variation was observed for Chlorophyll content of sweet pepper plant due to different potting media (Appendix VIII). At flowering stage, the highest chlorophyll a (2.24mg/g) was obtained from M_3 whereas the lowest chlorophyll a (1.57mg/g) was found from M_0 (Table 12).

Chlorophyll a at flowering stage varied significantly due to different level of *Trichoderma* (Appendix VIII). At flowering stage, the highest chlorophyll a (2.11mg/g) was found from T_2, while the lowest value (1.73mg/g) was recorded from T_0. (Table 13).

Combined effect of different potting media and *Trichoderma* varied significantly in terms of yield per plant (Appendix VIII). The highest chlorophyll a (2.40mg/g) was found from M_3T_2, while the lowest value (1.36mg/g) was recorded from M_0T_0 treatment combination (Table 14).

Table 12. Effect of different potting media on growth and fruit quality parameters of sweet pepper

Treatment (potting media)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total Chlorophyll (a+b) (mg/g)	Vitamin C Content (mg/100g)
M_0	1.57 d	0.49 d	2.06 d	15.06 d
M_1	1.82 c	0.57 c	2.39 c	16.70 c
M_2	2.14 b	0.68 b	2.82 b	18.25 b
M_3	2.24 a	0.71 a	2.96 a	19.01 a
LSD(0.05)	0.03	0.01	0.05	0.24
CV (%)	2.07	2.17	2.10	1.46

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) ,M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v)]

Table 13. Effect of *Trichoderma* on growth and fruit quality parameters of sweet pepper

Treatment (*Trichoderma*)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total Chlorophyll (a+b) (mg/g)	Vitamin C Content (mg/100g)
T_0	1.73 c	0.54 c	2.28 c	16.10
T_1	1.98 b	0.63 b	2.61 b	17.09
T_2	2.11 a	0.67 a	2.79 a	18.58
LSD(0.05)	0.03	0.01	0.04	0.21
CV (%)	2.07	2.17	2.10	1.46

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [T_0: *Trichoderma* 0gm/pot (control),T_1: *Trichoderma* 25gm/pot,T_2: *Trichoderma* 50gm/pot]

Table 14. Combined effect of different potting media and *Trichoderma* on growth and fruit quality parameter of sweet pepper

Treatment combination	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total Chlorophyll (a+b) (mg/g)	Vitamin C Content (mg/100g)
M_0T_0	1.36 i	0.42 i	1.78 i	14.07 i
M_0T_1	1.64 g	0.51 g	2.16 g	15.04 h
M_0T_2	1.70 g	0.53 g	2.24 g	16.08 g
M_1T_0	1.54 h	0.48 h	2.02 h	15.45 h
M_1T_1	1.88 f	0.59 f	2.47 f	16.56 f
M_1T_2	2.04 d	0.65 d	2.69 d	18.09 d
M_2T_0	1.96 e	0.62 e	2.59 e	17.27 e
M_2T_1	2.15 c	0.68 c	2.84 c	18.21 cd
M_2T_2	2.30 b	0.73 b	3.04 b	19.28 b
M_3T_0	2.06 d	0.65 d	2.72 d	17.61 e
M_3T_1	2.26 b	0.72 b	2.98 b	18.55 c
M_3T_2	2.40 a	0.76 a	3.17 a	20.88 a
LSD(0.05)	0.06	0.02	0.09	0.42
CV (%)	2.07	2.17	2.10	1.46

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability [M_0: Soil (control), M_1: Soil : coco peat (2:1 v/v) ,M_2: Soil : vermicompost (2:1 v/v) M_3: Soil: coco peat: vermicompost (1:1:1 v/v), T_0: *Trichoderma* 0gm/pot (control),T_1: *Trichoderma* 25gm/pot,T_2: *Trichoderma* 50gm/pot]

Chlorophyll b

At flowering stage, the highest chlorophyll b (0.71mg/g) was obtained from M_3 whereas the lowest chlorophyll a (0.49mg/g) was found from M_0 (control) treatment (Table 12).

Chlorophyll b at flowering stage varied significantly due to different level of *Trichoderma* (Appendix VIII). At flowering stage, the highest chlorophyll a (0.67mg/g) was found from T_2, while the lowest value (0.54mg/g) was recorded from T_0 (control) treatment (Table 13).

Combined effect of different potting media and *Trichoderma* varied significantly in terms of yield per plant (Appendix VIII). The highest chlorophyll a (0.76mg/g) was found from M_3T_2, while the lowest value (0.42mg/g) was recorded from M_0T_0 treatment combination (Table 14).

Total Chlorophyll content

Significant variation was observed for Chlorophyll content of sweet pepper plant due to different potting media (Appendix VIII). At flowering stage, the highest chlorophyll (2.96mg/g) was obtained from M_3 whereas the lowest chlorophyll (2.06mg/g) was found from M_0 (control) treatment (Table 12).

Total Chlorophyll content at flowering stage varied significantly due to different level of *Trichoderma* (Appendix VIII). At flowering stage, the highest chlorophyll (2.79mg/g) was found from T_2, while the lowest value (2.28mg/g) was recorded from T_0 (control) treatment (Table 13).

Combined effect of different potting media and *Trichoderma* varied significantly in terms of yield per plant (Appendix VIII). The highest chlorophyll content (3.17mg/g) was found from M_3T_2, while the lowest value (1.78mg/g) was recorded from M_0T_0 treatment combination (Table 14).

4.14 Vitamin C content

From the result of present experiment it was observed that there was significant variation in vitamin C content of sweet pepper plant due to different potting media

(Appendix VIII). The highest vitamin C (19.01mg/100g) was obtained from M_3 whereas the lowest value (15.06mg/100g) was found from M_0 (Table 12).

Vitamin C varied significantly due to different level of *Trichoderma* (Appendix VIII). The highest vitamin C (18.58mg/100g) was found from T_2, while the lowest value (16.10mg/100g) was recorded from T_0 (control) treatment (Table 13).

Combined effect of different potting media and *Trichoderma* varied significantly in terms of Vitamin C (Appendix VIII). The highest vitamin C (20.88mg/100g) was found from M_3T_2. Similar result was found by (Nerdy, 2018). The lowest value (14.07 mg/g) was recorded from M_0T_0 treatment combination (Table 14).

CHAPTER V
SUMMARY AND CONCLUSION

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The research was conducted in the Net House of "Field Laboratory of plant stress Management" in the Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from October 2018 to March 2019 to to study the influence of different potting media and doses of *Trichoderma* on growth, yield and economic benefit of sweet pepper. The experiment was laid out in two factors Complete Randomized Design (CRD) with three replications. Factor A- different potting media and factor B- different level of *Trichoderma*. Potting media (four levels) were M_0= Soil (control), M_1= Soil: Coco peat (2:1 v/v) M_2= Soil: vermicompost (2:1 v/v) and M_3= Soil: coco peat: vermicompost (1:1:1 v/v). *Trichoderma* treatments were (three level) T_0= *Trichoderma* @ 0g/pot (control), T_1= *Trichoderma* @ 25g/pot and T_2= *Trichoderma* @ 50g/pot. Data on different growth parameters and yield contributing characters of sweet pepper such as plant height, number of branches per plant,stem diameter, number of leaves per plant, first flower initiation, number of flowers per plant, number of total fruit per plant, length of fruit, diameter of fruit, pericarp thickness, individual fruit weight, fruit yield per plant, chlorophyll content, vitamin C content were recorded. The data were analyzed by variances (ANOVA) of data statistically on different characters and yield of sweet pepper.

In case of different potting media at final harvest highest plant height 68.28cm was found in M_3 treatment while lowest plant height 62.63cm was recoded in treatment M_0. The highest number of branches per plant (9.66) was recorded from M_3 treatment, while the minimum number (6.77) was recorded from M_0 treatment. At final harvest, the highest number of leaves per plant (136) was recorded from M_2 treatment, again the lowest number (119.33) was recorded from M_0 treatment. Highest (13.88mm) plant diameter was recorded in treatment M_3 where lowest (11.00mm) was found in M_0 treatment at final harvest. In M_3 treatment lowest (55.11) days from transplant to 1st flowering was recorded while highest (59.88) was recorded in treatment M_0. The maximum number of flowers per plant (32.33) was observed from M_3 treatment, whereas the minimum number (26.55) was found from M_0 treatment. The maximum number of fruits per plant (12.44) was observed from M_3 treatment, while the

minimum number (8.00) was found from M_0 treatment. The highest length of fruit (7.9 cm) was found from M_3 treatment, again the lowest length (5.94 cm) was recorded from M_0 treatment. The highest diameter of fruit (5.54cm) was recorded from M_3 treatment, while the lowest diameter (4.67 cm) was found from M_0 treatment. The highest pericarp thickness (5.88 mm) was recorded from M_3 treatment, while the lowest thickness (4.55 mm) was found from M_0 treatment. The maximum weight of individual fruit (66.33g) was found from M_3 treatment and the minimum weight (55.00 g) was recorded from M_0 treatment. The maximum yield per plant (829.89 g) was observed from M_3 treatment whereas, the minimum yield per plant (441.44 g) was found from M_0 treatment. In terms of quality parameters, highest chlorophyll a (2.24mg/g), chlorophyll b (0.71mg/g) and total chlorophyll content (2.96mg/g) was recorded in M_3 treatment whereas, the minimum chlorophyll a (1.57mg/g), chlorophyll b (0.49mg/g) and total chlorophyll content (2.06mg/g) was found in M_0 treatment. In case of vitamin C highest value (19.01mg/100g) was recorded in M_3 and lowest value (15.06mg/100g) was found in M_0 treatment.

For different level of *Trichoderma*, the longer plant (67.64cm) was observed from T_2 treatment, while the shorter plant (63.30cm) from T_0 treatment at final harvest. The highest number of branches per plant (8.91) was recorded from T_2 treatment, while the lowest number (7.25) from T_0 treatment. The highest number of leaves per plant (133.42) was observed from T_2 treatment, while the lowest number (122.50) from T_0 treatment. In case of diameter of stem highest (13.08mm) in T_2 and lowest (11.66mm) in T_0 was recorded. In T_2 treatment lowest (55.66) days from transplant to 1st flowering was recorded while highest (59.25) was recorded in treatment T_0. Significant difference was found in case of number of flower. Highest number of flower (31.66) was in T_2 and lowest (27.50) was in T_0.The highest number of fruits per plant (11.75) was recorded from T_2 treatment, while the lowest number (8.91) from T_0 treatment. The highest length of fruit (7.71cm) was observed from T_2 treatment, while the lowest length (6.46cm) was observed from T_0 treatment. The highest diameter of fruit (5.80cm) was found from T_2 treatment, while the lowest diameter (4.80 cm) was recorded from T_0 treatment. The highest pericarp thickness (5.83mm) was recorded from T_2 treatment, while the lowest thickness (4.91mm) was recorded from T_0 treatment. The highest weight of individual fruit (64.25 g) was recorded from T_2 treatment, while the lowest weight (57.50 g) was recorded from T_0

treatment. The highest yield per plant (765.25 g) was recorded from T_2 treatment, while the lowest yield per plant (518.08 g) was recorded from T_0 treatment. In terms of quality parameters, highest chlorophyll a (2.11mg/g), chlorophyll b (0.67mg/g), total chlorophyll content (2.79mg/g) was recorded in T_2 treatment whereas, the minimum chlorophyll a (1.73mg/g), chlorophyll b (0.54mg/g), total chlorophyll content (2.28mg/g) was found in T_0 treatment. In case of vitamin C highest value (18.58mg/100g) was recorded in T_2 and lowest value (16.10mg/100g) was found in T_0 treatment.

Due to the combined effect of different potting media and different level of *Trichoderma*, the tallest plant (70.90 cm) was recorded from M_3T_2 treatment combination at final harvest whereas the shortest plant (60.05cm) from M_0T_0 treatment combination. The highest number of branches per plant (11.00) was recorded from M_3T_2 treatment combination at final harvest and the lowest number (6.00) from M_0T_0 treatment combination. The highest number of leaves per plant (141.0) was obtained from M_3T_2 treatment combination at final harvest, whereas the lowest number (115.0) from M_0T_0 treatment combination. In case of days from transplanting to 1st flowering highest days (61.33) was in M_0T_0 and lowest days (53.33) was recorded in treatment M_3T_2. The maximum number of flowers per plant (35.33) was obtained from M_3T_2 treatment combination, while the minimum number (25.0) from M_0T_0 treatment combination. The maximum number of fruits per plant (14.00) was found from M_3T_2 treatment combination, while the minimum number (7.00) from M_0T_0 treatment combination. The highest length of fruit (8.36cm) was recorded from M_3T_2 treatment combination, while the lowest length (5.53cm) from M_0T_0 treatment combination. The highest diameter of fruit (6.00cm) was found from M_3T_2 treatment combination, while the lowest diameter (4.50cm) from M_0T_0 treatment combination. The highest pericarp thickness (6.33 mm) was obtained from M_3T_2 treatment combination, while the lowest thickness (4.33 mm) from M_0T_0 treatment combination. The maximum weight of individual fruit (70.00g) was obtained from M_3T_2 treatment combination, while the minimum weight (53.00g) from M_0T_0 treatment combination. The maximum yield per plant (980.00 g) was recorded from M_3T_2 treatment combination, while the minimum yield per plant (371.00 g) from M_0T_0 treatment combination. In terms of quality parameters, highest chlorophyll a (2.40mg/g), chlorophyll b (0.76 mg/g) and total chlorophyll content (3.17 mg/g) was

recorded in M_3T_2 treatment combination whereas, the minimum chlorophyll a (1.36mg/g), chlorophyll b (0.42 mg/g) and total chlorophyll content (1.78 mg/g) was found in M_0T_0 treatment combination. In case of vitamin C highest value (20.88mg/100g) was recorded in M_3T_2 and lowest value (14.07mg/100g) was found in M_0T_0 treatment combination.

Conclusion:

Considering the above result of this experiment, the following conclusion and recommendation can be drawn:

- In the experiment, potting media (soil: cocopeat: vermicompost = 1:1:1 v/v) was superior to the other treatments in terms of growth, yield and quality.
- In respect of all doses of *Trichoderma*, 50g/pot showed better performance than others.
- The treatment combination of M_3T_2 [(soil: cocopeat: vermicompost = 1:1:1 v/v) with *Trichoderma* 50g/pot)] showed best potentiality in respect of plant growth, yield and quality.

As it was a pot experiment, sweet pepper can be grown in pot with M_3T_2 media along with *Trichoderma* 50g/pot on the roof top, corridor or where there is scarcity of cultivable land.

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APPENDICES

Appendix I. Physical and chemical characteristics of the initial soil.

Characteristics	Value
%Sand	57
%Silt	23
%clay	20
Texture class	Sandy-clay loam
pH	6.2
Organic matter (%)	0.78
Total N (%)	0.003
Available P (ppm)	20.00
Exchangeable K (me/100g soil)	0.10
Available S (ppm)	45
Salinity (ds/m)	2

Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Appendix II: Monthly records of temperature, rainfall, and relative humidity of the experiment site during the period from November 2018 to March 2019

Year	Month	Air Temperature (^{0}C)			Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Maximum	Minimum	Mean			
2018	November	29.5	18.6	24.0	69.5	0.0	233.2
	December	26.9	16.2	21.5	70.6	0.0	210.5
2019	January	24.5	13.9	19.2	68.5	1.0	194.1
	February	28.9	18.0	23.4	61.0	2.0	121.5
	March	33.6	29.5	31.6	72.7	3.0	127.0

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-121

Appendix III: Analysis of variance of the data on plant height at different days after transplanting (DAT) of sweet pepper as influenced by different potting media and *Trichoderma* doses

Source of variation	Degrees of freedom	Mean square			
		Plant height (cm) at different days after transplanting			
		30 DAT	60 DAT	90 DAT	120 DAT
Replication	2	0.1865^{NS}	0.584^{NS}	0.5900^{NS}	0.9831^{NS}
Potting media (A)	3	89.7611*	125.332*	70.0766*	67.0066*
Doses of *Trichoderma*(B)	2	79.7997*	108.645*	59.7201*	56.6834*
Interaction (AxB)	6	8.8795*	2.244*	1.8480*	1.9422*
Error	22	0.1676	1.253	1.2887	1.7992

*: Significant at 0.05 level of probability and ^{NS}**:**Non-significant

Appendix IV: Analysis of variance of the data on number of branch and stem diameter of sweet pepper as influenced by different potting media and *Trichoderma* doses

Source of variation	Degrees of freedom	Mean square	
		number of branch	stem diameter (mm)
Replication	2	0.0278^{NS}	0.111^{NS}
Potting media (A)	3	15.657*	15.657*
Doses of *Trichoderma*(B)	2	8.7778*	6.361*
Interaction (AxB)	6	0.9630*	0.546*
Error	22	0.1490	0.171

*: Significant at 0.05 level of probability and ^{NS}**:**Non-significant

Appendix V: Analysis of variance of the data on number of leaves at different days after transplanting (DAT) of sweet pepper as influenced by different potting media and *Trichoderma* doses

Source of variation	Degrees of freedom	Mean square			
		Number of leaves at different days after transplanting			
		30 DAT	60 DAT	90 DAT	120 DAT
Replication	2	0.444^{NS}	1.083^{NS}	8.44^{NS}	0.750^{NS}
Potting media (A)	3	152.324*	465.213*	1340.18*	533.213*
Doses of *Trichoderma*(B)	2	113.028*	348.250*	881.69*	365.083*
Interaction (AxB)	6	2.324*	11.769*	46.84*	4.157*
Error	22	0.535	0.902	5.35	2.386

*: Significant at 0.05 level of probability and ^{NS}**:**Non-significant

Appendix VI: Analysis of variance of the data on some yield contributing characters of sweet pepper as influenced by different potting media and *Trichoderma* doses

Source of variation	Degrees of freedom	Mean square		
		Days from transplanting to 1st flowering	Number of flowers per plant	Number of fruits per plant
Replication	2	0.3611^{NS}	0.2500^{NS}	0.0278^{NS}
Potting media (A)	3	43.4352*	60.7778*	37.3704*
Doses of *Trichoderma*(B)	2	38.8611*	52.3333*	24.1944*
Interaction (AxB)	6	0.6019*	1.4444*	0.7870*
Error	22	0.5429	1.4924	0.1490

*: Significant at 0.05 level of probability and ^{NS}**:**Non-significant

Appendix VII: Analysis of variance of the data on some yield contributing characters of sweet pepper as influenced by different potting media and *Trichoderma* doses

Source of variation	Degrees of freedom	Mean square				
		Length of fruit (cm	Diameter of fruit (cm)	Pericarp thickness (mm)	Individual fruit weight (g)	Yield per Plant (g)
Replication	2	0.016^{NS}	0.02111*	0.333*	1.77^{NS}	104*
Potting media (A)	3	7.342*	1.394*	3.481*	238.694*	283477*
Doses of *Trichoderma*(B)	2	4.691*	1.051*	2.583*	137.528*	183780*
Interaction (AxB)	6	0.126*	0.060*	0.064*	4.306*	7614*
Error	22	0.01664	0.00838	0.24242	2.657	899

*: Significant at 0.05 level of probability and ^{NS}**:**Non-significant

Appendix VIII: Analysis of variance of the data growth and fruit quality parameters of sweet pepper as influenced by different potting media and *Trichoderma* doses

Source of variation	Degrees of freedom	Mean square			
		Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total Chlorophyll (a+b) (mg/g)	Vitamin C Content (mg/100g)
Replication	2	0.01859^{NS}	0.00205^{NS}	0.03300^{NS}	0.1178^{NS}
Potting media (A)	3	0.84593*	0.09345*	1.50170*	27.587*
Doses of *Trichoderma*(B)	2	0.45331*	0.05008*	0.80472*	18.7542*
Interaction (AxB)	6	0.00687*	0.00076*	0.01219*	0.37*
Error	22	0.00163	0.00018	0.00289	0.063

*: Significant at 0.05 level of probability and ^{NS}**:**Non-significant