EFFECT OF MICRONUTRIENTS WITH MANURE ON GROWTH AND YIELD OF TOMATO

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EFFECT OF MICRONUTRIENTS WITH MANURE ON GROWTH AND YIELD OF TOMATO

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This is to certify that thesis entitled, **"EFFECT OF MICRONUTRIENTS WITH MANURE ON GROWTH AND YIELD OF TOMATO"** submitted to the Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in HORTICULTURE**, embodies the result of a piece of bona fide research work carried out by **JINIA AFSUN**, Reg. No. **12-04764** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma in any institute.

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

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TO

MY BELOVED PARENTS AND BROTHER

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ABSTRACT

A field experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka from October, 2017 to March, 2018. There were four combination of micronutrients viz. N_0 - 0 kg/ha, N_1- Zn+B (2+1.5 kg/ha), N_2- Zn+B (4+2 kg/ha), N_3-Zn+ B (6+2.5 kg/ha) and four levels of manure viz M_0-0 t/ha, M_1-Cowdung (15 t/ha), M_2-Poultry manure (10 t/ha), M_3-(Cowdung 7.5 t/ha+ Poultry manure 5 t/ha). The experiment was laid out in a Randomized Complete Block Design with 3 replications. Application of micronutrients and manure significantly influenced the growth, yield and size of tomato. For micronutrients the highest yield (66.96 t/ha) was found from N_2 and the lowest yield (25.69 t/ha) was obtained from N_0. Due to application of organic, the highest yield (50.78 t/ha) was obtained from M_3 and lowest yield (39.86 t/ha) was recorded from M_0. In case of combined effect, the highest yield (76.33 t/ha) was found from N_2M_3 and lowest yield (24.60 t/ha) was found from N_0M_0. Economic analysis raveled that N_2M_3 gave the maximum benefit cost ratio (3.2). So, application of Zn+ B (4+2 kg/ha) along with Cowdung 7.5 t +Poultry manure 5 t/ha was the best for growth and yield of tomato.

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LIST OF ACRONYMS

ABBREVIATIONS	ELABORATIONS
%	Percent
@	At the rate
AEZ	Agro –Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
Agron.	Agronomy
ANOVA	Analysis of variance

BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Corporation
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BD	Bangladesh
cm	Centimeter
Cult.	Culture
CV%	Percentage of coefficient of variance
df	Degrees of Freedom
DMRT	Duncan's Multiple Range Test
et al.	and others
etc.	Etcetera
FAO	Food And Agriculture Organization of United Nations
hr.	Hours
Hort.	Horticulture
j.	Journal
Kg/ha	Kilograms per hectare
Kg	Kilogram
m	Meter
m^2	Meter square
MoA	Ministry of Agriculture
MSE	Mean square of the error
no.	Number
RCBD	Randomized Complete Block Design
Rep.	Replication
Res.	Research

SAU	Sher-e- Bangla Agricultural University
Sc.	Science
(SRDI)	Soil Resource Development Institute

CHAPTER I

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops grown throughout the world including Bangladesh. and it is under the solanaceae family. Tomato is cultivated in almost all over the country for its adaptability to wide range of soil and climate in Bangladesh (Ahmed,1995). Tomato ranks next to potato and sweet potato in respect of vegetable production in the world (Hossain *et al*., 2010). It ranks fourth in respect of production and third in respect of area in Bangladesh (BBS, 2016). The largest tomato producing countries of the world are China, United States of America, India, Egypt, Turkey, Iran, Italy, Mexico, Brazil and Indonesia (FAO, 2002).

The popularity and different products of tomato are increasing day by day. Tomato is a valuable crop because of higher contents of vitamins A, B and C with Ca and carotene (Bose and Som,1990). It is also popular for its medicinal value. Tomato is a major component in the daily diet, and can be used in making soups, pickles, ketchup, sauces, juices etc. Ripe tomatoes having antioxidant-lycopene. The well ripped tomato (edible portion/100g) contains water (94.1%); energy (23 calories); Ca (1.0 gm); Mg (7.0 mg); vitamin A (1000 IU); ascorbic acid (22 mg); thiamin (0.09 mg); riboflavin (0.03 mg); niacin (0.8 mg) (Mac Gillivary, 1961).

In Bangladesh, the yield of tomato is not enough satisfactory in compare to other tomato growing countries of the World (Aditya *et al*., 1997). The cultivated area under tomato in Bangladesh was 75602 acre and total production was 413610 metric tons during the year 2014-2015 (BBS, 2015). The low yield of tomato in Bangladesh is due to the use of poor yielding varities and improper cultural practices and now it is considered as one of the major problem to successful upland crop production in Bangladesh (Islam and Noor, 1982). For better yield the cultivation of tomato requires proper supply of plant nutrients. Sufficient supply of nutrient can improve the yield, fruit quality, fruit size, keeping quality, colour, and taste of tomato (Shukla and Naik, 1993).since , the land is limited in Bangladesh, it is important to increase yield of any crop.Though the effects of different on the yield of tomato were studied earlier ,the effect of micronutrients and manure on growth and yield of tomato were not studied in detail so for in Bangladesh. Among the micronutrients, boron and zinc play an important role in improving the yield and quality of tomato in addition to checking various diseases and physiological disorders (Magalhaes *et al.,* 1980).

It is known that, Zinc (Zn) is an important essential micronutrient which helps in the formation of tryptophan, a precursor of IAA responsible for growth stimulation (Mallick and Muthukrishnan, 1980) and plays a vital role in synthesis of carbonic anhydrase enzyme which helps in transport of CO_2 in photosynthesis (Alloway, 2008). Zinc deficiency causes shorter and thinner internodes, stunted growth, appearance of chlorotic flecks on the older leaves and twisting of leaf borders in upward direction and plant with abnormal features (Passam *et al.,* 2007). The zinc deficiency may be due to soil deficient in Zn, competition with Ca, Mn, Fe, P, to some degree K, and soil properties that influence Zn availability (Srivastava and Singh, 2003).

In addition, Boron has a pronounced effect on the production and quality of tomato. Boron is needed by the crop plants for cell division, nucleic acid synthesis, uptake of calcium and transport of carbohydrates (Bose and Tripathi, 1996). Boron also plays an important role in flowering and fruit formation (Nonnecke, 1989). Adequate B levels help to maintain leaf K levels in tomato during fruit development (Sperry, 1995).B has major influence on the plasma membrane of plant cells and ion transport and those B amendments increased Calcium, and Mg levels (Blevins *et al*., 1993) .

Boron deficiency affects the growing points of roots and youngest leaves. The leaves become wrinkled and curled with light green colour. Its deficiency affects translocation of sugar, starches, nitrogen and phosphorus, synthesis of amino acids and proteins (Stanley *et al*., 1995). In boron deficient plants the youngest leaves become pale green, losing more colour at the base then at the tip. Boron deficiency symptoms will often appear in the form of thickened wilted, or curled leaves, a thickened, cracked, or water soaked condition of petioles and stems, and discoloration, cracking or rotting of fruit, tubers or roots. (Tisdale *et al*., 1985). The improvement in quality parameters of tomato fruit due to boron application could be the result of overall growth and development of the crop (Naresh, 2002).

To improve texture, structure, humus, color, aeration, water holding capacity and microbial activity of soil used by proper amount of manures such as cowdung, poultry manure. In our country, the soils of most regions have less than 1.5% and some soils even have less than one percent organic matter (BARC, 1997). Manure has the largest effect on yield and quality of tomato. It also improve the vegetative growth, flowering and fruit set of tomato. The increase in vegetative growth of tomato could be attributed to physiological role of organic manure and its involvement in the metabolism of protein, synthesis of pectin, maintaining the water relation within the plant, resynthesis of ATP and translocation of sugar at development of the flowering and fruiting stages (Bose and Tripathi, 1996). For better growth of tomato a large amount of organic manure are required. (Opena *et al.*, 1988).

We know decomposed cowdung also contains beneficial bacteria, which convert nutrients into easily accessible forms so they can be slowly released without burning tender plant root . Besides poultry manure contains high % of N and P for the healthy growth of plants (Ewulo, 2005).The physical properties of the soil improved by application of poultry manure. poultry manure improve the fertility of the cultivated soil by increasing the organic matter content, water holding capacity, oxygen diffusion rate and the aggregate stability of the soils (Mahimairaja *et al*., 1995 and Adeli *et al*., 2009). Large quantities of poultry manure are available especially in urban centers and it is effective source of nutrients for vegetables such as tomato (Adediran *et al.*, 2003).

Therefore, to increase growth and yield of fruit, an attempt was made to study the effect of micronutrients in presence of different levels of organic manure on growth and yield of tomato with the following objectives-

- to find out the optimum level of micronutrients on the growth, yield contributing characters and yield of tomato
- to observed the optimum level of manure for growth and yield of tomato and
- to investigate the combined effect of micronutrients and manure on the growth and yield of tomato.

CHAPTER II
REVIEW OF LITERATURE

Tomato is most popular, widely grown vegetables of the world , which received much attention to the researcher throughout the world. Among various research works, investigations have been made in various parts of the world to determine the optimum dose of micronutrient and organic manure that have marked effects on tomato production. An attempt has been made in this chapter to present relevant review of literature on the research works performed till to date in Bangladesh and other part of the world in relation to the effect of micronutrients in presence of different levels of organic manure on growth and yield of tomato

2.1 Effect of micronutrients on the growth and yield of tomato

Gurmani *et al.* (2012) designed a glasshouse pot experiment, with 2 tomato cultivars VCT-1 and Riogrande, to evaluate the effects of four levels of soil application of B (0, 0.5, 1.0 and 1.5 mg/kg) in the form of borax on plant growth, biochemical content, antioxidant activity and fruit yield. Higher plant growth and fruit yield were achieved in both cultivars the soil application of B 1.0 and 1.5mg/kg respectively. Application of B 1.0 and 1.5 mg/kg had higher dry matter production and fruit yield than application of 0.5 mg B /kg. The percent increase of fruit yield at 0.5 mg B per kg was 12 in VCT1 and 10 in Riogrande In the same cultivars, B application @ 1.0 mg B per kg caused the fruit yield by 23 and 21% while 1.5 mg B /kg enhanced by 22 and 20% respectively. Boron concentration in leaf, fruit and root increased with the increasing level of B. Superoxide dismutase and catalase activity was significantly increased by the soil application of 1.5 mg B/ kg in both cultivars of tomato. Boron application at 1.0 and 1.5 mg/ kg significantly increased chlorophyll, sugar and protein content in both cultivars. The study results showed that soil application of 1.0 mg B/ kg soil have positive effect on plant growth, yield and biochemical.

Sakamoto (2012) conducted a study to evaluated the only role of B in plants as the structural maintenance of cell wall. The author stated that soil B, as boric acid, is acquired through roots and then distributed around the plant through the passive and active transport pathway. To adapt variations in the environmental B status, the active B transport system is tightly regulated at the molecular level in plants. In agriculture, both deficient and excess levels of soil B impair plant growth, resulting in the reduction of quantity and quality of crops. The major causes of B toxicity in plants oxidative stress, metabolism alteration and deoxyribonucleic acid damage.

Farzaneh *et al.* (2011) conducted a study to the effect of nitrogen and boron on yield, shoot and root dry weights and leaf concentration of nutrient elements in hydroponically grown tomato in greenhouse by completely randomized factorial experiment with 16 treatments and 3 replication in Agricultural College of Zanjan University in 2000. In this experiment, tomato seed of Rio Grande Ug was selected and simple and interaction effect of 4 levels of N (100, 200, 300 and 400 mg/L) and 4 levels of B (0.5, 1.0, 1.5 and 2.0 mg/L) on tomato yield, shoot and root dry weights and leaf concentration of nutrient elements was evaluated. The results showed the simple and interaction effect of nitrogen and boron on yield , shoot and root dry weights were significant. The highest yield and root dry weights were obtained in $N_{200}B_{1.0}$ treatment and the highest shoot dry weight was obtained in $N_{300}B_{1.0}$ treatment. By increasing the N level in the nutrient solution, leaf N and Mn concentration increased while B, Fe and Zn concentration of leaves decreased significantly. In the other hand, by increasing B levels, leaf N, B and Zn concentration increased and Fe and Mn concentration of leaves decreased significantly. With respect to the results of this study, applications of 200 mg/L N and 1.0 mg/L B of nutrient solution are recommended to obtain higher yield and better quality for tomato in hydroponic culture.

Ejaz *et al*. (2011) conducted a study to evaluate the efficacy of micronutrient of foliar application on tomato. The research project was executed during 2008–2009, to evaluate the effect of Zn, B (micronutrients) in combination with N (macro-nutrient) for the tomato grown under high tunnel. Macro/micro-nutrients solutions were provided by 4B Group of Fertilizers, Pakistan. The experiment was arranged in Completely Randomized Design (CRD) with 5 treatments and 4 replications. Foliar application of individual nutrients such as N (2%), B (5%) and Zn (6%) were used along with their combined mixture. In addition, a control treatment was also run as check. After the statistical analysis it was found that individual application of nutrient provide better results as compared to control. Then their combined effect (Zn = 6%, B = 5%, N = 2%) provided tangible results in plant heights, no. of leaves, no of flowers, no of fruits, average fruit weight and yield per plant. It is confirmed from the results that combination of macro-nutrients and micro-nutrients as foliar application has the ability to improve the growth and yield of tomato positively.

Nada *et al.* (2010) conducted a study to estimated a critical concentration of excess B in nutrient solution for hydroponically cultured tomato. The study also evaluated the influences of excess B on growth, photosynthesis and fruit maturity. In tomato topped at the first truss, B concentrations higher than 2 ppm in nutrient solution resulted in a significant increase in leaf B concentration. At the fruit developmental stage, fresh weights of leaf and fruit were suppressed at 8 ppm and 4 ppm B in nutrient solution, respectively. Photosynthetic rate, respiration rate decreased with excess B at 4 ppm or higher concentration from the 1^{st} truss flowering stage to fruit developmental stage. When tomato was topped at the 2^{nd} truss and limited to 2 fruits in each truss, excess B did not affect fruit growth or maturation in the 1^{st} truss. However, fruit size and Brix were reduced in the 2^{nd} truss. These may be caused by decrease in the photosynthate distribution to fruit in the 2^{nd} truss because of the decrease in photosynthetic activity. Furthermore, excess B could promote fruit maturity in the 2^{nd} truss because of production of ethylene with increase in injured leaves. Based on these results, the authors suggest that the critical concentration of B in nutrient solution is 4 ppm for longterm hydroponic cultivation of tomatoes.

Salam *et al*. (2010) conducted a study to investigate the effects of boron and zinc in presence of different levels of NPK fertilizers on quality of tomato at the Vegetable Research Farm of the Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. There were 12 treatment combinations which comprised 4 levels of boron and zinc viz., i) B_0Zn_0= 0 kg B + 0 kg Zn/ha, ii) $B_{1.5}Zn_{2.0}$= 1.5 kg B + 2.0 kg Zn/ha, iii) $B_{2.0}Zn_{4.0}$ = 2.0 kg B + 4.0 kg Zn/ha , iv) $B_{2.5}Zn_{6.0}$=2.5 kg B + 6.0 kg Zn/ha and 3 levels of NPK fertilizers viz., i) 50% less than the recommended NPK fertilizer dose (50% <RD), ii) Recommended NPK fertilizer dose (RD), iii) 50% more than the recommended NPK fertilizer dose (50% >RD). The highest pulp weight

(88.14%), dry matter content (5.34%), TSS (4.50%), acidity (0.47%), ascorbic acid (10.95 mg/100g), lycopene content (112.00 µg/100g), chlorophyll-a (41.00µg/100g), chlorophyll-b (56.00µg/100g), marketable fruits at 30 days after storage (67.48%) and shelf life (16 days) were recorded with the combination of 2.5 kg B+ 6 kg Zn/ha and recommended dose of NPK fertilizers.

Hossein (2008) conducted a study to evaluate the effect of Zn and B on the growth and yield of tomato at field experiment at Horticultural farm, BAU, Mymensingh during 2007-2008. The treatments were 4 levels of Zn (0, 0.5, 1.0 and 1.8 kg/ha) and 4 levels of B (0, 0.1, 0.3 and 0.6 kg/ha). The highest fruit yield (74.88 t ha-1) was obtained due to the application of 1.8 kg/ha Zn and 0.1kg /ha B .

Jyolsna and Mathew (2008) conducted a to study the effects of 0, 0.5, 1.0, and 1.5 kg B ha^{-1} with recommended doses of chemical fertilizers (75:40:25 N, P_2O_5 and K_2O kg/ha; RDF) and RDF + farmyard manure (FYM; 25 tons/ ha) on growth, yield, and quality of tomato as well as the B status of a lateritic soil in southern Kerala.This experiment was in pot culture . Boron significantly increased plant height and number of primary branches. It also reduced the days to flowering and increased fruit set (12.5 to 20% more at the highest level) both with and without FYM. Benefit–cost ratio was 40% greater for the highest level of B when applied in conjunction with RDF compared with RDF alone (no B). Quality parameters like reducing sugars, total sugars, vitamin C, and lycopene concentrations also improved following B application. Nevertheless, B availability in these soils attained sufficiency levels (2 mg/kg) at 0.5 kg/ ha of applied B, implying the need to exercise caution especially when applying higher doses.

Kamruzzaman (2007) conducted on tomato in field experiment at the field laboratory of Crop Botany Department, BAU, Mymensingh during 2006-07. The experiment comprised of four levels of boron viz. @ 0, 0.4, 0.6 and 0.8 kg B/ ha as foliar application.Application of standard dose of boron 0.4 kg B/ ha was found to produce highest fruit yield (2166.6 kg/ ha).

Sathya (2006) conducted to evaluate the various levels of B on yield of PKM1 tomato. The results showed that the highest fruit yield of 33 t /ha was recorded in treatment that received borax @ 20 kg/ ha and was found hightest to rest of the treatments (0, 5, 10, 15 and 25 kg/ ha). The yield increase was about 33.6 % over control.

Yadav *et al.* (2006) evaluated the effects of B (0.0, 0.10, 0.15, 0.02, 0.25, 0.30 or 0.35%), applied to foliage after transplanting, on the yield of tomato cv. DVRT-1 in Allahabad, this experiment was conducted in Uttar Pradesh, India, during 2003-04. The highest number of fruits/ plant (44.0), number of fruits/plot (704.0), yield/plant (0.79kg), yield/plot (12.78kg) and yield/ha (319.50 quintal) were obtained with 0.20% B, whereas the greatest fruit weight (27.27g) was recorded for 0.10% B.

Shah (2006) conducted a field experiment at the Horticulture farm, BAU, Mymensingh during the rabi season, 2005-06. There were 5 levels of NPKS and B fertilizers viz. i) N (0, 190, 253 and 317 kg /ha); ii) P (0, 66, 88 and 110 kg/ ha); iii) K (0, 94, 125 and 154 kg/ ha); iv) S (0, 15, 20 and 25 kg/ ha) and v) B (0, 1.5, 2 and 2.5 kg/ ha) in the 17 selected treatments. The different combinations of NPKS and B exhibited significant variation in respect of all the characters. The maximum number of flowers and matured fruits/plant were found from the treatment ($N_{253}P_{88}K_{125}S_{20}B_2$ kg/ ha). Importantly the plants fertilized with the same treatment gave the maximum fruit yield (62.69 ton/ ha).

Bhatt and Srivastava (2005) conducted to the effects of the foliar applications of B (boric acid), Zn (zinc sulfate), Mo (ammonium molybdate), Cu (copper sulfate), Fe (ferrous sulfate), manganese (sulfate), mixture of these nutrients, and Multiplex (a commercial micronutrient formulation) on the nutrient uptake and yield of tomato (Pusa hybrid-1) in Pantnagar, Uttaranchal, India, during the summer of 2002 - 2003. Zn, Fe, Cu, B and Mn were applied at 1000 ppm each, whereas Mo was applied at 50 ppm. Foliar spraying was conducted at 40, 50 and 60 days after transplanting. All treatments significantly improved dry matter yield, fruit yield and nutrient uptake over the control. The mixture of the micronutrients was higher in terms of dry matter yield of shoot (53.25 g /ha); dry matter content of shoot (27.25%); nitrogen (152.38 kg/ha), phosphorus (47.49 kg/ha), potassium (157.48 kg/ ha), sulfur (64.87 kg/ ha), zinc (123.70 g/ ha), iron (940.36 g/ ha), copper (72.70 g/ ha), manganese (359.17 g/ ha) and boron (206.58 g/ ha) uptake by shoots; total fruit yield (266.60 kg/ ha); dry matter yield of fruit (1698 kg/ ha); manganese (34.08 g /ha) and boron (95.23 g/ ha) uptake by fruits.

Sukanta *et al.*(2004) A field experiment was conducted at B.C.K. Viswavidyalaya farm, Kallani, Nadia during rabi season to evaluate the effect of micronutrients in improving the yield of tomato. In the experiment, the application of full recommended dose of N, P and K and NPK+Zintrac @ 0.6 L /ha , NPK+Borotrac @ 2.5 L/ ha , Seniphos @ 5.0 L /ha , NPK+Stopit @ 0.16 L/ ha. The average number of fruits per plant, average weight of individual fruits and the fruit yields indicated that all the micronutrient treatments recorded significantly higher fruit yields than the only NPK treated plot.

The effect of micronutrient boron application on dry matter yield, uptake and distribution in the plant parts of two tomato verities (Roma VF and Dandino) were studied by Oyinlola (2004) in a rainfed trial. Results showed variations in B distribution among plant parts. The concentration of B ranged from 6.0-109.0, 5.8-18.3 and 3.113.6mg/kg, in leaves, stem and roots, respectively. The effect of B rates on the DMY, B concentration and uptake was highly significant (P 0.010) on the leaves and stem, but not on the roots. The concentration of B in both varieties was more in the leaves, than in the stem. The roots had the least B concentration. Among the varieties RomaVF recorded lower B concentration in the various plant parts than Dandino. Application of B increased fruit yield of tomato fruit by 233 and 192% relative to the control for “Roma VF” and “Dandino” varieties, respectively.

Oyinlola and Chude (2004) conducted to the effects of 0, 1, 2, 3, 4 and 5 kg B/ha on the yield and biochemical properties of tomato cultivars Roma VF and Dandino. Matured ripe fruits were analyzed for biochemical properties such as ascorbic acid, reducing sugar and total soluble solid content and titratable acidity. B rates significantly ($P<0.01$) inriched the yield and yield attributes of the crop such as no of fruits and average weight of fruits, as well improved the biochemical properties of the fruits. In both years, the yield attributes of the crop such as number of fruits and average weight of fruits, as well as improved the biochemical properties of the fruits. In both years, the highest fruit yield and best fruit quality were found at 2 kg B/ha. Fruit yield increased by 121 and 72% relative to the control in 1992/93 and 1993/94, respectively. Cultivar Dandino showed higher ascorbic acid, total soluble solids, titratable acidity, reducing sugars and yield compared to cv. Roma VF, whereas cv. Roma VF flowered earlier than Dandino. Fruit yield correlated with all the yield attributes and biochemical properties determined for both years.

Dube *et al*., 2003 conducted to the effect of zinc on growth and yield of tomato and other crops. The effects of Zn (0.0, 1.0, 2.5, 5.0 or 10.0 mg/kg soil as zinc sulfate) on the yield and quality of tomato cv. Pusa Ruby were studied in a pot experiment. The application of Zn significantly increased biomass, fruit yield and fruit quality. The greatest biomass, fruit yield, total pulp weight, acidity, and lycopene, ascorbic acid, total carotene and water contents were obtained with 5.0 mg Zn/kg soil. Zn at 10 mg/kg have an adverse effect on fruit quality. The contents of P, Fe, Mn and Cu generally decreased with the increase in Zn concentration. The Zn content of leaves was highest at the highest rate of Zn.

Amarchandra and Verma (2003) conducted to evaluate the effects of boron and calcium on the growth and yield of tomato cv. Jawahar Tomato 99 and an experiment conducted during the rabi seasons of 1998 and 1999 at Jabalpur, Madhya Pradesh, India. Boron (1, 2, and 3 kg/ha, calcium carbonate), along with phosphorus (60 kg/ha) and potassium (40 kg/ha) were applied before transplanting, whereas nitrogen (100 kg/ha) was applied in split doses at 25 and 50 days after transplanting. Data were recorded for plant height, number of branches per plant, fruit yield and seed yield. Application of 2 kg B/ha + 2kg Ca/ha recorded the highest yield.

Davis *et al*. (2003) conducted to compare the effects of foliar and soil applied B on plant growth, fruit yield, fruit quality, and tissue nutrient levels. This experiment, B was associated with increased tomato growth and the concentration of K, Ca and B in plant tissue. Boron application was increased N uptake by tomato in field culture, but not under hydroponic culture. In field culture, foliar and/or soil applied B similarly increased fresh-market tomato plant and root dry weight, uptake and tissue concentrations of N, Ca, K, B and improved fruit set, total yields responses of tomato to foliar and root B application suggests that B is translocated in the phloem in tomatoes. Fruits from plants receiving foliar or root-applied B contained more B and K than fruits from plants not receiving B, indicating that B was translocated from leaves to fruits and is important factor in the management of K nutrition in tomato.

Naresh (2002) conducted an experiment to find out the response of foliar application of boron on vegetative growth, fruit yield and quality of tomato. Significant improvement in yield attributes of the experimental tomato crop due to boron application ultimately might have resulted in increased fruit yield of the crop. Significant and positive correlation between fruit yield and number of fruit per plant (0. 961 and 0.969) and average fruit weight (0.985 g and 0.980).The improvement in quality parameters of tomato fruit due to boron application could be the result of overall growth and development of the crop.

A greenhouse study was conducted by Alpaslan and Gunes (2001) to determine interactive affects of NaCl salinity and B on the growth, sodium (Na) chloride (Cl) boron (B) potassium (K) concentration and membrane permeability of salt resistant tomato (*Lycopersicon esculentum* cv. Lale F1). Plants were grown in a factorial combination of NaCl (0 and 30 mM for cucumber and 0 and 40 mM for tomato) and B (0, 5, 10 and 20 mg/kg soil). Boron toxicity symptoms appeared at 5mg/kg treatments in both plants. Salinity caused an increased in leaf injury due to B toxicity, but it was more severe in cucumber. Dry weights of the plants decreased with the increasing levels of applied B in non-saline conditions, but the decrease in dry weights due to B toxicity was more pronounced in saline condition especially in cucumber.

Cardozo *et al*. (2001) conducted to the effects of Ca and B fertilizers on the productivity of tomato cv. Debora Max were investigated in Espirito Santo do Pinhal, Sao Paulo, from April to July 2000. Aminobor at 300 ml/100 litres gave the highest value for fruit weight, while Ca at 60 g/100 litres and B at 150 g/ 100 litres recorded the highest number of fruits.

Yadav *et al.* (2001) conducted to evaluate the effect of different concentrations of zinc and boron on the vegetative growth, flowering and fruiting of tomato. This experiment studies during 1990 and 1991, in Hisar, Haryana, India. The treatments comprised of 5 levels of Zn (0, 2.5, 5, 7.5 and 10 ppm) and 4 levels of B (0, 0.5, 0.75 and 1.0 ppm) as soil application, as well as 0.5% Zn and 0.3% B as foliar application. The highest fruit length, fruit breadth and fruit numbers were obtained with the application of 7.5 ppm Zn and 1.0 ppm B.

Bose and Tripathi (1996) carried out an experiment to find the physiological role of boron and its involvement in the metabolism of proteins and found that the increase in vegetative growth of tomato could be attributed to physiological role of boron and its involvement in the metabolism of proteins, synthesis of pectin, maintaining the correct water relation within the plant, resynthesis of adenosine triphosphate (ATP) and translocation of sugar at development of the flowering and fruiting stages. Boron also plays an important role in flowering and fruit formation.

Singh and Gangwar (1991) conducted to the boron effect on tomato plants and found that boron had effects on many functions of the plant, such as hormone movement, active salt absorption, flowering and fruiting process, pollen germination, carbohydrates, nitrogen metabolism and water relations in the plants. Boron deficiency occurs in vegetable crops having high boron requirements when grown on alkaline soils with free lime and on sandy soils with low organic matter content. Boron deficiency causes reduced root growth, brittle leaves and necrosis of shoot apex. Cracking of surface of tomato fruit results in large losses.

2.2 Effect of organic manures on growth and yield of tomato

Mehdizadeh *et al.(* 2013) showed that addition of organic fertilizers at rate of 20 ton/ha significantly (at $P < 0.05$) increased tomato growth and yield compared to control (no fertilizer application). Also found results proved that tested treatments could be arranged in decreasing order as follows: municipal waste compost > poultry manure> cow manure> sheep manure > no fertilizer. Compost and poultry manure had a synergistic effect on both fresh and dry weights of tomato shoots and roots.

Application of poultry manure and 300 kg/ha NPK fertilizer significantly ($P<0.05$) increased plant N, P and K. Poultry manure at 20, 30 and 40 t/ha and NPK 15:15:15 fertilizer significantly ($P<0.05$) increased plant leaf, area height, number of leaves, branches fruits and fruit yield. Application of 10 t/ha poultry manure gave similar values of plant N, P and K and yield components compared with 300 kg/ha NPK fertilizer. The cumulative yield for the two seasons at 0, 10, 20, 30, 40 t/ha and 300kg/ha NPK were 9.6, 12.0, 18.1, 19.3, 14.4 and 13.5 t/ha respectively (Ayeni *et al*., 2010).

Ewulo *et al.* (2008) conducted to study the effect of poultry manure additions on nutrient availability, soil physical and chemical properties and yield of tomato, five levels of the manure, namely 0, 10, 25, 40 and 50 t/ha were applied at Akure, Southwest Nigeria. The soil at the two experimental sites were slightly acidic, low in organic matter, N, P, and Ca. Poultry manure increased soil organic matter, N and P. Soil bulk density were reduced and moisture content increased with levels of manure. Manure applications increased leaf N, P, K, Ca and Mg concentrations of tomato, plant height, number of branches, root length, number and weight of fruits. The 25 t/ ha poultry manure gave highest leaf P, K, Ca and Mg and yield relative to control. The 10, 25, 40 and 50 t/ha manure levels increased average fruit weight by 58, 102, 37 and 31% respectively.

Olaniyi and Ajibola (2008) conducted at effects of inorganic and organic fertilizers application on the growth, fruit yield and quality of tomato .The Teaching and Research Farm of Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Nigeria in the cropping seasons of 2004 and 2005. The treatments consisted of 2 levels of urea (0 and 60 kg N/ha) and 5 levels of poultry manure (Pm) (0, 3.0, 4.5, 6.0, 7.5 t/ha). The plant height and number of leaves showed increasing response as the amount of fertilizer applied increased. The combined application of the two types of fertilizers resulted in the highest marketable fruit yield. The content of essential nutrient elements increased and was also influenced by fertilizer treatments, except K in all the treatments. The yield and nutritional quality of tomato fruits were significantly improved by the application of sole poultry manure and mineral N fertilizer at 6.0 t. pm and 60 kg.N/ ha respectively, or their combined application at 30 kg.N by 6.0 t/ha. Pm . The yield and quality of tomato fruits produced with poultry manure are comparable with those obtained using mineral N fertilizer. Poultry manure can therefore be a suitable replacement for inorganic fertilizer in tomato production.

Plant height, number of leaves, leaf area, number of fruits and tomato yield as well as N, P and K were increased with the increase in the level of poultry manure up to 30 t/ha. The soil treated with 30 t/ha poultry manure showed highest plant K with corresponding increase in yields. The yield and growth parameters were found to decrease at 40 t/ha compare to 30 t/ha poultry manure indicating nutrient imbalance at the highest rate of application. The better performance of 30 t/ha poultry manure might be as a result of higher nutrient uptake especially N, P and K. It was indicated in the result that 40 t/ha PM reduced plant P, K, Ca and Mg compared to 20 t/ha of poultry manure. The least plant N, P and K contents recorded for tomato without poultry manure agrees with the observation that poultry manure supplied N, P and K (Ayeni, 2008, Ayeni *et al*., 2008). 20, 30 and 40 t/ha poultry manure performed better than 300 kg/ha NPK 15:15:15 fertilizers. This work shows that increase in poultry manure up to 30 t/ha maximizes yield than 20 t/ha of poultry manure earlier recommended by Akanni and Ojeniyi. (2007) as, optimum level for the production of tomato in the rain forest zone of southwest Nigeria.

Akanni and Ojeniyi.(2007).conducted to the relative effect of different levels (0, 10, 20, 40, 50 t/ha) of poultry manure on selected soil physical properties, nutrient status, growth and fruit yield of tomato (*Lycopersicon esculentum*) was studied in field experiments conducted at FECA and FUTA sites, Akure, in Southwest Nigeria. Soil bulk density and temperature reduced with level of poultry manure, while moisture content, height, number of branches, leaf area and taproot length increased. However the 20 t ha^{-1} poultry manure gave highest value of number and weight of fruits. The mean values of fruit weight recorded for 0, 10, 20, 40 and 50 t ha^{--1} manure were 17.6, 27.9, 35.6, 24.4 and 23.0 t ha^{-1}, respectively.

Solaiman *et al*. (2006). A field experiment was carried out at the Bangabandhu Sheikh Mujibur Rahman Agricultural University farm to assess the effects of inorganic and organic fertilizers on vegetative, flowering and fruiting characteristics as well as yield attributes and yield of Ratan variety of tomato. The plots were treated with three levels each of N (62, 100 and 200 kg/ha), P (11.7, 17.5 and 35 kg/ha), K (26.7, 40 and 80 kg/ha), S (5, 7.5 and 15 kg/ha) and cowdung (5, 10 and 15 t/ha). There were three replications for each treatment. The highest plant height and dry weight of shoot, the maximum number of clusters of flowers and fruits/plant as well as the greatest fruit size and fruit yield/plant, fruit yield/ha were obtained from the application of the recommended dose of nutrients viz. 200 kg N + 35 kg P + 80 kg K + 15 kg S/ha, but similar results were obtained from the treatment receiving 5t cowdung/ha along with half of the recommended doses of nutrients (100 kg N+ 17.5 kg P + 40 kg K + 7.5 kg S/ha). The effect of 10t cowdung per ha, along with one third of the recommended dose of nutrients, was also comparable to the effect of employing the recommended dose of nutrients. It was further observed, from an economic standpoint, that the combination of 5t cow dung/ha along with half of the recommended doses of nutrients appeared to be a viable treatment which would offer the maximum benefit concerning cost ratio (4.38) for tomato production in the shallow red- brown terrace soil (AEZ-28) of Bangladesh.

Aluko and Oyedele (2005) conducted on the effects of organic waste on soil physical properties and they observed that poultry manure incorporation had no significant effect on soil density and porosity. The author reported that the effect of different levels of poultry manure on soil bulk density, moisture content, nutrient status, growth and fruit yield of tomato.

Sangwoo *et al.* (2004) conducted an experiment taking two cowdung based and two plant-residue-based organic amendments to a simple peat-based potting mix were tested over 2 years for their ability to increased seedling biomass, out-planting success and yield in an organic tomato production system. Uniform, high quality transplants are necessary for good field establishment of tomato and field-grown flowers. The health and vigor of these transplants can affect the long-term growth and quality of the fruit. Healthy, vigorous starts will be less susceptible to insects and disease pressure and other streeses. Based upon these findings, excellent quality tomato transplants can be produced using either plant-based or cowdung based organic amendments

Akande and Adediran (2004) conducted to effects on soil physical properties and nutrient uptake, and sustainability of tomato production systems is scarce. This experiment showed utilization of poultry manure in tomato production in Nigeria . Adediran *et al.* (2003) compared poultry manure, household, market and farm waste and found that poultry manure at 20 t ha had highest nutrient contents and mostly increased yield of tomato and soil macro and micronutrients content. Akande and Adediran (2004) found that poultry manure at 5 t/ha significantly increased tomato and dry matter yield, soil pH, N, P, K,Ca and Mg and nutrient uptakes.

Ahammad *et al*. (1999) conducted an experiment in Gazipur, Bangladesh, during November 1996 to March 1997 to determine the tomato, cv. Ratan on roof garden. The pots were filled up different organic residues i.e. cowdung, poultry manure, mustard oil cake and urea at all different treatment combinations. There were significant differences among the treatments with respect to vegetative growth, flowering and fruiting fruit characteristics and yield of grafted tomato. The highest fruit yield per plant (4.41 kg) was obtained in the poultry manure treatment.

Hossain and Majid (1997) conducted field trials to study on the effect of water hyacinth (Eichlzornia) compost and cowdung as organic fertilizers on gourds, tomatoes and aubergines near Dhaka. The compost was applied on gourds, tomatoes and aubergines near Dhaka. The compost was applied alone or in a 2:1 mixture with cowdung to the gourds and in a 1:1 mixture with cowdung to tomatoes and aubergines. Gourd yields were highest with 180 kg weight, compost added per planting hole tomato yields were higher with mixture than with cowdung alone but aubergine yields were identical in two treatments.

Shaheed (1997) conducted an experiment to investigate the effect of organic manures on yield and quality of grafted tomato. He reported that mustard oil cake (150 g/plot) as an alternative of cowdung and poultry dropping played an important role in increasing the yield of grafted tomato.

Hallorans *et al*. (1993) reported that chiken manure along with cowdung (0, 5, 10 and 15 t/ha) was broadcast and incorporated in a Puerto Rican Cumulic Haplustoll and N (0, 56, 112 and 168 kg/ha) was applied by fertilization. A significant Olsen available P with chicken manure applications. Chicken manure did not increase tomato yields significantly, but it did increase the number of large and medium fruits.

Rahman (1993) reported that organic residues such as cowdung @15 t/ha in combination with other fertilizer played an important role in respect of growth and fruit yield of tomato.

Babafoly (1989) sated that poultry manure and cowdung were separated to all other organic residues improved growth, vigour and yield of tomato.

Prezotti *et al*. (1988) conducted that application of cowdung increased total productivity by 48% and improved the proportion of large fruits in the total yield.

Dumitrescu (1975) conducted that application on cowdung as organic manures of high fertilizing value reported that application of FYM at the rate of 20 t/ha gave higher total yield of tomato.

Numerous reports (USDA, 1980; Palm *et al.*, 1997) recommend 9-18 tons/acre of manure for good tomato yield. Application of broiler litter at the rate of 15 ton/ha, N at 40 kg/ha, P at 30 kg/ha and K at 30 kg/ha showed higher growth and fruit yield (Brown & James., 1995). Tomato can also be supplied with a combination of compost and mineral N fertilizers to improve fruit yield (Akanbi *et al*., 2005).

CHAPTER III

MATERIALS AND METHODS

The details of the materials and methods of this research work were described in this chapter as well as on experimental materials, site, climate and weather, experimental design, layout, materials used for experiment, raising of seedlings, treatments, land preparation, transplantation of seedlings, intercultural operations, harvesting, collection of data and statistical analysis which are given below:

3.1 Experimental site

The field experiment was conducted in the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka-1207. The location of the experimental site was at 23.75^0N latitude and 90.34^0E longitudes with an elevation of 8.45 meter from the sea level.

3.2 Experimental period

The experiment was carried out during the Rabi season from October 2017 to March 2018. Seeds was sown on 28 October, 2017, seedling transplanting was done on November, 2017 and harvested upto March, 2018.

3.3 Soil type

The experimental site was situated in the subtropical zone. The Soil of the experimental site lies in Agro-Ecological Zone of “Madhupur Tract” (AEZ 28). Its top soil is clay loam in texture and olive grey with common fine to medium distinct dark yellowish brown mottles. The pH 5.6, ECE 25.28 and organic carbon contents is 0.45.

3.4 Weather

The monthly mean of daily maximum, minimum and average temperature, relative humidity, monthly total rain fall and sunshine hours received at the experimental site during the period of the study have been collected from Bangladesh Meteorological Department, Agargoan, Dhaka.

3.5 Planting Materials

The tomato variety BARI Tomato-15 was used in the experiment. It was a high yielding variety. Seed was collected from Bangladesh Agricultural Development Corporation. Motijeel , Dhaka.(BADC).

3.6 Experimental Treatment

The two factor experiment consisted of four levels of micronutrients (Factor A) and four levels of manure (Factor B). The factors were as follows:

Factor A (Four levels of micronutrient)	Factor B (Four levels of manure)
N_0 - 0 kg/ha	M_0 - 0 ton/ha
N_1 - Zn+B (2+1.5 kg/ha)	M_1 - Cowdung (15 ton/ha)
N_2 - Zn+B (4+2 kg/ha)	M_2 - Poultry Manure (10 ton/ha)
N_3 - Zn+B (6+2.5 kg/ha)	M_3 - Cowdung + Poultry Manure (7.5+5) ton/ha

There were all together 16 treatments combination used in each block were

N_0M_0,N_0M_1.N_0M_2.N_0M_3.N_1M_0,N_1M_1,N_1M_2,N_1M_3,N_2M_0,N_2M_1,N_2M_2,N_2M_3,N_3M_0, N_3M_1,N_3M_2,N_3M_3.

3.7. Source of Zinc and Boron

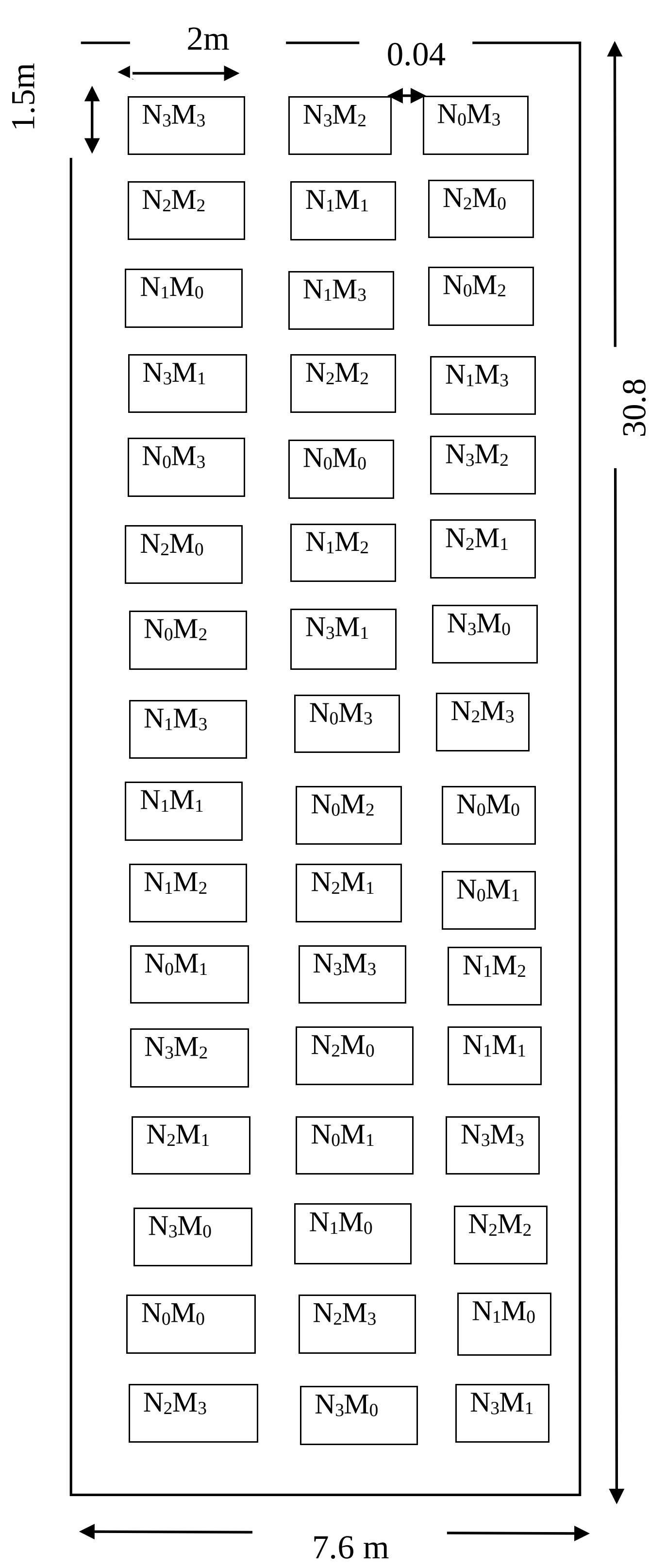
The source of Zinc and Boron were $ZnSO_4$ and Boric Acid.

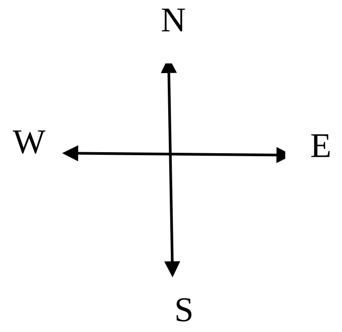
3.8 Application of Zn & B

The entire amount of Zn & B were applied final land preparation.

3.9 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) having two factors with three replications. An area of 30.8 m × 7.6 m was divided into three equal blocks. Each block consists of 16 plots where 16 treatments were allotted randomly. There were 48 unit plots in the experiment. The size of each plot was 1.5 m × 2 m. The distance between two blocks and two plots were kept 0.4 m and 0.4 m respectively. A layout of the experiment has been shown in figure 1.





Plot size=1.5×2m

Plant spacing=50×50cm

Spacing between plot=0.04m

Factor A

N_0-0 kg/ha

N_1- Zn+B (2+1.5 kg/ha)

N_2- Zn+B (4+2 kg/ha)

N_3- Zn+B (6+2.5 kg/ha)

Factor B

M_0-Control

M_1-Cowdung (15 ton/ha)

M_2-Poultry manure (10 ton/ha)

M_3-Cowdung+Poultry manure (7.5+5 ton/ha)

Fig 1: Experiment Layout

3.10 Raising of seedling

Tomato seedlings were raised in two seed beds of 3 m × l m and size. The soil was well prepared and converted into loose friable condition in obtaining good tilth. All weeds, stubble, sand, dead roots were removed. Twenty grams of seed were sown in each seed bed. The seeds were sown in seed bed on 28 October 2017. Seed were then covered with light soil and shading was provided by bamboo mat to protect young seedlings from scorching sunshine and rainfall. Light watering weeding and mulching were done as and when necessary to provide seedlings with good condition for growth.

3.11 Cultivation Procedure

3.11.1 Land preparation

The soil was prepared and tilth was ensured. The land of the experimental field was ploughed with a power tiller on November 2017. The experimental field was thoroughly ploughed and cleaned prior to seed sowing. Later on the land was ploughed three times followed by laddering to obtain desirable tilth. The corners of the land were spaded and larger clods were broken into smaller pieces. After ploughing and laddering, all the stubbles and uprooted weeds were removed .Then the land was made ready. The field layout and design or the experiment was followed after land preparation .

3.11.2 Application of manure and fertilizers

The sources of N, P_2O_5, K_2O as urea, TSP, MoP were applied, respective throughout this experiment. The entire amount of TSP was applied during the final land preparation. Urea was applied in three equal installments at 10, 25 and 40 days after seedling transplanting. On the other hand, 38.46% MoP was applied as basal dose and rest of the MoP was applied in two equal installments at 25 and 40 days after transplanting.. The fertilizer were applied on both sides of plants rows and mixed well with the soil.

Table 1: Fertilizer and manure applied for the experimental field preparation. Manure and fertilizer were used as recommended by Krishi Projukti Hatboi, BARI (2014)

Manure/ fertilizers	Rate/ha	Application (%)				
		Basal	10 DAT	25 DAT	35 DAT	40 DAT
Urea	450 kg	-	33.33	33.33	-	33.33
TSP	250 kg	100	-	-	-	-
MoP	260 kg	38.46	-	30.77	-	30.77

3.11.3 Transplanting of seedlings

Healthy and uniform 31 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots on 28 November, 2017 maintaining a spacing of 50 cm × 50 cm. This allowed an accommodation of 12 plants in each plot. The seedbed was watered before uprooting the seedlings from the seedbed so as to minimize damage to the roots. The seedlings were watered after transplanting. Seedlings were also planted around the border area of the experimental plots for gap filling.

3.11.4 Intercultural Operations

After transplanting the seedlings, various kinds of intercultural operations were done for better growth and development of the plants, which were as follows:

3.11.4.1 Gap filling

The soil around the base of each seedling was pulverized when the seedlings were well established. when initial planted seedling failed to survive then few gaps filling was done by healthy seedlings of the same stock

3.11.4.2 Weeding

Weeding was accomplished as and whenever necessary to keep the crop free from weeds.

3.11.4.3 Staking

When the plants were well established, staking was given to each plant by rope to keep them erect. Within a few days of staking, as the plants grew up.

3.11.4.4 Irrigation

Number of irrigation was given throughout the growing period by Garden pipe. The first irrigation was given immediately after transplantation. Then others were applied as and when required depending upon the condition of soil.

3.11.4.5 Plant Protection

Ripcord was applied @ 6 ml/L against the insect pests like cut worm, leaf hopper, fruit borer and others. The insecticide application was done fortnightly after transplanting before first harvesting

3.12. Harvesting

Fruits were harvested at 3 to 5 days interval during early ripe stage when they attained slightly red color.

3.13 Data collection

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

3.13.1 Plant Height (cm)

Plant height was measured from the sample plants in cm from the ground level to the tip of the longest stem and means value was calculated. Plant height was recorded at 25,45, 65 days after planting to observe the growth rate.

3.13.2 Number of leaves per plant

The number of leaves per plant was counted at 25, 45, 65 days after transplanting . The average of 5 plants were computed and expressed in average number of leaves per plant.

3.13.3 Number of branches per plant

The number of branches per plant was counted at 45, 65 days after transplanting from tagged plants. The average of 5 plants were computed and expressed in average number of branch per plant.

3.13.4 Number of cluster per plant

The number of clusters was counted at 45, 65 days after transplantation from the 5 sample plants and the average number of flower cluster produced per plant was recorded.

3.13.5 Number of flowers per cluster

The number of flowers per cluster was taken from sample plants at 45 and 65 DAT, and was calculated as follow

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

3.13.6 Number of flowers per plant

Total number of flowers was counted from 5 selected plants at 45, 65 days after transplanting and their average was taken as the number of flowers per plant.

3.13.7 Number of fruits per cluster

The number of fruits per cluster was counted from the sample plants and the average number of fruits per clusters was recorded.

3.13.8 Number of fruits per plant

The total number of fruit was recorded from the five sample plants at 45, 65 DAT and the average number of fruit produced per plant was recorded.

3.13.9 Fruit length (cm)

The length of fruit was measured with a slide calipers from the neck of the fruit to the bottom of 10 selected marketable fruits from each plot and there average was taken and expressed in cm.

3.13.10 Fruit breadth (cm)

Diameter of fruit was measured at the middle portion of 10 selected marketable fruits from each plot with a slide calipers and their average was in centimeter.

3.13.11 Length of fruit cavity (cm)

Length of fruit cavity was measured of 10 selected marketable fruits from each plot and their average was in centimeter.

3.13.12 Diameter of fruit cavity (cm)

Diameter of fruit cavity was measured of 10 selected marketable fruits from each plot and their average was in centimeter .

3.13.13 Weight of individual fruit (g)

The weight of individual fruit was counted from the sample plants.

3.13.14 % of Brix

The Brix % of individual fruit was counted from the sample plants by Brix meter.

3.13.15 % Dry matter content in fruit

After harvesting, randomly selected 100g plant fruit sample previously sliced into very thin pieces were put into envelop and placed in oven maintained at 60^0 C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken. The dry matter contents of fruit were computed by simple calculation from the weight recorded by the following formula:

$$\text{\% Dry matter content of fruit} = \frac{\text{Dry weight of fruit}}{\text{Fresh weight of fruit}} \times 100$$

3.13.16 Fruit yield per plot (kg)

A pan scale balance was used to take the weight of fruit per plot and recorded in kg.

3.13.17 Fruit yield per hectare (ton)

It was measured by the following formula:

$$\text{Fruit yield per hectare (ton)} = \frac{\text{Fruit yield per plot kg} \times 10000 \text{ m}^2}{\text{Area of plot in square meter (m}^2\text{)} \times 1000 \text{ kg}}$$

3.13.18 Statistical Analysis of Data

The data obtained for different characteristics in respect of growth, yield contributing characters of tomato and yield were statistically analyzed to find out the statistical significance. The means for all the treatments were calculated and the analysis of variance for all the characters was performed by "F" (variance ratio) test. The significance of the difference among the means was evaluated by Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez (1984) for interpretation of the result at 5% level of probability.

3.13.19 Economic Analysis

The cost of production was analyzed in order to find out the most economic treatment of micronutrients and organic manure. All input cost included the cost for lease of land and interest on running capital in computing the cost of production. The interest was calculated @ 13% in simple interest rate. The market price of tomato was considered for estimating the cost and return. Analyses were done according to the procedure determining by Alam *et al.* (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{The benefit cost ratio (BCR)} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}$$

CHAPTER IV

RESULTS AND DISCUSSION

The chapter comprises the presentation and discussion of the results obtained from the effect of micronutrients in presence of different level of organic manure on growth and yield of tomato. The effects due to different levels of micronutrients and organic manure and their interaction on the growth, yield contributing attributes and yield have been presented in Tables 2 to 13 and Figures 2 to 9. The results of each parameter studied in the experiment have been presented and discussed under the following headings:

4.1 Plant height

Plant height was measured starting from 25 days after transplanting. It was measured 20 days interval and continued up to 65 DAT. At 25 DAT, the maximum plant height (51.82 cm) was observed from N_2 - Zn+B (4+2 kg/ha) treatment and minimum plant height (44.13 cm) was observed from N_0 (0 kg/ha) treatment. At 45 DAT, the maximum plant height (83.42 cm) was observed from N_2 treatment which was statistically similar to N_3 (81.88 cm) treatment and minimum plant height (73.42 cm) was observed from N_0 (0 kg/ha) treatment. At 65 DAT, the maximum plant height (95.60 cm) was observed from N_2 treatment and minimum plant height from N_0 (82.86 cm) treatment in (Fig 2). Amarchandra and Verma (2003) found similar findings. This might be due to the fact balance absorption of nutrients might improve physiological activities , which resulted the endogenous growth hormone synthesis responsible for higher vegetative growth than control. Dube *et al*. (2004) founded the soil application of zinc sulphate and borax @ 10 and 20 kg/ha, respectively in combination with their foliar spray @ 0.5% and 0.3%, respectively where most effective in improving plant height (Appendix IV).

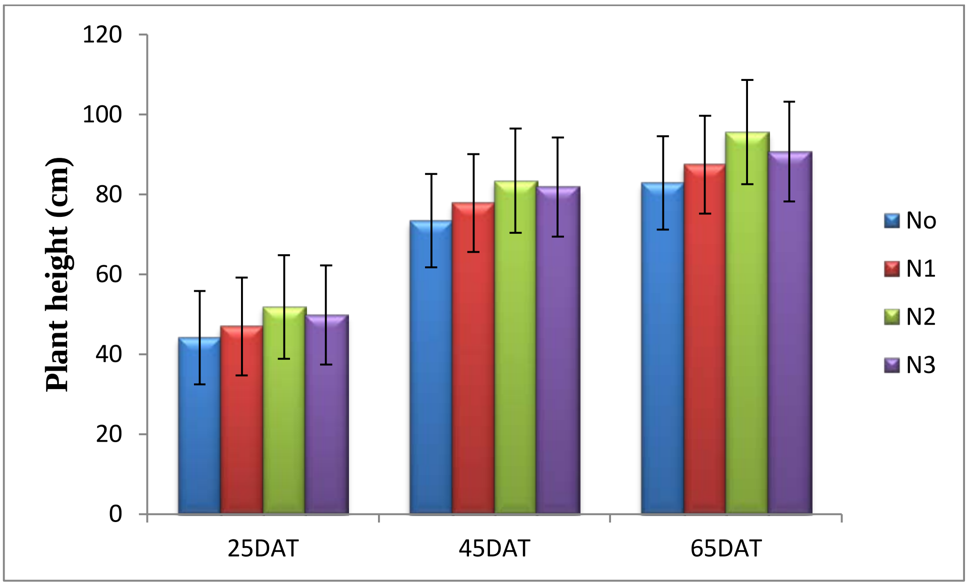


Fig. 2 Effect of micronutrients on the plant height of tomato

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

Marked variation was observed among treatments as to the plant height of tomato due to the application of different levels of manure at 25, 45 and 65 DAT of (Fig3). At 25 DAT, the maximum plant height (52.31cm) was observed from M_3 (Cowdung 7.5 ton+Poultry manure 5 ton/ha) treatment and control treatment (M_0) gave the minimum plant height (44.20 cm) treatment. At 45 DAT, the maximum plant height (82.82cm) was observed from M_3 treatment which was statistically similar to M_2 (80.77cm) and minimum plant height M_0 (75.31cm) treatments. At 65 DAT, the maximum plant height (93.22 cm) was observed from M_3 and minimum plant height (85.77cm) was observed from M_0 treatment..The reason for higher plant height might be explained in the way that the favourable soil condition influence of balanced uptake of nutrients, which were applied. Ewulo (2008) observed similar result (Appendix IV).

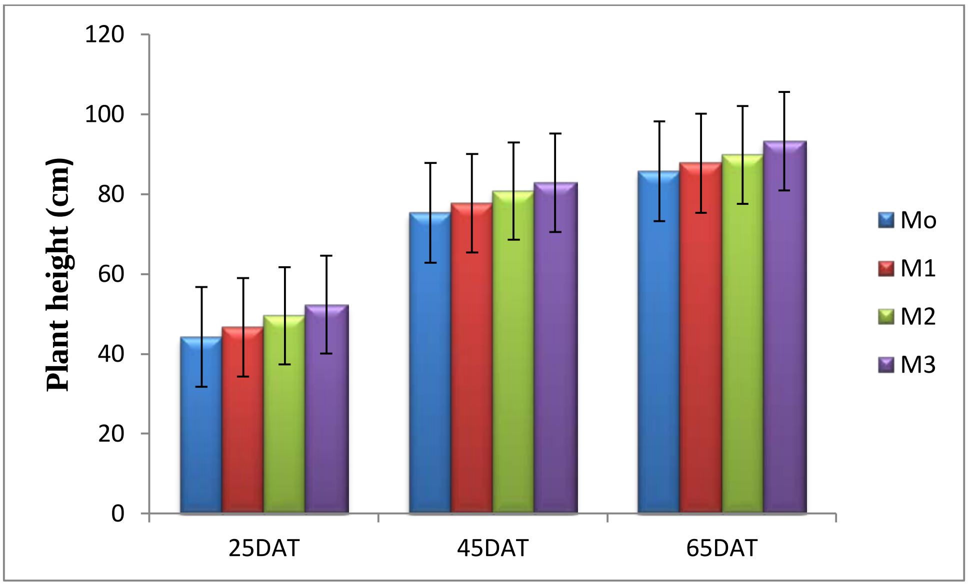


Fig. 3.Effect of manure on the plant height of tomato

Here, M_0 -Control, M_1 - Cowdung (15 ton/ha),

M_2 - Poultry manure (10 ton/ha) , M_3 - CD+PM (7.5+5 ton/ha)

The combined effect of micronutrients and organic manure showed statistically significant variation on plant height at 25, 45 and 65 DAT (Table 2). At 25 DAT, the maximum plant height (57.50 cm) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung 7.5 ton+Poultry manure 5 ton/ha) and statistically similar to N_3M_3 (54.20 cm) and control treatment (N_0M_0) treatment gave the minimum plant height (40.50 cm) which statistically similar to N_0M_1 (43.30 cm) and N_1M_0 (44.00 cm) treatment. At 45 DAT, the maximum plant height (89.20 cm) was obtained from N_2M_3 which statistically similar to N_2M_2 (85.30 cm) and N_3M_3 (84.80 cm). The control treatment (N_0M_0) gave the maximum plant height (70.00 cm) which similar to N_0M_1(72.70 cm) ,N_0M_2(74.50 cm) and N_1M_0 (74.00 cm) treatment. At 65 DAT, the maximum plant height (100.00 cm) was obtained from N_2M_3 and control treatment (N_0M_0) gave the minimum plant height(81.25 cm) which similar to N_0M_1(82.00 cm) treatment (Appendix IV).

Table 2: The combined effect of different levels of micronutrients and manure on the plant height (cm) of tomato at different days after transplanting

Treatments	Plant height (cm)		
	25 DAT	45 DAT	65 DAT
N_0M_0	40.50 h	70.00 h	81.25 h
N_0M_1	43.30 gh	72.70 gh	82.00 gh
N_0M_2	45.25 e-g	74.50 f-h	82.80 g
N_0M_3	47.50 d-f	76.50 e-g	85.40 f
N_1M_0	44.00 f-h	74.00 f-h	85.30 f
N_1M_1	45.90 e-g	76.80 e-g	86.00 f
N_1M_2	47.95 de	79.90 c-e	87.75 e
N_1M_3	50.05 cd	80.80 c-e	90.75 d
N_2M_0	46.55 e-g	78.00 d-f	90.25 d
N_2M_1	50.00 cd	81.20 b-d	94.30 c
N_2M_2	53.25 bc	85.30 ab	97.35 b
N_2M_3	57.50 a	89.20 a	100.50 a
N_3M_0	45.75 e-g	79.25 c-e	86.30 f
N_3M_1	47.50 d-f	80.10 c-e	88.75 e
N_3M_2	51.80 bc	83.40 bc	91.45 d
N_3M_3	54.20 ab	84.80 ab	96.50 b
CV%	7.41	8.67	8.25
LSD (0.05)	3.82	3.56	1.31

Means, in a column followed by same letter do not differ significantly at 5% level.

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha), M_3 - CD+PM (7.5+5 ton/ha)

4.2 Number of leaves per plant

No of leaves per plant of tomato varied significantly due to the application of different levels of micronutrients at 25, 45, and 65 DAT(Figure 4). At 25 DAT, the maximum number of leaves (12.10) was observed in N_2 - Zn+B (4+2 kg/ha) and minimum number of leaves per plant (7.83) was observed in N_0 (0 kg/ha) treatments. At 45 DAT, the maximum number of leaves per plant (25.31) was observed from N_2.The minimum number of leaves per plant (19.15) was observed from N_0 treatment which was statistically similar to N_1 (21.48) treatment. At 65 DAT, the maximum number of leaves per plant (33.17) was observed from N_2 and minimum number leaves N_0 (27.58) treatment. Oyinlola (2004) reported that application of boron significantly increased the number of leaves on tomato plant compared to control. Ejaz *et al.* (2011) found similar result (Appendix IV).

Number of leaves per plant of tomato varied significantly due to the application of different levels of manure at 25, 45 and 65 DAT of (Figure-5). At 25 DAT, the maximum number of leaves (11.61) was observed from M_3 (Cowdung 7.5 ton +Poultry manure 5 ton/ha) and minimum number of leaves per plant (8.53) was observed from M_0 (0 ton/ha) treatment. At 45 DAT, the maximum number of leaves per plant (24.21) was observed in M_3.The minimum number of leaves per plant (20.43) was observed from M_0 which was statistically similar to M_1 (21.80) treatment . At 65 DAT, the maximum number of leaves per plant (33.51) was observed from M_2 and minimum number leaves M_0 (27.91) which statistically similar to M_1 (29.65) (Appendix IV).

Combined effect micronutrients and organic manure showed statistically significant variation on number of leaves per plant at 25, 45 and 65 DAT (Table-3). At 25 DAT, the maximum number of leaves per plant (15.10) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung 7.5 ton + Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum number of leaves per plant (7.25) which statistically similar to N_0M_1 (7.60). At 45 DAT, the maximum no of leaves per plant (27.95) was obtained from N_2M_3 which statistically similar to N_2M_2 (25.80) and N_3M_3 (25.10). The control treatment (N_0M_0) gave the minimum number of leaves per plant (17.40 cm). At 65 DAT, the maximum number of leaves per plant (36.80 was obtained from N_2M_3 which was statistically similar to N_2M_2 (34.20) and N_3M_3 (34.30).The control treatment (N_0M_0) gave the minimum number of leaves per plant (25.50) . From the result present study it can be conducted that the treatment N_2M_3 provided better growing condition perhaps to supply of adequate plant nutrients, resulting in the number of leaves per plant (Appendix IV).

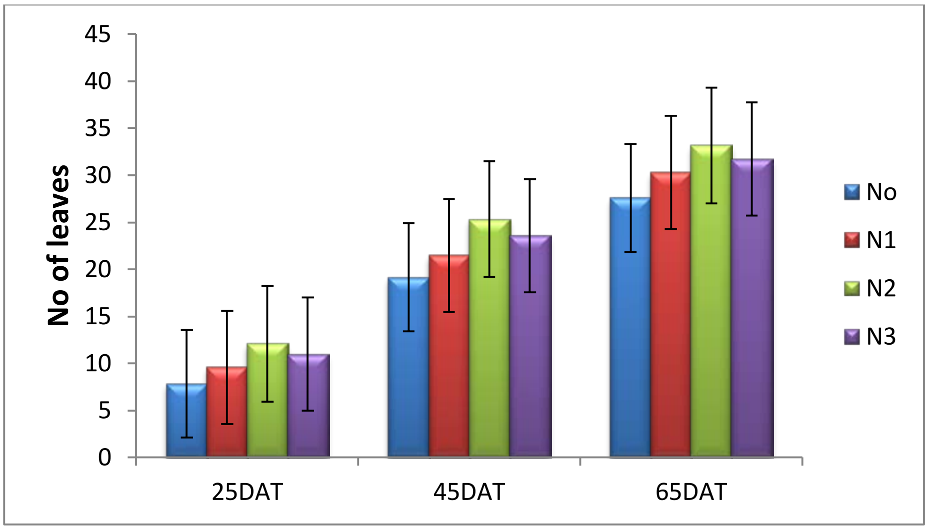


Fig. 4. Effect of micronutrient on no of leaves per plant of tomato

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 - Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

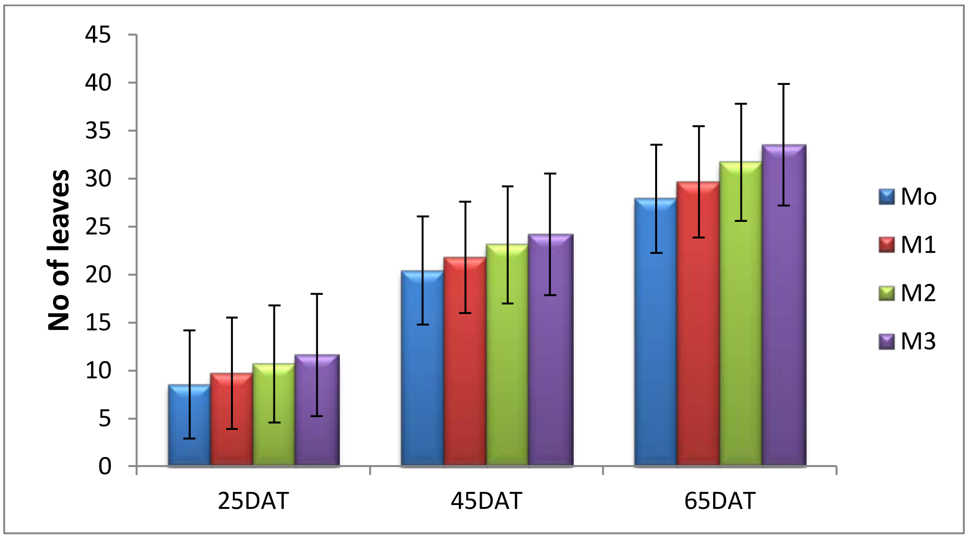


Fig. 5. Effect of manure on no of leaves per plant of tomato

Here,M_0=control, M_1=Cowdung (15 ton/ha), M_2=Poultry manure (10 ton/ha) , M_3=CD+PM (7.5+5 ton/ha)

Table 3: The combined effect of different levels of micronutrients and manure on number of leaves per plant of tomato at different days after transplanting

Treatments	Number of leaves/ plant		
	25 DAT	45 DAT	65 DAT
N_0M_0	7.25 j	17.40 g	25.50 e
N_0M_1	7.60 ij	18.20 fg	26.90 de
N_0M_2	8.05 hi	20.15 e-g	27.45 c-e
N_0M_3	8.45 gh	20.85 e-g	30.50 c-e
N_1M_0	8.35 g-i	18.90 e-g	27.50 c-e
N_1M_1	9.45 ef	21.60 e-g	29.30 c-e
N_1M_2	10.05 de	22.50 d-f	32.00 b-d
N_1M_3	10.50 d	22.95 c-e	32.45 b-d
N_2M_0	9.50 ef	23.20 c-e	29.60 c-e
N_2M_1	11.30 c	24.30 b-d	32.10 b-d
N_2M_2	12.50 b	25.80 ab	34.20 ab
N_2M_3	15.10 a	27.95 a	36.80 a
N_3M_0	9.05 fg	22.15 d-f	29.05 c-e
N_3M_1	10.40 d	23.10 c-e	30.30 c-e
N_3M_2	12.10 b	24.00 b-d	33.20 bc
N_3M_3	12.40 b	25.10 a-c	34.30 ab
CV%	9.98	8.16	10.97
LSD (0.05)	0.76	4.69	4.04

Means,in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha), M_3 - CD+PM (7.5+5 ton/ha)

4.3 Number of branches per plant

Number of branches per plant of tomato varied significantly due to the application of different levels of micronutrients at 45 and 65 DAT (Table 4). At 45 DAT, the maximum number of branches per plant (5.06) was observed from N_2 - Zn+B (4+2 kg/ha) and minimum number of branches per plant (3.55) was observed in from N_0 (0 kg/ha) treatment. At 65 DAT, the maximum number of branches per plant (5.72) was observed from N_2 treatment. The minimum number of branches per plant (4.46) was observed from N_0 . Amarchandra and Verma (2003) stated similar findings (Appendix IV).

Number of branches per plant of tomato was found significantly influences due to the application of different levels of manure at 45 and 65 DAT (Table- 4). At 45 DAT, the maximum number of branches (4.77) was observed from M_3 (Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha) and minimum number of branches per plant (3.70) was observed in M_0 (0 ton/ha) treatment. At 65 DAT, the maximum number of branches per plant (5.89) was observed in M_3 which was statistically similar to M_2(Poultry manure 10ton/ha) here found the number of branches was (5.63).The minimum number of branches per plant (4.78) was observed from M_0 treatment (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on the number of branches per plant at 45 and 65 DAT (Table 5). At 45 DAT, the maximum number of leaves per plant (6.05) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum number of branches per plant (3.15) which was statistically similar to N_0M_1 (3.45) treatment. At 65 DAT, the maximum number of branches per plant (7.25) was obtained from N_2M_3 which statistically similar to N_2M_2 (6.85) treatment .The control treatment (N_0M_0) gave the minimum number of branches per plant (4.10) which was statistically similar to N_0M_1(4.30), N_0M_2(4.60), and N_1M_0 (4.25) treatments respectfully .this might be due to the fact that balanced uptake and influences of nutrients which improve of vegetative growth. Manure improved physical conditions of the soil , which increased the water holding capacity and better nutrients availability and uptake by the crop (Appendix IV).

Table 4:The effect of different levels of micronutrients and manure on number of branches per plant of tomato of at different days after transplanting

Treatments	Number of branch per plant	
	45 DAT	65 DAT
Micronutrients		
N_0	3.55 d	4.46 d
N_1	3.92 c	4.79 c
N_2	5.06 a	6.51 a
N_3	4.53 b	5.72 b
CV%	10.68	11.58
LSD(0.05)	0.25	0.25
Manure		
M_0	3.70 d	4.78 c
M_1	4.12 c	5.17 b
M_2	4.47 b	5.63 a
M_3	4.77 a	5.89 a
CV%	10.68	11.58
LSD (0.05)	0.21	0.30

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1–Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha),
M_3 - CD+PM (7.5+5 ton/ha)

Table5: The combined effect of different levels of micronutrients and manures on number of branches per plant of tomato at different days after transplanting

Treatments	Number branches per plant	
	45 DAT	65 DAT
N_0M_0	3.15 h	4.10 j
N_0M_1	3.45 gh	4.30 h-j
N_0M_2	3.70 fg	4.60 h-j
N_0M_3	3.90 fg	4.85 f-h
N_1M_0	3.70 fg	4.25 ij
N_1M_1	3.90 fg	4.75 g-i
N_1M_2	4.00 ef	5.05 fg
N_1M_3	4.10 ef	5.14 e-g
N_2M_0	4.05 ef	5.70 de
N_2M_1	4.70 cd	6.25 cd
N_2M_2	5.45 b	6.85 ab
N_2M_3	6.05 a	7.25 a
N_3M_0	3.90 fg	5.10 fg
N_3M_1	4.45 de	5.40 ef
N_3M_2	4.75 cd	6.05 cd
N_3M_3	5.05 bc	6.35 bc
CV%	10.68	11.58
LSD (0.05)	0.51	0.59

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha), M_3 - CD+PM (7.5+5 ton/ha)

4.4 Number of clusters per plant

Marked singnificant variation was found as to the number of clusters per plant due to application of different levels of micronutrients at 45 and 65 DAT (Table 6). AT 45 DAT, the maximum number of flower clusters per plant (5.65) was observed from N_2 - Zn+B (4+2 kg/ha) treatment and minimum number of clusters per plant (3.95) was observed from N_0 (0 kg/ha) treatment which was statistically similar to N_1 (4.37).At 65 DAT, the maximum number of clusters per plant (12.96) was observed from N_2.The minimum number of clusters per plant (7.41) was observed from N_0 treatment (Appendix IV).

Number of clusters per plant of tomato was found varied significantly due to the application of different levels of manure at 45 and 65 DAT (Table 6). AT 45 DAT, the maximum number of flower clusters per plant (4.99) was observed from M_3 (Cowdung 7.5 ton/ha +Poultry manure 5 ton/ha) and minimum number of clusters per plant (4.36) was observed from M_0 (0 ton/ha) treatment. AT 65 DAT, the maximum number of flower clusters per plant (10.73) was observed from M_2 (Poultry manure 10ton/ha) and minimum number of clusters per plant (8.63) was observed from M_0 (0 ton/ha) treatment. Solaiman *et al.,* (2006) reported similar result (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on number of cluster per plant at 45 and 65 DAT (Table 7). At 45 DAT, the maximum number of clusters per plant (6.21) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum number of cluster per plant (3.80). At 65 DAT, the maximum number of clusters per plant (14.05) was obtained from N_2M_3 which statistically similar to N_2M_2 (13.50).The control treatment (N_0M_0) gave the minimum number of cluster per plant(6.80) which was statistically similar to N_0M_1 (7.2) treatment (Appendix IV).

4.5 Number of flowers per cluster

The variation among the micronutrients level application in relation to the number of flower per cluster was found significant influences at 45 and 65 DAT (Table 6). At 45 DAT, the maximum number of flower per clusters (3.75) was observed from N_2 - Zn+B (4+2 kg/ha) treatment which was statistically similar to N_3 (3.59) and minimum number of flowers per cluster (2.60) was observed from N_0 (0 kg/ha) treatment. At 65 DAT, the maximum number of flowers per clusters (6.42) was observed from N_2 treatment. The minimum number of flowers per clusters (3.67) was observed from N_0 treatment (Appendix IV).

Number of flowers per cluster of tomato varied significantly due to the application of different levels of organic manure at 45 and 65 DAT (Table 6). At 45 DAT, the maximum number of flowers per cluster (3.78) was observed from M_3 (Cowdung 7.5 ton/ha +Poultry manure 5 ton/ha) and minimum number flowers per cluster (2.69) was observed from M_0 (0 ton/ha). At 65 DAT, the maximum number of flowers per cluster (5.86) was observed from M_3. The minimum number of flowers per cluster (4.42) was observed from M_0 (control). Flowering in plants occurred more when the combindly application of cowdung and poultry manure, this might be due to the fact that manure improve the physical condition of the soil .which increased the microbial activity,water holding capacity of soil. Manure improve soil fertility, which increased the adequate absorption of all nutrients required by plants and consequently helped in increasing the number of flower per plant (Appendix IV).

The combined effect of micronutrients and manure application showed statistically significant variation on number of flower per cluster at 45 and 65 DAT (Table 7). At 45 DAT, the maximum number of flowers per clusters (4.25) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum number of flowers per cluster (2.35). At 65 DAT, the maximum number of flowers per cluster (7.05) was obtained from N_2M_3 treatment.

The control treatment (N_0M_0) gave the minimum number of flowers per cluster (3.00) treatment (Appendix IV).

4.6 Number of flowers per plant

Remarkable differences was observed among the micronutrients application of different levels of micronutrients at 45 and 65 DAT (Table-6). AT 45 DAT, the maximum number of flower per plant (20.73) was observed from N_2 - Zn+B (4+2 kg/ha) and minimum number of flowers per plant (10.56) was observed from N_0 (0 kg/ha).At 65 DAT, the maximum number of flowers per plant (84.60) was observed from treatment N_2 .The minimum number of flowers per plant (27.53) was observed in treatment N_0.. Ejaz *et al* (2011) and Shah (2006) also reported similar result (Appendix IV).

Number of flowers per plant of tomato varied significantly due to the application of different concentrations of manure at 45 and 65 DAT (Table 6). At 45 DAT, the maximum number of flowers per plant (18.68) was observed from M_3 (Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha) and minimum number flowers per plant (12.03) was observed from M_0 (0 ton/ha) treatment. At 65 DAT, the maximum number of flowers per plant (65.15) was observed in treatment M_3. The minimum number of flowers per plant (39.81) was observed from treatment M_0 (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on number of flower per plant at 45 and 65 DAT (table-7). At 45 DAT, the maximum number of flowers per plant (24.00) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton/ha+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum no of flowers per plant (9.25). At 65 DAT, the maximum number of flowers per plant (98.80) was obtained from treatment N_2M_3.The control treatment (N_0M_0) gave the minimum no of flowers per plant (20.50) (Appendix IV).

Table 6: The effect of different levels of micronutrients and manure on number of clusters per plant, flower per cluster, flowers per plant of tomato at different days after transplanting.

Treatments	Number of clustesr per plant		Number of flowers per cluster		Number of flowers per plant	
	45 DAT	65 DAT	45 DAT	65 DAT	45 DAT	65 DAT
Micronutrients						
N_0	3.95 c	7.41 d	2.60 c	3.67 d	10.56 d	27.53 d
N_1	4.37 bc	8.32 c	3.08 b	4.73 c	13.63 c	39.51 c
N_2	5.65 a	12.96 a	3.75 a	6.42 a	20.73 a	84.60 a
N_3	4.73 b	10.13 b	3.59 a	5.64 b	17.42 b	57.82 b
CV%	10.45	9.62	10.66	11.43	9.27	9.56
LSD (0.05)	0.45	0.34	0.24	0.10	2.14	2.21
Manure						
M_0	4.36 c	8.63 d	2.69 d	4.42 d	12.03 d	39.81 d
M_1	4.57 b	9.38 c	3.07 c	4.88 c	14.59 c	47.97 c
M_2	4.79 b	10.07 b	3.48 b	5.30 b	17.04 b	56.53 b
M_3	4.99 a	10.73 a	3.78 a	5.86 a	18.68 a	65.15 a
CV%	10.45	9.62	10.66	11.43	9.27	9.56
LSD (0.05)	0.18	0.42	0.20	0.31	1.08	2.57

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha), M_3 - CD+PM (7.5+5 ton/ha)

Table 7: The combined effect of different levels of micronutrients and manure on number of clusters per plant, flower per cluster, flowers per plant of tomato at different days after transplanting

Treatments	Number of clusters per plants		Number of flowers per cluster		Number of flowers per plant	
	45 DAT	65 DAT	45 DAT	65 DAT	45 DAT	65 DAT
N_0M_0	3.80 g	6.80 i	2.35 j	3.00 h	9.25 g	20.50 i
N_0M_1	3.90 g	7.20 ij	2.41 ij	3.45 h	9.55 g	24.75 i
N_0M_2	4.03 fg	7.60 hi	2.60 h-j	4.05 g	10.50 g	31.00 h
N_0M_3	4.10 fg	8.05 gh	3.07 gh	4.20 fg	12.95 e-g	33.90 gh
N_1M_0	4.05 fg	7.70 hi	2.41 ij	4.10 fg	9.74 g	31.75 h
N_1M_1	4.32 e-g	8.00 gh	2.85 hi	4.55 ef	12.34 fg	36.63 fg
N_1M_2	4.53 e-g	8.50 fg	3.34 fg	4.75 e	15.17 d-f	40.00 ef
N_1M_3	4.60 e-g	9.00 ef	3.75 de	5.55 d	17.27 b-d	49.68 d
N_2M_0	5.25 b-d	11.25 cd	3.05 gh	5.75 cd	16.05 d-f	64.50 c
N_2M_1	5.39 a-c	13.05 b	3.60 c-e	6.20 bc	19.30 bc	80.60 b
N_2M_2	5.75 ab	13.50 ab	4.10 ab	6.70 a	23.60 a	94.50 a
N_2M_3	6.21 a	14.05 a	4.25 a	7.05 a	24.00 a	98.80 a
N_3M_0	4.35 e-g	8.75 ef	2.95 gh	4.85 e	13.10 e-g	42.50 e
N_3M_1	4.68 e-g	9.25 e	3.45 d-f	5.35 d	17.20 c-e	49.90 d
N_3M_2	4.85 d-f	10.70 d	3.90 b-d	5.73 d	18.90 bc	60.65 c
N_3M_3	5.00 c-e	11.85 c	4.07 bc	6.65 ab	20.50 ab	78.25 b
CV%	10.45	9.62	10.66	11.43	9.27	9.56
LSD (0.05)	0.90	0.68	0.49	0.46	4.28	4.42

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha),
M_3 - CD+PM (7.5+5 ton/ha)

4.7 Number of fruits per cluster

Significance variation was noted, regarding the number of fruit per cluster as the varied levels of micronutrients (Table 8). The maximum number of fruit per clusters (5.92) was observed from N_2 - Zn+B (4+2 kg/ha) and minimum number of fruit per cluster (4.17) was observed from N_0 (0 kg/ha) treatment which was statistically similar to treatment N_1(4.6) (Appendix IV).

Number of fruit cluster of tomato varied significantly due to the application of different concentrations of manure (Table 8). The maximum number of fruit per cluster (5.32) was observed from M_3 (Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha) which statistically similar to M_2 (5.12) treatment and minimum number fruit per cluster (4.49) treatment was observed in M_0 (0 ton/ha) which was statistically similar to M_1(4.89) treatment (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on number of fruit per cluster (Table-9). The maximum number of fruits per cluster (6.30) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum number of fruits per cluster (3.85) treatment. From the present study it was observed that the combination of micronutrients and organic manure had pronounced effect in this respect. The number of fruits per cluster increased with the increasing micronutrients and manure .however the plants which were grown without micronutrients and manure performed less number of fruits per cluster.This might be due to micronutrients such as, Zinc and Boron increase pollen formation and pollen tube growth . Manure supply available moisture resulting higher number of fruits per cluster. Kumari (2012) reported that boron 100 ppm increase number of fruits per plant (Appendix IV).

4.8 Number of fruits per plant

Significant variation was noted regarding the number of fruits per plant of tomato due to the application of different levels of micronutrients at 45 and 65 DAT (Table 8). AT 45 DAT, the maximum number of fruit per plant (5.61) was observed from N_2 - Zn+B (4+2 kg/ha) and minimum number of fruits per plant (1.18) was observed from N_0 (0 kg/ha) treatment . At 65 DAT, the maximum number of fruits per plant (34.80) was observed from treatment N_2.The minimum number of fruits per plant (17.68) was observed from treatment N_0 .Yadav *et al* (2006), Ejaz *et al* (2011), Naresh (2002) reported similar result. (Appendix IV).

The number of fruits per plant of tomato varied significantly due to the application of different concentrations of manure at 45 and 65 DAT (Table 8). At 45 DAT, the maximum number of fruits per plant (3.79) was observed from M_3 (Cowdung7.5 ton+Poultry manure 5 ton/ha) which was statistically similar to M_2 (3.47) and minimum number fruits per plant (2.65) treatment was observed in M_0 (0 ton/ha) which statistically similar to M_1 (3.07).At 65 DAT, the maximum number of fruit per plant (26.57) was observed from M_3 treatment. The minimum number of fruits per plant (23.90) was observed from treatment M_0 (control). Solaiman *et al.* (2006) reported similar result (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on number of fruit per plant at 45 and 65 DAT (Table 9). At 45 DAT, the maximum number of fruit per plant (6.75) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum number of fruits per plant (0.95). At 65 DAT, the maximum number of fruit per plant (36.80) was obtained from N_2M_3 treatment. The control treatment (N_0M_0) gave the minimum number of fruits per plant (15.70) (Appendix IV).

4.9 Fruit length (cm)

Fruit length of tomato differed significantly due to the application of different levels of micronutrients Table-8. The maximum length of fruit (6.33cm) was observed in N_2 N_2 - Zn+B (4+2 kg/ha) treatment and minimum length of fruit (5.44cm) was observed in N_0 (0 kg/ha) treatment. Yadav *et al* (2004) reported similar result (Appendix IV).

Fruit length of tomato varied significantly due to the application of different levels of manure application (Table 8). The maximum length fruit (6.21cm) was observed from M_3 (Cowdung 7.5 ton+Poultry manure 5 ton/ha) which statistically similar to M_2

(6.02cm) and minimum fruit length (5.60cm) was observed in M_0 (0 ton/ha) which statistically similar to M_1 (5.83cm) treatment (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on fruit length Table 9. The maximum fruit length (6.70cm) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum fruit length (5.15cm) (Appendix IV).

4.10 Fruit breadth (cm)

Fruit breadth of tomato varied significantly due to the application of different levels of micronutrients (Table 8). The maximum breadth of fruit (5.44 cm) was observed in N_2 - Zn+B (4+2 kg/ha) treatment and the minimum breadth of fruit (4.67 cm) was observed from N_0 (0 kg/ha).Yadav *et al.* (2004) reported similar result (Appendix IV). Fruit breadth tomato varied significantly due to the application of different levels of organic manure application (Table 8). The maximum breadth (5.44 cm) was observed from M_3 (Cowdung 7.5 ton+Poultry manure 5 ton/ha) treatment while the minimum fruit breadth (4.76 cm) was observed from M_0 (0 ton/ha) treatment (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on fruit breadth (Table 9). The maximum fruit breadth (5.75cm) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung 7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum fruit breadth (4.45 cm) which was statistically similar to N_0M_2 (4.70) and N_0M_1 (4.46) treatments (Appendix IV).

Table 8 : The effect of different levels of micronutrients and manure on fruit per cluster, per plant, fruit length. fruit breadth of tomato at different days after transplanting

Treatments	Fruit per cluster	Fruits per plant		Fruit length (cm)	Fruit breadth (cm)
		45 DAT	65 DAT		
Micronutrients					
N_0	4.17 c	1.18 d	17.68 d	5.44 d	4.67 d
N_1	4.60 c	2.47 c	21.75 c	5.77 c	5.05 c
N_2	5.92 a	5.61 a	34.80 a	6.33 a	5.44 a
N_3	5.13 b	3.71 b	27.01 b	6.11 b	5.25 b
CV%	12.87	9.37	10.42	8.62	7.54
LSD(0.05)	0.45	0.48	2.02	0.18	0.17
Manure					
M_0	4.49 b	2.65 c	23.90 c	5.60 b	4.76 d
M_1	4.89 b	3.07 bc	25.04 b	5.83 b	5.01 c
M_2	5.12 a	3.47 ab	25.72 b	6.02 a	5.21 b
M_3	5.32 a	3.79 a	26.57 a	6.21 a	5.44 a
CV%	12.87	9.37	10.42	8.62	7.54
LSD(0.05)	0.42	0.43	0.64	0.15	0.14

Means,in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha),
M_3 - CD+PM (7.5+5 ton/ha)

Table 9: The combined effect of different levels of micronutrients and manure on fruit per cluster, per plant, fruit length and fruit breadth of tomato at different days after transplanting

Treatments	Fruit per cluster	Fruit per plant		Fruit length (cm)	Fruit breadth (cm)
		45	65		
N_0M_0	3.85 g	0.95 i	15.70 f	5.15 g	4.45 h
N_0M_1	4.04 g	1.01 i	17.82 ef	5.37 fg	4.56 gh
N_0M_2	4.30 fg	1.39 hi	18.10 ef	5.55 ef	4.70 f-h
N_0M_3	4.50 fg	1.40 hi	19.10 ef	5.70 d-f	5.00 d-f
N_1M_0	4.15 fg	1.99 gh	20.40 de	5.50 e-g	4.70 f-h
N_1M_1	4.60 e-g	2.47 fg	21.75 de	5.70 d-f	4.95 d-f
N_1M_2	4.70 e-g	2.50 fg	22.25 d	5.85 de	5.20 cd
N_1M_3	4.95 d-f	2.95 fg	22.60 cd	6.05 b-d	5.36 bc
N_2M_0	5.43 b-d	4.65 cd	33.18 b	5.95 cd	5.05 c-e
N_2M_1	5.89 ab	5.10 bc	33.94 b	6.27 bc	5.39 bc
N_2M_2	6.08 a	5.95 ab	35.30 a	6.40 ab	5.60 ab
N_2M_3	6.30 a	6.75 a	36.80 a	6.70 a	5.75 a
N_3M_0	4.53 e-g	3.04 ef	26.35 bc	5.80 de	4.85 e-g
N_3M_1	5.03 d-f	3.70 de	26.65 c	6.00 cd	5.17 c-e
N_3M_2	5.41 c-e	4.05 d	27.25 c	6.28 bc	5.35 bc
N_3M_3	5.55 bc	4.08 d	27.80 c	6.39 ab	5.65 ab
CV%	12.87	9.37	10.42	8.62	7.54
LSD (0.05)	0.90	0.97	2.04	0.36	0.34

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha), M_3 - CD+PM (7.5+5 ton/ha)

4.11 Length of fruit cavity (cm)

Length of fruit cavity of tomato varied significantly due to the application of different levels of micronutrients (Table 10). The maximum length of fruit cavity (4.35 cm) was observed in N_2 - Zn+B (4+2 kg/ha) and minimum length of fruit cavity (3.23 cm) was observed in N_0 (0 kg/ha) treatment (Appendix IV).

Fruit cavity length of tomato varied significantly due to the application of different concentrations of manure (Table 10). The maximum length of fruit cavity (4.22 cm) was observed from M_3 (Cowdung 7.5 ton+Poultry manure 5 ton/ha) and minimum fruit cavity length (3.42 cm) was observed from M_0 (0 ton/ha) (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on fruit cavity length (Table 11). The maximum fruit cavity length (4.75 cm) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum fruit cavity length (2.55 cm) (Appendix IV).

4.12 Breadth of fruit cavity (cm)

Breadth of fruit cavity of tomato varied significantly due to the application of different levels of micronutrients (Table 10). The maximum breadth of fruit cavity (3.41 cm) was observed from N_2 - Zn+B (4+2 kg/ha) and minimum length of fruit cavity (2.68 cm) was observed from N_0 (0 kg/ha) treatment (Appendix IV).

Breadth of fruit cavity of tomato varied significantly due to the application of different concentrations of manure (Table 10). The maximum breadth of fruit cavity (3.33 cm) was observed from M_3 (Cowdung 7.5 ton+Poultry manure 5 ton/ha) and minimum fruit cavity breadth (2.70 cm) was observed from M_0 (0 ton/ha) (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on fruit cavity breadth (Table -11). The maximum fruit cavity breadth (3.80 cm) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung 7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the minimum fruit cavity length (2.45 cm) (Appendix IV).

4.13 Individual fruit weight (g)

Individual Fruit weight of tomato varied significantly due to the application of different levels of micronutrients (Table 10). The highest weight of fruit (104.71 g) was observed in N_2 - Zn+B (4+2 kg/ha) treatment while the lowest weight of fruit (85.76 g) was observed in N_0 (0 kg/ha) treatment. Oyinlola and Chude (2004) reported similar findings. The increase in individual weight of fruit might be due to optimum level of micronutrients improved plant physiological activity like photosynthesis and translocation of food materials of fruits. Dube *et al* .(2004) reported that , the soil application of zinc sulphate and borax@ 10 and 20 kg/ha, respectively give highest tomato yield (Appendix IV).

Individual fruit weight of tomato varied significantly due to the application of different concentrations of manure application (table -10). The highest weight of fruit (105.00 g) was observed in M_3 (Cowdung 7.5 ton +Poultry manure 5 ton/ha) and lowest fruit weight (86.74 g) was observed from M_0 (0 ton/ha) treatment (Appendix IV).

The individual fruit weight was significantly affected as to the combined effect of micronutrients and manure application (Table 11). The highest fruit weight (117.40 g) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) treatment and control treatment (N_0M_0) gave the lowest fruit weight (78.95 g) (Appendix IV).

4.14 Brix%

Brix% of tomato varied significantly due to the application of different levels of micronutrients (Table 10). The highest Brix% of fruit (5.86) was observed from N_2 - Zn+B (4+2 kg/ha) and lowest brix% of fruit (3.61) was observed from N_0 (0 kg/ha) treatment (Appendix IV).

Brix% of tomato varied significantly due to the application of different levels of manure (Table 10). The highest brix% of fruit (6.55) was observed in M_3 (Cowdung7.5 ton+Poultry manure 5 ton/ha) and lowest brix% fruit (2.88) was observed from M_0 (0 ton/ha) (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on brix% of fruit (Table 11). The highest brix% of fruit (8.60) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the lowest brix% of fruit (2.55) (Appendix IV).

4.15 Dry matter contents in fruit (%)

Diverse variation was seen as to the dry matter content of tomato due to the application of different levels of micronutrients (Table 10). The highest dry matter of fruit (5.95) was observed from N_2 - Zn+B (4+2 kg/ha) treatment and lowest dry matter of fruit (2.31) was observed from N_0 (0 kg/ha) treatment. Salam *et al.* (2010) reported similar result (Appendix IV).

Dry matter content of tomato varied significantly due to the application of different concentrations of manure (Table 10). The highest dry matter of fruit (4.77) was observed in M_3 (Cowdung 7.5 ton+Poultry manure 5 ton/ha) and lowest dry matter of fruit (3.42) was observed from M_0 (0 ton/ha) treatment.. Akande and Adediran(2004) reported similar finding (Appendix IV).

The combined effect of micronutrients and manure showed statistically significant variation on dry matter of fruit (Table 11). The highest dry matter of fruit (7.00) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the lowest dry matter of fruit (2.05) (Appendix IV).

Table10: The effect of different levels of micronutrients and manure on cavity length, breadth, individual fruit weight(g), brix% and dry matter of fruit % of tomato at different days after transplanting

Treatments	Cavity length (cm)	Cavity breadth (cm)	Individual fruit weight (g)	Brix %	Dry matter of fruit %
Micronutrients					
N_0	3.23 d	2.68 c	85.76 d	3.61 c	2.31 d
N_1	3.73 c	2.97 b	92.04 c	4.42 b	3.24 c
N_2	4.35 a	3.41 a	104.71 a	5.86 a	5.95 a
N_3	4.12 b	3.07 b	100.66 b	5.45 a	4.85 b
CV%	5.67	8.76	9.31	7.17	11.74
LSD(0.05)	0.15	0.20	2.01	0.46	0.15
Manure					
M_0	3.42 d	2.70 c	86.74 d	2.88 c	3.42 d
M_1	3.76 c	2.95 b	92.48 c	3.68 b	3.80 c
M_2	4.03 b	3.15 ab	98.96 b	6.22 a	4.36 b
M_3	4.22 a	3.33 a	105.00 a	6.55 a	4.77 a
CV%	5.67	8.76	9.31	7.17	11.74
LSD(0.05)	0.17	0.13	2.67	0.43	0.22

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha, N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha), N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha),
M_3 - CD+PM (7.5+5 ton/ha)

Table 11: The combined effect of different levels of micronutrients and manure on cavity length , breadth, individual fruit weight(g), brix% and dry matter of fruit % of tomato at different days after transplanting.

Treatments	Cavity Length(cm)	Cavity Breadth(cm)	Individual fruit weight (gm)	Brix%	Dry matter of fruit %
N_0M_0	2.55 k	2.45 g	78.95 j	2.55 h	2.05 k
N_0M_1	3.20 j	2.52 g	83.00 i	3.50 e-g	2.18 jk
N_0M_2	3.55 hi	2.80 e-g	87.45 gh	4.05 c-e	2.37 ij
N_0M_3	3.65 hi	2.95 d-f	93.65 ef	4.35 cd	2.64 hi
N_1M_0	3.45 ij	2.65 fg	84.20 hi	2.70 gh	2.79 h
N_1M_1	3.65 hi	2.85 e-g	90.15 fg	3.75 d-f	2.95 h
N_1M_2	3.80 f-h	3.10 c-e	94.85 e	4.75 c	3.40 g
N_1M_3	4.05 d-f	3.30 bc	98.95 d	6.50 b	3.85 f
N_2M_0	3.95 e-g	3.00 d-ef	93.70 ef	3.05 f-h	5.00 d
N_2M_1	4.15 de	3.35 bc	99.95 d	3.75 d-f	5.60 c
N_2M_2	4.55 ab	3.50 ab	107.80 bc	8.05 a	6.20 b
N_2M_3	4.75 a	3.80 a	117.40 a	8.60 a	7.00 a
N_3M_0	3.75 gh	2.70 e-g	90.10 fg	3.25 f-h	3.85 f
N_3M_1	4.05 d-f	3.10 c-e	96.80 de	3.75 d-f	4.50 e
N_3M_2	4.25 cd	3.20 b-d	105.75 c	8.00 a	5.47 c
N_3M_3	4.45 bc	3.30 bc	110.00 b	6.75 b	5.60 c
CV%	5.67	8.76	9.31	7.17	11.74
LSD (0.05)	0.28	0.40	2.03	0.93	0.31

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha),
M_3 - CD+PM (7.5+5 ton/ha)

4.16. Fruit yield per plot (kg)

The yield of fruits per plot different markedly as to different levels of micronutrients (Fig 6). The highest yield/plot (20.09 kg) was observed from N_2 - Zn+B (4+2 kg/ha) and lowest yield/plot (7.70 kg) was observed from N_0 (0 kg/ha) treatment. Yadav *et al.* (2006) reported similar result (Appendix IV).

Fruit yield per plot of tomato varied significantly due to the application of different levels of manure (Fig 7). The highest yield/plot (15.23 kg) was observed from M_3 (Cowdung 7.5 ton+Poultry manure 5 ton/ha) and lowest yield/plot (11.95kg) was observed from M_0 (0 ton/ha) treatment. (Appendix IV).

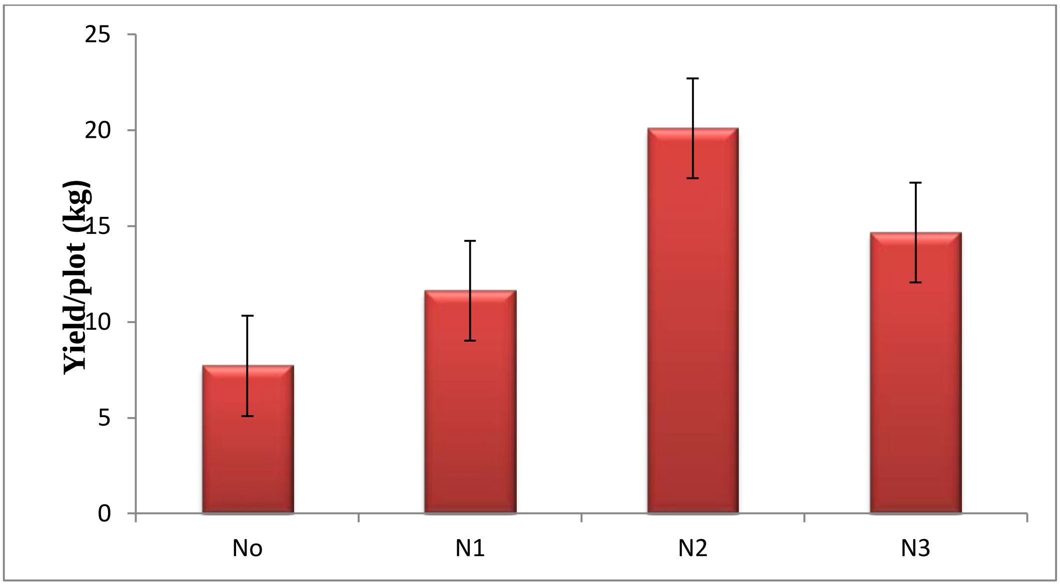


Fig 6: Effect of different levels of micronutrients on the yield per plot of tomato

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) ,
N_3– Zn+B (6+2.5 kg/ha)

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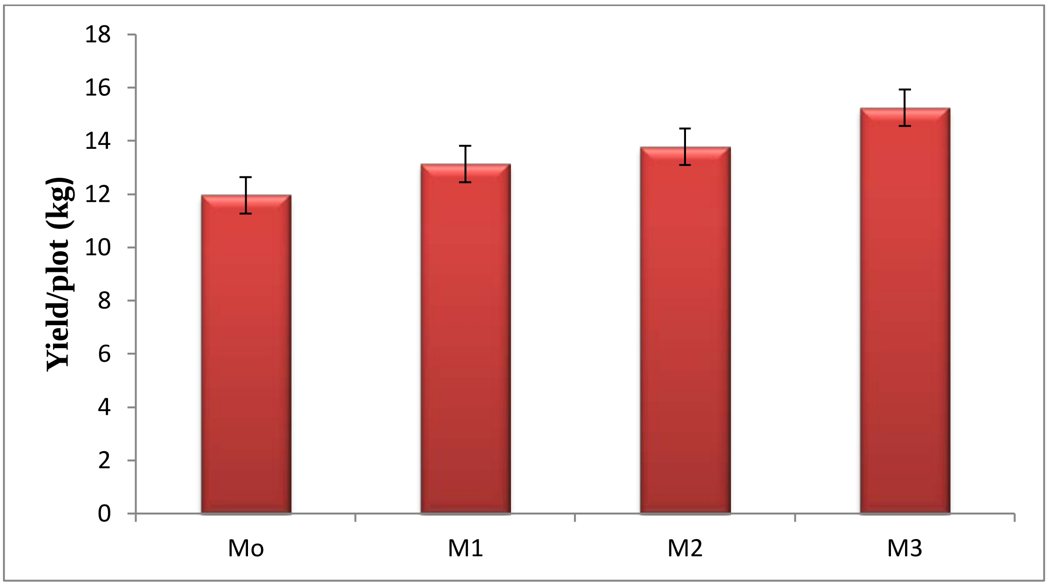

Fig 7: Effect of different levels of manure on the yield per plot of tomato

Here, M_0=control, M_1=Cowdung (15 ton/ha),

M_2=Poultry manure (10 ton/ha) , M_3=CD+PM (7.5+5 ton/ha)

The combined effect micronutrients and manure showed statistically significant variation on yield/plot (Table-12). The highest yield /plot (22.90 kg) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure ton/ha) ,on the other hand, control treatment (N_0M_0) gave the lowest yield/plot (7.38 kg). Fruit yield per plant significantly affected as to combindly application of micronutrients and manure. It has observed that the minimum fruit yield per plant was found from without micronutrients and organic manure. The possible reason for higher fruit yield per plant might be due to higher number of fruits per plant , bigger fruit size and fruit weight . Dube *et al.* (2004) found the highest tomato yield with the soil application of micronutrient (Appendix IV).

4.17 Fruit yield per hectare

Yield of tomato per hectare varied significantly due to the application of different levels of micronutrients(Fig 8) . The highest yield/hectare (66.96 ton/ha) was observed from N_2 - Zn+B (4+2 kg/ha) and lowest yield/hectare (25.69 ton/ha) was observed from N_0

(0 kg/ha) treatment . Gurmani *et al.* (2012) and Hossein (2008) reported similar result (Appendix IV).

Fruit yield of tomato per hectare varied significantly due to the application of different levels of manure (Fig 9) .The highest yield/hectare (50.78 ton/ha) was observed from M_3 (Cowdung7.5+Poultry manure 5 ton/ha) and lowest yield/hectare (39.86 ton/ha) was observed from M_0 (0 ton/ha) . Ahammad *et al.*(1999) reported similar result (Appendix IV).

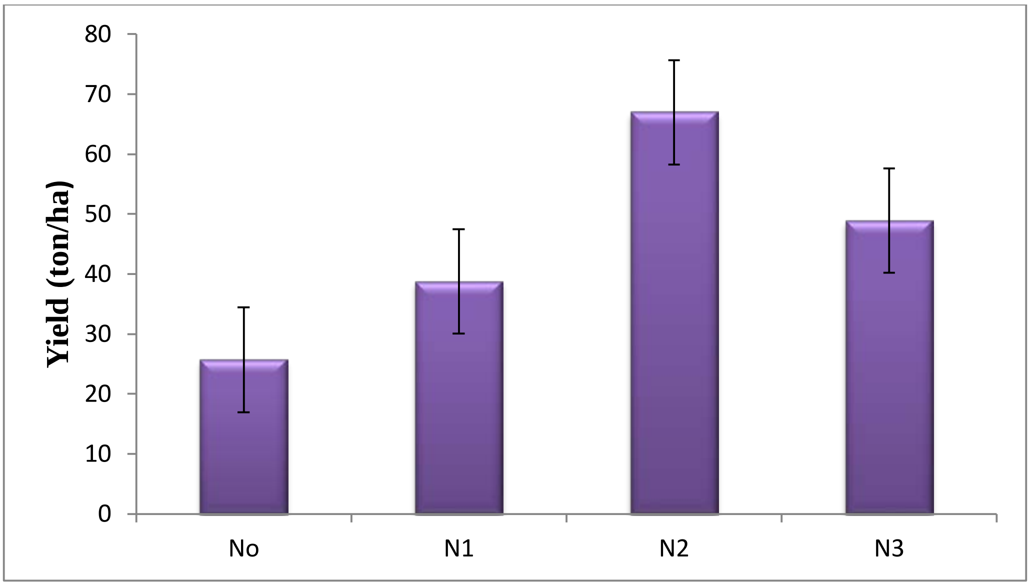

Fig 8: Effect of different levels of Micronutrients on the yield of tomato

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

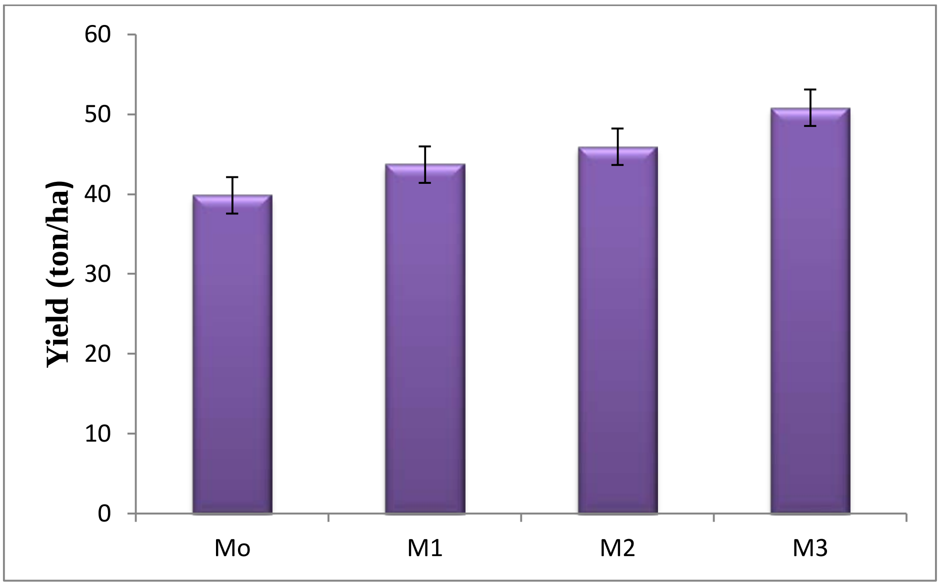

Fig 9: Effect of different levels of manure on the yield of tomato

Here,M_0=control, M_1=Cowdung (15 ton/ha),
M_2=Poultry manure (10 ton/ha) , M_3=CD+PM (7.5+5 ton/ha)

The Combined effect of micronutrients and manure showed statistically significant variation on yield/ha (Table 12). The highest yield /hectare (76.33 ton/ha) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5+Poultry manure 5 ton/ha) and control treatment (N_0M_0) gave the lowest yield/hectare (24.60 ton/ha) (Appendix IV).

Table 12: The combined effect of different levels of micronutrients and manure on yield per plot and yield ton per hectare of tomato at different days after transplanting.

Treatments	Yield per plot (kg)	Yield ton per ha
N_0M_0	7.38 k	24.60 k
N_0M_1	7.55 j	25.16 j
N_0M_2	7.75 j	25.83 j
N_0M_3	8.15 i	27.16 j
N_1M_0	9.25 i	30.85 i
N_1M_1	11.65 h	38.81 h
N_1M_2	12.45 gh	41.50 gh
N_1M_3	13.15 fg	43.83 fg
N_2M_0	18.15 c	60.49 c
N_2M_1	19.13 c	63.76 c
N_2M_2	20.18 b	67.28 b
N_2M_3	22.90 a	76.33 a
N_3M_0	13.05 g	43.49 g
N_3M_1	14.15 ef	47.16 ef
N_3M_2	14.70 e	49.00 e
N_3M_3	16.75 d	55.83 d
CV%	12.87	12.43
LSD (0.05)	1.01	2.39

Means, in a column followed by same letter do not differ significantly at 5% level

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)

M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha),
M_3 - CD+PM (7.5+5 ton/ha)

4.18 Economic analysis

Input cost for land preparation, seed cost, fertilizer & manure cost and man power required for all the operations from transplanting of seedling to harvesting of tomato were recorded for unit plot and converted into cost per hectare. Prices of tomato were considered in market rate basis. The economic analysis was done to find out the gross and net return and the benefit cost ratio in the present experiment and presented under following headings-

4.18.1 Gross return

In the combination of micronutrients and manure showed different gross return under the trial. The highest gross return (Tk. 725136/ha) was obtained from N_2M_3- Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) On the other hand, the lowest gross return (Tk. 233700/ha) was calculated from control treatment (N_0M_0) . (Table 13).

4.18.2 Net return

In case of net return, different treatment combinations showed different results. The highest (Tk. 499128/ha) net return were obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5+Poultry manure 5 ton/ha) . The lowest net return (Tk. 8989/ha) was obtained from control treatment (N_0M_0) (Table 13).

4.18.3 Benefit cost ratio (BCR)

The combination of micronutrients and manure for benefit cost ratio was different in all treatment combination (Table 13). The highest benefit cost ratio (3.2) was obtained from N_2M_3 - Zn+B (4+2 kg/ha) with Cowdung7.5 ton+Poultry manure 5 ton/ha) and whereas the lowest benefit cost ratio (1.04) was obtained from control treatment (N_0M_0).From the economic point of view, it is apparent that N_2M_3 treatment combination Zn+B (4+2 kg/ha) with Cowdung7.5+Poultry manure 5 ton/ha) was the most profitable than rest of the treatment combinations under the study.

Table 13: Cost and return of tomato cultivation as influenced by micronutrients and organic manure

Treatments	Cost of production (Tk./ha)	Marketable Yield of tomato (t/ha)	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
N_0M_0	224711	24.60	233700	8989	1.04
N_0M_1	226499	25.16	239020	12521	1.05
N_0M_2	207424	25.83	245385	37961	1.18
N_0M_3	216961	27.16	258020	41059	1.25
N_1M_0	192812	30.85	293075	100363	1.52
N_1M_1	231322	38.81	368695	137373	1.59
N_1M_2	212247	41.50	394250	182003	1.85
N_1M_3	197259	43.83	416385	218856	2.11
N_2M_0	229862	60.49	574655	344793	2.50
N_2M_1	235546	63.76	605720	370174	2.57
N_2M_2	216471	67.28	639160	422689	2.95
N_2M_3	226008	76.33	725136	499128	3.20
N_3M_0	229530	43.49	413155	183625	1.80
N_3M_1	239769	47.16	448020	208251	1.86
N_3M_2	220694	49.00	465500	244806	2.10
N_3M_3	205707	55.83	530385	324678	2.57

Here, N_0-0 kg/ha , N_1 –Zn+B (2+1.5 kg/ha), N_2 – Zn+B (4+2 kg/ha) , N_3– Zn+B (6+2.5 kg/ha)
M_0 - 0 ton/ha, M_1 - Cowdung (15 ton/ha), M_2 - Poultry manure (10 ton/ha),
M_3 - CD+PM (7.5+5 ton/ha)

Total cost of production was done in details according to the procedure of krishitattik Fasaler utpadan O unnayan(in Bengali).1989 by Alam *et al.*(1984)

- Sale of marketable tomato @ Tk. 9,500/ton
- Gross return= Marketable yield × Tk/ton
- Net income=Gross income-total cost of production
- BCR=Gross return ÷ cost of production

CHAPTER V

SUMMARY AND CONCLUSION

This experiment was conducted in the Horticultural Farm of Sher-e-Bangla Agricultural University Dhaka 1207, Tejgaon series under (AEZ No.28) from October 2017 to March 2018, to study effect of micronutrients with manure on growth and yield of tomato. The texture of soil was silty clay loam in having pH 5.6 and organic carbon content of 0.45%. Four levels of micronutrient (0 kg/ha,
Zn+B (2+1.5 kg/ha), Zn+B (4+2 kg/ha), Zn+B (6+2.5 kg/ha,) and four levels of organic manure (0 ton/ha, Cowdung 15 ton/ha, Poultry manure 10 ton/ha, Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha) were used in the study and 16 treatment combinations. The experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 1.5 m × 2 m which accommodated 12 plants. The crop was harvested up to March, 2018.

Data on growth and yield contributing parameters were recorded and the collected data were statistically analyzed to evaluate the treatment effects. The summary of the results has been presented in this chapter.

At 65 days after transplantation micronutrients had a significant effect on plant height. Plants grown with Zn+B (4+2 kg/ha) showed maximum plant height (95.60 cm) while the shortest (82.86 cm) plant was observed from 0 kg/ha micronutrient (control). In case of manure, the highest plant (93.28 cm) was produced by Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha and the shortest plant (85.77 cm) was shown by control plant (0 kg/ha manure). The treatment combinations demonstrated significant variation in plant height at 25, 45 and 65 DAT. At 65 DAT, the highest plant (100.50 cm) was produced by Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha whereas, the shortest (81.25 cm) was shown from treatment combination of 0 kg/ha micronutrient and 0 ton/ha organic manure.

At 65 days after transplantation micronutrients had a significant effect on number of leaves per plant. Plants grown with Zn+B (4+2 kg/ha) showed maximum leaves number (33.17) while the minimum (27.58) plant was observed from 0 kg/ha micronutrient (control). In case of manure, the maximum leaves number (33.51 cm) was produced by

Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha and the minimum number of leaves (27.91) was shown by control plant (0 kg/ha organic manure). The treatment combinations demonstrated significant variation in plant height at 25, 45 and 65 DAT. At 65 DAT, the maximum leaves number (36.80) was produced by Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha whereas, the minimum (25.50) was shown from treatment combination of 0 kg/ha micronutrient and 0 ton/ha manure. At 65 days after transplantation micronutrients had a significant effect on number of branch per plant. Plants grown with Zn+B (4+2 kg/ha) showed maximum branch number (6.51) while the minimum (4.46) plant was observed from 0 kg/ha micronutrients (control). In case of manure, the maximum branch number (5.89) was produced by Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha and the minimum branch number (4.78) was shown by control plant (0 kg/ha organic manure). The treatment combinations demonstrated significant variation in plant height at 45 and 65 DAT. At 65 DAT, the maximum branch number (7.25) was produced by Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha whereas, the minimum (4.10) was shown from treatment combination of 0 kg/ha micronutrients and 0 ton/ha manure.

Significant variation was observed in respect of the number of flower clusters per plant, flowers per clusters and flowers per plant as influenced by different levels of micronutrients and manure. At 65 DAT, the highest values of these characters were obtained from Zn+B (4+2 kg/ha) micronutrients and the lowest were obtained from the control (0 kg/ha) micronutrient treatment. In case of manure application the maximum values of these characters were found from Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha but the minimum values were obtained from 0 ton/ha manure. On the other hand, in case of interaction effect of micronutrients and manure the highest number of flower clusters per plant (14.05), flowers per cluster (7.05) and flowers per plant (98.80) were produced by the treatment combination of Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha, the lowest number of flower clusters per plant (6.80), flowers per cluster (3.00) and flowers per plant (20.50) were produced by the control treatment (0 kg/ha micronutrients with 0 ton/ha organic manure) at 65 DAT.

At 65 DAT, different levels of micronutrients and manure showed significant effect on number of fruits per cluster , fruits per plant ,fruit length, fruit breadth. The highest values of these characters were obtained from Zn+B (4+2 kg/ha) and the lowest were obtained from the control (0 kg/ha) treatment. In case of micronutrients application the highest values of these characters were obtained from the Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha while the lowest values were obtained from 0 ton/ha. In case of interaction effect of micronutrients and manure the highest number of fruits per cluster (6.30), fruits per plant (36.80), fruit length (6.70 cm), fruit breadth (5.75 cm) were produced by the treatment combination of Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha . On the other hand, the lowest number of fruit per cluster (3.85), fruits per plant (15.70) , fruit length (5.15cm), fruit breadth (4.45 cm) were produced by the control treatment (0 kg/ha micronutrients with 0 ton/ha manure) .

Different levels of micronutrients and manure showed significant effect on number of fruits cavity length, fruits cavity breadth, individual fruit weight, brix %, dry matter of fruits. The highest values of these characters were obtained from Zn+B (4+2 kg/ha) and the lowest were obtained from the control (0 kg/ha) treatment. In case of micronutrients application the highest values of these characters were obtained from the Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha while the lowest values were obtained from 0 ton/ha. In case of interaction effect of micronutrients and manure the highest number of fruit cavity length (4.75 cm), cavity breadth (3.80 cm),fruit weight (117.40), brix%(8.60) , dry matter (7.00) were produced by the treatment combination of Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha. On the other hand, the lowest number of fruit cavity length (2.55 cm), cavity breadth (2.45cm), fruit weight (78.95),brix% (2.55), dry matter(2.05) were produced by the treatment combination (0 kg/ha micronutrients with 0 ton/ha manure) .

Different levels of micronutrients and manure showed significant effect on yield per plot, yield ton/ha. The highest values of these characters were obtained from Zn+B (4+2 kg/ha) and the lowest were obtained from the control (0 kg/ha) treatment. In case of micronutrients application the highest values of these characters were obtained from the Cowdung 7.5 ton/ha+Poultry manure 5 ton/ha while the lowest values were obtained from 0 ton/ha. In case of interaction effect of micronutrients and manure the highest number of yield/plot (22.90 kg), yield ton/ha (76.33) were produced by the treatment combination of Zn+B (4+2 kg/ha) with Cowdung 7.5 ton/ha + Poultry manure 5 ton/ha. On the other hand, the lowest number of yield/plot (7.38 kg), yield ton/ha (24.60) were produced by the treatment combination (0 kg/ha micronutrients with 0 ton/ha manure) .

The highest gross return (Tk. 725136/ha), net return (Tk. 499128/ha), benefit cost ratio (3.2), was recorded from the treatment combination of N_2M_{3-} Zn+B (4+2 kg/ha) with Cowdung7.5+Poultry manure 5 ton/ha) whereas, the lowest gross return (Tk. 233700/ha), net return (Tk. 8989/ha) and benefit cost ratio (1.04) was recorded from the treatment combination of 0 kg/ha micronutrients and 0 ton/ha manure.

The overall results obtained from the study facilitated to draw the following conclusions:

- A combination of 4 kg zinc and 2 kg boron per hectare demonstrated was better result in respect of plant growth and fruit yield of tomato.
- Organic manure played an important role on the growth, fruit yield of tomato. In respect of all the yield attributes and yield, cowdung 7.5 ton/ha+ poultry manure 5ton/ha showed better performance.
- Based on the findings of the study further investigation may be needed to observe in different agroecological zones before more conformation of the results.

REFERENCES

Adediran, J.A., Taiwo, L.B. and Sobulo, R.A. 2003. Organic wastes and their effect on tomato (*Lycopersicon esculentum*) yield. *Afr. Soils* **33**: 99-116.

Adeli, A., Tewolde, H., Sistani, K.R. and Rowe, D.E. 2009. Broiler litter fertilization and cropping system impacts on soil properties. **110**: 1304-1310 .

Aditya, T. L., Rahman, L., Alam M. S. and Ghoseh , A. K. 1997. Correlation and path co-efficient analysis in tomato. Bangladesh J. Agril. Sci., 26(1):119-122.

Ahammad, K., Ali M.., Islam M.S. and Karim A.I.M.S.1999. Optimization of organic residues and urea for pot culture of tomato. Ann. *Bangladesh Agric*.,**9**(2): 99104.

Ahmed, K. 1995. Phul Phal O Shak-Sabjee. 5th Edition, 414 Senpara, Parbata, Mirpur, Dhaka, Bangladesh .

Akanbi, W.B., Akande, M.O. and Adediran, J.A. 2005. Suitability of composted maize straw and mineral N fertilizer for tomato production**. 11**(1): 57-65.

Akande, M.O., Adediran, J.A. 2004. Effects of terralyt plus fertilizer on growth nutrients uptake and dry matter yield of two vegetable crops. *Moor J. of Agric. Res.* **5**:12107.Aka.

Aknni, D.I. and Ojeniyi, S.O.2007. Effect of Different Levels of Poultry Manure on Soil Physical Properties, Nutrients Status, Growth and Yield of Tomato (*Lycopersicon esculentum*). *Res. J. Agron.* Vol., **1**:((1-4).

Alam, M.S., Iqbal, T.M.T., Ami, M. and Gaffar, M.A. (1989). Kamishitattic Fasaler Utpadan O Unnayan (In Bengali). T. M. Jubair Bin Iqbal, Sirajganj. pp. 231-239.

Alloway, B.J. 2008. Fundamental aspects of zinc in soils and plants. Zinc in Soils and crop nutrition. 2nd Edi, Published by IZA and IFA, Brussels, Belgium and Paris, France, pp: 30-52.

Alpaslan, M. and Gunes, A. 2001. Interaction effects of boron and salinity stress on the growth, membrane permeability and mineral composition of tomato and cucumber plants. Plant and Soil. **236**(1): 123-128.

Aluko, O.B.and Oyedele, D.J. 2005. Influence of organic incorporation on changes in selected soil physical properties during drying of a Nigerian alfisols. *J. of Applied Sci.* **5**:357-362.

Amrachandra, S. and Verma, B.K. 2003. Effect of boron and calcium on plant growth and seed yield of tomato. *JNKVV Res. J. of India*. **37**(2): 13-14.

Ayeni ,L.S. 2010. Integration of cocoa pod ash, poultry manure and NPK 15:15:15 for soil management – Incubation study. Continental J. *Agron. Wilolud online Journals***. 2**: 25-30.

Ayeni, L.S.,Adetunji, M.T., Ojeniyi, S.O., Ewulo, B.S. and Adeyemo, A.J. 2008. Comparative and cumulative effect of cocoa pod husk ash and poultry manure on soil and nutrient contents and yield of maize. *American-Eurasian J. of sustain. Agric.* **2**(1): 92 -97.

Babafoly, J.O.1989. Effect of some organic manure on nematodes in tomato cultivatuion. *Pakistan. J. Nematol*., **7**(1): 39-46.

BARC.1997. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council. Farmgate, Dhaka-1215. pp. 1-72.

BARI. 2014. Krishi Projukti Hatboi, Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. p. 304.

BBS. 2016. Yearbook of Agricultural Statistics-2015 (27thSeries). July 2016. Ministry of Planning Government of the People's Republic of Bangladesh. 297.

BBS.2015.Year book of Agricultural statistics of Bangladesh.2015 27th ed.Bangladesh Bureau of statistics. Statistics Division, Ministry of planning. Govt of the people Republic of Bangladesh.P-304.

Bhatt, L. and Srivastava, B.K. 2005. Effect of foliar application of micronutrients on nutrients uptake in tomato. Veg. Sci. **32**(2): 158-161.

Blevins, D.G., Reinbott, T.M. and Boyce, P.J. 1993. Foliar fertilization of soybeans with boron and magnesium. Plant Physiol. p. 1-6.

Bose, T. K. and Som, M. G. 1990. Vegetable Crops in India. Naya Prakash, Calcutta Six, India. pp. 687-691.

Bose, U.S. and Tripathi, S.K.1996. Effect of micronutrients on growth, yield and quality of tomato cv. Pusa Ruby. *Crop. Res.* Hisar. **12**(1): 61-64

Bose, V. S. and Triphathi, S. K.1996. Effect of micronutrient on growth and yield of cauliflower. Ann. Agric. Res., **18**: 391-392.

Brown, J.E. 1995. Comparison of broiler litter and commercial fertilizer on production of tomato.

Cardozo, V.P., Pizetta, N.V. and Teixeira, N.T. 2001. Manuring of foliate with calcium and boron in the culture of the tomato (*Lycopersicon esculentum* Mill*)* cv.Debora Max. *Ecossistema*. **26**(1): 39-41.

Davis, J.M., Sanders, D.C., Nelson, P.V., Lengnick, L. and Sperry, W.J. 2003. Boron improve growth, yield, and nutrient content of tomato. *J. Americ. Society of Hort. Sci.* **128** (3): 441- 446.

Ditya, T. L., Rahman, L., Alam M. S. and Ghoseh , A. K.1997. Correlation and path co-efficient analysis in tomato. *Bangladesh J. Agril. Sci*., **26**(1):119-122.

Dube, B. K., Pratima,S. and Chatterjee,C. 2003. Effects of zinc on the yield and quality of tomato. *Indian J. Hort. India***. 60** (l): 59-63.

Dube, B. K., S. Pratima and C. Chatterjee. 2004. Effects of boron and zinc on the yield and quality of tomato. Indian J. Hort. **61**(1): 48-52. Hunter, A. H. 1980.

Dumitrescu, M.1975. Composts as organic manures of high fertilizing value. Gard. Via. Liv., 14(10): 16-22. [Cited from Hort. Abst., **36**(3): 4905,1966].

Ejaz, M., Rahman, S., Waqas, R., Manan, A., Imran, M. and Bukhari, M.A. 2011. Combined efficacy of macro-nutrients and micro-nutrients as foliar application on growth and yield of tomato. *Int. J. Agro Vet. & Medic. Sci.* **5**(3): 327-335.

Ewulo, B. S., Ojeniyi.S. O. and Akanni, D. A.2008. Effect of poultry manure on selected soil physical and chemical properties, growth, yield and nutrient status of tomato. *African Journal of Agricultural Research* Vol. **3** (9), pp. 612-616,

Ewulo, B.S., 2005. Effect of poultry and cattle manure on sandy clay loam soil. J. Anim. Vet. Sci., 4: 839-841.

FAO. 2002. FAO Production Year Book. Food and Agricultural Organization of the United Nations, Rome 00100, Italy.

Farzaneh, N., Ghochin, A. and Majd, K.H. 2011. The effect of nitrogen and boron on growth, yield and concentration of some nutrient elements of tomato. *J. Sci. & Technol. of Greenhouse Cult.***1**(2): 19-29.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research (2nd Edn.). Int. Rice Res. John Willey and Sons, *Int. Sci. Singapore*. **3**:28-92.

Gurmani, A.R., Andaleep, R. and Khan, S. 2012. Biochemical attributes, plant growth and yield of tomato as affected by boron application rates. *J. Agric. Res.* **48**(2):451-455.

Hallorans, J. M., Munoz M.A. and Colberg O. 1993. Effect of chicken manure on chemical properties of a Mollisol and tomato production. *J. Agric*., **77**(3-4): 181191.

Hossain, M.E., Alam, M.J., Hakim, M.A., Amanullah, A.S.M., Ahsanullah, A.S.M. 2010. An Assessment of Physicochemical Properties of Some Tomato Genotypes and Varieties Grown At Rangpur. *Bangladesh Res. Pub. J*., **4**(3): 135-243.

Hossain, M.M. and Mazid, F.Z. 1997. Further studies on the use of water hyacinth (Eichhornia) compost and cowdung manure as organic fertilizer. Bangladesh. *J.Sci. Ind. Res*., **32**(3);477-479.

Hossein, M. 2008. Effect of zinc and boron on the growth and yield of tomato. M.S. Thesis, Department of Agricultural Chemistry, BAU, Mymensingh .

Islam, J. K. and Noor, S. P.1982. Deficiency of soil nutrient is now considered as one of the major constraints to successful upland crop production in Bangladesh. *Pakistan J. Sci. Res*., **34** (3-4): 113-119.

Jyolsna, V.K. and Mathew, U. 2008. Boron nutrition of tomato grown in the laterite soils of southern Kerala. *J. Tropic. Agric.* **46**(1-2):73–75.

Kamruzzaman, A.H.M. 2007. Effect of B on the yield of mustard. M.S. Thesis. Department of Crop Botany, BAU, Mymensingh.

Kumari, S. 2012. Effect of micronutrients on quality of fruit and seed in tomato (*solanum licopersicum* L.).*International journal of farm sciences*;**2**(1):43-46.

Mac Gillivary, K.1961. Nutritional status of winter tomato. Vegetable Science. **16**(2): 119-124.

Magalhaes, J.R. I., Solwa Dc,C.E.W.L and Monnerat. P.H.1980. Levels and methods of boron application in tomatoes. Pesquisa Agropecuria Brasilesia **10** (2) : 153-157 [Cited from Hort. Abstr. **50**(4): 2031, 19811.

Mahimairaja, S., Bolan, N.S. and Hedley, M.J. (1995) Agronomic effectiveness of poultry manure composts. Communications in Soil Science and Plant Analysis 26: 18431861.

Mallick, M.F.R. and Muthukrishnan, C.R.1980. Effect of micro nutrients on tomato (*Lycopersicon esculentum* Mill.), Effect on flowering, fruit-set and yield. South Indian Hort. **28** (1): 14-20.

Mehdizadeh, M., Ebrahim, I.D., Naseri-Rad ,H. and Tobeh, A. 2013. Growth and yield of tomato (*Lycopersicon esculentum*Mill.) as influenced by different organic fertilizers. *Intl J. Agron. and Plant Production*. **4** (4):734-738.

Nada, K., Nakai, H., Yoshida, H., Isozaki, M. and Hiratsuka, S. 2010. The effects of excess boron on growth, photosynthesis and fruit maturity of tomato [*Lycopersicon esculentum*] grown in hydroponic culture. *J. Hort. Res.* **9**(2):203208 .

Naresh, B. 2002. Response of foliar application of boron on vegetative growth, fruit yield and quality of tomato var. Pusa-Ruby. *Indian J. of Hilly Farming*. **15(**1):109-112.

Nonnecke, I.B.L.1989. Vegetable Production. Avi Book Publishers. New York, USA. pp.200-229.

Olaniyi, J.O. and Ajibola, A.T.2008. Effects of inorganic and organic fertilizers application on the growth, fruit yield and quality of tomato (*Lycopersicon lycopersicum*).*Journal of Vegetable Crop Production* .**1**(1): 53-62.

Opena, R.T., Kuo, C.C. and Yoon, J.Y.1988. Breeding and Seed Production of Chinese cabbage in the Tropics and Subtropics. T Ozbun, L., ech. Bul., 17, AVRDC. p. 97.

Oyinlola, E.Y. 2004. Response of irrigated tomatoes to boron fertilizer on growth and nutrient concentration. *Nigerian J. Soil Res*. **5**: 62-68.

Oyinlola, E.Y. and Chude, V.O. 2004. Response of irrigated tomato to boron fertilizer on yield and quality. *Nigerian J. Soil Res***. 5**: 53-61.

Palm, C.A., Myers, J.K. and Nandwa, S.M. 1997. Combined use of organic and inorganic nutrient Sources for soil fertility maintenance and replenishment. Soil Science Society of America Special Publication **51**: 193-217.

Passam, C.H., Ioannis, C., Karapanos, J., Penelope, Bebeli and Savvas, D. 2007. A review of recent research on tomato nutrition, breeding and post-harvest technology with reference to fruit quality. *Eur. J. Plant Sci. Biotecnol*. **1**(1): 121.

Prezotti, L.C., Balbino J.M.D., Stock L.A. and Ferrira L.R. .1988. Effect of organic matter, phosphorus and calcium on the productivity in tomatoes. EMCAPA, Brazil, 45:9. [Cited from Hort. Abstr. **58(**8): 4964;1988].

Rahman, M.A.1993. Growth and yield of tomato as influenced by fertilizers and manures. MS Thesis , Department of Soil Science. IPSA, Salna, Gazipur. Pp. 62-72.

Sakamoto, T. 2012. Role of Boron in plant and soil. Journal of Citable Reviews of Life Sciences. **12**(20): 23-29.

Salam, M.A., Siddique,M.A. and Rahim, M.A. 2010. Quality of tomato (*Lycopersicon esculentum* mill.) As influenced by boron and zinc under different levels of NPK fertilizers. *Bangladesh J. Agric. Res*. **35**(3):475-488.

Sangwoo, L., Yeon, S.S. and Yeon, L.S. 2004. Effect of amount of reutiled cowdung and compost after enokitake cultivation on growth and yield of tomato plants (*Lycopersicon esculentus* Mill) in recycled or non-recycled hydroponics. *Korean J. Hort. Sci. Tech*., **23**(4): 372-376.

Sathya, S. 2006. Effect of Boron on yield of tomato. M.Sc. (Ag.) Thesis. Agricultural College and Research Institute, Madurai, India.

Shah, M. 2006. Effect of N, P, K and B on the growth and quality of tomato. MS Thesis. Department of Horticulture, BAU, Mymensingh .

Shaheed, M.A. 1997. Effect of manures and nitrogen fertilizers on performance of grafted tomato in pot culture. An MS thesis, Department of Soil Science, Institute of Postgraduate Studies in Agriculture, Salna, Gazipur, Bangladesh. pp. 51-54.

Shukla, V. and Naik, L.B. 1993. Agro-techniques for Solanaceous Vegetables. In: Vegetable Crops: Part-l, Advances in Horticulture. Vol. 5, Eds: K. L. Chadha and G. Kalloo, Maihotra Publishing House, New Delhi, India . p.371

Singh, D. and Gangwar, R. 1991. Management practices for higher productivity in India a review. *Agric. Res*. **12**:15-21.

Solaiman, A. and Rabbani, M.M. 2006. Effects of NPKS and cowdung on growth and yield of tomato. Bulletin of the Institute of Tropical Agriculture, Kyushu University**. 29**. 31-37.

Sperry, W.J. 1995. Influence of boron and potassium on quality, yield, and nutrition of fresh-market tomato. PhD diss. N.C. State Univ., Raleigh, N.C

Srivastava, A.K. and Singh,S. 2003. Soil-plant nutrient limits in relation to optimum fruit yield of sweet orange (*Citrus sinensis* Osbeck) cultivar Mosambi. *Indian. J. Agric. Sci***. 73**(4): 209-211.

Stanley, D.W., Bourne, M.C., Stone A.P. and Wismer. W.V. 1995. Low temperature blanching effects of chemistry, firmness and structure of canned green beans and carrots. *Food Sci*. (60): 327-333.

Sukanta, K.; Mukharjee, A. K.; Ghosh, R. K. and Mukharjee, N. 2004. Effect of micronutrients on the growth and yield of tomato. *Indian J. Agric. Chem*. **39** (2 & 3): 40-42.

Tisdale, S.L., Nelson,W.L. and Beaton.J.D. 1985. Soil fertility and fertilizers. pp: 754

USDA, 1980. Report and Recommendations on organic farming. USDA study Team on organic farming. U.S. Department of Agriculture, Washington D.C. 94.pp.

Yadav, M., Singh, D.B., Chaudhury, R. and Reshi, T.A. 2006. Effect of boron on yield of tomato (*Lycopersicon esculentum* Mill) cv. DVRT-1. Plant Archives. **6**(1):383-384.

Yadav, P.V.S., Abha, T. and Sharma, N.K. 2001. Effect of zinc and boron on growth, flowering and fruiting of tomato (*Lycopersicon esculentum*, Mill). *Haryana J. Hort. Sci*. **30**(1/2):105-107.

APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location.

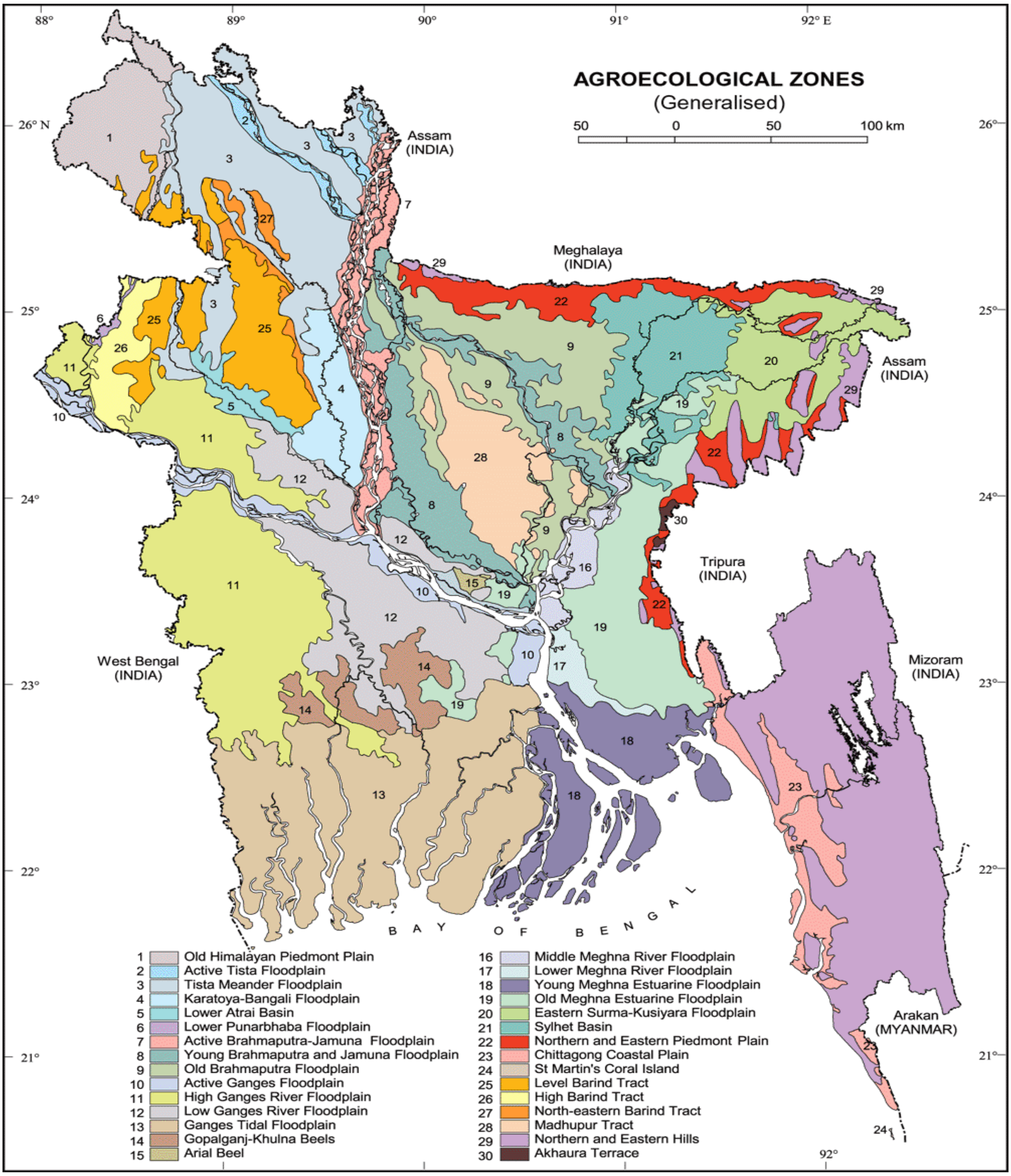

Fig. 7. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from October 2017 to March 2018.

Month	Air temperature		Relative humidity(%)	Total rainfall(mm)	Sunshine(hr)
October, 2017	31.6	23.8	78	172.3	5.2
November, 2017	29.6	19.2	77	34.4	5.7
December ,2017	26.4	14.1	69	12.8	5.5
January, 2018	25.4	12.7	68	7.7	5.6
February, 2018	28.7	15.5	68	28.9	5.5
March, 2018	32.5	20.4	64	65.8	5.2

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Horticilture 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
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV: Analysis of variance of the data on plant height, number of leaves, no of branch as influenced by micronutrients and manure of tomato

Source of variation	Degrees of freedom (df)	Mean Square of							
		ph25	ph45	ph65	nol25	nol45	nol65	branch45	branch65
Replication	2	9.991	443.5	0.184	1.208	0.458	1.003	2.554	2.321
Factor A (Nutrient)	3	97.014**	409.3**	21.504**	12.686**	4.714*	8.215**	98.936**	33.389**
Factor B (Manure)	3	42.570 **	510.2**	31.251**	78.063**	5.989*	5.517**	89.951**	29.186*
A x B	9	44.302*	428.8**	11.488**	10.935**	4.353*	3.415*	48.768*	20.602*
Error	30	15.549	35.4	2.196	1.917	1.452	1.136	15.443	6.867

* Significant at 0.05 level of probability; **Significant at 0.01 level of probability and NS Non-significant

Appendix IV: Analysis of variance of the data on cluster per plant, flowers per cluster, flowers per plant as influenced by micronutrients and manure of tomato

Source of variation	Degrees of freedom (df)	Mean Square of						
		clustplant45	clustplant65	flwrclust45	flwrclust65	flwrplnt45	flwrplnt65	fruit/clust
Replication	2	34.176	23.042	46.382	0.108	0.503	4.257	4.887
Factor A (Nutrient)	3	124.404**	126.647**	132.332**	9.543**	19.348 *	64.867 **	29.143**
Factor B (Manure)	3	111.871**	113.002**	125.010**	11.631**	21.646 *	86.432**	37.028**
A x B	9	80.167*	59.758*	129.268**	7.807*	15.677 *	31.977*	14.582*
Error	30	26.971	19.452	38.018	2.064	5.009	9.296	4.259

* Significant at 0.05 level of probability; ** Significant at 0.01 level of probability and NS Non-significant

Appendix IV: Analysis of variance of the data on fruit per plant, fruit length, fruit breadth, fruit cavity length, fruit cavity breadth, individual fruit weight as influenced by micronutrients and manure of tomato

Source of variation	Degrees of freedom (df)	Mean Square of						
		frutplnt45	frutplnt65	fruitlent	fruitbret	cavitlent	cavitbreat	fruitwt
Replication	2	5.533	66.809	0.353	0.486	3.021	0.787	8.902
Factor A (Nutrient)	3	57.377**	88.242**	7.767**	13.380**	26.481*	44.896 **	87.875**
Factor B (Manure)	3	46.576 **	95.986**	12.098**	17.015**	29.095*	49.280**	85.623**
A x B	9	31.049*	67.771*	4.026*	12.704*	22.282*	19.005*	55.516*
Error	30	11.566	21.538	1.152	4.713	7.458	6.046	17.932

* Significant at 0.05 level of probability; ** Significant at 0.01 level of probability and NS Non-significant

Appendix IV: Analysis of variance of the data on brix %, dry matter contents of fruit, yield per plot, yield ton/ha as influenced by micronutrients and manure of tomato

Source of variation	Degrees of freedom (df)	Mean Square of			
		brix	dryfruit	yield/plot	ton/ha
Replication	2	20.701	0.041	5.472	249.51
Factor A (Nutrient)	3	94.121**	1.262*	101.372**	1406.03**
Factor B (Manure)	3	104.005**	4.093**	125.430**	5201.43**
A x B	9	78.951*	1.406*	61.426*	411.14*
Error	30	31.059	0.643	21.988	132.67

* Significant at 0.05 level of probability; ** Significant at 0.01 level of probability and NS Non-significant