EFFECT OF VERMICOMPOST AND SALINITY ON GROWTH AND YIELD PERFORMANCE OF TOMATO (BARI TOMATO 18)

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*This is to certify that the research work entitled, **"EFFECT OF VERMICOMPOST AND SALINITY ON GROWTH AND YIELD PERFORMANCE OF TOMATO (BARI TOMATO 18)"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, in partial fulfillment for the requirements for the degree of **MASTER OF SCIENCE IN SOIL SCIENCE,** embodies the results of a piece of bona fide research work successfully carried out by **MST. ZENIA SULTANA MOU** bearing Registration No.* **19-10104** *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, as has been availed of during the course of this investigation has duly been acknowledged.

Dated:
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____
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DEDICATED

TO

MY BELOVED HUSBAND

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All praises are due to the Almighty God who has enabled me to complete this thesis for the degree of Master of Science (MS) in Soil Science

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ABSTRACT

A pot experiment was conducted at the research field in Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period of November 2019 to March 2020, to assess the effect of vermicompost and salinity on growth and yield of tomato. The experiment comprised of two factors: four levels of vermicompost (VC_0 = 0; VC_1= 7.11; VC_2= 14.22; VC_3=21.33 g pot^{-1}) and three levels of salinity (S_0=0; S_1=100; S_2=200 mM) and was laid out on randomized complete block design with three replications. The result showed that the highest number of leaves plant^{-1} (17.56), number of flowers cluster^{-1} (5.76), weight of fruit plant^{-1} (0.46 kg) were observed from VC_3, whereas the lowest number of leaves plant^{-1} (13.56), weight of fruit plant^{-1} (0.24 kg) were observed from VC_0. In case of salinity, the highest number of leaves plant^{-1} (17.17), number of clusters plant^{-1} (4.75), number of flowers cluster^{-1} (6.10), number of flowers plant^{-1} (29.21), number of fruits plant^{-1} (13.30), weight of fruits plant^{-1} (0.49 kg), were observed from S_0 and the lowest number of leaves plant^{-1} (13.67), number of clusters plant^{-1} (3.25), number of flowers cluster^{-1} (4.35), number of flowers plant^{-1} (14.17), number of fruits plant^{-1} (6.27), weight of fruits plant^{-1} (0.21 kg) were observed from S_2. In case of interaction, the highest number of leaves plant^{-1} (20.67), number of flowers cluster^{-1} (7.19), number of flowers plant^{-1} (38.13), number of fruits plant^{-1} (18.25), weight of fruit plant^{-1} (0.72 kg), were observed from VC_3S_0, whereas the lowest number of leaves plant^{-1} (12.67), number of flowers cluster^{-1} (4.17), number of cluster plant^{-1} (2.33), number of flowers plant^{-1} (10.00), number of fruits plant^{-1} (5.08), weight of fruit plant^{-1} (0.16 kg) were observed from VC_0S_2. The greatest residual effect of organic matter (1.46%), available sulphur (26.61 ppm), and available phosphorus (26.40 ppm) were observed from VC_3S_0 and the lowest organic matter (1.30%) and available phosphorus (14.73 ppm) were observed from VC_0S_2. The greatest electrical conductivity (6.95 dSm^{-1}) was observed from VC_2S_2 on the contrary the lowest electrical conductivity (3.12 dSm^{-1}) was observed from VC_2S_0. It can be concluded that the treatment combination VC_3S_0 can be considered as the best considering all other treatment combinations.

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LIST OF ABBREVIATION

BARI	= Bangladesh Agricultural Research Institute
cm	= Centimeter
CV	= Coefficient of Variation
DAT	= Days After Transplanting
g	= Gram
ha	= Hectare
kg	= Kilogram
LSD	= Least Significant Difference
MoP	= Murate of Potash
NS	= Not Significant
PPM	= Parts Per Million
TSP	= Triple Super Phosphate
AEZ	= Agro-Ecological Zone
RCBD	= Randomized Complete Block Design

CHAPTER 1

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family Solanaceae, is one of the most popular and quality vegetables grown in Bangladesh. It is popular for its taste, nutritional status and various uses. It was originated in tropical America (Salunke *et al.*, 1987), particularly in Peru, Ecuador, Bolivia of the Andes (Kallo, 1986). Tomato is cultivated all over the country due to its adaptability to wide range of soil and climate (Ahmed, 1976). It ranks third, next to potato and sweet potato, in terms of world vegetable production (FAO, 2002). Global production is estimated at 170.8 million metric tons with China and India as the leading producers in 2017. China accounted for 31% of the total production. India and the United States followed with the second and third highest production of tomatoes in the world. The global tomato exports the previous year was worth 88 billion USD (Worldatlas, 2019). Bangladesh is primarily an agriculture-based country and agriculture is the main source of employment, income and food and nutrition security (Ferdous *et al*., 2016). The soil and climate conditions of winter season of Bangladesh are congenial for tomato cultivation. Among the winter vegetable crops grown in Bangladesh, tomato ranks second in respect of production and third in respect of area (BBS, 2004). Tomato is one of the most important and popular vegetable in Bangladesh which cultivated in an area of 68.37 thousand acres of land accounting for production of 388725 metric tons in 2016-2017 (BBS, 2017).

Tomatoes are the major dietary source of the antioxidant lycopene, which has been linked to many health benefits, including reduced risk of heart disease and cancer. They are also a great source of vitamin C, vitamin A, potassium, folate and vitamin K. Carbohydrates make up 4% of raw tomatoes. Simple sugars, such as glucose and fructose, make up almost 70% of the carbohydrate content (Healthline, 2015). 100 grams of red, ripe and raw tomatoes contain 18 calories, 0.9 g proteins, 3.9 g carbohydrates, 2.6 g sugar and 1.2 g fiber (USDA, 2019). It can be taken both in raw as ripen and after cooking. The popularity of tomato and different products produced from tomato is increasing day by day. It is a nutritious and delicious vegetable used in salads, soups and processed into stable products like ketchup, sauce, marmalade, chutney and juice. They are extensively used in the canning industry for canning.

The production potentiality of tomato is decreasing in the recent years due to the changing environmental condition of biotic and abiotic factors and it's becoming a tremendous challenge to face the demand of the vegetables with increasing population in Bangladesh. There are various abiotic environmental factors such as flooding, drought, salinity, high or low temperature, metal toxicity, etc. which pose serious threat to world agriculture. Among these abiotic factor's salinity is becoming a major concern for crop production including tomato in southern districts of Bangladesh. Over 30% of the net cultivable area exists in the coastal regions of Bangladesh. Out of 2.85 million hectares of the coastal and offshore areas, about 0.833 million hectares of the arable lands, which constitutes 52.8% of net cultivable saline area are dispersed in 64 sub-districts of 13 districts. In those areas, the ranges of the salinity are categorized on the basis of electrical conductivity (EC) between 2 dSm^{-1} and 16 dSm^{-1}. The severity of salinity problem in Bangladesh increases from November to May with the desiccation of the soil when concentration of salts in the soil surface builds up by rapid evapo-transpiration (ET). During the wet monsoon, the severity of salt injury is reduced due to dilution of the salt in the root-zone of the standing crop (Ahmed *et al*., 2017).

Vermicompost is an important organic manure. Use of organic manures to meet the nutrient requirements of a crop would be a valuable practice for sustainable agriculture. Organic manure improves physical, chemical and biological properties of soil along with conserving the moisture holding capacity and thus resulting in enhanced crop productivity and quality (Premsekhar and Rajashree, 2009). Thus, the successful application of manure to soil requires an understanding of the impact of manure addition on microbial characteristics of the soil (Pell, 1997).

It has been reported vermicompost improve the morphological and physiological functions in plant to cope with adverse environment (Mohsen Kazemi et al., 2014). Therefore, the effect of vermicompost to minimize the effect of salt toxicity in the reduction of yield of tomato is essential to investigate, especially for saline prone area.

This study focuses on the independent or interactive effect of vermicompost in alleviation of salt toxicity in tomato by improving the morpho-physiology and yield to different levels of salt stress in Bangladesh.

Therefore, the present investigation was, carried out with a view to achieving the following objectives:

a. to evaluate the growth and yield performance of tomato by using different rates of vermicompost and levels of salinity, and
b. to find out the suitable combination of vermicomost and salinity for maximum agronomic yield and residual nutrients on post-harvest soil.

CHAPTER II

REVIEW OF LITERATURE

Tomato is one of the crops with the greatest economic importance in the world and salinity stress causes reduction in the quantity and quality of crop production. Today the main challenge in world agriculture is to support the continuously growing global population and this becomes more difficult due to climatic change, as this imposes further abiotic stress like salinity. Application of vermicompost has different modifying influences on growth, yield and yield contributing characters of tomato as well as other vegetables. Some of the available research works in this connection have been reviewed with the hope that these may contribute useful information to the present study. In these chapter morphological characters, growth, yield and quality parameters have been reviewed as follows:

2.1 Effect of vermicompost

Islam *et al*. (2017) conducted an experiment on the tomato for yield and quality of fruits using different types of organic and inorganic fertilizers at the horticulture farm of Bangladesh Agricultural University (BAU), Mymensingh. Fertilizer treatments were tested on two varieties of tomato ca. Roma VF and BARI Tomato-15. The fertilization treatments were T_1, vermicompost (12 t ha^{-1}); T_2, compost (10 t ha^{-1}); T_3, integrated plant nutrient system (IPNS) or mixed fertilizers (organic 2/3 part and inorganic 1/3 part); T_4, inorganic fertilizers; and a control (T_5). Results showed growth and yield (20.8 t ha^{-1}) in tomato were higher in the IPNS treatment. A higher number of fruits per plant (73.7) and plant height (73.5 cm) were obtained from mixed fertilizers (organic 2/3 + inorganic 1/3) or IPNS (integrated plant nutrient system) in Roma VF than other treatments. Fruit yield and diameter were found statistically significant. No significant difference was observed in the quality (total soluble solids) of tomato fruits in both varieties' response to the treatments. The electrical conductivity and pH of the soil were improved by the application of organic manure.

Wang *et al.* (2017) conducted a greenhouse pot test was conducted to study the impacts of replacing mineral fertilizer with organic fertilizers for one full growing period on soil fertility, tomato yield and quality using soils with different tomato planting history. Four types of fertilization regimes were compared: (1) conventional fertilizer with urea, (2) chicken manure compost, (3) vermicompost, and (4) no fertilizer. The effects on plant growth, yield and fruit quality and soil properties (including microbial biomass carbon and nitrogen, $NH_4^+NH_4^+$-N, $NO_3^-NO_3^-$-N, soil water-soluble organic carbon, soil pH and electrical conductivity) were investigated in samples collected from the experimental soils at different tomato growth stages. The main results showed that: (1) vermicompost and chicken manure compost more effectively promoted plant growth, including stem diameter and plant height compared with other fertilizer treatments, in all three types of soil; (2) vermicompost improved fruit quality in each type of soil, and increased the sugar/acid ratio, and decreased nitrate concentration in fresh fruit compared with the CK treatment; (3) vermicompost led to greater improvements in fruit yield (74%), vitamin C (47%), and soluble sugar (71%) in soils with no tomato planting history compared with those in soils with long tomato planting history; and (4) vermicompost led to greater improvements in soil quality than chicken manure compost, including higher pH (averaged 7.37 vs. averaged 7.23) and lower soil electrical conductivity (averaged 204.1 vs. averaged 234.6 μS cm^{-1}) at the end of experiment in each type of soil. We conclude that vermicompost can be recommended as a fertilizer to improve tomato fruit quality and yield and soil quality, particularly for soils with no tomato planting history.

Thuy *et al*. (2017) conducted an experiment arranged in a randomized complete block design (RCBD) included six vermicompost levels (10, 15, 20, 25, 30, 35 t ha^{-1}) with three replications. The results given that vermicompost dose had a significant effect on plant height, leaf number, and height and internode number from stump to the first flower cluster. When applying higher vermicompost levels, significantly higher in individual fruit weight and yield of tomato was supported. The highest yield was observed at 35 t ha^{-1} vermicompost (in autumn-winter season 2013) and at 30 t ha^{-1} vermicompost (in autumn-winter season 2012, but the difference was not significant as compared to level 35 t ha^{-1}). Vermicompost had beneficial effects not only on yield but also on fruit quality. By regression way, the regression equation that presents depended relation between yield of HT152 tomato variety and vermicompost dose was established as following: y = 0.0054x2 + 0.3596x + 34.602 with R^2 = 0.4745. The result of the optimal calculation indicated that the highest yield of HT152 tomato variety at optimal vermicompost dose of 33.3 t ha^{-1}. The knowledge gained from this study provided an important link about organic production, and could further improve product quality not only in tomato but also in other plants.

Khan *et al*. (2017) conducted an experiment on the effect of compost and inorganic fertilizers on yield and quality of tomato was investigated in a field experiment carried out on silt loam soil at Nuclear Institute of Food and Agriculture (NIFA), Peshawar during summer 2016. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replications and seven treatments. N, P and K fertilizers at 180, 100 and 60 kg ha^{-1} respectively were applied with or without compost, while compost was applied at 20 t ha^{-1}. The sources of N, P and K were urea, triple superphosphate, and muriate of potash. The results of the study showed that yield and quality parameters of tomato fruit were significantly affected by the combined use of compost and inorganic fertilizers. Maximum tomato fruit and dry matter yields, fruit density, number of fruit kg^{-1}, N, P and K uptake by tomato plant were obtained from treatment where a full dose of N, P and K with10 tons of compost were applied. Maximum vitamin C content in tomato fruit was observed where full doses of compost and mineral fertilizers were applied. Soil organic matter and N, P, K contents were improved where full doses of mineral fertilizers with a full dose of compost were applied. It was found that a combination of plant residue compost and mineral fertilizers significantly improved the yield, quality of tomato fruit and sustained soil fertility status.

Organic agriculture in India can become a potent endeavor because 81% of small and marginal farmers dominate the major section of agriculture. The minor stream is directly benefitted from urban-oriented growth, while the majority section is still on the verge of the struggle for producing sufficient food and income for sustaining a livelihood. These farmers have a unique set of needs that the modern, chemically equipped agriculture paradigm has not been able to fulfill. The intensive, rather excessive use of chemical fertilizers has completely degraded the soil health, environmental and ecological parameters reflecting today's human health and security. Supporting a serious suitable option for small scale production system, organic agriculture holds another kind of promise in terms of overall productivity with ecological parameters. Keeping in view a vigorous demand for a sustainable source and value-added commercial tomato farming in terms of secured economic gains and returns, a study was conducted at farmer's field during 2012-13 on standardizing organic production package for commercially grown tomato (cv. *Solan Salima*). The experiment was laid out in a randomized block ANUM ASSOCIATION Meknes, Morocco 1-2 May 2015 www.anuma.ma 2 design (RBD) with seven treatments and five replications each of organic manures (Farmyard manure and Vermicompost), biofertilizers (*Azotobacter*, *Azospirillium*, and PSB) and farmers practice (control). A tomato grown under both systems was analyzed for their quality attributes and nutritional composition. The results of the study indicated that the application of different microbial preparations in treatment T_3 (FYM@ 200 q ha^{-1} + *Azospirillum* + PSB + *Trichoderma herzianum* (4 kg ha^{-1} each) in comparison to control led to a balanced OC (0.99%), NPK status (413.1 Kg ha^{-1}, 26.33 Kg ha^{-1} and 285.4 Kg ha^{-1}) crop quality attributes. The results of studies indicated that the maximum yield (665.0 q ha^{-1}) was recorded with maximum net return (1,360,950 ha^{-1}) and cost-benefit ratio of (1:2:29) under the organic system and the minimum (649.0q ha^{-1}) under chemical cultivation with (1:1:59). reported by Thakur and Tripathi (2015)

Najar *et al*. (2015) conducted an experiment to investigate the effect of different rates (2, 4 and 6 t ha^{-1}) of macrophyte-based vermicompost on germination, growth, and yield of *Solanum melongena* under field conditions. The data revealed that different rates of vermicompost produced a varied and significant effect (P\0.05) as compared to the control on germination, growth and yield parameters with the maximum value recorded at 6 t ha^{-1}, followed by 4 t ha^{-1} and the least at 2 t ha^{-1}. The dose of 6 t ha^{-1} significantly (P\0.05) increased germination (22.56 ± 2.5 %), number of fruits per plant (3.55 ± 0.07) mean fruit weight (73 ± 5.0 g), yield per plant (1.48 ± 0.05 kg) and marketable fruits (28.66 ± 3.0 %) when compared with the control. The study proved that macrophyte-based vermicompost as a potential source of plant nutrients for sustainable crop production.

Mukta *et al*. (2015) conducted a pot experiment to investigate the yield and nutrient content of tomato (*Lycopersicon esculentum*) as influenced by the application of vermicompost and chemical fertilizers. The experiment was laid out in a completely randomized design (CRD) with 3 replications and comprised of 8 treatments viz., T_1 - control, T_2 - recommended dose of NPK fertilizers (CF), T_3 - vermicompost @ 5 t ha^{-1} (VC_1), T_4 - vermicompost @10 t ha^{-1} (VC_2), T_5 - VC_1 + 50% CF, T_6 - VC_1 + 75% CF, T_7 - VC_2 + 50% CF and T_8 - VC_2 + 75% CF. Application of vermicompost @ 10 t ha^{-1} along with 50% chemical fertilizers showed the best performance for plant height, number of leaves plant^{-1}, number of flowers branch^{-1}, number of fruits branch^{-1} number of fruits plant^{-1}, fruit size, and yield of tomato. Vermicompost treated soils significantly contributed the highest contents of sugar, pH, N, P, K, Ca, Mg, S, Zn & B in tomato, influenced nutrient status of the postharvest soil and conserved more organic C, N, P, K, Ca, Mg, S, Zn & B contents over control. However, soluble solids and vitamin C content in tomato were not significantly influenced by the application of vermicompost and chemical fertilizers. Results of the study demonstrate that the combined application of vermicompost and chemical fertilizers would help to maintain the long-term soil productivity for sustainable tomato cultivation.

According to Tiwari. (2015) the twelve treatment combinations were replicated three times in a randomized block design. The NPK fertilizers were applied as urea, SSP and MOP/ha. The seedlings were transplanted on 17.08.2014 and the first picking was started from 2014. Treatments-12 T_1 FYM 20 t/ha, T_7 Vermicompost 5 t ha^{-1} +*Azotobactor* , T_2 Vermicompost 5 t ha^{-1}, T_8 FYM 10 t ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Azotobactor* , T_3 FYM 10 t ha^{-1} + Vermicompost 2.5 t ha^{-1} , T_9 FYM 15 t ha^{-1} + *Azotobactor* + 50% NPK, T_4 FYM 10 t ha^{-1} + 50% NPK + *Azotobactor*, T_{10} Vermicompost 5 t ha^{-1} + Biofertilizer (*Azotobactor*) + 50% NPK, T_5 Vermicompost 2.5 t ha^{-1} + 50% NPK + *Azotobactor*, T_{11} FYM 10 t ha^{-1}+ Vermicompost 2.5 t ha^{-1} + *Azotobactor* + 50% NPK ,T_6 FYM 10 t ha^{-1} + *Azotobactor* T_{12} RFD of NPK (100:60:80) Undergrowth characters height of plant and number of branches were studied. Under reproductive characters, a number of flower clusters $plant^{-1}$, flowers $cluster^{-1}$ and days to fruit-set $cluster^{-1}$ were taken. In yield characters, a number of fruits $plant^{-1}$, average fruit weight and yield $hectare^{-1}$ were studied. Nutritional quality of fruit, as well as the grading of fruits, were also determined. the combined application of organic-cum-inorganic nutrients, T_{11} having four sources of nutrients was continued to be the best with respect to quality also. Accordingly, the significantly higher dry matter of tomato fruit (8.17%), "A" grade tomato (54.59%), TSS to 10.84% Brix was obtained from the fertility treatment T_{11}. The second best fertility treatment was T_1 having 20 t FYM/ha (dry matter 7.80, "A" grade tomato 52.16%, TSS to 10.50% Brix. The "C" grade tomato was in the lowest range. This was followed by T_8 and T_9 treatments. On the other hand, the significantly lowest values (6.53-6.63% dry matter, 48.49-48.61% "A" grade tomato, 8.47-9.02% Brix TSS and was obtained from T_6 and T_7 treatments having half dose of FYM or vermicompost with *Azotobacter.*

Uz *et al*. (2014) were conducted this study to investigate the direct short-term impact of vermicompost on some soil biological properties by monitoring changes after addition of vermicompost as compared to farmyard manure in alkaline soil with high lime content from the semi arid Mediterranean region of Turkey. For this purpose, mixtures of soil and organic fertilizers in different doses were incubated under greenhouse condition. Soil samples collected at regular intervals were analyzed for biological parameters including dehydrogenase, β-glucosidase, urease, alkaline phosphatase activities, and a total number of aerobic mesophilic bacteria. Even though soil dehydrogenase activity appeared to be dose-independent based on the overall evaluation, organic amendments were found to elevate dehydrogenase activity when sampling periods are evaluated individually. β-glucosidase, urease, alkaline phosphatase activity, and aerobic mesophilic bacterial numbers in vermicompost treatments fluctuated but remained significantly above the control. A slight but statistically significant difference was detected between organic amendments in terms of urease activity. Vermicompost appeared to more significantly increase the bacterial number in soil. Clearly, vermicompost has the potential to be used as an alternative to farmyard manure to improve and maintain soil biological activity in alkaline calcareous soils from the Mediterranean region of Turkey. Further studies are needed to assess its full potential for these soils.

Joshi *et al*. (2014) showed in the present review, vermicompost is described as an excellent soil amendment and a biocontrol agent which make it the best organic fertilizer and more eco-friendly as compared to chemical fertilizers. Vermicompost is ideal organic manure for better growth and yield of many plants. It can increase the production of crops and prevent them from harmful pests without polluting the environment. Application of vermicompost increased seed germination, stem height, number of leaves, leaf area, leaf dry weight, root length, root number, total yield, number of fruits/plant, chlorophyll content, pH of juice, TSS of juice, micro and macronutrients, carbohydrate (%) and protein (%) content and improved the quality of the fruits and seeds. Studies suggested that treatments of humic acids, plant growth promoting bacteria and vermicompost can be used for sustainable agriculture discouraging the use of chemical fertilizers.

Abduli *et al*. (2013) research shows, the effect of using vermicompost on the growth rate, fertility and characteristics of tomatoes has been studied. Four vermicompost: soil mixture were supplied with ratios of 1:1, 1:2, 1:3, and 1:4 and also four different beds were provided. Total of 24 small globe tomato plants was tested and in each bed combination, six tomato plants were embedded. Rate of growth and yielding of plants grown in each of four beds were investigated in two periods of 40 days and 90 days after planting. The results showed a significant rise in the growth of tomato plants by increasing the ratio of vermicompost combined with soil. Obviously, the plant mostly appeared in the main stem of the plant and there was no significant enhancement in the number of leaves. The main stem diameter, height, the number of leaves per plant, and yielding of tomato plants obtained the highest rate in four tested beds after 40 days in vermicompost to soil ratios of 1:3, 1:1, 1:3, and 1:2, respectively. In the mentioned observations, some changes were made after 90 days of testing and maximum yielding and height of tomato plants were obtained in 1:1 ratio. Vitamin C and total sugar content in tomatoes increase with using vermicompost. The maximum amount of vitamin C and total sugar, soluble solids, insoluble solids and total nitrites of fresh tomato were observed in ratios of 4:1, 4:1, 3:1, 2:1 and 3:1, correspondingly.

Singh *et al*. (2013) a field experiment was conducted for two years to investigate the effect of vermicompost, organic mulching and irrigation level on growth, yield and quality attributes of tomato (*Solanum lycopersicum* L.) with an ultimate aim of optimizing water and nutrient requirement of tomato in mild-tropical climate during the dry season. The vermicompost together with organic mulching increased plant height (106.5 cm), leaf area (40.6 cm^2), leaf weight (1301 mg $leaf^{-1}$), fruit weight (92.9 g), fruit yield (4.013 kg $plant^{-1}$), fruit density (0.972 g cc^{-1}), post-harvest shelf-life (15.0 days) and TSS (5.2% Brix) of tomato significantly. Application of vermicompost alone too increased the shelf-life of fruits by 25-106 % and TSS beyond 4.5 %, both of which are traits highly desirable for the production of summer tomato and related processing industry. The application of vermicompost @ 5 t ha^{-1}, 5 cm thick mulching with dried crop residues, a two-thirds dose of NPK fertilizer (80:40:40 kg ha^{-1}) and 30 % irrigation is optimum for obtaining better quality and productivity of field-grown tomatoes during the dry period of mild-tropical climate.

Meenakumari and Shekhar (2012) an experiment was conducted to determine the effect of vermicompost and other fertilizers on growth, yield and fruit quality of tomato in the field condition. The field trials were conducted using different fertilizers having an equal concentration of nutrients to determine their impact on different growth parameters of tomato plants. Six types of experimental plots were prepared whereT_1 was kept as control and five others were treated by different category of fertilizers (T_2-

Chemical fertilizers, T_3-Farm Yard Manure (FYM), T_4-Vermicompost, T_5, and T_6-FYM supplemented with chemical fertilizers and vermicompost supplemented with chemical fertilizer respectively). The treatment plots (T_6) showed 73% better yield of fruits, and dry weight of leaves, dry weight of fruits, number of branches and number of fruits per plant than control, followed by T_5.

Joshi and Vig (2010) conducted a study on the effect of vermicompost on growth, yield, and quality of tomato (*Lycopersicon esculentum* Mill). The treatments (control), VC15 (Soil+15% VC), VC30 (Soil+30% VC), VC45 (Soil+45% VC). Various growth and yield parameters like mean stem diameter, mean plant height, yield plant^{-1}, marketable yield plant^{-1}, mean leaf number and total plant biomass were recorded for each treatment. Various quality parameters like ascorbic acid, titrable acidity, soluble solids, and insoluble solids were recorded for tomatoes from each treatment. Almost all the growth, yield, and quality parameters increased significantly as compared to control.

Singh *et al*. (2010) were conducted a field experiment with an objective to investigate the effects of vermicompost and NPK fertilizer application on morpho-physiological traits, yield and quality attributes of tomato (*Solanum lycopersicum* L.) with an ultimate aim of optimizing nutrient requirements of tomato in mild-tropical agro-climate. The application of vermicompost together with NPK fertilizer increased plant height, leaf area, leaf weight, fruit weight, fruit yield, fruit density, post-harvest life and TSS of tomato. Application of vermicompost alone too increased the shelf-life by 250% and TSS beyond 4.5%, both of which are traits highly desirable for the summer production of tomato and the related processing industry. Present study reveals that application of vermicompost in the amount of 7.5 t ha^{-1} in combination with 50% dose of NPK fertilizer (60:30:30 kg ha^{-1}) was optimum for obtaining better quality and productivity of field-grown tomatoes in mild-tropical agro climate, eventually integrated nutrient supply will sustain the soil fertility and plant productivity eco-friendly.

Azarmi R *et al*. (2008) reported that an experiment was conducted to determine the effects of vermicompost on growth, yield and fruit quality of tomato (*Lycopersicum esculentum* var. *Super Beta*) in a field condition. The experiment was a randomized complete block design with four replications. The different rates of vermicompost (0, 5, 10 and 15 t ha^{-1}) was incorporated into the top 15 cm of soil. During the experiment period, fruits were harvested twice in a week and the total yield was recorded for two months. At the end of the experiment, growth characteristics such as leaf number, leaf area and shoot dry weights were determined. The results revealed that the addition of vermicompost at a rate of 15 t ha^{-1} significantly (at $p < 0.05$) increased growth and yield compared to control. Vermicompost with the rate of 15 t ha^{-1} increased EC of fruit juice and percentage of fruit dry matter up to 30 and 24%, respectively. The content of K, P, Fe, and Zn in the plant tissue increased 55, 73, 32 and 36% compared to untreated plots respectively. The result of our experiment showed the addition of vermicompost had significant ($p < 0.05$) positive effects on growth, yield and elemental content of plant as compared to control.

Sendurkumaran *et al*. (1998) also observed an increased yield in tomato and brinjal, respectively when plots were fertilized with both organic and inorganic sources. The quality parameters such as TSS, ascorbic acid lycopene were comparatively higher in tomato when grown organically.

2.2 Effect of salinity

El-mogy *et al*. (2018) conducted an experiment taking different levels of salinity and reported that salinity affects growth, yield, fruit quality, storability and marker-gene expression in cherry tomato. The influence of different salt concentrations on physiological responses and the expression of some selected genes of cherry tomato (*Solanum lycopersicum* L.), cv. West Virginia 106, was examined. Tomato plants were grown in peat moss substrate and irrigated with 0, 25, 50, 75, 100 or 150 mM sodium chloride (NaCl) in a glasshouse. The NaCl treatments of 75, 100and 150-mM salt resulted in shorter plants, decreased stem width, a lower plant dry weight, fewer flowers, and smaller leaf area while yield was reduced by treatment with concentrations of 50 mM NaCl and above. Average fruit weight and fruit number were also negatively affected by treatment with 50 mM salt and above. Salinity treatment led to increased fruit total soluble solids, titratable acidity and firmness and improved the taste index. Salt-responsive marker genes identified in Moneymaker were also induced in cherry tomato but not at the highest salt concentrations. The results indicated that cherry tomato treated with 25 mM NaCl produced fruit with improved quality in comparison with non-salinized control plants without compromising yield, while at 50 and 75 mM the improved fruit quality was accompanied by a reduction in yield.

Saline water occupies 71% of the Earth area. It is thought that even a quarter of the whole pedosphere is affected by salts amounting to 950 × 106 ha while 23 % of the 1.5 × 109 ha cultivated land is considered as saline. This study was carried out to investigate the influence of salinity on the growth and yield of tomato varieties. The seedlings 20 genotype were divided into three groups, Sodium chloride (NaCl) dissolved in irrigation water to make variant concentration of 0, 30, 60 mg L^{-1} of salt concentration using E. C meter which were used to water the plants. The result of this research suggest that salinity decline both vegetative and reproductive parameters in tomato (Umar *et al*., 2018).

Heuvelink (2018) said in his book Tomatoes (Crop Production Science in Horticulture) salinity can reduce the fruit growth rate and final fruit size by an osmotic effect. High salinity lower water potential in the plant which was reduce the water flow in the fruit and that therefore the rate of fruit expansion. ECs of 4.6-8 dS m^{-1} reduced fruit yield because reduction of fruit size whereas ECs of 12 dSm^{-1} reduced number and size of fruit.

Ahmed *et al*. (2017) was conducted an experiment to find out the salinity effect on tomato production at water management research field of Bangladesh Agricultural University (BAU), Bangladesh during October 2007 to April 2008 cropping season. The experiment was carried out in a randomized complete block design (factorial) with 3 replications. The treatments were: T_1= Irrigation with fresh water, T_2= Irrigation with saline water containing 4 dSm^{-1} of Electrical conductivity (Sea water cannot hold as much dissolved oxygen as freshwater due to its high salinity. Conductivity and salinity have a strong correlation.), T_3= Irrigation with saline water containing 6 dS m^{-1} of Electrical conductivity, T_4= Irrigation with saline water containing 8 dS m^{-1} of Electrical conductivity and T_5= Irrigation with saline water containing 10 dS m^{-1} of Electrical conductivity. They found that the plants irrigated with the T_1 treatment was the highest fruit yield $plant^{-1}$ (1.52 kg) whereas, the lowest yield (0.667 kg) was obtained from the higher level of saline water treatment T_5. When the fruit yield was considered the effective treatment for the highest total fruit yield (36.57 t ha^{-1}) was produced by the T_1 treatment (Irrigation with fresh water) and the lowest fruit yield (21.87 t ha^{-1}) was found from the treatment T_5. The effect of different salinity levels of irrigation such as fresh water, 4 dS m^{-1}, 6 dS m^{-1}, 8 dSm^{-1} and 10 dS m^{-1} on total soluble solid was significantly influenced. The highest total soluble solid (2.53) was shown in T_5 treatment whereas the lowest (2.00) in Irrigation with fresh water treatment.

Yang *et al*. (2017) stated that salinity as one of the major environmental constraints hindering crop plant yields around the world. That's why; exploring the salt-tolerant mechanism and developing crops with salt tolerance capability are two of the most effective ways of sustaining crop production worldwide. The variation in metabolite profiles was analyzed between common wild soybean and salt-tolerant wild soybean in response to neutral-salt stress and alkali-salt stress to explore the salt-tolerant mechanism. The findings indicated that the salt-tolerant wild soybean grew better than common wild soybean under both treatments. Differential metabolites profiling noted that the levels of some carbohydrates and fatty acids were minimum in common wild soybean than in salt-tolerant wild soybean under salt stress. These metabolites included lactose, ribose, lauric acid, palmitic acid, stearic acid and linolenic acid. Amino acid accumulation was reported in the two wild soybeans under alkali-salt stress. The amino acids were valine, tyrosine, glutamic acid, leucine and isoleucine. In salt-tolerant wild soybean subjected to alkali-salt stress the content of most organic acids and proline were increased. The organic acids found in the experiment were mucic acid, glutaric acid, galactonic acid, and dehydroascorbic acid. In common wild soybean the TCA cycle was reported to be enhanced in response to both treatments but was reduced in salt-tolerant wild soybean. This study indicated that the salt-tolerant mechanism in common wild soybean may encourage the TCA cycle to generate more ATP. However, salt-tolerant wild soybean may regulate amino acid and organic acid metabolism to produce more compatible solutes.

Rodriguez-Ortega *et al*. (2017) conducted an experiment with tomato variety 'Óptima', using different soilless crop systems (perlite substrate, hydroponics, and the nutrient film technique) and several levels of salinity in the irrigation water. The yield, quality parameters, vegetative growth, mineral composition, water relations, and gas exchange parameters were measured. They found that salinity caused changes in the water status of the plants, toxicity due to Cl^- and Na^+, and nutritional imbalances that altered the physiology of the plants, thereby reducing yield, although the fruit quality was improved.

Zhang *et al*. (2016) conducted an experiment to find out the effects of salinity stress on growth, yield, fruit quality and water use efficiency of tomato under hydroponics system. Salt added to nutrient solution is an easy method that can improve tomato fruit quality but plant growth and fruit production are negatively affected. Salinity reduces tomato root elongation rate and lateral root growth due to restriction of root cell growth and increased root lesion. Tomato leaf, shoot height and stem diameter reduced under salinity stress caused by photosynthesis reduction, tissues expansion reduction and cell divided inhibition. Salinity also reduces leaf chlorophyll content, stomatal resistance and photosynthetic activities. Total yield of tomato is significantly reduced at salinity equal and above 5 dS m^{-1} and a 7.2% yield reduction per unit increase in salinity. Salinity can decrease root water uptake through its osmotic effect and subsequently induce water stress. Fruit quality is the only parameter which is positively affected with increased salinity.

Kayees *et al*. (2016) assayed the emergence percentage, radical length, plumule length, proline content, K^+ or Na^+ of the seedling under five levels salinity; control (0), 4, 8, 12 and 16 dSm-1. The growth and subsequent development of tomato seedling negatively affected with the rising of salinity. Emergence percentage, radical length, plumule length, K^+ or Na^+ ratio were decreased with the increment of salinity. Proline content was increased with the increment of salinity. The overall results of the experiment exhibited that among the varieties BARI Tomato 2, Mintoo and Unnoyon were comparatively more tolerant to higher salinity on the basis of studied parameters.

An experiment was conducted by Mazumder (2016) and reported that the growth, development, yield and yield attributes of tomato varied with the variation of varieties. He carried out his experiment with four tomato genotype (BARI Tomato 2, BARI Tomato 11, BARI Tomato 14, BARI Tomato 15) and four salinity levels (0,5 10 and 15 dSm^{-1}. He reported that salt stress greatly affects growth, development, yield and yield attributes of tomato. Growth and yield of tomato decreased with increasing the level of salt stress. Exposure of different level of salt stress decreased plant height, number of leaf $plant^{-1}$ and other growth and biochemical attributes including chlorophyll content. Salt stress decreased number of flower cluster, total flower $plant^{-1}$ but increased flower dropping. Yield reduction increased with increasing the level of salinity.

An experiment was conducted by Shiam *et al*. (2015) at the Sher-e-Bangla Agricultural University, Bangladesh to evaluate influence of salt (NaCl) on sixteen tomato lines. Sixteen lines coded from V_1 (Line-01) to V_{16} (Line-16) were executed under different NaCl salinity conditions (S_0: Control; S_1: 12dS m^{-1} and S_2: 16 dS m^{-1} following completely randomized design with three replications. Apart from control, V_8 provided tallest plant in 12 dS m^{-1} (43.7 cm) and in 16 dS m^{-1} (38.4 cm) salinity level at 60 days after transplanting which was statistically similar with the V_9 tomato line. V_8 line provided the maximum number of leaves per plant except control (24.2 and 21.1 in 12 dS m^{-1} and 16 dS m^{-1}, respectively). V_9 line produced maximum leaf area (123.7 cm^2 and 97.6 cm^2 in 12 dS m^{-1} and 16 dS m^{-1}, respectively) under saline conditions which was followed by V_8 line (112.7 cm^2 and 92.6 cm^2 in 12dS m^{-1} and 16 dS m^{-1}, respectively). Maximum number of bunch per plant was observed from V_9 line (10.7 and 9.3 in 12 dS m^{-1} and 16 dS m^{-1}, respectively) followed by V_8 line (9.3 and 9.3 in 12 dS m^{-1} and 16 dS m^{-1}, respectively) except control. Maximum yield was found from V_9 line (0.92 kg $plant^{-1}$) followed by V_2 line (0.493 kg $plant^{-1}$) in 12 dS m^{-1} salinity level and maximum yield was found from V_9 line (0.593 kg $plant^{-1}$) which was closely followed by V_8 line (0.407 kg $plant^{-1}$) in 16 dS m^{-1} salinity level. Tomato line-09 was found the best tomato cultivar for salt affected areas in Bangladesh.

Liu *et al*. (2014) conducted an experiment to find out differential responses to short term salinity stress of heat-tolerant cherry tomato cultivars grown at high temperatures. It was hypothesized that cultivars which perform better in high temperatures are also more tolerant to salinity stress. Two highly heat-tolerant cultivars, ‘Tainan ASVEG No. 19’ (TA19) and ‘Taiwan Seed ASVEG No. 22’ (TSA22), and one moderately heat-tolerant cultivar, ‘Hualien ASVEG No. 21’ (HA21), were grown under high temperature conditions and were irrigated with a 0, 50, 150, or 200 mM NaCl solution for 20 days. Number of leaves, leaf area, shoot fresh and dry weight and root fresh weight were generally decreased with increasing level of salinity stress but root dry weight was not affected, resulting in an increase in root to shoot ratio in all three cultivars. Yield was also decreased by salinity treatments in all three cultivars due to reduced number of flowers, fruit set, and fruit size.

The response of tomato varieties [Cal-ji, Flat Chirani, Chef Flat Americ, Primo Earily and Chef] against five salinity levels [distilled water as control, 25, 50, 75 and 100 mM] were studied at germination and early seedling stages. Results obtained in that study indicated that interaction of salt × genotype had significant effect on growth indices in all the cases [$P < 0.05$]. With increase in salinity level, germination percentage was significantly decreased. Increased salt level results in reduction of plumule fresh weight indices (Sardoei *et al*., 2014).

Rahil *et al*. (2013) reported that the reduction in fruit number observed in the present study appeared to be related to a reduction in the average number of flowers per trees, fruits per cluster and per plant observed with increasing salinity.

Edris *et al*. (2012) reported that salinity treatment strongly affected the yield in cherry tomato. Addition of supplemental Ca^+ and K^+ can ameliorate negative impact of high salinity. Small fruit development in salinity conditions could be related to disorder in water relations and decrease in photosynthetic productions (due to leaf area reduction) as well as chlorophyll content.

A pot experiment was carried out to study the salt tolerance of eight tomato varieties viz., J-5, Binatomato-5, BARI tomato 7, CLN-2026, CLN-2366, CLN-2413, CLN2418 and CLN-2443 at Bangladesh Institute of Nuclear Agriculture. Three levels of salinity viz., control 0, 6 and 10 dS m^{-1} were imposed at pre-flowering stage of tomato varieties. Plant height, primary branches, flower cluster, fruit cluster, number of fruits and total fruit yield $plant^{-1}$, individual fruit weight, amino acid content in leaves gradually decreased while total sugar and reducing sugar content in leaves increased with the increase in salinity levels. BARI tomato 7, CLN-2026, CLN-2413, CLN2418, CLN-2366 and CLN-2443 had shown better performance with salinity and identified to be better tolerant (Islam *et al*., 2011).

Al-Yahyai *et al*. (2010) conducted a two-factor experiment at the Agricultural Research Station, Rumais, Oman to evaluate the performance of yield and quality of tomato (*Lycopersicon esculentum* L.) with three levels of saline water (3, 6 and 9 dS m^{-1}) and three types of fertilizers viz, inorganic NPK, organic (cow manure), and a mixed fertilizer of both. Results indicated that growing tomatoes under 3 and 6 dS m^{-1} irrigation water produced the highest yield whereas, irrigating with 9 dS m^{-1} significantly reduced the final fruit number and fruit weight. Tomatoes grown using cow manure produced the least amount of yield compared to those with inorganic and mixed fertilizers.

Hajiboland *et al*. (2010) conducted an experiment where plants treated with the arbuscular mycorrhizal fungi *Glomus intraradices* (+AMF) showed beneficial effect in salt condition. Tomato (*Solanum lycopersicum* L.) cultivars Behta and Piazar were cultivated in soil without salt (EC= 0.63 dS m^{-1}), with low (EC= 5 dS m^{-1}), or high (EC= 10 dS m^{-1}) salinity. Growth and plant yield reduction affected by salinity can be the reason of variation in photosynthetic products translocation toward root, decrease of plant top especially leaves, partial or total enclosed of stomata, chlorophyll content, direct effect of salt on photosynthesis system and ion balance. Mycorrhization alleviated salt-induced reduction of P, Ca, and K uptake. Ca or Na and K or Na ratios were also better in +AMF. Mycorrhization improved the net assimilation rates through both elevating stomatal conductance and protecting photochemical processes of PSII against salinity.

Yong-Gen *et al*. (2009) conducted an experiment to elucidate the mechanisms, of the transport of carbohydrates into tomato fruits and the regulation of starch synthesis during fruit development in tomato plants. Tomato plants cv. 'Micro-Tom' exposed to high levels of salinity stress were examined. Growth with 160 mM NaCl doubled starch accumulation in tomato fruits compared to control plants during the early stages of development, and soluble sugars increased as the fruit matured. Tracer analysis with 13C confirmed that elevated carbohydrate accumulation in fruits exposed to salinity stress was confined to the early development stages and did not occur after ripening. Salinity stress also up-regulated sucrose transporter expression in source leaves and increased activity of ADP-glucose pyrophosphorylase (AGPase) in fruits during the early development stages. The results indicate that salinity stress enhanced carbohydrate accumulation as starch during the early development stages and it is responsible for the increase in soluble sugars in ripe fruit.

Al-Ormran (2008) conducted an experiment to study the effect of saline water and drip irrigation on tomato yield in sandy calcareous soil amended with natural conditioners. The results showed a significant decrease in yield with saline water in both season and the decrease was more apparent in the open field experiment compared to green house.

Agrawal *et al*. (2005) conducted an experiment on the effect of water salinity on tomato under drip irrigation and reported that the tomato yield was drastically affected when the salt was increased in the root zone. This also decreased the number of fruits cluster^{-1}, fruits plant^{-1}, fruit weight, fruit maturity and other yield contributing characters.

Maggoi *et al*. (2004) demonstrated in field grown tomato plants exposed to increasing NaCl concentration, that the physiological basis for short (24h) and long term (entire growth season) osmotic adjustment may respond to different biological and environmental cures, since plants that best somatically adjusted to short term stress were not necessarily those that best adjusted to a long term stress.

Hernandez *et al*. (2003) stated that cell division and expansion inhabited by salt stress. Salinity also inhibited growth of leaf area. Lacerda (2003) studied one salt tolerant variety (CSF 20) and other salt sensitive cultivars (CSF 18) of sorghum where they were grown in nutrient solution of different concentration for seven days, where salt sensitive variety showed higher reduction of P mostly due to larger accumulation of sodium and chlorine ion that probably exceeded the amount needed for the osmotic adjustment.

Munns *et al*. (2002) studied the salinity stress resulted in a clear stunting of plant growth, which results in a considerable decrease in the fresh weight of leaves and stems. Increasing salinity was accompanied also by significant reductions in shoot weight and plant height.

Leperen, W.V. (1996) conducted three different experiments at different time to find out the effect of salinity on tomato and they reported separately that, the number of cluster plant^{-1} was reduced both with high salinity and long salinization periods in case of tomato.

CHAPTER III

MATERIALS AND METHODS

The details of the materials and methods of this research work were described in this chapter.

3.1 Experimental site

The experiment was conducted at research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 Bangladesh. The specific location of the site was 23074 N′ latitude and 90035′ longitude with an elevation of 8.2 meter from sea level.

3.2 Experimental period

The experiment was carried out during the Rabi season from November 2019 to April 2020. Seedlings were transplanted on 25 November 2019 and were harvested up to 17 March 2020.

3.3 Soil type

The soil of the experimental area belongs to the agro-ecological zone (AEZ-28) Madhupur Tract (UNDP, 1988) under AEZ No. 28. The selected area was medium high land and the soil series was Tejgaon (FAO, 1988). The soil sample was collected from a depth of 0-30 cm before conducting the experiment and analyzed in the Soil Testing Laboratory, Soil Resources Development Institute (SRDI), Farmgate, Dhaka and details soil characteristics were presented in Appendix 1.

3.4 Climate and weather

The climate of the experimental site was subtropical in nature and characterized by three distinct seasons, winter season from November to February and the pre-monsoon or summer season from March to April and the monsoon period from May to October. The monthly average temperature, humidity, rainfall and sunshine hours prevailed at the experimental area during the study period were collected from the Bangladesh Meteorological Department (climate division) (Appendix II).

3.5 Pot soil collection and preparation

The soil was collected 20 days prior to setting the experiment. The topsoil at a 15 cm depth was collected from the research field area of eastern-west corner of Sher-e-Bangla Agricultural University, mixed thoroughly and makes it clean by removing stones, grass, roots and other debris.

3.6 Materials used for experiment

The tomato variety BARI Tomato 18 was used for the experiment. This is indeterminate type of high yielding variety. Seeds were collected from Bangladesh Agricultural Development Corporation Dhaka.

3.7 Treatments

The experiment consisted of two factors

Factor A: Different levels of vermicompost such as

VC_0 = Control (00)

VC_1 =7.11 (g pot^{-1}) & 2 th^{-1}

VC_2 =14.22 (g pot^{-1}) & 4 th^{-1}

VC_3 =21.33 (g pot^{-1}) & 6 th^{-1}

Factor B: Three levels salinity

S_0 = Control (00)

S_1 = 100 mM

S_2 = 200 mM

There were all together 12 treatments combination used in each block were as follows:

VC_0S_0, VC_1S_0, VC_2S_0, VC_3S_0, VC_0S_1, VC_1S_1, VC_2S_1, VC_3S_1, VC_0S_2, VC_1S_2, VC_2S_2, VC_3S_2.

3.8 Design and layout of the experiment

The experiment was laid out in (RCBD) randomized complete block design method with three replications. Seedlings were planted in the middle of the potting soil and 12 pots were placed in each row. Pots were placed considering distanced between row to row and plant to plant was 60 cm and 40 cm, respectively.

3.9 Pot preparation

Earthen pots were used in this experiment. The height and width of each pot were 35 and 30 cm respectively. One hole was made in the middle of the bottom of each pot and holes were covered by the broken pieces of the earthen pot. The final check was made to remove plant propagates, inert materials, visible insect and pests. In the lower part of all the pots were filled with general sun-dried and clean soil; only upper 20 cm of the pot was filled with vermicompost mixed well-prepared soil and topmost upper 5 cm of the pot was blank for irrigation purpose.

3.10 Application of manure and fertilizers in pot

Urea, TSP and MP were applied, respectively (Recommended dose of BARI) in all pot. TSP, Gypsum, Zinc Sulphate and boric acid were applied during final pot preparation. Urea and MP were used in two equal installments at 15 and 35 days after transplanting around the plants followed by irrigation. Cowdung was applied during final pot preparation.

The recommended doses of chemical fertilizers by BARI for tomato cultivation. The following recommended chemical fertilizers was used in the experiment.

Fertilizers	Dose (Kg ha^{-1})	Application(%)		
		Basal	15 DAT	35 DAT
Urea	120	-	50	50
TSP	36	100	-	-
MP	80	-	50	50
Boric acid	15	100	-	-
Zypsum	2	100	-	-
$ZnSO_4$	0.6	100	-	-

3.11 Transplanting of seedlings

Healthy and uniform 30 days old seedlings were transplanted in the experimental pots in the afternoon of 25 November 2019.

3.12 Application of NaCl

5.85g salt was mixed with 1 litter water for 100 mM and 11.7g salt was mixed with 1 litter water for 200 mM saline water. Saline water application was started 18 December 2019.As per the treatment, the required amount of NaCl was applied in the pot during application of water.

3.13 Intercultural operation

3.13.1 Irrigation

After transplanting, immediate light watering to the individual seedling was provided to overcome water deficit. At two days interval, the plants were supported with water as a regular basis.

3.13.2 Staking

When the plants were well established, staking was given to each plant by bamboo sticks to keep them erect.

3.13.3 Weeding

Weeding was done to keep the plots clean and easy aeration of soil which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully. Mulching for breaking the crust of the soil was done when needed.

3.13.4 Gap filling

Gap filling was done when needed.

3.13.5 Control of pest and disease

Malathion 57 EC was applied @ 2 ml/L against the insect pests like cut worm, leaf hopper fruit borer and others. The insecticide application was made fortnightly for a week after transplanting to a week before first harvesting. Furadan 10 G was also applied during final land preparation as soil insecticide. During foggy weather precautionary measured against disease infection of tomato was taken by spraying Dithane M-45 fortnightly @ 2 g/L, at the early vegetative stage. Ridomil gold was also applied @ 2 g/L against blight disease of tomato.

3.14 Harvesting

Fruits were harvested at 3 days intervals during early ripe stage when they attained slightly red color. Harvesting was started from 03 March, 2020 and was continued up to 17 March, 2020.

3.15 Collection of data

Plants were selected randomly from each unit pot for data collection. Data on the following parameters were recorded from the sample plants during the course of experiment.

3.15.1 Plant height

Plant height was measured from the sample plants in centimeter from the ground level to the tip of the longest stem and means value was calculated. Plant height was recorded 30 and 60 days after planting to observe the growth rate.

3.15.2 Number of leaf plant^{-1}

The number of leaf was counted from the sample plants and the average number of leaf plant^{-1} was calculated.

3.15.3 Number of flower cluster plant^{-1}

The number of flower clusters was counted from the sample plants periodically and the average number of flower clusters plant^{-1} was calculated.

3.15.4 Number of flower cluster^{-1}

The number of flowers cluster^{-1} was calculated as follows:

$$\text{Number of flowers per cluster} = \frac{\text{Total number of flowers in sample plant}}{\text{Total number of flowers clusters in sample plants}}$$

3.15.5 Number of fruits cluster^{-1}

The number of fruits cluster^{-1} was counted from the sample plants and average was recorded.

3.15.6 Number of flowers plant^{-1}

The number of flowers plant^{-1} was counted from the sample plants and average was recorded.

3.15.7 Number of fruits plant^{-1}

The number of fruits plant^{-1} was counted from the sample plants and average was recorded.

3.15.8 Weight of individual fruit

Individual fruit weight was recorder from the five sample plants by calculating the average.

3.15.9 Fruit yield plant^{-1}

A pan scale balance was used to take the weight or fruits per plot. It was measured by totaling of fruit yield from each unit plot during the period from first to final harvest and was recorded in kilogram.

3.15.10 soil pH

The pH of the soil was determined with the help of a glass electrode pH meter using soil : water ratio being 1 : 2.5 (Jackson, 1973).

3.15.11 Organic matter

Organic matter was determined by multiplying the percent value of organic carbon with the Van Bemmelen factor, 1.724. The result was expressed in percentage.

% organic matter = % organic carbon * 1.724

3.15.12 Electrical conductivity

Electrical conductivity was determined with the help of a conductivity meter following Jackson (1973).

Electrical conductivity of soil = observed EC of soil * K

3.15.13 Available sulphur

Available Sulphur in soil was determined by extracting the soil samples with 0.15%$CaCl_2$ solution (Page *et al*. 1982). The S content in the extract was determined turbidimetrically and the intensity of turbid was measured by spectrophotometer at 420 nm wavelength.

3.15.14 Available phosphorus

Available phosphorus was extracted from soil by shaking with 0.5 M $NaHCO_3$ solution of pH 8.5 (Olsen et al. 1954). The phosphorus in the extract was then determined by developing blue colour using $SnCl_2$ reduction of phosphomolybdate complex. The absorbance of the molybdophosphate blue colour was measured at 660 nm wave length by spectrophotometer and available P was calculated with the help of a standard curve.

3.16 Analysis of data

The collected data were compiled and tabulated. Statistical analysis was done on various plant characters to find out the significance of variance resulting from the experimental treatments. Data were analyzed using analysis of variance (ANOVA) technique with the help of computer package program STATISTIX 10 (software) and the mean differences were adjudged by least significant difference test (LSD) as laid out by Gomez and Gomez, (1984) for interpretation of the results at 5% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results obtained from the impact of salinity and vermicompost on growth and yield of tomato and residual level nutrient in post-harvest soil. The results of each parameter studied in the experiment have been presented and discussed under the following headings.

4.1 Plant height

Plant height of tomato varied significantly due to the application of different levels of vermicompost. At 30 DAT the longest plant height (44.00 cm) was recorded from VC_3, while the shortest plant height (38.00 cm) was recorded from VC_0. At 60 DAT the longest plant height (84.56 cm) was recorded from VC_3, while the shortest plant height (51.67 cm) was recorded from VC_0 (Figure 1 and Appendix III). This result agreed with the findings of Thuy *et al*. (2017), Mukta *et al*. (2015) and Singh *et al*. (2010).

Plant height of tomato was insignificant due to the application of different levels of salinity at 30 DAT. The longest plant height (42.17 cm) was recorded from S_2, while the shortest plant height (40.75 cm) was recorded from S_0. Plant height of tomato varied significantly due to the application of different level of salinity at 60 DAT. At 60 DAT the longest plant height (74.58 cm) was recorded from S_0, while the shortest plant height (66.92 cm) was recorded from S_2 (Figure 2 and Appendix III). This result agreed with the findings of El-mogy *et al*. (2018), and Islam *et al*. (2011).

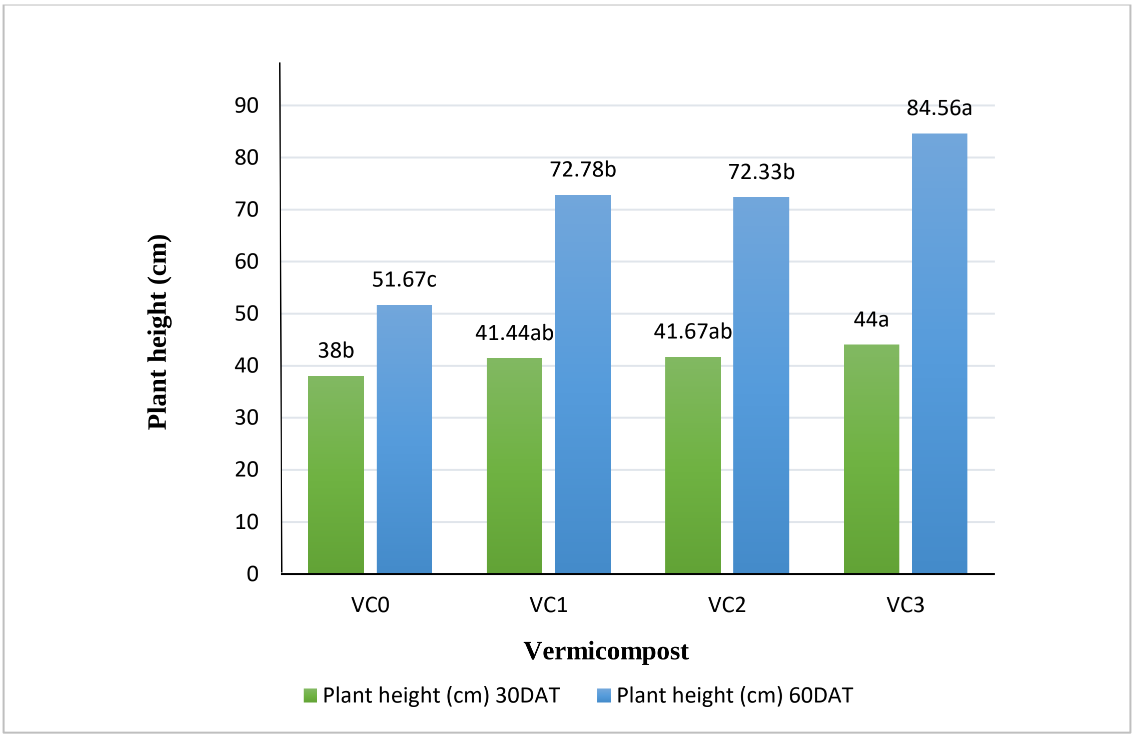

Figure 1. Effect of vermicompost on plant height of tomato ($LSD_{0.05}$ = 4.58 and 8.74 at 30 and 60 DAT respectively)

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

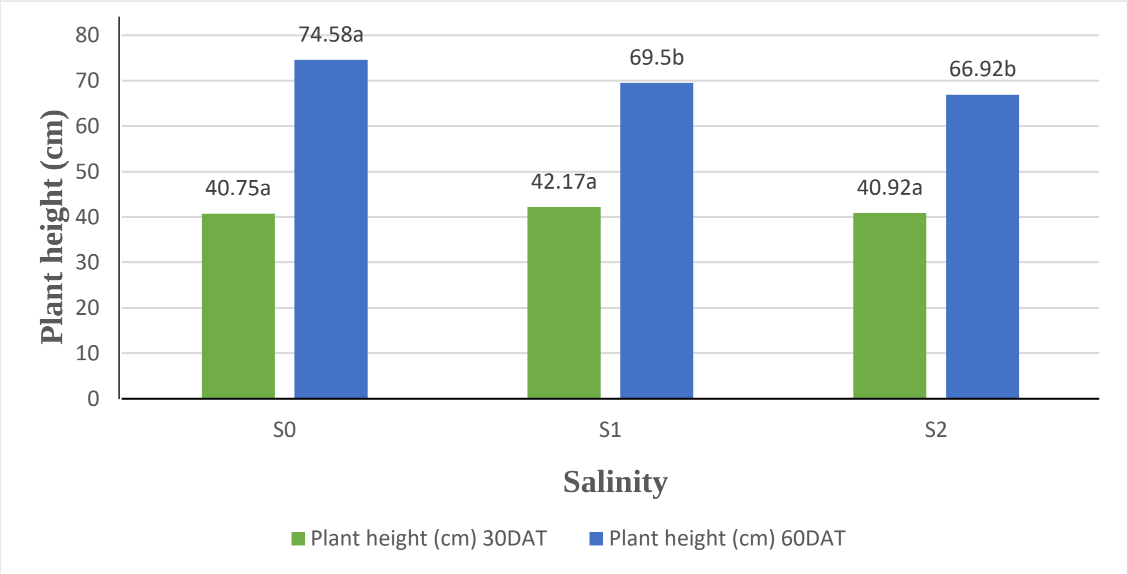

Figure 2. Effect of salinity on plant height of tomato ($LSD_{0.05}$ = 3.97 and 7.57 at 30 and 60 DAT respectively)

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

Due to combined effect of different vermicompost and salinity showed statistically significant variation on plant height at 30 and 60 DAT. At 30 DAT the longest plant height (46.67 cm) was recorded from VC_3S_0 and the shortest plant height (32.33 cm) was recorded from VC_0S_0. At 60 DAT the longest plant height (85.67 cm) was recorded from VC_3S_0 which is similar with VC_3S_1 and the shortest plant height (48.67 cm) was recorded from VC_0S_2 (Table 1 and Appendix III).

Table 1. Combined effect of vermicompost and salinity on plant height of tomato

Treatments		Plant height (cm)	
		30DAT	60DAT
VC_0	S_0	32.33 d	53.67 de
	S_1	41.67 abc	52.67 de
	S_2	40.00 abcd	48.67 e
VC_1	S_0	45.33 ab	78.67 abc
	S_1	42.00 abc	70.00 bc
	S_2	37.00 cd	69.67 bc
VC_2	S_0	38.67 bcd	80.33 abc
	S_1	42.67 abc	70.00 bc
	S_2	43.67 abc	66.67 cd
VC_3	S_0	46.67 a	85.67 a
	S_1	42.33 abc	85.33 a
	S_2	43.00 abc	82.67 ab
$LSD_{(0.05)}$		7.94	15.15
CV (%)		11.35	12.72

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g
S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

4.2 Number of leaves plant^{-1}

Number of leaves of tomato varied significantly due to the application of different levels of vermicompost. The maximum number of leaves (17.56) was observed in VC_3, which is similar with VC_2, while the minimum number of leaves (13.56) was observed in VC_0 which is similar with VC_1 (Figure 3 and Appendix IV). Similar results were found by Thuy *et al*. (2017) and Mukta *et al*. (2015).

Number of leaves of tomato varied significantly due to the application of different levels of salinity. The maximum number of leaves (17.17) was recorded from S_0, while the minimum number of leaves (13.67) was recorded from S_2 (Figure 4 and Appendix IV).

Due to combined effect of different levels of vermicompost and salinity showed statistically significant variation. The maximum number of leaves (20.67) was observed from VC_3S_0 and the minimum number of leaves (12.67) was recorded from VC_0S_2 (Table 2 and Appendix IV).

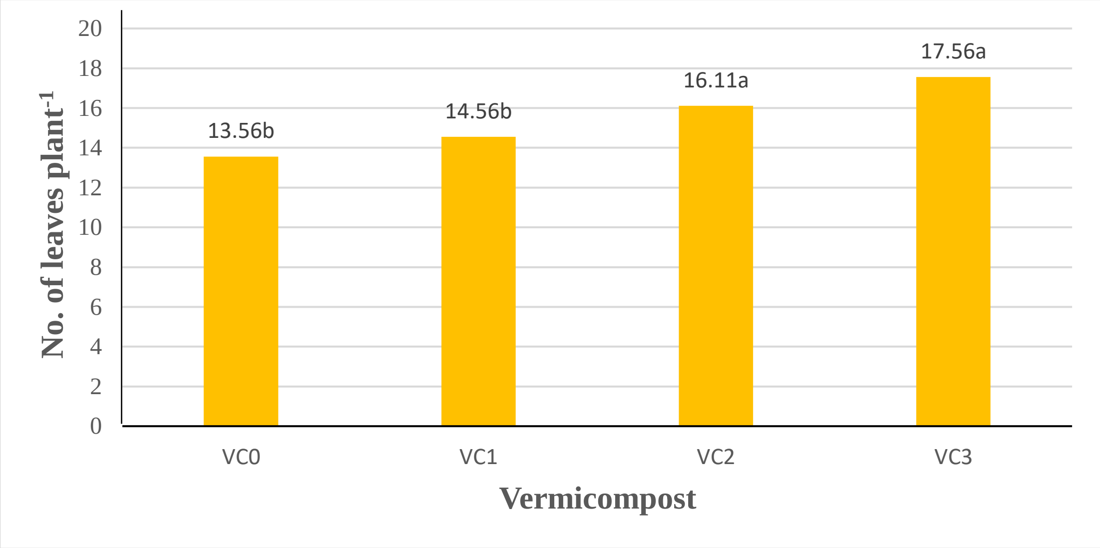

Figure 3. Effect of vermicompost on leaf number of tomato ($LSD_{0.05}$ = 1.52)

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

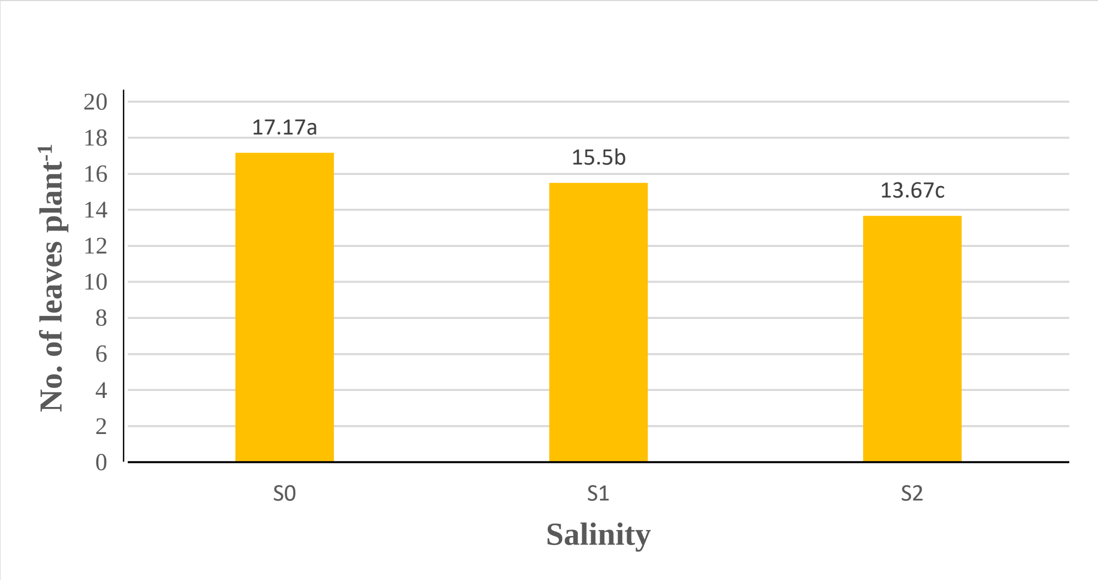

Figure 4. Effect of salinity on leaf number of tomato ($LSD_{0.05}$ = 1.32)

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

4.3 Number of flower clusters plant^{-1}

The effect of different levels of vermicompost in respect of flower clusters plant^{-1} was significant. The maximum number of flower clusters plant^{-1} (4.78) was found from VC_2 and the minimum number of flower clusters plant^{-1} (3.33) was found from VC_0 (Figure 5 Appendix V).

The number of flower clusters plant^{-1} was also significantly influenced by salinity. The highest number of flower clusters plant^{-1} (4.75) was found from S_0 and the lowest number of flower clusters plant^{-1} (3.25) was found from S_2 (Figure 6 and Appendix V). This result agreed with the findings of Mazumder (2016) and Islam *et al*. (2011).

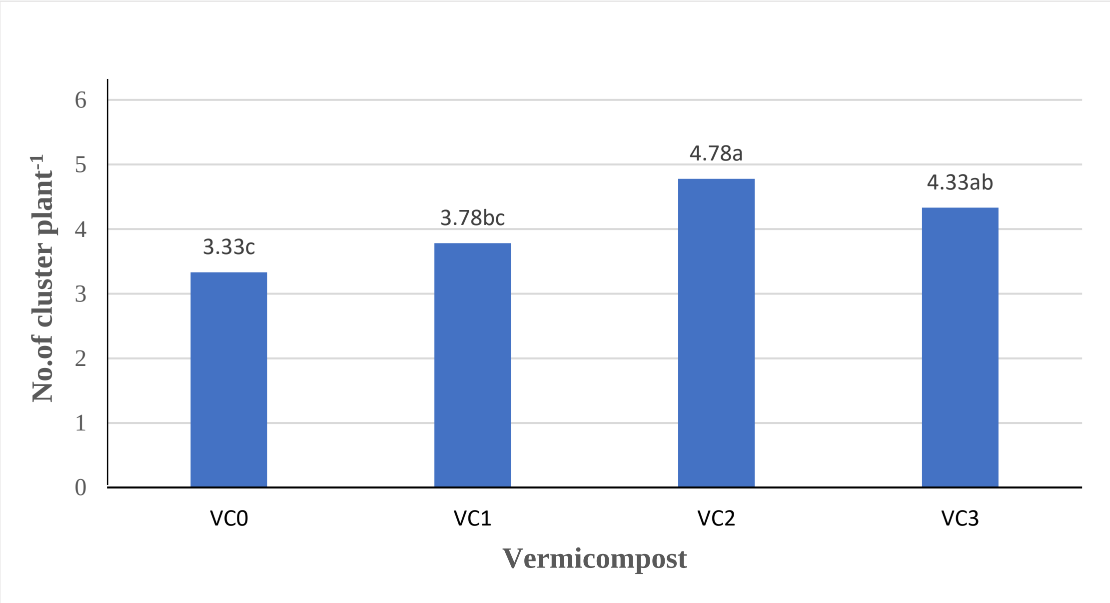

Figure 5. Effect of vermicompost on flower cluster of tomato ($LSD_{0.05}$ = 0.63)
VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

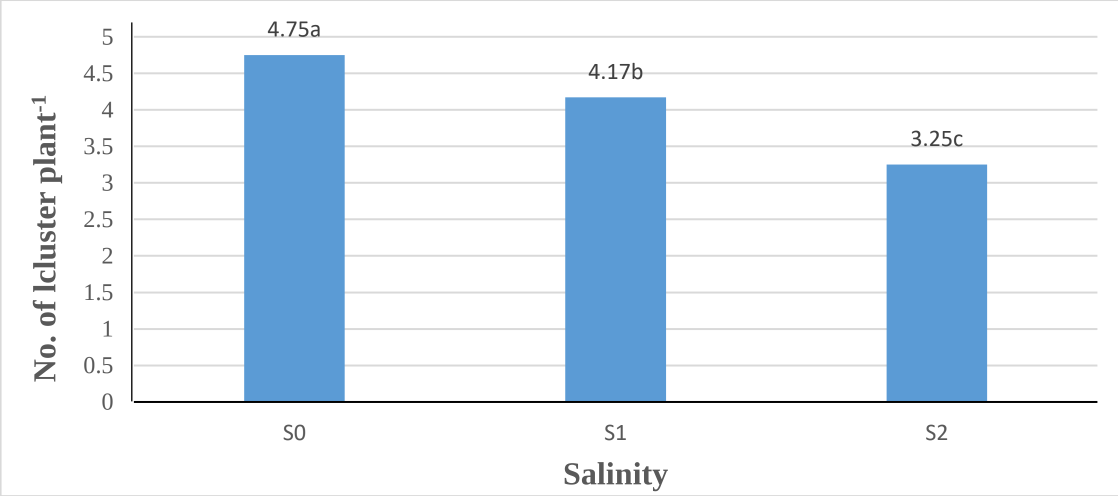

Figure 6. Effect of salinity on flower cluster of tomato ($LSD_{0.05}$ = 0.55)

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

There was statistically significant difference among the treatment combinations in respect of number of flower clusters plant^{-1}. The maximum number of flower clusters plant^{-1} (5.33) was recorded from the treatment combination of VC_3S_0 which is similar with VC_2S_0 and the minimum number of flower cluster plant^{-1} (2.33) was recorded from the treatment combination of VC_0S_2 (Table 2 and Appendix V).

Table 2. Combined effect of vermicompost and salinity on number of leaves plant^{-1} and flower clusters plant^{-1} of tomato

Treatments		Number of leaves plant^{-1}	Number of flower clusters plant^{-1}
VC_0	S_0	14.67 cde	4.00 bc
	S_1	13.33 de	3.67 c
	S_2	12.67 e	2.33 d
VC_1	S_0	15.67 bcd	4.33 abc
	S_1	15.00 cde	3.67 c
	S_2	13.00 e	3.33 cd
VC_2	S_0	17.67 b	5.33 a
	S_1	16.67 bc	5.00 ab
	S_2	14.00 de	4.00 bc
VC_3	S_0	20.67 a	5.33 a
	S_1	17.00 bc	4.33 abc
	S_2	15.00 cde	3.33 cd
$LSD_{(0.05)}$		2.64	1.09
CV (%)		10.08	16.01

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33g
S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

4.4 Number of flowers cluster^{-1}

A significant variation in the number of flowers cluster^{-1} was observed due to effect of different levels of vermicompost (Appendix VI). The highest number of flowers cluster^{-1} (5.76) was observed from VC_3, and the lowest number of flowers cluster^{-1} (5.02) was found from VC_1 which is similar with VC_0 (Table 3 and Appendix VI).

The variation in number of flowers cluster^{-1} at different levels of salinity was significant. The highest number of flowers cluster^{-1} (6.10) was obtained from S_0 and the lowest number of flowers cluster^{-1} (4.35) was obtained from S_2 (Table 3 and Appendix VI).

Combined effect or different levels of vermicompost and salinity on number of flowers cluster $^{-1}$ was significantly observed. The maximum number of flowers cluster^{-1} (7.19) was observed in the treatment combination of VC_3S_0 and the minimum number of flowers cluster^{-1} (4.17) was observed from VC_0S_2 (Table 4 and Appendix VI).

4.5 Number of fruits cluster^{-1}

The number of fruits cluster^{-1} at different levels of vermicompost was significantly observed. The maximum number of fruits cluster^{-1} (2.68) was observed from VC_3 and the minimum number of fruits cluster^{-1} (2.19) was observed from VC_0 which is similar with VC_1 (Table 3 and Appendix VII).

There was significant difference in different salinity levels on the number of fruits cluster^{-1}. The highest number of fruits cluster^{-1} (2.77) was observed from S_0 which is similar with S_1 and the lowest number of fruits cluster^{-1} (1.96) was observed from S_2 (Table 3 and Appendix VII).

There was significant interaction effect between different levels vermicompost and salinity in regard to number of fruits cluster^{-1}. The maximum number of fruits cluster^{-1} (3.43) was found from VC_3S_0 and the minimum number of fruits cluster^{-1} (1.95) was found from VC_3S_2 which is similar with VC_2S_2 (Table 4 and Appendix VII).

Table 3. Effect of vermicompost and salinity on number of flower cluster^{-1} and number of fruits cluster^{-1} of tomato

Treatments	Number of flowers cluster^{-1}	Number of fruits cluster^{-1}
Different level of vermicompost		
VC_0	5.13 b	2.19 b
VC_1	5.02 b	2.28 b
VC_2	5.41 ab	2.53 ab
VC_3	5.76 a	2.68 a
LSD $_{(0.05)}$	0.49	0.39
CV (%)	9.51	16.53
Salinity		
S_0	6.10 a	2.77 a
S_1	5.54 b	2.53 a
S_2	4.35 c	1.96 b
LSD $_{(0.05)}$	0.43	0.34
CV (%)	9.51	16.53

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

Table 4. Combined effect of vermicompost and salinity on number of flowers cluster^{-1} and number of fruits cluster^{-1} of tomato

Treatments		Number of flowers cluster^{-1}	Number of fruits cluster^{-1}
VC_0	S_0	5.63 b	2.33 bcde
	S_1	5.58 b	2.17 cde
	S_2	4.17 d	2.08 cde
VC_1	S_0	5.62 b	2.60 bcd
	S_1	5.14 bc	2.39 bcde
	S_2	4.31 cd	1.86 e
VC_2	S_0	5.95 b	2.72 bc
	S_1	5.89 b	2.91 ab
	S_2	4.39 cd	1.96 de
VC_3	S_0	7.19 a	3.43 a
	S_1	5.53 b	2.65 bc
	S_2	4.55 cd	1.95 de
LSD $_{(0.05)}$		0.86	0.68
CV (%)		9.51	16.53

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

4.6 Number of flowers plant^{-1}

The effect of different levels of vermicompost in respect of flowers plant^{-1} was significant. The maximum number of flowers plant^{-1} (26.14) was found from VC_2 which is similar with VC_3 and the minimum number of flowers plant^{-1} (17.62) was found from the VC_0 which is similar with VC_1 (Table 5 and Appendix VIII).

The number of flowers plant^{-1} was also significantly influenced by salinity. The highest number of flowers plant^{-1} (29.21) was found from S_0 and the lowest number of flowers plant^{-1} (14.17) was found from S_2 (Table 5 and Appendix VIII). The similar findings was stated by El-mogy *et al*. (2018) and Mazumder (2016).

There was statistically significant difference among the treatment combinations in respect of number of flowers plant^{-1}. The treatment combination of VC_3S_0 gave the maximum number of flowers plant^{-1} (38.13) and the minimum number of flowers plant^{-1} (10.00) was recorded from the treatment combination of VC_0S_2(Table 6 and Appendix VIII).

4.7 Number of fruits plant^{-1}

The effect of different levels of vermicompost in respect of fruits plant^{-1} was significant. The maximum number of fruits plant^{-1} (12.25) was found from VC_2 which is similar with VC_3 and the minimum number of fruits plant^{-1} (7.47) was found from the VC_0 which is similar with VC_1 (Table 5 and Appendix IX). This result agreed with the findings of Mukta *et al*. (2015).

The number of fruits plant^{-1} was also significantly influenced by salinity. The highest number of fruits plant^{-1} (13.30) was found from S_0 and the lowest number of fruits plant^{-1} (6.27) was found from S_2 (Table 5 and Appendix IX). This result agreed with the findings of El-mogy *et al*. (2018), Islan *et al*. (2011) and Agrawal *et al*. (2005).

Table 5. Effect of vermicompost and salinity on number of flowers plant^{-1} and number of fruits plant^{-1} of tomato

Treatments	Number of flowers plant^{-1}	Number of fruits plant^{-1}
Different level of vermicompost		
VC_0	17.62 b	7.47 b
VC_1	19.14 b	8.63 b
VC_2	26.14 a	12.25 a
VC_3	25.63 a	11.97 a
LSD $_{(0.05)}$	2.92	1.54
CV (%)	13.50	15.64
Salinity		
S_0	29.21 a	13.30 a
S_1	23.03 b	10.67 b
S 2	14.17 c	6.27 c
LSD $_{(0.05)}$	2.53	1.33
CV (%)	13.50	15.64

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

There was statistically significant difference among the treatment combinations in respect of number of fruits plant^{-1}. The treatment combination of VC_3S_0 gave the maximum number of fruits plant^{-1} (18.25) and the minimum number of fruits plant^{-1} (5.08) was recorded from the treatment combination of VC_0S_2 (Table 6 and Appendix IX).

Table 6. Combined effect of vermicompost and salinity on number of flowers plant^{-1} and number of fruits plant^{-1} of tomato

Treatments		Number of flowers plant^{-1}	Number of fruits plant^{-1}
VC_0	S_0	22.53 de	9.33 cd
	S_1	20.33 def	8.00 de
	S_2	10.00 h	5.08 f
VC_1	S_0	24.43 cd	11.20 c
	S_1	18.67 efg	8.67 cde
	S_2	14.34 gh	6.01 ef
VC_2	S_0	31.75 b	14.42 b
	S_1	29.34 bc	14.66 b
	S_2	17.34 fg	7.66 def
VC_3	S_0	38.13 a	18.25 a
	S_1	23.77 d	11.33 c
	S_2	15.00 gh	6.34 ef
LSD $_{(0.05)}$		5.06	2.67
CV (%)		13.50	15.64

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

4.8 Weight of individual fruit

The effect of different levels of vermicompost in regard to weight of individual fruit was significant. The maximum individual fruit weight (37.54 g) was found from VC_3 which is similar with VC_2 and the minimum (32.13 g) was found from the VC_0 (Table 7 and Appendix X). This result agreed with the findings of Thuy *et al*. (2017), Najar *et al*. (2015) and Singh *et al*. (2010).

The weight of individual fruit was also significantly influenced by salinity. The highest weight of a fruit (36.18 g) was found from S_0 which is similar with S_1 and the lowest weight of a fruit (33.49 g) was found from S_2 (Table 7 and Appendix X). This result was line with the findings of El-mogy *et al*. (2018), Islan *et al*. (2011), Mazumder (2016) and Agrawal *et al*. (2005).

There was statistically significant difference among the treatment combinations in regard to weight of individual fruit. The treatment combination of VC_3S_0 gave the maximum weight of a fruit (40.00 g) and the minimum weight for individual fruit (31.60 g) was recorded from the treatment combination of VC_0S_2 which is similar with VC_0S_0 and VC_0S_1 (Table 8 and Appendix X).

4.9 Weight of fruits pot^{-1}

Weight of fruits pot^{-1} was significantly affected by different levels of vermicompost. Weight of fruits pot^{-1} increased with increasing level of vermicompost. The highest fruits weight pot^{-1} (0.46 kg) was obtained from VC_3 which is similar with VC_2 and the lowest fruits weight pot^{-1} (0.24 kg) was obtained from VC_0 which is similar with VC_1 (Table 7 and Appendix XI). This result agreed with the findings of Thuy *et al*. (2017), Najar *et al*. (2015) and Singh *et al*. (2010).

Weight of fruits pot^{-1} was also significantly affected by different levels of salinity. The highest fruits weight pot^{-1} (0.49 kg) was found from S_0 and the lowest fruits weight pot^{-1} (0.21 kg) was found from S_2 (Table 7 and Appendix XI). This result agreed with the findings of El-mogy *et al*. (2018), Islan *et al*. (2011), Mazumder (2016) and Agrawal *et al*. (2005).

Different treatment combinations of vermicompost and salinity had significant effect on fruits weight pot^{-1}. The highest fruits weight pot^{-1} (0.72 kg) was found from VC_3S_0. The lowest fruits weight pot^{-1} (0.16 kg) was found from VC_0S_2 (Table 8 and Appendix XI).

Table 7. Effect of vermicompost and salinity on individual fruit weight and fruits weight pot^{-1} of tomato

Treatments	Individual fruit weight (g)	Fruits weight pot^{-1} (kg)
Different level of vermicompost		
VC_0	32.13 c	0.24 b
VC_1	33.78 b	0.29 b
VC_2	36.49 a	0.45 a
VC_3	37.54 a	0.46 a
LSD $_{(0.05)}$	1.64	0.06
CV (%)	4.79	16.68
Salinity		
S_0	36.18 a	0.49 a
S_1	35.29 a	0.38 b
S_2	33.49 b	0.21 c
LSD $_{(0.05)}$	1.42	0.05
CV (%)	4.79	16.68

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

Table 8. Combined effect of vermicompost and salinity on individual fruit weight and fruits weight pot^{-1} of tomato

Treatments		Individual fruit weight (g)	Fruits weight pot^{-1} (kg)
VC_0	S_0	32.47 de	0.30 de
	S_1	32.33 de	0.26 efg
	S_2	31.60 de	0.16 g
VC_1	S_0	35.97 bc	0.40 cd
	S_1	34.43 cd	0.29 e
	S_2	30.93 e	0.19 fg
VC_2	S_0	36.27 bc	0.52 b
	S_1	37.40 ab	0.55 b
	S_2	35.80 bc	0.27 ef
VC_3	S_0	40.00 a	0.72 a
	S_1	37.00 bc	0.42 c
	S_2	35.63 bc	0.23 efg
LSD $_{(0.05)}$		2.84	0.10
CV (%)		4.79	16.68

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

4.10. Soil pH

Soil pH was insignificant due to the application of different levels of vermicompost. The maximum soil pH (5.86) was observed in VC_3, while the minimum soil pH (5.83) was obtained from VC_2 (Table 9 and Appendix XII).

Soil pH varied significantly due to the application of different levels of salinity. The maximum soil pH (5.94) was recorded from S_2, while the minimum Soil pH (5.74) was recorded from S_0 (Table 9 and Appendix XII).

Due to combined effect of different levels of vermicompost and salinity showed statistically significant variation. The maximum soil pH (5.98) was observed from VC_3S_2 and the minimum soil pH (5.73) was observed from VC_3S_0 which is similar with VC_2S_0, VC_1S_0, and VC_0S_0 (Table 10 and Appendix XII).

4.11. Organic matter

Organic matter varied significantly due to the application of different levels of vermicompost. The maximum organic matter (1.38%) was observed in VC_3 which is similar with VC_2, while the minimum organic matter (1.32%) was obtained from VC_0 (Table 9 and Appendix XIII).

Organic matter varied significantly due to the application of different levels of salinity. The maximum organic matter (1.41%) of was recorded from S_0, while the minimum organic matter (1.31%) was recorded from S_2 (Table 9 and Appendix XIII).

Due to combined effect of different levels of vermicompost and salinity showed statistically significant variation. The maximum organic matter (1.46%) was observed from VC_3S_0 and the minimum organic matter (1.30%) was observed from VC_0S_2 which is similar with VC_1S_2 (Table 10 and Appendix XIII).

4.12. Electrical conductivity

Electrical conductivity varied significantly due to the application of different level of vermicompost. The maximum electrical conductivity (5.14 dS m^{-1}) was observed in VC_3, while the minimum electrical conductivity (4.72 dS m^{-1}) was observed from VC_3 (Table 9 and Appendix XIV).

Electrical conductivity varied significantly due to the application of different level of salinity. The maximum electrical conductivity (6.59 dS m^{-1}) was recorded from S_2, while the minimum (3.47 dS m^{-1}) was recorded from S_0 (Table 9 and Appendix XIV).

Due to combined effect of different levels of vermicompost and salinity showed statistically significant variation. The maximum electrical conductivity (6.95 dS m^{-1}) was observed from VC_2S_2 and the minimum electrical conductivity (3.12 dS m^{-1}) was observed from VC_2S_0 (Table 10 and Appendix XIV).

4.13. Available sulphur

Available sulphur varied significantly due to the application of different level of vermicompost. The maximum available sulphur (22.92 ppm) was obtained from VC_3, while the minimum (18.94 ppm) was obtained from VC_0 which is similar with VC_1 (Table 9 and Appendix XV).

Available sulphur varied significantly due to the application of different level of salinity. The maximum available sulphur (22.89 ppm) of was recorded from S_0, while the minimum (17.98 ppm) was recorded from S_2 (Table 9 and Appendix XV).

Due to combined effect of different levels of vermicompost and salinity showed statistically significant variation. The maximum available sulphur (26.61 ppm) was observed from VC_3S_0 and the minimum available sulphur (17.10 ppm) was observed from VC_1S_2 which is similar with VC_0S_2 (Table 10 and Appendix XV).

4.14. Available phosphorus

Available phosphorus varied significantly due to the application of different level of vermicompost. The maximum available phosphorus (22.22 ppm) was obtained from VC_3, while the minimum (16.74 ppm) was obtained from VC_0 (Table 9 and Appendix XVI).

Available phosphorus varied significantly due to the application of different levels of salinity. The maximum available phosphorus (22.86 ppm) was recorded from S_0, while the minimum (16.16 ppm) was recorded from S_2 (Table 9 and Appendix XVI).

Due to combined effect of different levels of vermicompost and salinity showed statistically significant variation. The maximum available phosphorus (26.40 ppm) was observed from VC_3S_0 and the minimum available phosphorus (14.73 ppm) was observed from VC_0S_2 (Table 10 and Appendix XVI).

Table 9. Effect of vermicmpost and salinity on soil pH, organic matter, electrical conductivity, available sulphur and phosphorus

Treatment	Soil pH	Organic matter (%)	Electrical conductivity ($dS\ m^{-1}$)	Available sulphur (ppm)	Available phosphorus (ppm)
Different level of vermicompost					
VC_0	5.84	1.32c	5.24 a	18.94c	16.74 d
VC_1	5.84	1.34b	5.28a	19.43c	18.81 c
VC_2	5.83	1.38a	5.14a	20.57b	20.72 b
VC_3	5.86	1.38a	4.72b	22.92a	22.22 a
$LSD_{(0.05)}$	NS	0.01	0.39	0.84	1.16
CV (%)	0.67	1.25	7.79	4.19	6.02
Salinity					
S_0	5.74c	1.41 a	3.47c	22.89 a	22.86 a
S_1	5.85b	1.35b	5.22b	20.52 b	19.86 b
S 2	5.94a	1.31c	6.59a	17.98 c	16.16 c
$LSD_{(0.05)}$	0.03	0.01	0.34	0.73	1.00
CV (%)	0.67	1.25	7.79	4.19	6.02

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

Table 10. Combined effect of vermicmpost and salinity on soil pH, organic matter, electrical conductivity, available sulphur and phosphorus of tomato

Treatments		Soil pH	Organic matter (%)	Electrical conductivity (dS m^{-1})	Available Sulphur (ppm)	Available Phosphorus (ppm)
VC_0	S_0	5.74f	1.36 de	3.80d	19.83e	19.00 efg
	S_1	5.83 e	1.32 fgh	5.24c	19.49e	16.50 hi
	S_2	5.93ab	1.30h	6.68 ab	17.49f	14.73 i
VC_1	S_0	5.75f	1.39c	3.76 de	21.57 cd	21.64 cd
	S_1	5.85de	1.34 ef	5.38c	19.62e	19.23 ef
	S_2	5.93 abc	1.30h	6.68 ab	17.10f	15.57 hi
VC_2	S_0	5.74f	1.42b	3.12e	23.55b	24.40 ab
	S_1	5.85 de	1.37 cd	5.35c	20.53 de	20.67 de
	S_2	5.91 bcd	1.33 efg	6.95a	17.64f	17.10 gh
VC_3	S_0	5.7f	1.46a	3.18 de	26.61a	26.40 a
	S_1	5.87cde	1.38 cd	4.92c	22.44 bc	23.03 bc
	S_2	5.98a	1.31 gh	6.06b	19.69 e	17.23 fgh
$LSD_{(0.05)}$		0.07	0.03	0.67	1.4502	2.00
CV (%)		0.67	1.25	7.79	4.19	6.02

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

VC_0 = 00, VC_1 = 7.11 g, VC_2 = 14.22 g, VC_3 =21.33 g

S_0 = 00, S_1 = 100 mM, S_2 = 200 mM

CHAPTER V

SUMMARY AND CONCLUSIONS

The experiment was carried out to determine the performance of BARI Hybrid Tomato 18 with the effect of vermicompost and salinity. The experiment was conducted at research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh during the period of November 2019 to March 2020. The experiment comprised of two factors: four levels of vermicompost (VC_0 = 0; VC_1= 7.11; VC_2= 14.22; VC_3=21.33 g pot^{-1}) and three levels of salinity (S_0=0; S_1=100; S_2=200 mM) and was laid out on randomized complete block design with three replications.

In case of vermicompost, at 30 DAT the longest plant height (44.00 cm) was recorded from VC_3, while the shortest plant height (38.00 cm) was recorded from VC_0. At 60 DAT the longest plant (84.56 cm) was recorded from VC_3, while the shortest plant height (51.67 cm) was recorded from $VC_{0.}$ The maximum number of leaves plant^{-1}(17.56) was observed in VC_3, while the minimum number of leaves plant^{-1} (13.56) was obtained from $VC_{0.}$ The maximum number of flower clusters plant^{-1} (4.78) was found from VC_2 and the minimum number of flower clusters plant^{-1} (3.33) was found from $VC_{0.}$ The maximum number of flowers cluster^{-1} (5.76) was obtained from VC_3, and the minimum number of flowers cluster^{-1} (5.02) was obtained from VC_1. The maximum number of fruits cluster^{-1} (2.68) was obtained from VC_3 and the minimum number of fruits cluster^{-1} (2.19) was obtained from VC_0. The maximum number of flowers plant^{-1} (26.14) was obtained from VC_2 and the minimum number of flowers plant^{-1} (17.62) was obtained from VC_0. The maximum number of fruits plant^{-1} (12.25) was obtained from VC_2 and the minimum number of fruits plant^{-1} (7.47) was obtained from the VC_0. The maximum individual fruit weight (37.54 g) was found from VC_3 and the minimum (32.13 g) was found from the $VC_{0.}$ The highest fruit weight plant^{-1} (0.46 kg) was obtained in VC_3 and the lowest fruit weight plant^{-1} (0.24 kg) was obtained in VC_0. The maximum soil pH (5.86) was observed in VC_3, while the minimum soil pH (5.83) was obtained from VC_2. The maximum organic matter (1.38%) was observed in VC_3, while the minimum organic matter (1.32%) was obtained from VC_0. The maximum electrical conductivity (5.14 dS m^{-1}) was observed in VC_3, while the minimum electrical conductivity (4.72 dS m^{-1}) was obtained from VC_3. The maximum available sulphur (22.92 ppm) was observed in VC_3, while the minimum available sulphur (18.94 ppm) was obtained from VC_0. The maximum available phosphorus (22.22 ppm) was observed in VC_3, while the minimum available phosphorus (16.74 ppm) was obtained from VC_0.

In case of salinity, at 30 DAT the longest plant (42.17 cm) was recorded from S_2, while the shortest plant (40.75 cm) was recorded from S_0. At 60 DAT the longest plant (74.58 cm) was recorded from S_0, while the shortest plant (66.92 cm) was recorded from S_2. The maximum number of leaves (17.17) was recorded from S_0, while the minimum number of leaves (13.67) was recorded from S_2. The highest number of flower clusters plant^{-1} (4.75) was found from S_0 and the lowest number of flowers clusters plant^{-1} (3.25) was found from S_2. The highest number of flowers cluster^{-1} (6.10) was produced in S_0 and the lowest number (4.35) was obtained from S_2. The highest number of fruits cluster^{-1} (2.77) was produced by S_0 and the lowest number of fruits cluster^{-1} (1.96) was recorded in S_2. The highest number of flowers plant^{-1} (29.21) was found from S_0 and the lowest number of flowers plant^{-1} (14.17) was found from S_2. The highest number of fruits plant^{-1} (13.30) was found from S_0 and the lowest number of fruits plant^{-1} (6.27) was found from S_2. The highest weight of a fruit (36.18 g) was found from S_0 and the lowest weight (33.49 g) was found from S_2. The highest fruit weight plant^{-1} (0.49 kg) was found from S_0 and the lowest fruit weight plant^{-1} (0.21 kg) was produced from S_2. The maximum soil pH (5.94) was recorded from S_2, while the minimum Soil pH (5.74) was recorded from S_0. The maximum organic matter (1.41%) of was recorded from S_0, while the minimum organic matter (1.31%) was recorded from S_2. The maximum electrical conductivity (6.59 dS m^{-1}) was recorded from S_2, while the minimum electrical conductivity (3.47 dS m^{-1}) was recorded from S_0. The maximum available sulphur (22.89 ppm) of was recorded from S_0, while the minimum available sulphur (17.98 ppm) was recorded from S_2. The maximum available phosphorus (22.86 ppm) was recorded from S_0, while the minimum available phosphorus (16.16 ppm) was recorded from S_2.

In case of combined effect of vermicompost and salinity, at 30 DAT the longest plant height (46.67 cm) was recorded from VC_3S_0 and the shortest plant (32.33 cm) was recorded from VC_0S_0. At 60 DAT the longest plant (85.67 cm) was recorded from VC_3S_0 and the shortest plant height (48.67 cm) was recorded from VC_0S_2. The maximum number of leaves (20.67) was observed from VC_3S_0 and the minimum number of leaves (12.67) was recorded from VC_0S_2. the maximum number of flower clusters plant^{-1} (5.33) was recorded from the treatment combination of VC_3S_0 and the minimum number of flower cluster plant^{-1} (2.33) was recorded from the treatment combination of VC_0S_2. The maximum number of flowers cluster^{-1} (7.19) was observed in the treatment combination of VC_3S_0 and the minimum (4.17) from VC_0S_2. The maximum number of fruits cluster^{-1} (3.43) was found from VC_3S_0 and the minimum number of fruits cluster^{-1} (1.95) was found from VC_3S_2. The treatment combination of VC_3S_0 gave the maximum number of flowers plant^{-1} (38.13) and the minimum number of flowers plant^{-1} (10.00) was recorded from the treatment combination of VC_0S_2. The treatment combination of VC_3S_0 gave the maximum number of fruits plant^{-1} (18.25) and the minimum number of fruits plant^{-1} (5.08) was recorded from the treatment combination of VC_0S_2. It was evident that the treatment combination of VC_3S_0 gave the maximum weight of a fruit (40.00 g) and the minimum weight for individual fruit (31.60 g) was recorded from the treatment combination of VC_0S_2. The highest fruit weight plant^{-1} (0.72 kg) was recorded in VC_3S_0. The lowest fruit weight plant^{-1} (0.16 kg) was found from VC_0S_2. The maximum soil pH (5.98) was observed from VC_3S_2 and the minimum soil pH (5.73) was recorded from VC_3S_0. The maximum organic matter (1.46%) was observed from VC_3S_0 and the minimum organic matter (1.30%) was recorded from VC_0S_2. The maximum electrical conductivity (6.95 dS m^{-1}) was observed from VC_2S_2 and the minimum electrical conductivity (3.12 dS m^{-1}) was recorded from VC_2S_0. The maximum available sulphur (26.61 ppm) was observed from VC_3S_0 and the minimum available Sulphur (17.10 ppm) was recorded from VC_1S_2. The maximum available phosphorus (26.40 ppm) was observed from VC_3S_0 and the minimum available phosphorus (14.73 ppm) was recorded from VC_0S_2.

From the present study, the following conclusions may be drawn –

- Effect of vermicompost was found positive on growth and yield of tomato.
- Negative effect of salinity was found on growth and yield of tomato.
- The combined effect of vermicompost and salinity affected growth, yield and yield attributes of tomato.

Further research works at different regions of the country are needed to be carried out for the confirmation of the present findings.

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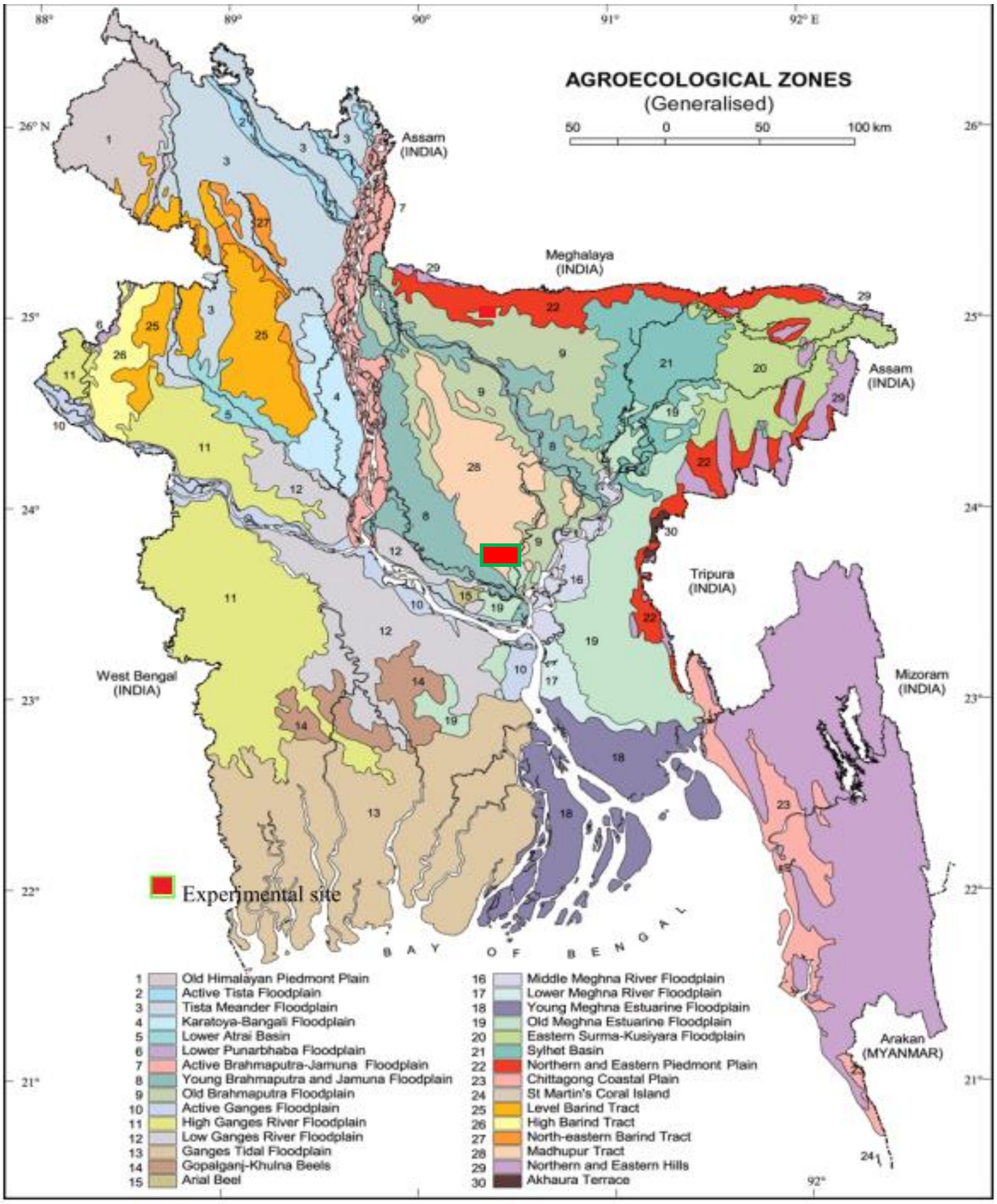
APPENDICES

Appendix I. Map showing the experimental site under the study



The experimental site under study

Appendix II. (A) Records of meteorological information (monthly) during the period from November 2019 to May 2020

Name of the Months	Air temperature (0C)		Relative humidity(%)	Rainfall (mm)
	Maximum	Minimum		
November	32	19	65	35
December	29	15	74	15
January	26	10	68	7
February	15	24	57	25
March	34	16	57	65

Source: World weather online

(B). Morphological characteristics of soil of the experimental plot

Morphological features	Characteristics
Location	Soil Science farm,SAU, Dhaka.
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land Type	High land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood Level	Above flood level
Drainage	Well drained

(c)Physical and chemical properties of the initial soil

Characteristics	Value
Particle size analysis	
% Sand	27
%Silt	43
% Clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix III. Analysis of variance of plant height (cm)

(a) At 30 DAT

Source	DF	SS	MS	F	P
Replication	2	460.22	230.111		
VC	3	165.00	55.000	2.50	0.0856
Salinity	2	14.39	7.194	0.33	0.7241
VC*Salinity	6	314.50	52.417	2.39	0.0628
Error	22	483.11	21.960		
Total	35	1437.22			

Grand Mean 41.278
CV 11.35

(b) At 60 DAT

Source	DF	SS	MS	F	P
Replication	2	484.67	242.33		
VC	3	5046.22	1682.07	21.03	0.0000
Salinity	2	365.17	182.58	2.28	0.1257
VC*Salinity	6	153.94	25.66	0.32	0.9191
Error	22	1760.00	80.00		
Total	35	7810.00			

Grand Mean 70.333
CV 12.72

Appendix IV. Analysis of variance of leaf number

Source	DF	SS	MS	F	P
Replication	2	7.389	3.6944		
VC	3	83.333	27.7778	11.47	0.0001
Salinity	2	73.556	36.7778	15.19	0.0001
VC*Salinity	6	15.333	2.5556	1.06	0.4181
Error	22	53.278	2.4217		
Total	35	232.889			

Grand Mean 15.444
CV 10.08

Appendix V. Analysis of variance of cluster number

Source	DF	SS	MS	F	P
Replication	2	0.7222	0.36111		
VC	3	10.7778	3.59259	8.52	0.0006
Salinity	2	13.7222	6.86111	16.27	0.0000
VC*Salinity	6	1.3889	0.23148	0.55	0.7655
Error	22	9.2778	0.42172		
Total	35	35.8889			

Grand Mean 4.0556
CV 16.01

Appendix VI. Analysis of variance of flower cluster^{-1}

Source	DF	SS	MS	F	P
Replication	2	0.1421	0.07105		
VC	3	2.9190	0.97300	3.79	0.0248
Salinity	2	19.0461	9.52305	37.09	0.0000
VC*Salinity	6	3.1581	0.52635	2.05	0.1015
Error	22	5.6480	0.25673		
Total	35	30.9133			

Grand Mean 5.3297
CV 9.51

Appendix VII. Analysis of variance of fruits cluster^{-1}

Source	DF	SS	MS	F	P
Replication	2	0.9584	0.47919		
VC	3	1.3228	0.44094	2.75	0.0668
Salinity	2	4.1225	2.06125	12.87	0.0002
VC*Salinity	6	1.6698	0.27829	1.74	0.1592
Error	22	3.5223	0.16010		
Total	35	11.5958			

Grand Mean 2.4211
CV 16.53

Appendix VIII. Analysis of variance of flowers plant^{-1}

Source	DF	SS	MS	F	P
Replication	2	25.13	12.565		
VC	3	518.44	172.814	19.35	0.0000
Salinity	2	1372.34	686.168	76.83	0.0000
VC*Salinity	6	226.48	37.747	4.23	0.0056
Error	22	196.48	8.931		
Total	35	2338.87			

Grand Mean 22.136
CV 13.50

Appendix IX. Analysis of variance of fruits plant^{-1}

Source	DF	SS	MS	F	P
Replication	2	28.342	14.171		
VC	3	154.793	51.598	20.77	0.0000
Salinity	2	302.428	151.214	60.86	0.0000
VC*Salinity	6	75.626	12.604	5.07	0.0021
Error	22	54.661	2.485		
Total	35	615.850			

Grand Mean 10.080
CV 15.64

Appendix X. Analysis of variance of individual fruit weight (g)

Source	DF	SS	MS	F	P
Replication	2	10.321	5.1603		
VC	3	165.616	55.2055	19.68	0.0000
Salinity	2	44.882	22.4411	8.00	0.0025
VC*Salinity	6	30.358	5.0596	1.80	0.1449
Error	22	61.726	2.8057		
Total	35	312.903			

Grand Mean 34.986
CV 4.79

Appendix XI. Analysis of variance fruits weight plant^{-1}

Source	DF	SS	MS	F	P
Replication	2	0.04029	0.02015		
VC	3	0.32676	0.10892	29.98	0.0000
Salinity	2	0.46804	0.23402	64.42	0.0000
VC*Salinity	6	0.15418	0.02570	7.07	0.0003
Error	22	0.07992	0.00363		
Total	35	1.06918			

Grand Mean 0.3613
CV 16.68

Appendix XII. Analysis of variance of Soil pH

Source	DF	SS	MS	F	P
Replication	2	0.00665	0.00333		
VC	3	0.00357	0.00119	0.78	0.5179
Salinity	2	0.23287	0.11643	76.35	0.0000
VC*Salinity	6	0.00607	0.00101	0.66	0.6800
Error	22	0.03355	0.00153		
Total	35	0.28270			

Grand Mean 5.8417
CV 0.67

Appendix XIII. Analysis of variance organic matter

Source	DF	SS	MS	F	P
Replication	2	0.00112	0.00056		
VC	3	0.01979	0.00660	22.85	0.0000
Salinity	2	0.05847	0.02923	101.28	0.0000
VC*Salinity	6	0.00736	0.00123	4.25	0.0055
Error	22	0.00635	0.00029		
Total	35	0.09307			

Grand Mean 1.3558
CV 1.25

Appendix XIV. Analysis of variance of electrical conductivity

Source	DF	SS	MS	F	P
Replication	2	0.9647	0.4823		
VC	3	1.7705	0.5902	3.75	0.0259
Salinity	2	59.0204	29.5102	187.30	0.0000
VC*Salinity	6	1.1140	0.1857	1.18	0.3535
Error	22	3.4663	0.1576		
Total	35	66.3359			

Grand Mean 5.0939
CV 7.79

Appendix XV. Analysis of variance of available of Sulphur

Source	DF	SS	MS	F	P
Replication	2	1.636	0.8181		
VC	3	84.937	28.3123	38.60	0.0000
Salinity	2	144.754	72.3769	98.67	0.0000
VC*Salinity	6	20.202	3.3670	4.59	0.0036
Error	22	16.137	0.7335		
Total	35	267.666			

Grand Mean 20.463
CV 4.19

Appendix XVI. Analysis of variance of available phosphorus

Source	DF	SS	MS	F	P
Replication	2	3.575	1.787		
VC	3	152.296	50.765	36.32	0.0000
Salinity	2	270.662	135.331	96.83	0.0000
VC*Salinity	6	22.121	3.687	2.64	0.0442
Error	22	30.747	1.398		
Total	35	479.401			

Grand Mean 19.626
CV 6.02