EFFECT OF ORGANIC MANURES ON GROWTH AND YIELD OF TOMATO VARIETIES AND ASSESSMENT OF SHELF LIFE

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CERTIFICATE

This is to certify that thesis entitled, "EFFECT OF ORGANIC MANURES ON GROWTH AND YIELD OF TOMATO VARIETIES AND ASSESSMENT OF SHELF LIFE" submitted to the Dept. of Horticulture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of *MASTER OF SCIENCE in HORTICULTURE,* embodies the result of a piece of *bona fide* research work carried out by *SOHELY PARVIN* Registration No. *10-04206* under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated : June, 2012
Place: Dhaka, Bangladesh

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Dedicated to
My
Beloved Parents

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BY

SOHELY PARVIN

ABSTRACT

The field experiment was conducted in the Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October 2010 to March 2011. Two factors were used in the experiment, viz. factor A. four types of organic manure such as M_0= Control, M_1 = Cowdung (20 t/ha), M_2 = Poultry manure (16 t/ha) and M_3 = Vermicompost (14 t/ha) and factor B. three varieties such as V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2. The experiment was laid out in Randomized complete Block Design with three replications. The maximum yield (86.25 t/ha) was recorded from treatment combination of M_2V_1, while M_0V_3 gave the minimum (31.25 t/ha).The highest benefit cost ratio (2.98) was obtained from M_2V_1 and the lowest (1.41) from M_0V_3. In case of shelf life three storage conditions were used, such as open at room temperature 24^0C, perforated polythene bag in room temperature 24^0C and refrigerator in 10^0C with both in half ripe and full ripe conditions. The height shelf life was found when tomato was kept in refrigerator in 10^0C in half ripe (23.80 days) and lowest (1.00 days) from open room temperature 24^0C in full ripe condition.

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CHAPTER I
INTRODUCTION

Tomato (Lycopersicon esculentum Mill.) belongs to the family Solanaceae. It was originated in tropical America (Salunkhe et al.1987), particularly in peru, Ecuador and Bolivia of the Andes (Kalloo, 1989). It is one of the important, popular and nutritious vegetables grown in Bangladesh in both winter and summer season around all parts of the country (Haque et al., 1999). Bangladesh produces 103 thousand tones of tomato from 18.16 thousand hectares of land, the average yield being 8.72 t/ha (BBS, 2010). This yield is very low compared to other tomato growing countries. This low yield may be due to use of low yielding varieties and poor crop management.

Organic matter is a source of food for the innumerable number of microorganisms and creatures like earthworm who breaks down these to micronutrients, which are easily absorbed by the plants. Organic manure plays a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils. Organic manures such as cow dung, poultry manure and vermin compost improves the soil structure, aeration, slow release nutrient which support root development leading to higher growth and yield of tomato plants. The macronutrients calcium and micronutrients boron, manganese, molybdenum and iron are important for tomato cultivation. Biologically active soils with adequate organic matter usually supply enough of these nutrients (Singh and Kushwah 2006).

In Bangladesh, a large number of tomato varieties are grown which are of exotic origin and were developed long before. Most of them lost their potentiality due to genetic deterioration and disease contamination. Hence, in order to improve the present situation of tomato production in Bangladesh, it is essential to better varieties to the growers of Bangladesh. Recently the

Bangladesh Agricultural Research Institute (BARI) developed some varieties with good contributing characters.

Tomato can be grown on a wide range of soil types, ranging from light sand to heavy loam or, even clay that are well supplied with organic matter (Kaynes, 1995). Fertilizer management is one of the most important factors, which assured crop production. Use of chemical fertilizers in crop production is one of the important causes of environmental pollution. Use of organic matter in crop production has many advantages over chemical fertilizers. Organic manure saves the crop plants from adverse environment.

Stage of maturity at harvest is another important factor regulating different physiological changes during storage and ripening of tomato. Storage quality of tomato is highly dependant upon the stage of harvesting. Tomatoes when harvested at later stages had reduced shelf life, while early harvesting caused more loss in weight but showed better storability (Subburamu *et. al*.1990).

Shelf life depends to a great extent on the variety and to some extent on the storing condition (Morimoto and Hashimoto 2003). Research in many countries of the world contributed to the development of variety with good shelf life of tomato.

Increasing the production and improving the keeping quality of tomato are of paramount importance, now-a-days, for meeting the internal demand the consumers. Hence efforts should be given to identify varieties with high yield potential and long shelf life. Adequate information's on field and storage performance of tomato cultivars are lacking in the country.

The present study was undertaken in view of the following objectives:

Objectives :

1. To determine the best organic manure on growth and yield of tomato;

2. To observe the suitable variety on growth and yield of tomato;

3. To investigate the suitable storage condition for higher shelf life of tomato.

CHAPTER II
REVIEW OF LITERATURE

Tomato is one of the most popular, nutritious vegetables and widely grown in Bangladesh and most of the country of the world. The response of tomato the different types of organic manures has been investigated by numerous investigators in various parts of the world. The consumers purchase fruits on the basis of quality of tomato fruit is largely dependent on the stage of maturity of fruits and various ripening conditions. During storage changes in physiological characteristics as well as ripening must be determined the fitness of tomato fruit for fresh consumption and marketing. In Bangladesh little work (s) has been done in the respect. The reports on shelf life of tomato are scants. However, available literature and their findings on some different varieties of tomato and stage of maturity at harvest regulating different physiological changes during storage and ripening of tomato have been reviewed in this chapter under the following headings.

2.1 Literatures on organic manure

Nileema, and Sreenivasa, (2011) was conducted an experiment at main Agricultural Research Station, University of Agricultural Sciences, Dharwad to study the influence of liquid organic manures, viz. panchagavya, jeevamruth and beejamruth on the growth, nutrient content and yield of tomato in the sterilized soil during kharif 2009. The various types of organic solutions prepared from plant and animal origin are effective in the promotion of growth and fruiting in tomato. The Panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate biological reactions in the soil and to protect the plants from disease incidence. Jeevamruth promotes immense biological activity in soil and enhance nutrient availability to crop. Beejamruth protect the crop from soil borne and seed borne

pathogens and also improves seed germination. Significantly the highest plant growth and root length was recorded with the application of RDF + Beejamruth + Jeevamruth + Panchagavya and it was found to be significantly superior over other treatments. The application of Beejamruth + Jeevamruth + Panchagavya was next best treatment and resulted in significantly the highest yield as compared to RDF alone.

Jagadeesha, (2008) conducted a field experiment was conducted at the University of Agricultural Sciences, Dharwad during kharif season of 2007 to study the effect of organic manures and biofertilziers on plant growth, seed yield and quality parameters in tomato. Results of field experiment in kharif 2007 revealed that, application of RDF (60:50:30 kg NPK/ha) + biofertilzier (Azospirillum and P solubilizing bacteria 2.5 kg/ha each) records higher plant height (64.37, 109.50 and 162.33 cm), number of leaves (92.50, 153.33 and 146.50), leaf area (898.05, 4314.31 and 4310.94 cm2) and leaf area index (898.05, 4314.31 and 4310.94 cm2) at 30, 60 and 90 DAT respectively and records lesser days to 50 per cent flowering (38.00) followed by FYM (50%) + vermicompost (50%) + biofertilzier. The application of RDF + biofertilziers records higher seed yield (106.87 kg/ha) followed by FYM (50%) + vermicompost (50%) (101.94 kg/ha) over FYM alone. The seed yield was significantly higher with the application of RDF + biofertilziers was attributed to number of fruits per plant (45.22) number of seeds per fruit (109.45) fruit weight per plant (1280.98 g) and 1000 seed weight (2.84 g).

Sathish *et al.* (2009) Studies were carried out to evaluate biological activity of organic manures against tomato fruit borer, Helicoverpa armigera (Hub.) and safety of otanicals and biopesticides against egg parasitoid, richogramma chilonis Ishii and biochemical effects of Pseudomonas florescens on tomato under pot culture conditions. The feeding and infestation of the larvae of H. armigera were significantly low in farm yard manure (FYM) zospirillum+silicate solubilising bacteria (SSB)+Phosphobacteria+neem cake

applied plants followed by FYM+Azospirillum+SSB+Phosphobacteria+mahua cake applied plants. Trichogramma parasitization on H. armigera eggs was adversely effected by neem oil 3% on treated plants followed by neem seed kernel extract (NSKE 5%)+spinosad 75 g a.i./ha. Under laboratory condition among the microbial pesticide tested Spinosad (75 g a.i./ha), HaNPV+Spinosad+Bt (1.5×1012 POBs/ha+75 g a.i./ha+15000 IU/mg (2 lit/ha)), Spinosad+Bt (75 g a.i./ha+15000 IU/mg-2 lit/ha) showed higher insecticidal toxicity (100 per cent mortality on 72 h) to all instars of H. armigera larvae. Biochemical parameters like phenol content, peroxidase and phenyl alanine ammonialyase (PAL) activity recorded higher levels in Pseudomonas florescens seed treatment @ 30 g/kg of seed and its foliar spray @ 1 g/litre in treated tomato plants.

Goutam, *et al.* (2011) Field trials was conducted a field trials where using different fertilizers having equal concentration of nutrients to determine their impact on different growth parameters of tomato plants. Six types of experimental plots were prepared whereT_1 was kept as control and five others were treated by different category of fertilizers (T_2-Chemical fertilizers, T_3-Farm Yard Manure (FYM), T_4-Vermicompost, T_5 and T_6- FYM supplemented with chemical fertilizers and vermicompost supplemented with chemical fertilizer respectively).The treatment plots (T_6) showed 73% better yield of fruits than control, Besides, vermicompost supplemented with N.P.K treated plots (T_5) displayed better results with regard to fresh weight of leaves, dry weight of leaves, dry weight of fruits, number of branches and number of fruits per plant from other fertilizers treated plants.

Fioreze and Ceretta (2006) conducted a study in Rio Grande do Sul, Brazil to determine the organic sources of nutrients in potato production systems. The treatments include hen and hog residue and mineral fertilizers. Results indicated that organic sources are economical and technical alternatives to chemical fertilizers. However, their efficiency is maximized when coupled with

chemical fertilizers, mainly to maintain nitrogen supply along the crop cycle, especially in the case of using hog residues. Hen residue is better than hog residue because it has higher amount of nutrients.

Singh and Kushwah (2006) was conducted a field experiment at Central Potato Research Station, Gwalior, Madhya Pradesh, India, during the winter seasons (rabi) of 2001-02 and 2002-03 to study the effect of organic and inorganic sources of nutrients on potato production. The treatments included 25, 50, 75 and 100% doses of NPK with and without organic manures (farmyard manure (FYM) and Nadep compost at 30 t/ha). Application of 100% NPK+30 t FYM/ha resulted in significantly higher tuber yield of 456 q/ha compared with that of other treatments except 100% NPK+30 t Nadep/ha and 75% NPK+30 t FYM/ha. The effect of organic manures (FYM and Nadep compost) in combination with inorganic fertilizers was more pronounced compared with that of organic manures alone. However, FYM was more effective than Nadep compost in producing higher tuber yield. Maximum net return of Rs 63 627/ha was also obtained from 100% NPK+30 t FYM/ha. However, benefit:cost ratio was almost same under 75% NPK with 30 t/ha FYM or Nadep compost and 100% NPK with 30 t/ha FYM or Nadep compost.

Klikocka *et al.* (2006) were conducted two experiments in Poland. In experiment 1 (1996-2001), the treatments consisted of: conventional soil tillage (ploughing at 20-cm depth, and pre-winter ploughing at 25-cm depth), autumn ridge tillage (ploughing at 20-cm depth, and establishment of 20- to 25-cm-deep ridges with a furrow plough ridger), and spring ridge soil tillage (ploughing at 20-cm depth with planting of spring potato, and establishment of 25-cm-deep ridges with a planting machine). For all treatments, cattle manure was applied at 30 t/ha. In experiment 2 (2001-03), the treatments were: summer ridge soil tillage (plough skimming at 10-cm depth, establishment of 25-cm-deep ridges, and sowing of white mustard or Sinapis alba as a catch crop), autumn ridge soil tillage (plough skimming at 10-cm depth, sowing of white

mustard, cultivation at 15-cm depth, and establishment of ridges), and spring ridge soil tillage (plough skimming at 10-cm depth, sowing of white mustard during the planting of spring potato, and establishment of 20- to 25-cm-deep ridges with a planting machine). For all treatments, 5 t triticale straw/ha and 1.0 kg N in the form of urea per 200 kg of straw were applied. Tillage with ridge establishment in the autumn resulted in the highest total and commercial tuber yields. The tillage treatments had no significant effects on the N content at the 0- to 25-cm soil layer. The formation of ridges in the autumn reduced the N content at the 25- to 40-cm soil layer. The use of straw as fertilizer and mulch, along with the planting of white mustard, reduced N leaching and prevented soil erosion.

El-Fakhrani (1999) conducted an experiment on the effects of N fertilizer (0, 300 or 600 kg/ha as urea) and poultry manure (0 or 10 t/ha) on the performance of potato (cv. Monaliza) irrigated with saline water (EC of 0.42, 1.56 or 2.85 dS/m). N application significantly increased shoot dry weight per plant, and tuber fresh and dry weights over the control. N at 300 kg/ha resulted in the greatest tuber volume (241.2 cm3), tuber fresh weight (257.9 g), tuber dry weight (48.8 g), and shoot dry weight (9.02 g) per plant. Poultry manure at 10 t/ha enhanced tuber volume (224.4 cm3), tuber fresh weight (239.9 g), tuber dry weight (45.2 g), and shoot dry weight (8.12 g) per plant. The values of these parameters decreased with the increase in the salinity level. N at 300 kg/ha also registered the greatest P (12.37 mg per plant) and K (652.9 mg per plant) uptake, and total carbohydrate content (36.8 g per plant). Poultry manure also increased N (209.7 mg per plant), P (13.47 mg per plant) and K (602.3 mg per plant) uptake, and total carbohydrate content (34.6 g per plant). The interaction between 300 kg N and 10 t poultry manure/ha was optimum for all parameters.

Kushwah, *et al.* (2005) was conducted an experiment during rabi 2004/05 on silty clay loam soil at Gwalior, Madhya Pradesh, India to study the effect of

farmyard manure (FYM), Nadep compost, vermicompost and inorganic NPK fertilizers on yield and economics of potato. Application of FYM, Nadep compost and vermicompost alone or in combination did not influence tuber yield significantly. However, organic manures at 7.5 t/ha in combination with 50% recommended dose of NPK significantly increased tuber yield. The highest tuber yield (321 q/ha) was recorded with 100% recommended dose of NPK fertilizers. The highest incremental benefit cost ratio (7.5) was obtained with 50% recommended dose of NPK.

In an experiment, Gomes, *et al.* (1970) in Brazil found that the variety Floradel was slightly superior to the other varieties, namely, Maca, Caqui and Manalucie as regards to yield and number of fruits.

In a performance trial of six varieties of tomato conducted at the Bangladesh Agricultural Institute, Joydebpur, Hossain and Ahmed (1973) observed that cv. Sanmarzano was the highest yielder (28.98 t/ha), followed by 'Oxheart', 'Roma', Bulgaria, USA and Anabik. They also observed that 'Oxheart' produce the longest fruits with the average weight of 87 g followed by the Bulgaria, Roma, USA, Anabik and Sanmarzano.

Ali and Siddique (1974) found that the plants of Oxheart variety were 190.8 cm in height and yield 26.6 t/ha. In the above study they observed that the plants took 23.1 DAT for flowering.

Norman (1974) carried out an experiment to observe the performance of 13 varieties of tomato in Ghana. He found significant differences between cultivars in plant height, fruit maturity, yield and quality. He also stated that in the dry season, 'Floradel', 'Ace VF', 'Floralon', 'Piacenza 0164', 'Red colour' and No. 1 were found to be high yielders and appeared promising.

A yield trial was conducted at the vegetable Division of Agricultural Research Institute, Dhaka in 1969-70, with five varieties of tomato ('Oxheart',

‘Sinkurihara’, ‘L-7’, ‘Marglobe’ and ‘Bulgaria’). The experiment was repeated in 1971-72. In both years, the varieties ‘Oxheart’ and ‘Sinkurihara’ were found to be similar and significantly higher yielder than the others (Hoque *et al.*, 1975).

Prasad and Prasad (1977) carried out an experiment with 8 varieties tomato in India. The highest yield was obtained from ‘Kalyanpur Angurlate’ followed by ‘Kolyanpur T_1, and ‘Sioux’. The ‘Kolyanpur T_1, had the largest fruit.

To compare the yielding ability and to assess the distinguishing external morphological characters of seven varieties of tomato an investigationwork carried out by Sarker and Hoque (1980) during the period from 19October 1977 to March1978. Thevarieties were, ‘Master No.2’, ‘Ramulas’, ‘Roma’, ‘Rambo’, ‘Marmande’, ‘Bigo’ and World Champion. They reported that, the ‘Rambo’ produced the highest yield (28.28 t/ha) followed by ‘Bigo’ (24.63 t/ha), ‘World Champion’ (23.38 t/ha), ‘Master No.2’ (21.98 t/ha), ‘Roma’ (21.03 t/ha) and ‘Ramulas’ (20.21 t/ha).

Ahmed *et al.* (1986) assessed eight F-7 lines of tomato at the Horticulture farm, Bangladesh Agricultural University, Mymensingh. They observed that all the lines had shown indifferences in plant height and fruit size. In contrast fruit number had shown significant difference among the varieties. The line 0014-60-3-9-1-0 gave the highest yield of fruits (56.9 t/ha), followed by 0013-52-10-27-32-0 (50.0 t/ha).

Kalloo (1989) worked with some tomato varieties (Pusa Early Dwarf, HS 102, Hisar Arun and Punjab Chhuhara) in northern India. The ‘HS 102’ and ‘Punjab Chhuhara’ were fit for summer cultivation and ‘Pusa Early Dwarf’ and ‘Hisar Arun’ were suitable for getting early fruits.

A field experiment was carried out in 1990 and 1992 with some tomato cultivars, namely, ‘Punjab Kesari’, ‘Punjab Chhuhara’, ‘Punjab Tropic’, ‘PNR-

7', 'S-12' 'Pusa Ruby' and the 'Hybrid THL- 2312' (Bhangu and Singh, 1993). They observed mean annual yield was highest in 'Punjab Tropic'. Punjab Tropic produced the largest fruits (66.69 g) and the highest number of fruits per plant was obtained 'Punjab Kesari' (123).

Singh *et al. (*1994) conducted an experiment to evaluate the performance of tomato varieties(Arka Vikas, LE 79, BT 14, Punjab Chhuhara, BWRI and Pusa Ruby). They observed that BT 12 produced the tallest plant and BT 14 the shortest plant (mean values of 75.09 cm and 62.52 cm respectively).They also reported that Arka Vikas Had the heaviest fruits (54.87 g) and Punjab Chhuhara the smallest (21.93 g). Arka Vikas gave the highest mean yield (157.55 q/ha) and BT 14 the lowest (119.79 q/ha).

Berry *et al.* (1995) conducted an experiment at Wooster, USA with Hybrid processing tomato 'Ohio Ox 38'. It was observed that, the yield of variety in 1992 and 1993 were higher (70.3 and 80.4 t/ha, respectively) compared to other cultivars.

A field trial was conducted by Ajlouni *et al.* (1996) in Jordan 1993 to study the yield of 13 local and introduced open pollinated tomato cultivars, to compare the yields to that of 3 common hybrids (Maisara F_1, 898 $F_1$and GS 12 F_1) in relation to seasonal distribution of marketable and unmarketable yield and fruit number. The cultivars varied in their marketable yield during the harvesting period (10 weeks from 22 June 1993). The results indicated that the cultivars 'Rio Grande,' 'Nagina' and '$T_{2,}$ improved were superior to the hybrids.

An experiment was conducted with two summer tomato varieties (BINA Tomato 2 and BINA Tomato 3) to study the yield performance at 3 locations of Bangladesh (Magura, Comilla and Khulna) during the summer season (BINA 1998). It was observed that 'BINA Tomato 2' produced higher fruit yield at Magura (38 t/ha) and Khulna (17 t/ha), while 'BINA Tomato 3' gave higher

yield (29 t/ha) at Comilla. However mean fruit yield from three locations showed that, the variety ‘BINA Tomato 2’ produced higher fruit yield than ‘BINA Tomato 3’.

2.2 Effect of different storage condition on shelf-life of tomato

Lopez *et al.* (2003) at Coexphal Institute conducted an experiment for Agricultural Research and Development in Spain on the time evolution of tomato quality parameters versus storage conditions. Tomatoes cv. were exposed to different storage conditions simulating their transport to distant countries by ship (controlled atmosphere cool-container for eleven days) and to closer countries by truck (cool-rooms for seven days) followed by a storage period of seven days in a refrigerator simulating cool-storage conditions of tomatoes at home or supermarkets after their acquisition. According to the results, controlled atmosphere cool containers seem to be interesting alternatives for sending tomatoes to distant countries, especially when harvested in the breaker stage.

Kinetic model of surface color in tomato fruits during the post-harvest storage and its application was studied by Wang *et a!.(*2001).Kinetic models were derived for surface colour changes in tomato fruits during ripening. Changes value in tomato fruits during storage followed a first order reaction kinetics. Rate constants and activation energy value at a reference temperature of 13°C were calculated. A time-temperature indicator based on Hue angle models was designed for predicting and controlling quality changes in tomato fruits during storage.

Experiments on the effects of different packing materials on the storage life of tomatoes (cv. Peshawar Local) was conducted in 1994-95 by Noor, *et al*. Five treatments were compared: unpacked material, packing in black polyethylene, transparent polyethylene, Kraft and perforated polyethylene bags, each containing 400 g fruit. Fruit was stored for 1 5daysat IO°C. Weight loss, skin

firmness and fruit colour were assessed. They found that the maximum weight loss (224.1 g) occurred for unpacked fruits while the minimum of 77.5 g was recorded for tomatoes packed in black polyethylene bags. The best colour retention was noted in black polyethylene bags; it was the poorest in the control and perforated bags. Skin firmness was best in the black polyethylene bags and lowest in the control. Overall, the best results were given by the black polyethylene bags.

Balla *et al.* (1994) carried out an experiment in Slovenia and reported that visual color did not change during over ripening but the texture softened. They also stated that chlorophyll content decreased and 13-carotene and lycopene contents increased. There had a strong correlation between the coefficient of elasticity and visual color score during ripening.

In India, Mallik *et al.* (1996) reported that fruits of tomato (cv. Rorna-VF) showed the lowest physiological weight loss of 7.7-9.7% after 6 days storage under ambient conditions.

Syamal (1981) conducted an experiment on effect of different environmental condition on the post harvest losses of tomato. He concluded that the highest weight loss was found in perforated polythene bag due to the rate of transpiration was lower in sealed polythene bags. He reported that the weight loss of tomatoes depends upon the transpiration and respiration of the tomato in storage condition, which are lower at sealed condition.

Subburamu *et al.* (1990) conducted as experiment in India, with tomato fruits of the cultivars, harvested at 4 maturity stages, viz. (i) Mature green (ii) Breaker (iii) Half ripe and (iv) Red ripe were held under ambient conditions for longer shelf life. They observed that the shelf life was longer (11-12.5 days) in fruits picked at the mature green stage, their quality after storage was poor and tomatoes picked at the breaker stage were of better quality and held an acceptable shelf life (8.3-10.5 days).

In a trial at Osaka in Japan, Hamauzu *et al.* (1995/1998) reported that the color of mature tomato fruits changed from green to red during storage at 20°C. But changes to a mixed color or a speckled pattern of red, orange and yellow at 30°C and turned yellow at 35°C. The epidermis is more sensitive and lycopene was significantly inhibited in surface tissue. High temperature prevented the acumulation of pheromone more than that of lycopene. The content of [3-carotene increased in the epidermis and the flesh (more so in the epidermic) during storage at 30°C, but decreased with extended storage (afte7 about 15 days).

Syamal (1981) performed an experiment in India, with pink fruits of tomato cvs. stored in perforated polythene bags at 20°C and 65% RH for up to 12 days. He observed that the greatest and least weight losses after 12 days storage occurred in 'Margiobe' and 'Pusa Ruby' @ 15.8 and 14.07% respectively.

Yoltas *et al.* (1994) obtained that a 1.2% semperfresh (a fatty acid sucrose ester mixture) significantly reduced the weight loss m tomato fruit (cv Galit-135) during storage at 21°C temperature in Turkey.

Agnihotri and Ram (1970) observed that a 6% wax emulsion significantly reduced the weight loss in tomato fruit during storage at room temperatures in India.

In India, Anju-Kumari *et al.* (1993) reported that the shelf life for all tomato cultivars were longest with harvesting at the mature green stage (10.9-13.5days) but resulted m the lowest ascorbic acid content after storage and m patchy color develop on ripening.

At Mohonpur m India, Mallik *et al.* (1996) reported that tomato cultivars at an ambient condition. Earlier harvesting, being 10.9-13.5 days for mature green fruits and 3.5- 5.1 days for red ripe fruits increased shelf life. Fruits of Roma

showed the lowest physiological weight loss (7.7-9% after 6 days) and longest shelf life (13.5 days when harvested at the mature green stage). They also said that fruits harvested at the breaker of half ripe stage exhibited good shelf life and keeping quality.

In another experiment at Yalova in Turkey, Kaynas and Surmeli (1995) recorded that tomato fruits exhibited a shelf life of 40 days at 12°C when fruits stored at were green mature and breaker stages and pmk fruits can be held for 25-30 days at 8°C. They also stated that tomatoes at the light red and red stages can be held for 10-15 days at 8°C and for 10 days at 12°C.

Park *et al.* (1994) conducted an experiment with tomatoes at 2 maturity tages, viz. breaker and pmk were coated with corn-zem film, control (noncoated) and coated tomatoes were stored at 21°C. They found that corn-zein film delayed color change and loss of firmness and weight reduced in storage. They also stated that coating fruits with corn-zein film extended the shelf life by 6 days.

Hossain *et al.* (1996) carried out an experiment at the Bangladesh Agricultural Research Institute, Gazipur and recorded that the tomato fruits of the lines 'TMO-850' and 'TMO-854' exhibited a shelf life of 14-17 days when stored at ordinary storage condition.

Dennis *et al.* (1979) stated that it was possible to store green mature fruits cultivars (Sonato and Soatine) for up to 6 to 10 weeks at control atmosphere storage (3% 02, 5% CO2 and 92% N2) at 13°C and 93-95% RH.

Gupta *et at.* (1988) stated that at room temperature the tomato fruits could be stored up to 12 days only with less than 10% weight loss compared to 20 at 10°C and 28 days at 5°C and the respiration rate was higher in iJ/ treated fruits than in those ripened on the plants.

Thai *et al.* (1990) studied with a 2.6% prediction error for fruit under step-varying temperature storage. A new relationship between firmness and colour development for tomato fruit was derived and found to yield about 2% prediction error under variable temperature conditions.

According to Morimoto *et al.* (2003) the former treatment is useful for short-term storage, and the latter is useful for comparatively long-term storage. With the single heat treatment, the temperature first rises to the highest level (40°C), which is maintained over a period of 24th, and then suddenly drops to the lowest level (15°C). In particular, the sudden drop in temperature from the highest level to the lowest level provided lower values of the rate of water loss than maintaining the temperature constantly at the lowest level throughout the control process. These results suggest that application of heat stress to fruit is effective in maintaining freshness of fruit during storage.

Ketelaere *et al.* (2004) stated that the firmness of 13 loose tomato cultivars was followed during a 2-week storage experiment using a non-destructive commercial acoustic firmness sensor. The same experiment was later repeated for a second harvest. The firmness change was modeled using a linear mixed model for repeated measurements showing a significant difference in firmness change among cultivars. Harvest had a significant effect on firmness change, with summer tomatoes being less firm at harvest, but showing a less pronounced firmness decline than autumn tomatoes. The linear mixed model parameters were used to group the different tomato cultivars according to their firmness change, their shelf life and their variance within a cultivar. Ordering of initial firmness across harvest remained more or less the same, indicating that the acoustic firmness tester was suitable for determining differences among tomato cultivars.

According to Rad and Shahidi (2004) bulk tomato paste is produced in concentrations higher than 35% (350 Brix scale) and its packaging is not

hermetic. In recent years, the production of this product in our country has considerably increased. One of the most important problems in the tomato paste industry of Iran is the preservation of bulk tomato paste. Shelf-life of tomato paste depends on many factors such as initial quality of tomato paste, cooling conditions, salting, packaging, handling, and cold storage. Data showed that using high brix (3 5-38) in producing tomato paste along with salting the product surface and storing it at 0°C had only a limiting effect on microbial changes and could not prevent their growth completely. On the basis of the results obtained from this study, cooling of bulk tomato paste in ambient temperature is critical to bulk tomato paste production process and also has an important effect on the quality and shelf-life of the product.

A solar drier with a rockbed storage system was used to dry fresh tomatoes by Asota (1996), Department of Agricultural Engineering, Ahmadu Bello University, Zaria, Nigeria. Dried samples were stored in polyethylene bags at room temperature (25-35°C) for up to 10 months. Product quality assessed by organoleptic evaluation indicated that the pastes made from the rehydrated products were still acceptable after 10 months of storage, and that the levels of oxidative rancidity and microbial growth during storage were not high enough to affect quality. Reconstitution tests on the dried products showed that okra and tomatoes dehydrated in this maimer reach only 63% and 75% of their initial moisture content, respectively, after 40 minutes.

Two maturity stages of commercially grown tomatoes (breaker and mature green) were exposed to ethanol vapour for 6 h at 20°C prior to storage at 5 and 20°C. Yanuriati *et al.* (1996). During storage the color and firmness were examined every 3 and 7 days, respectively. The results showed that ethanol vapour treatment could significantly slow down the colour changes and softening of both mature green and breaker tomatoes with greater effects on storage at 5°C. No different effects of maturity in retardation of colour changes

and softening were found. The results suggest that ethanol vapour pretreatment could be used as a cheap and easy method to extend the storage life of tomatoes.

Li Li Ping *et al.* (1996) studied the quality, degree of chilling injury and physiological changes occurring in tomato fruits heated at 33 or 38°C for 2, 5 or 8 days after cold storage (2±1°C, 85-90% RH) were investigated. Heat-treatment was able to lower respiration rate, cell membrane permeability and malondialdehyde (MDA) content, increase free proline content and decrease chilling injury. The best treatments were 33°C for 5 days or 38°C for 2 days; 33°C for 2 days had less effect, and treatment for 8 days resulted in fruit injury, increased MDA content, cell membrane permeability and off-flavour, and decreased fruit firmness. There was a positive correlation between the chilling injury index and cell membrane permeability (r = 0.9744).

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in carrying out the experiment. It includes a short description of location of the experiment, characteristics of soil, climate, materials used, land preparation, manuring and fertilizing, transplanting and gap filling, staking, after care, harvesting and collection of data.

3.1 Location:

The field experiment was conducted in the Horticulturel farm at Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 during the period from October 2010 to March 2011. The location of the experimental site was at in 23.75^0 N latitude and 90.34^0 E longitudes with an elevation of 8.45 meter from the sea level (Anonymous, 1989).

3.2 Climate of the experimental area:

The climate of the experimental area was subtropical in nature. It is characterized by heavy rainfall, high temperature, high humidity and relatively long day during kharif season (April to September) and a scanty rainfall associated with moderately low temperature, low humidity and short day period during rabi season (October to March). Details of the meteorological data in respect of monthly maximum, minimum and average temperature, rainfall, relative humidity, average sunshine hours and soil temperature during the period of experiment are presented in Appendix I.

3.3 Soil of the experimental field:

Soil of the study site was silty clay loam in texture. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ-28) with p^H 5.8-6.5, ECE 25-28. The analytical data of the soil sample collected from the experimental area were

determined in the Soil Resources Development Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka and have been presented in Appendix II.

3.4. Plant materials used in the experiment

Three varieties of tomato were used in this experiment. Tomato seeds were collected from Vegetable division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.5. Seedbed preparation

Seedbed was prepared on 8 October' 2010 for raising seedlings of tomato and the size of the seedbed was 3 m × 1 m. For making seedbed, the soil was well ploughed and converted into loose friable and dried masses to obtained good tilth. Weeds, stubbles and dead roots were removed from the seedbed. Cow dung was applied to the prepared seedbed at the rate of 10 t/ha. The soil was treated by seven 50 WP @ 5 kg/ha to protect the young plants from the attack of mole crickets, ants and cutworm.

3.6. Seed treatment

Seeds were treated by Vitavax-200 @ 5 g/1kg seeds to protect some seed borne diseases such as leaf spot, blight, anthracnose, etc.

3.7. Seed sowing

Seeds were sown on 12 October 2010 in the seedbed. Sowing was done thinly in lines spaced at 3cm distance. Seeds were sown at a depth of 2 cm and covered with a fine layer of soil followed by light watering by water can. Thereafter the beds were covered with dry straw to maintain required temperature and moisture. The cover of dry straw was removed immediately after emergence of seed sprout. When the seeds were germinated, shade by bamboo mat (Chatai) was provided to protect the young seedlings from scorching sunshine and rain.

3.8. Raising of seedlings

Light watering and weeding were done several times. No chemical fertilizers were applied for rising of seedlings. Seedlings were not attacked by any kind of insect or disease. Healthy and 30 days old seedlings were transplanted into the experimental field on 12 November 2010.

3.9. Design of the experiment

A. Field experiment:

The field experiment was conducted by Randomized Complete Block Design (RCBD) with three replications. Two factors were used in the experiment, viz. four types of organic manure and three types of variety.

Factor A. Four types of organic manure coded as M

M_0 = Control (No organic manure)

M_1 = Cow dung (20 t/ha)

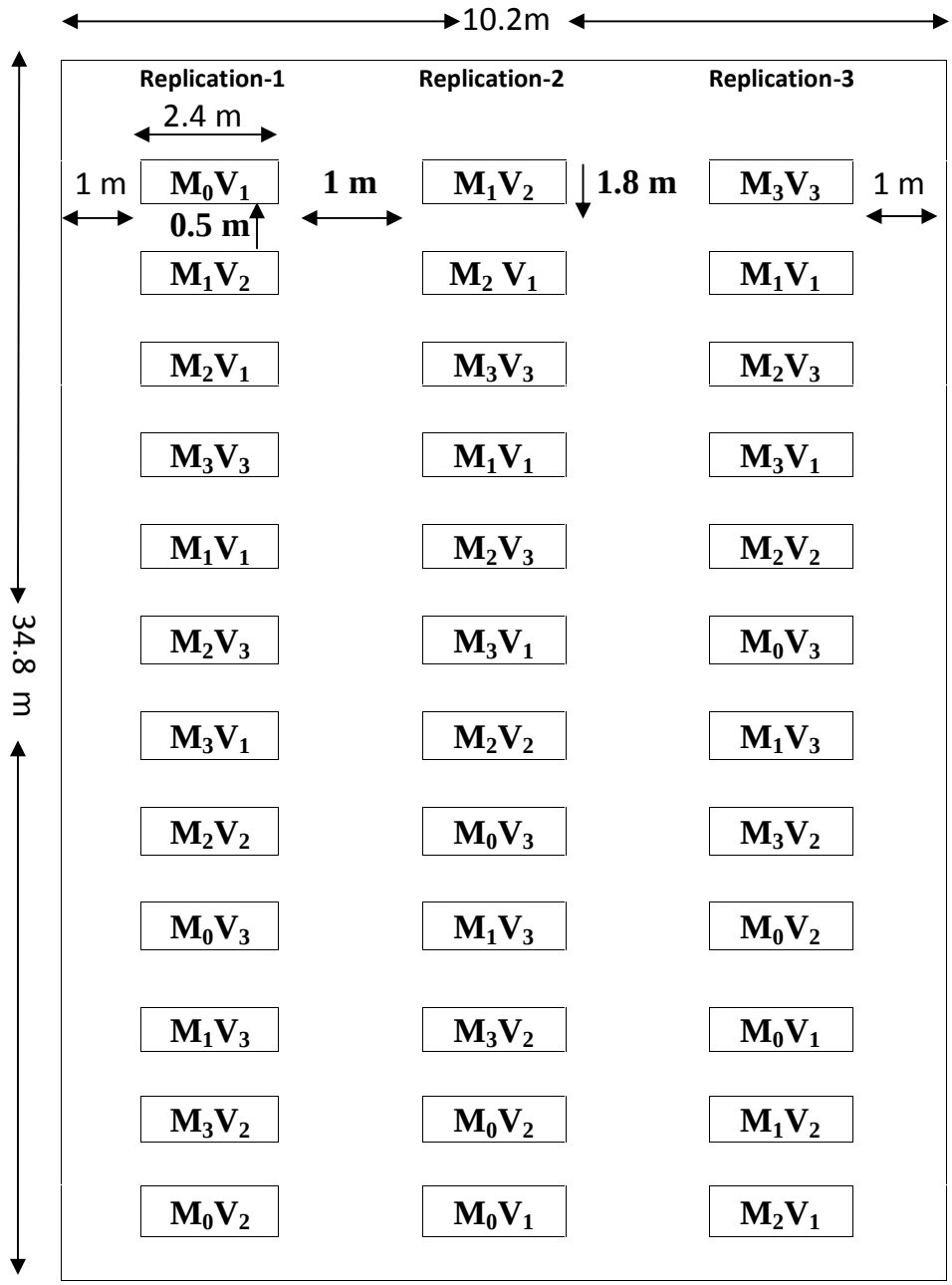
M_2 = Poultry manure (16 t/ha)

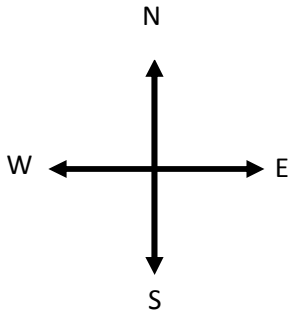
M_3 = Vermicompost (14 t/ha)

Factor B. Three types of variety coded as V

V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2

There were altogether 12 (4 x 3) treatments combination used in each block were as follows; M_0V_1, M_1V_2, M_2V_3, M_0V_2, M_1V_3, M_3V_1, M_0V_3, M_2V_1, M_3V_2, M_1V_1, M_2V_2, M_3V_3.





Plot size: 2.4 m x 2.4 m
Spacing: 60 cm x 40 cm
Spacing between plot: 50 cm
Spacing between replication:1 m

Factors: A
M_0 : Control
M_1 : Cowdung (20t/ha)
M_2 : Poultry Manure (16t/ha)
M_3 : Vermicompost (14t/ha)

Factor:B
V_1 = BARI tomato 15
V_2 = BARI tomato 14
V_3 = BARI tomato 2

Fig 1: Field layout of the two factors experiment

3.10. Layout

The experimental plot was first divided into three blocks. Each block consisted of 12 plots. Thus, the total numbers of plot were 36. Different combinations of treatments were assigned to each plot as per design of the experiment. The size of a unit plot was 2.4 m ×2.4 m. A distance of 0.5 m between the plots and 1.0 m between the blocks were kept.

3.11. Land preparation

The experimental area was first opened on 15 October 2010 by a disc plough to open direct sunshine to kill soil borne pathogens and soil inhabitant insects. It was prepared by several ploughing and cross ploughing with a power tiller followed by laddering to bring about a good tilth. The land was leveled, corners were shaped and the clods were broken into pieces. The weeds, crop residues and stables were removed from the field. Total organic manures were applied according to their treatment and finally leveled. The soil of the plot was treated by Sevin 50wp @ 5 kg/ha to protect the young plants from the attack of mole cricket, ants and cutworm.

3.12. Transplanting

The seedbed was watered before uprooting the seedlings to minimize the damage of roots. At the time of uprooting, care was taken so that root damage become minimum and some soil remained with the roots. Thirty days-old healthy seedlings were transplanted at the spacing of 60 cm × 40 cm in the experimental plots on 12 November 2010. Thus the 24 plants were accommodated in each unit plot. Planting was done in the afternoon. Light irrigation was given immediately after transplanting around each seedling for their better establishment. The transplanting seedlings were shaded for five days with the help of white polythene to protect them from scorching sunlight, watering was done up to five days until they became capable of establishing on their own root system.

3.13. Intercultural operations

1. Gap filling

Very few seedlings have been damaged after transplanting and new seedlings from the same stock replaced these.

2. Weeding

The plants were kept under careful observation. Three times weeding were done during cropping period, viz. 1st December, 15th December and 1st January, for proper growth and development of the plants.

3. Spading

After each irrigation soils of each plot were pulverized by spade for easy aeration.

4. Irrigation

Irrigation was given by observing the soil moisture condition. Five times irrigation were done during crop period, viz. 4th December, 14th December, 24th December, 5th January and 15th January for proper growth and development of plants.

5. Earthing up

Earthing up was done by taking the soil from the space between the rows on 2nd December 2010.

6. Insects and disease control

Few plants were damaged by mole crickets and cut worms after the seedlings were transplanted in the experimental plots. Seven 80WP was dusted to the soil before irrigation to controlled mole crickets and cut worms on 1st December 2010. Some of the plants were infected by alternaria leaf spot disease. Rovral

50 WP @ 20 g per 10 litre of water was sprayed to prevent the spread of the disease on 25th December 2010.

7. Harvesting

Fruits were harvested at 3-day intervals during early ripe stage when they attained slightly red color. Harvesting was started from 15 February, 2010 and was continued up to 15 March, 2010.

B. Post harvest potential

Laboratory experiment was carried out after harvesting the fruit to find out the shelf life of tomato at different storage condition. The experiment was laid out in two factors Completely Randomized Design (CRD) with four organic manures and 3 varieties combinations under three storage conditions. The storage conditions were as follows:

i) Stored in open condition at room temperature (24^0C) both in half ripe and full ripe stage
ii) Stored in perforated polythene bags at room temperature (24^0C) both in half ripe and full ripe stage
iii) Stored in perforated polythene bags at 10^0 C in refrigerator both in half ripe and full ripe stage.

The three mature tomatoes were selected for each treatment. The selected tomato was kept in a perforated polythene bag. The changes of physiological structure of tomato fruit were recorded by eye estimation. Laboratory trail comprised of four organic manure and three varieties combinations with three storage conditions.

Data collection

Data on post harvest duration (days) was estimated until the changes of physiological structure of tomato fruit under different storage condition.

3.14. Parameter assessed

Ten plants were selected at random and uprooted carefully at the time of collecting data of root from each plot and mean data on the following parameters were recorded

i) Plant height

ii) Number of leaves per plant

iii) Number of flower clusters per plant

iv) Number of flowers per cluster

v) Number of fruit set per plant

vi) Number of fruits per plant

vii) Dry matter of leaves

viii) Dry matter of fruit

ix) Weight of individual fruit

x) Yield of fruits per plant

xi) Yield of fruits per plot

xii) Yield of fruits per hectare

3.15. Data collection

Ten plants were selected randomly from each plot for data collection in such a way that the border effect could be avoided for the highest precision. Data on the following parameters were recorded from the sample plants during the course of experiment.

i) Plant height

Plant height at final harvest was measured from sample plants in centimeter from the ground level to the tip of the longest stem and the mean value for each treatment was calculated. Plant height was also recorded at 15 days interval starting from 30 days of transplanting up to final harvest.

ii) Number of leaves per plants

The numbers of the sample plant were counted at 30 DAT, 45 DAT, 60 DAT and at final harvest and the average number of leaves produced per plant was recorded.

iii) Number of flower clusters per plant

The numbers of flower clusters were counted from the sample plants and the average number of flower clusters produced per plant was recorded at the time of final harvest.

iv) Number of flowers per cluster

It was calculated by the following formula,

$$\text{Number of flowers per cluster} = \frac{\text{sample plant}}{\text{Total number of flower clusters from ten sample plant}}$$

v) Number of flowers per plant

Total number of flowers was counted from selected plants and their average was taken as the number of flowers per plant.

vi) Number of fruits per plant

It was recorded by the following formula:

$$\text{Number of fruits per plant} = \frac{(\text{Total number of fruits from 10 sample plants up to final harvest})}{10}$$

vii) Dry matter of leaves per plant

After harvesting, randomly selected 100 gram of leaf sample previously sliced in to very thin pieces were put into envelop and placed in oven maintained at 60^0c for 72 hrs. The sample was then transferred into desiccators and allowed to cool down to the room temperature. The final weight of the sample was taken. The dry matter was calculation by the following formula,

$$\text{Dry matter of leaf} = \frac{\text{Dry weight of leaf}}{\text{Fresh weight of leaf}} \quad X\ 100$$

viii) Dry matter of fruits per plant

After harvesting, randomly selected 100 gram of fruit sample previously sliced into very thin pieces. The fruits were then dried in the sun for one day and followed by above mentioned procedure from the following formula was used to find out dry matter of fruits

$$\text{Dry matter of fruit} = \frac{\text{Dry weight of fruit}}{\text{Fresh weight of fruit}} X\ 100$$

ix) Weight of individual fruit

Among the total number of fruits during the period from first to final harvest the fruits, except the first and final harvests, were considered for determining the individual fruit weight by the following formula:

$$\text{Weight of individual fruit (Kg)} = \frac{\text{Total weight of fruits from 10 harvest of sample plant}}{\text{Total number of fruits from 10 harvest of sample plant}}$$

x) Yield of fruits per plant

It was measured by the following formula:

$$\text{Weight of fruits per plant (Kg)} = \frac{\text{Total weight of fruits in 10 sample plants}}{10}$$

xi) Yield of fruits per plot

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

xii) Yield of fruits per hectare

It was measured by the following formula,

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

3.16.Statistical analysis

The data in respect of yield, quality and yield components were statistically analyzed to find out the significance of the experimental results. The means of all the treatments were calculated and the analysis of variance for each of the characters under study was performed by F test. The difference among the treatment means were evaluated by Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez, (1984).

3.17. Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of organic manures and varieties of tomato. All the non-material and material input costs and interests on running capital were considered for computing the cost of production. The interests were calculated for six months @ 13% per year. The price of one kg tomato at harvest was considered to be Tk. 5.00. Analyses were done according to the procedure determining by Alam *et al.* (1989).

The Benefit cost ratio (BCR) was calculated by the following formula:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return}}{\text{Total cost of production}}$$

CHAPTER IV

RESULTS AND DISCUSSION

The present study was conducted to determine the effect of organic manures on growth and yield of tomato varieties and assessment of shelf life. Data on different yield contributing characters and yield were recorded. The analysis of variance (ANOVA) of the data on different yield components and yield are given in Appendix III-VIII. The results have been presented and discussed, and possible interpretations were given under the following headings.

4.1. Plant Height

Plant height is one of the important parameter, which is positively correlated the yield of tomato. Plant height was recorded at different days after transplanting (DAT) and at final harvest. Application of organic manures exhibited a significant influence on the height of tomato plants at 30, 45, 60 days after transplanting (DAT) and at final harvest (Figure 2 and Appendix III). At 30 DAT, the plant height ranged from 26.33 cm to 35.68 cm. The tallest plant (35.68 cm) was found in the application of poultry manure (M_2) and the shortest plant (26.33 cm) was recorded from control treatment (M_0). At 45 DAT, the plant height (59.32 cm) was recorded from M_2, while the lowest (43.88 cm) was recorded from M_0. At 60 DAT, the plant height ranged from 62.08 cm to 77.35 cm. The longest plant (77.35 cm) was recorded from M_2 and the shortest plant (62.08 cm) was recorded from M_0. At final harvest, plant height ranged from 67.44 cm to 83.90cm. The highest plant (83.90 cm) was recorded from M_2, while the lowest (67.44 cm) was recorded from M_0. It was revealed that the plant height increased with the increased in days after transplanting (DAT) i.e., 30, 45, 60 DAT and the final harvest. Poultry manure is rich in nitrogen and nutrient content. This favorable condition creates better nutrient absorption and favors for vegetative growth. Consequently longest plant was found by poultry manure. This is an agreement with the findings of Norman (1974) in tomato.

Different varieties showed significant influence on plant height of tomato plants at different DAT and final harvest (Figure 3 and Appendix III). At 30 DAT, the tallest plant (33.71cm) was found from V_1 (BARI Tomato 15) and the shortest plant (29.53 cm) was found from variety V_3 (BARI Tomato 2). At 45 DAT, the highest plant height (53.77 cm) was recorded from V_1, while the lowest (48.48 cm) was recorded from V_3.The plant height ranged from 70.31cm to 75.33 cm at 60 DAT. The longest plant (75.33 cm) was recorded from V_1 and the shortest plant (70.31cm) was recorded from V_3. At final harvest, the highest plant (78.12cm) was recorded from V_1, while the lowest (71.88 cm) was recorded from V_3. The results of this study are comparable to the findings Singh and Sahu (1998).

The variation was found due to combined effect of organic manure and variety on plant height at different days after transplanting (Appendix III& Table 1). The maximum plant height (48.80 cm) was recorded from the treatment combination of M_2V_1, while the treatment combination of M_0V_3 gave the minimum plant height (16.66 cm) at 30 DAT. At 45 DAT significant differences in terms of plant height was observed among the treatment combinations. How ever the largest plant (75.08 cm) was recorded from the treatment combination of M_2V_1 whereas the minimum (36.20 cm) was recorded from treatment combination of M_0V_3. At 60 DAT, the tallest plant (90.61 cm) was recorded from the treatment combination of M_2V_1, while the minimum plant height (51.22 cm) was recorded from treatment combination of M_0V_3. At harvest the maximum plant height (97.80 cm) was obtained from the treatment combination M_2V_1 whereas the minimum (58.90 cm) was found from the treatment combination of M_0V_3.

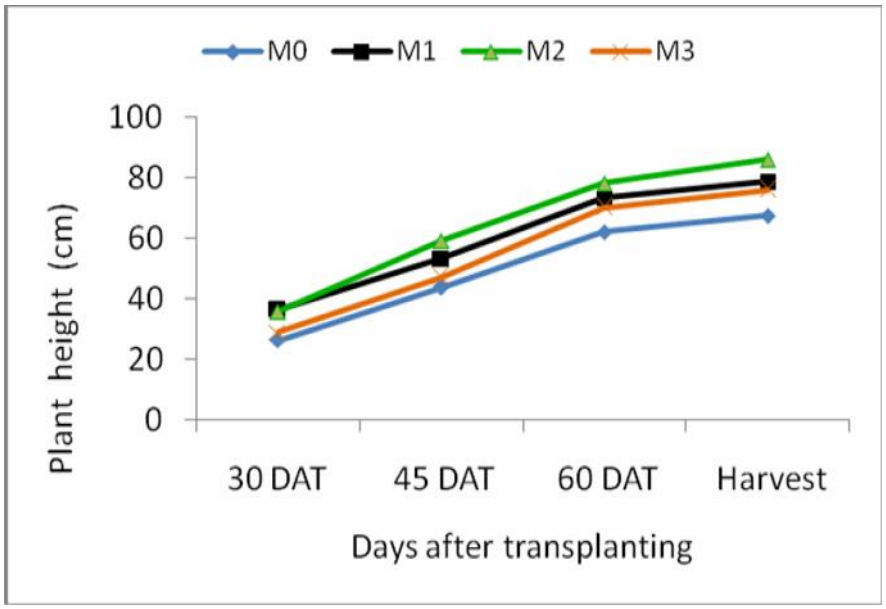


Fig . 2. Effect of organic manures on plant height of tomato

M_0 = Control , M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost

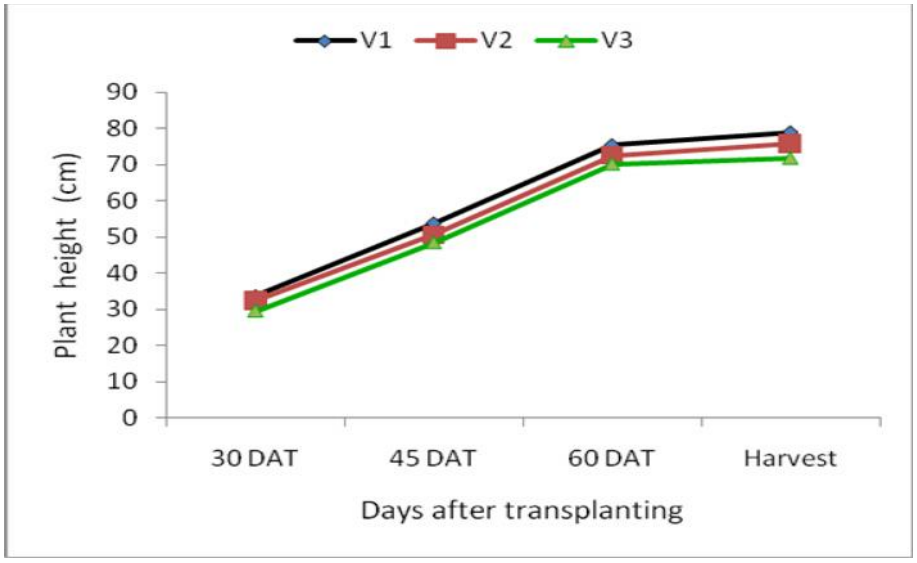


Fig. 3. Effect of varieties on plant height of tomato

V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2

Table 1: Interaction effect of organic manures and varieties on plant height of tomato

Treatment	Plant height (cm) at			
	30 DAT	45 DAT	60 DAT	Final harvest
M_0V_1	22.56 ef	37.92 e	62.08de	67.24 bcde
M_0V_2	17.02 f	36.89 e	61.15 de	62.98 cde
M_0V_3	16.66 f	36.20 e	51.22 e	58.90 e
M_1V_1	24.40 ef	51.13 bcde	66.24 cd	69.67 bcde
M_1V_2	36.58 bc	57.18 bcd	78.42 abc	83.51 ab
M_1V_3	48.76 a	65.04 ab	80.90 a	81.16 abc
M_2V_1	48.80 a	75.08 a	90.61 a	97.80 a
M_2V_2	34.76 bcd	47.10 cde	64.92 cd	65.36 de
M_2V_3	35.68 bcd	55.78 bcd	78.24 abc	84.49 ab
M_3V_1	40.94 ab	45.56 cde	73.29 bcd	79.29 abcd
M_3V_2	28.80 cde	59.66 bc	85.02 ab	86.05 ab
M_3V_3	27.22 de	43.60 de	72.95 bcd	76.18 bcde
LSD (0.05)	8.021	13.81	12.19	9.45
CV (%)	7.35	8.95	10.36	7.45

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance

Where,

Organic manures

M_0 = Control

M_1 = Cowdung

M_2 = Poultry manure

M_3 = Vermicompost

Variety

V_1 = BARI tomato 15,

V_2 = BARI tomato 14

V_3 = BARI tomato 2

4.2 Number of leaves per plant

Application of organic manures exhibited a significant influence on number of leaves per plants at 30, 45, 60 days after transplanting (DAT) and at final harvest (Figure 4 & Appendix III). At 30 DAT, the maximum (16.05) number of leaves per plant was recorded from M_2, while the minimum (15.70) was obtained from M_0. The maximum (23.70) number of leaves per plant was recorded from M_2 and the minimum (17.44) was found from M_0 at 45 DAT. At 60 DAT, the maximum (41.25) number of leaves per plant was recorded from M_2 and the minimum (29.67number of leaves per plant was obtained from M_0. At harvest the maximum (57.20) number of leaves per plant was recorded from M_2 and the minimum (49.79) was recorded from M_0. Poultry manure content appreciable amount of nitrogen and other essential element which encourage the vegetative growth as well as number of leaves. The present findings also supported to the statement of Jagadeesha (2008) and Sathish (2009).

Different varieties had significant influence on number of leaves per plant at different DAT (Figure 5).The maximum (16.44) number of leaves per plant was recorded from V_1 and the minimum (15.34)number of leaves per plant was obtained from V_3 at 30 DAT. At 45 DAT, the maximum (22.66) number of leaves per plant was recorded from V_1 while the minimum (20.01) number of leaves per plant was found from V_3. The maximum (38.19) number of leaves per plant was recorded from V_1 while the minimum (36.23) number of leaves per plant was recorded from V_3 at 60 DAT. At harvest the maximum (54.62) number of leaves per plant was recorded from V_1 while the minimum (52.81) number of leaves per plant was recorded from V_3. Similar trend of the results were found by Singh and Sahu (1998).

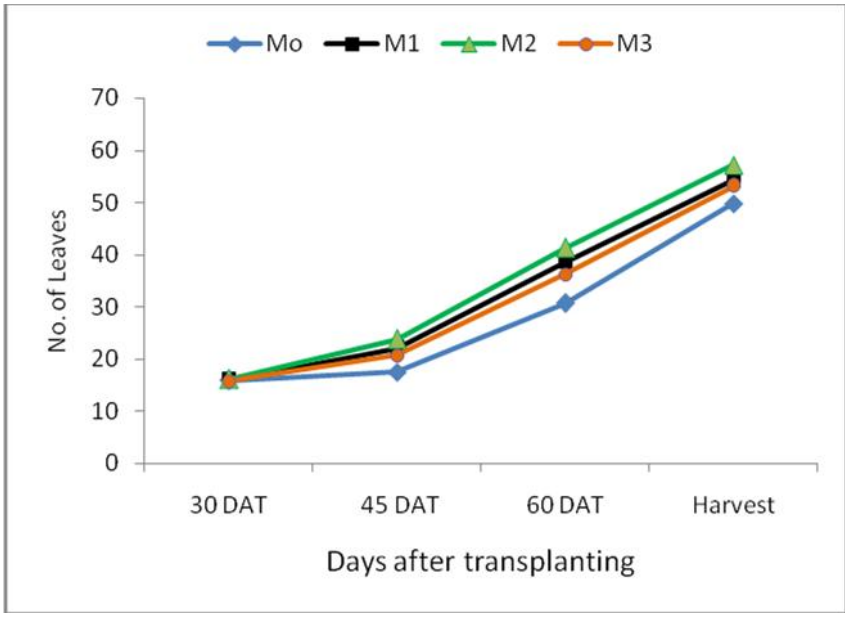


Fig. 4. Effect of organic manures on number of leaves/plant of tomato

M_0 = Control, M_1 = Cowdung, M_2 = Poultry manure And M_3 = Vermicompost

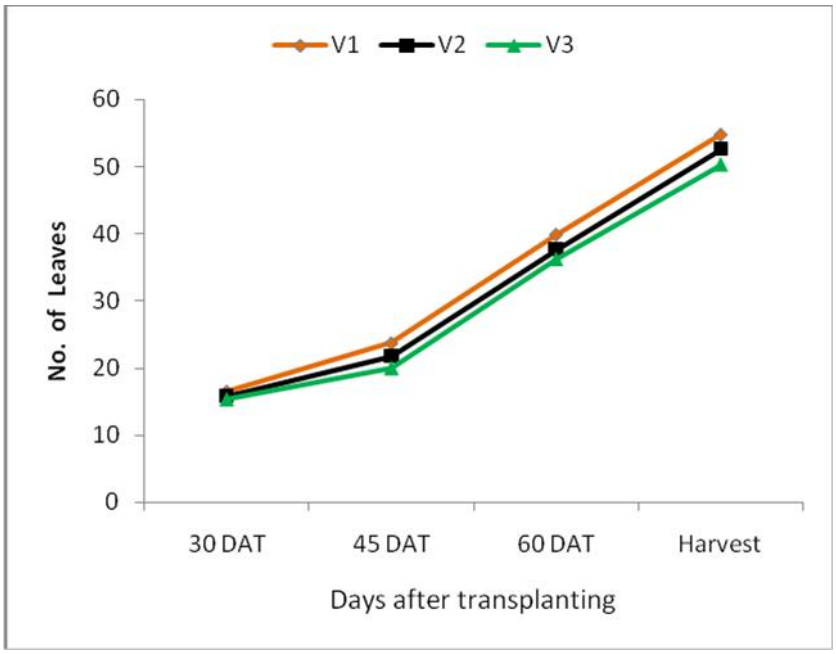


Fig. 5. Effect of varieties on number of leaves/plant of tomato

V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2

Due to combined effect of organic manure and variety showed significant differences on number of leaves per plant at different days after transplanting (Appendix IV & Table 2). The maximum (21.55) number of leaves per plant was recorded from treatment combination of M_2V_1, while the treatment combination of M_0V_3 gave the minimum (13.12) number of leaves per plant at 30 DAT. At 45 DAT significant differences in terms of number of leaves per plant was observed among the treatment combinations and the maximum (32.02) number of leaves per plant was recorded from the treatment combination of M_2V_1 whereas the minimum (11.04) was found from the treatment combination of M_0V_3. At 60 DAT the maximum (49.57) number of leaves per plant was recorded from the treatment combination of M_2V_1, while the minimum (23.26) number of leaves per plant was recorded from treatment combination M_0V_3. At harvest, the maximum (62.82) number of leaves per plant was obtain from the treatment combination of M_2V_1 whereas the minimum (43.91) was recorded from treatment combination of M_0V_3.

4.3 Number of flower clusters per plant

Application of organic manures exhibited a significant influence on the number of flower cluster per tomato plant (Table 3 & Appendix V). The maximum number of flower clusters per plant (9.74) was recorded from M_2 (Poultry manure), which was statistically identical (8.89) to M_1 while the minimum (8.27) was obtained from M_0 (Control treatment).

A significant variation was recorded due to combined effect of different varieties on number of flower clusters per plant under the present investigation (Table 4 Appendix V). The maximum number of flower cluster per plant (10.61) was recorded from V_1 (BARI Tomato 15) and the minimum number of flower cluster per plant (7.49) was obtained from V_3 (BARI Tomato 2).

The variation was found due to combined effect of organic manure and varieties for number of flower cluster per plant (Appendix V & Table 5). The maximum number of flower cluster per plant (11.64) was recorded from the

Table 2: Interaction effect of organic manures and varieties on number of leaves/plant of tomato

Treatment	No. of leaves per plant at			
	30 DAT	45 DAT	60 DAT	Final harvest
M_0V_1	13.49 de	15.38 d	32.51 de	50.38 ab
M_0V_2	13.25 e	14.95 d	29.67 e	44.01 b
M_0V_3	13.12 e	11.04 e	23.26 f	43.91 b
M_1V_1	13.84 de	15.67 d	33.27 de	49.88 ab
M_1V_2	14.33 de	23.00 c	40.60 b	57.30 ab
M_1V_3	19.52 ab	30.33 ab	47.90 a	61.41 a
M_2V_1	21.55 a	32.02 a	49.57 a	62.82 a
M_2V_2	15.46 cde	17.44 d	32.93 de	51.38 ab
M_2V_3	14.73 de	23.70 c	41.25 b	57.39 ab
M_3V_1	15.14 cde	21.67 c	39.22 bc	54.64 ab
M_3V_2	18.70 abc	28.43 b	45.93 a	54.33 ab
M_3V_3	17.27 bcd	23.84 c	36.07 cd	55.48 ab
LSD (0.05)	3.471	3.236	3.572	14.96
CV (%)	6.65	7.15	8.15	9.23

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance.

Where,

Organic manures	Variety
M_0 = Control	V_1 = BARI tomato 15
M_1 = Cowdung	V_2 = BARI tomato 14
M_2 = Poultry manure	V_3 = BARI tomato 2
M_3 = Vermicompost	

Table 3: Effect of organic manures on flower cluster/plant, fower/cluster, Flower/plant and fruit/plant of tomato

Treatment	Flower Cluster /plant	Flower/cluster	Fruit set/plant	Fruit/Plant
M_0	8.27 b	8.41 a	36.11 b	26.83 b
M_1	8.89 b	8.76 a	47.12 ab	32.87 ab
M_2	9.74 a	9.24 a	58.25 a	42.07 a
M_3	8.99 b	8.81 a	43.10 ab	33.04 ab
LSD (0.05)	0.5963	1.744	19.46	10.61
CV (%)	6.26	7.15	7.25	9.26

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance.

M_0 = Control , M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost

Table 4: Effect of varieties on flower cluster/plant, flower/cluster, flower/plant, fruit/plant of tomato

Treatment	Cluster/plant	Flower/cluster	Fruit set/plant	Fruit/Plant
V_1	10.61 a	10.52 a	48.05 a	36.65 a
V_2	9.25 b	8.83 a	45.92 a	32.83 a
V_3	7.49 c	7.07 b	44.47 a	31.63 a
LSD(0.05)	0.5963	1.744	19.46	10.61
CV (%)	6.26	7.15	7.25	9.26

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance.

V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2

treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15) which was statistically identical to M_2V_2 (11.37) (Poultry manure + BARI Tomato 14), while the treatment combination of M_0V_3 (Control + BARI Tomato 2) gave the minimum (6.34) number of flower clusters per plant.

4.4. Number of flowers per cluster

Organic manure varied significantly for number of flowers per cluster under the present study (Appendix V & Table 3). The maximum number of flower per cluster (9.24) was recorded from M_2 (Poultry manure), while the minimum (8.41) was obtained from control (M_0).

Different varieties showed significant variation on number of flowers per cluster under the present trial (Table 4). The maximum number of flower per cluster (10.52) was recorded from V_1 (BARI Tomato 15) which was statistically similar to V_2 (BARI Tomato 14) and the minimum number of flowers per cluster (7.07) was found from V_3 (BARI Tomato 2).

The variation was also found due to combined effect of organic manures and varieties on number of flowers per cluster per tomato plant (Appendix V & Table 5). The maximum number of flower per cluster (11.43) was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control + BARI Tomato 2) gave the minimum number of flowers per cluster (5.58).

4.5. Number of fruit set per plant

Number of flowers per plant varied significantly due to application of different organic manures (Appendix V & Table 3). The maximum number of flowers per plant (58.25) was recorded from M_2 (Poultry manure), while the minimum (36.11) was obtained from control treatment (M_0).

Different varieties showed significant variation on number of flowers per plant under the present investigation (Appendix V & Table 4). The maximum number of flower per plant (48.05) was recorded from V_1 (BARI Tomato 15) and the minimum number of flower per plant (44.47) was found from V_3 (BARI Tomato 2).

Table 5 : Combined effect of organic manures and varieties on flower cluster/plant, flower/cluster, flower/plant, fruit/plant

Treatment	Cluster /plant	Flower /cluster	Flower /plant	Fruit /Plant
M_0V_1	7.73 f	8.01 c	30.75 e	19.04ef
M_0V_2	7.27 f	6.12 d	26.89 e	19.62 def
M_0V_3	6.34 g	5.58 d	26.40 e	15.70 f
M_1V_1	8.40 e	8.24 c	28.75 e	19.71 ef
M_1V_2	8.61 de	8.29 c	43.78 cde	30.93 cd
M_1V_3	8.99 cd	8.57 bc	71.19 b	38.96 bc
M_2V_1	11.64 a	11.43 a	91.16 a	55.91 a
M_2V_2	11.37 a	10.57 a	36.44 de	31.71 c
M_2V_3	10.34 b	10.45 ab	54.83 bcd	41.71 bc
M_3V_1	9.08 cd	9.62 ab	38.20 de	29.93 cde
M_3V_2	9.27 c	10.25 ab	64.20 bc	50.58 ab
M_3V_3	10.34 b	8.54 bc	41.16 de	40.61 bc
LSD (0.05)	0.5963	1.744	19.46	10.61
CV (%)	6.26	7.15	7.25	9.26

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance.

Where, M_0 = Control , M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost,

and V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2

The variation was found due to combined effect of organic manures and varieties on number of flowers per plant (Appendix V & Table 5). The maximum number of flower per plant (91.16) was recorded from the treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control +BARI Tomato 2) performed the minimum number of flower per plant (26.40).

4.6 Number of fruits per plant

Number of fruits per plant differed significantly for application of different organic manures under the present investigation (Appendix V & Table 3). The maximum (42.07) number of fruits per plant was recorded from M_2 (Poultry manure), while the minimum (26.83) was recorded from M_0 (Control treatment). It was revealed that number of fruits per plant increased in poultry manure. This might be caused that Poultry manure contents high amount of nitrogen and nitrogen enhance photosynthesis, cell division and cell enlargement. Similar trend of the results were found by Goutam *et al.* (2011).

Different varieties showed significant variation on number of fruits per plant under the present trial (Appendix V & Table 4). The maximum (36.65) number of fruit per plant was recorded from V_1 (BARI Tomato 15) and the minimum (31.63) number of fruits per plant was observed in V_3 (BARI Tomato 2). The reports also supported by the results of Berry (1995) and Ajlouni , (1996).

Due to combined effect of organic manures and varieties showed significant differences on number of fruits per plant (Appendix V & Table 5). The maximum (55.91) number of fruit per plant was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination M_0V_3 (Control +BARI Tomato 2) gave the minimum (15.70) number of fruits per plant.

4.7. Dry matter (%) of leaves

Dry matter (%) of leaves varied significantly due to application of different organic manures (Appendix VII). The maximum (7.56 g) dry matter (%) of leaves was recorded from M_2 (Poultry manure), while the minimum (8.24 g) was recorded from M_0 (Control treatment).

A significant variation was recorded from different varieties on dry matter (%) of leaves (Appendix VII). The maximum (7.88 g) dry matter (%) of leaves was recorded from V_3 (BARI Tomato 2) and the minimum (6.44 g) dry matter (%) of leaves was recorded from V_1 (BARI Tomato 15).

The variation was found due to combined effect of organic manures and varieties for Dry matter (%) of leaves (Appendix VII). The maximum (8.06 g) dry matter (%) of leaves was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) performed the minimum (6.06 g) dry matter (%) of leaves.

4.8. Dry matter (%) of fruit

Dry matter (%) of fruit varied significantly due to application of different organic manures (Appendix VII). The maximum (10.71 g) Dry matter (%) of fruit was recorded from M_2 (Poultry manure), while the minimum (8.24g) was recorded from M_0 (Control treatment).

A significant variation was recorded from different varieties on Dry matter (%) of fruit (Appendix VII). The maximum (10.10 g) Dry matter (%) of fruit was recorded from V_3 (BARI Tomato 2) and the minimum (8.96 g) Dry matter (%) of fruit was recorded from V_1 (BARI Tomato 15).

The variation was found due to interaction effect of organic manures and varieties for Dry matter (%) of fruit (Appendix VII). The maximum (11.67 g) Dry matter (%) of fruit was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_1 (Poultry manure + no manure) performed the minimum (7.15 g) weight of individual fruit.

Table 6: Effect of organic manures on individual fruit, diameter of individual fruit individual fruit weight, fruit weight weight/plant and fruit weight /plot of tomato

Treatment	Length of individual fruit (cm)	Diameter of individual fruit (cm)	Individual Fruit Weight(g)	yield /Plant(Kg)	Yield /Plot (kg)
M_0	6.29 c	8.84 a	91.69 b	0.99 c	23.68c
M_1	6.98 b	10.35 a	122.81 ab	1.53 bc	32.64 b
M_2	7.97 a	10.43 a	123.33 a	2.06 a	44.08a
M_3	7.71 a	9.44 a	118.33 ab	1.65 b	40.96 ab
LSD (0.05)	0.6358	1.761	10.10	0.32	9.01
CV (%)	9.21	10.12	7.63	8.21	7.54

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance

Where, M_0 = Control, M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost.

Table 7: Effect of varieties on length of individual fruit, diameter of individual fruit, individual fruit weight, fruit weight weight/plant and fruit weight /plot of tomato

Treatment	Length of individual fruit (cm)	Diameter of individual fruit (cm)	Individual Fruit Weight(g)	yield /Plant(Kg)	Yield /Plot (kg)
V_1	7.66 a	10.18 a	134.58 a	1.75 a	36.9 a
V_2	7.39 a	9.93 a	108.35 b	1.54 ab	34.86 a
V_3	6.66 b	9.18 a	99.18 bc	1.37 b	34.26 a
LSD(0.05)	0.6358	1.761	10.10	0.32	9.01
zaCV (%)	9.21	10.12	7.63	8.21	7.54

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance

Where, V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2

4.9. Length of individual fruit

Length of individual fruit varied significantly for different organic manures (Appendix VI & Table 6). The maximum length of individual fruit (7.97 cm) was recorded from M_2 (Poultry manure), while the minimum (6.29 cm) was recorded from M_0 (Control) which was statistically identical (7.71 cm) to M_3 (Vermicompost).

Different varieties showed significant variation on length of individual fruit under the present investigation (Appendix VI & Table 7).). The maximum (7.66 cm) length of individual fruit was recorded from V_1 (BARI Tomato 15) and the minimum (6.66 cm) length of individual fruit was obtained from V_3 (BARI Tomato 2).

The variation was found due to combined effect of organic manures and varieties for length of individual fruit under the present trial (Appendix VI & Table 8). The maximum (10.94 cm) length of individual fruit was recorded from treatment combination of M_2V_1 (Poultry manure + BARI tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) performed the minimum (4.08 cm) length of individual fruit.

4.10. Diameter of individual fruit

Diameter of individual fruit was not significantly influence by different organic manures (Appendix VI & Table 6). The maximum (10.43 cm) diameter of individual fruit was recorded from M_2 (Poultry manure), which was statistically identical with M_3 (9.44 cm) and M_1 (10.35 cm), while the minimum (8.84 cm) was recorded from M_0 (Control treatment).

Different varieties did not show the significant variation on diameter of individual fruit under the present investigation (Appendix VI & Table 7). The maximum (10.18 cm) diameter of individual fruit was recorded from V_1 (BARI Tomato 15) and the minimum (9.18 cm) diameter of individual fruit was obtained from V_3 (BARI Tomato 2).

Combined effect of organic manure and varieties varied significantly on diameter of individual fruit (Appendix VI & Table 8). The maximum (13.31 cm) diameter of individual fruit was recorded from treatment combination of M_2V_1 (Poultry manure +BARI Tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) gave the minimum (6.60 cm) diameter of individual fruit.

4.11. Weight of individual fruit

Weight of individual fruit varied significantly due to application of different organic manures (Appendix VI & Table 6). The maximum (123.33 g) weight of individual fruit was recorded from M_2 (Poultry manure), while the minimum (91.69 g) was recorded from M_0 (Control treatment).

A significant variation found different varieties on weight of individual fruit under the present trial (Appendix VI & Table 7). The maximum (134.58 g) weight of individual fruit was recorded from V_1 (BARI Tomato 15) and the minimum (99.18 g) weight of individual fruit was recorded from V_3 (BARI Tomato 2).

The variation was found to be the significant due to combined effect of organic manures and varieties on weight of individual fruit (Appendix VI & Table 8). The maximum (176.66 g) weight of individual fruit was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) performed the minimum (73.41 g) weight of individual fruit.

4.12. Yield per plant

Yield per plant varied significantly due to application of different organic manures (Appendix VI & Table 6). The maximum (2.06 kg/plant) yield was recorded from M_2 (Poultry manure), while the minimum (0.99kg/plant) was found from M_0 (Control treatment). Poultry manures applied the maximum nutrient compare to cow dung and Vermicompost which enhance the maximum size of fruits and weight. As a result poultry manure performed the maximum yield. The results also agreed to the findings of Kushwah *et. al.* (2005).

Table 8: Combined effect of organic manures and varieties on length of individual fruit (cm), diameter of individual fruit (cm), individual fruit weight (g), yield/plant, and yield /plot of tomato

Treatment	Length of individual fruit (cm)	Diameter of individual fruit (cm)	Individual Fruit Weight (g)	Yield / Plant (Kg)	Yield /Plot (kg)	Yield (t/ha)
M_0V_1	5.02 h	7.39 gh	95.0 e	1.18 cd	28.32 cd	49.17 cd
M_0V_2	4.69 hi	7.06 gh	95.0 e	1.03 de	24.72 de	42.92 de
M_0V_3	4.08 i	6.60 h	73.41 f	0.75 e	18.0 e	31.25 e
M_1V_1	5.32 h	8.14 fgh	96.77 e	1.19 d	28.56 d	49.58 d
M_1V_2	6.98 f	8.84 efg	115.0 cd	1.39 c	33.36 c	57.92 c
M_1V_3	9.26 c	12.7 ab	121.66 c	1.50 bc	36.0 bc	62.50 bc
M_2V_1	10.9 a	13.31 a	176.66 a	2.07 a	49.68 a	86.25 a
M_2V_2	6.22 g	10.43 cde	106.66 de	1.69 bc	40.56 b	70.42 b
M_2V_3	7.97 de	10.34 cde	108.33 d	1.75 b	42.0 ab	72.92 ab
M_3V_1	7.71 e	9.45 def	133.33 b	1.71 bc	41.04 ab	71.25 ab
M_3V_2	10.10 b	11.82 abc	113.33 cd	1.70 bc	40.8 ab	70.83 b
M_3V_3	8.56 d	11.08 bcd	133.33 b	1.71 bc	41.04 ab	71.25 ab
LSD (0.05)	0.63	1.76	10.10	0.32	9.01	15.65
CV (%)	9.21	10.12	7.63	8.21	7.54	9.21

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance.

M_0 = Control , M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost

V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2

Different varieties showed significant variation on yield per plant under the present investigation (Appendix VI & Table 7). The maximum (1.75 kg/plant) yield was recorded from V_1 (BARI Tomato 15) and the minimum (1.37kg/plant) yield was obtained from V_3 (BARI Tomato2). Similar trend of results were found by scientists like Thomas *et al.* (1979), Hossain and Ahmed (1973) and Berry *et. al.* (1995).

A significant variation was found due to combined effect of organic manures and varieties for yield per plant (Appendix VI & Table 8). The maximum (2.07 kg/plant) yield was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination M_0V_3 (Control treatment + BARI Tomato 2) gave the minimum yield (0.75 kg/plant).

4.13. Yield per plot

Yield per plot varied significantly due to application of different organic manures (Appendix VII & Table 6). The maximum (44.08 kg/plot) yield was recorded from M_2 (Poultry manure), while the minimum (23.68 kg/plot) was recorded from M_0 (Control treatment).

Different varieties showed significant variation on yield per plot under the present trial (Appendix VII & Table 7). The maximum (36.9 kg/plot) yield was recorded from V_1 (BARI Tomato 15) and the minimum yield (34.26 kg/plot) was recorded from V_3 (BARI Tomato 2).

The variation was found due to combined effect of organic manures and varieties for yield per plot (Appendix VII & Table 8). The maximum (49.68kg/plot) yield was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) gave the minimum yield (18.00 kg/plot).

4.14. Yield per hectare

Yield per hectare varied significantly due to different organic fertilizer (Appendix VII & figure 8). The maximum (67.36 t/ha) yield was obtained from M_2 (Poultry manure), while the minimum (50.56 t/ha) was recorded from M_0 (Control treatment).

Different varieties showed significant variation on yield per hectare under the present investigation (Appendix VII & figure 9). The maximum yield (63.85 t/ha) was recorded from V_1 (BARI Tomato 15) and the minimum yield (59.48 t/ha) was recorded from V_3 (BARI Tomato 2).The present investigation also agreed to the findings of Ajlouni *et.al*. (1996).

A significant variation was found due to combined effect of organic manures and varieties for yield per hectare (Appendix VII & Table 8). The maximum yield (86.25 t/ha) was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) gave the minimum yield (31.25t/ha).

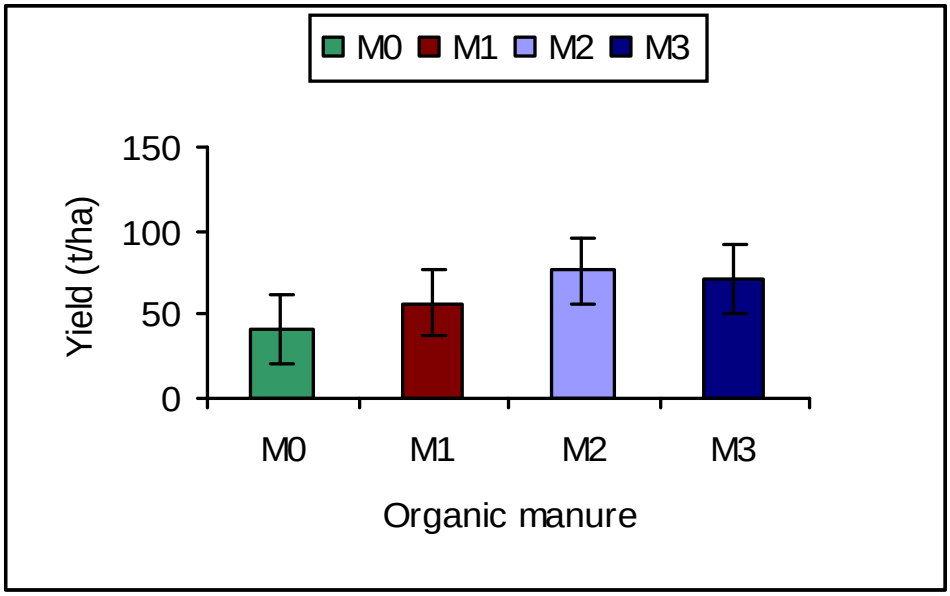


Fig : 6. Effect of organic manures on yield of tomato

M_0 = Control , M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost

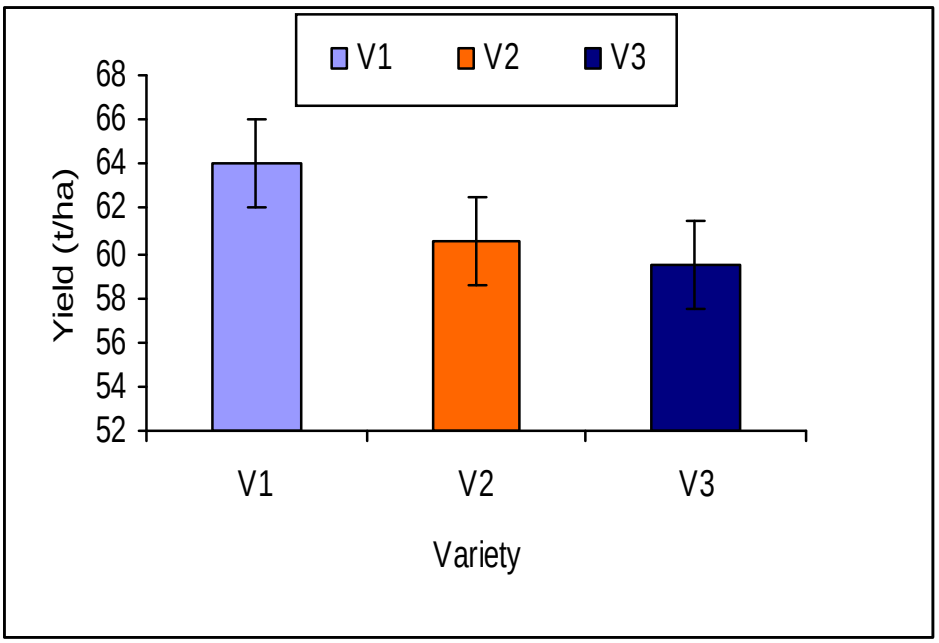


Fig : 7. Effect of organic manures on yield of tomato

V_1 = BARI tomato 15, V_2 = BARI tomato 14 andV_3 = BARI tomato 2

Assessment the shelf life of tomato

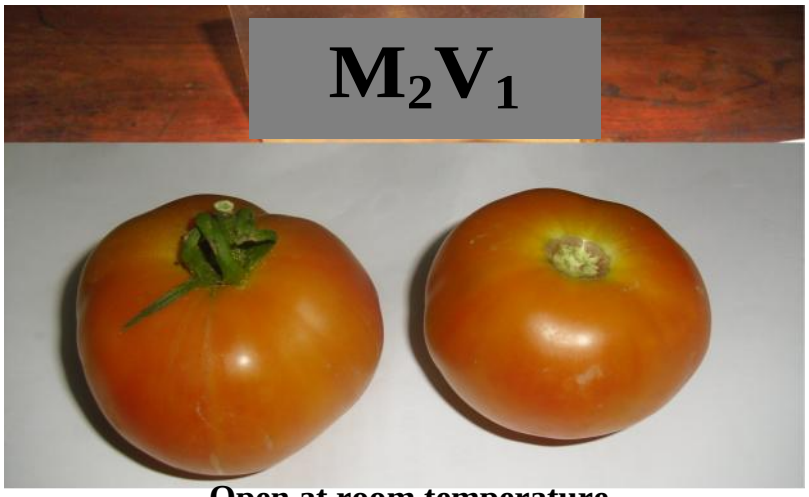
Almost all vegetable are known to exhibit a rise in respiration after harvest. A high rate of respiration deteriorates the storage quality of vegetable. Post-harvest changes take place rapidly in tomato and make it unsuitable for consumption if appropriate storage conditions are not maintained (Fig. 8).

Organic manures exhibited a significant influence on shelf life of tomato at different storage conditions viz., open at room temperature, polyethylene bag at room temperature and polyethylene bag at refrigerator (Appendix VIII & Table 9).

Shelf life of tomato in open at room temperature in half ripen condition ranged from 4.00 to 12.00 days and in open at room temperature in full ripen condition ranged from 2.00 to 8.80 days. In half ripen condition the maximum shelf life (12.00 days) of tomato was found in M_2 (Poultry manure) and minimum (4.00 days) was found in M_0 (control). In full ripen condition the maximum shelf life (8.80 days) of tomato was found in M_2 (Poultry manure) and minimum (2.00 days) was found in M_0 (control).).

Shelf life of tomato in polyethylene bag at room temperature in half ripens condition ranged from 7.00 to 15.47 days. And in full ripen condition ranged from 5.00 to 11.80 days. In half ripen condition the maximum shelf life (15.47 days) of tomato was found in M_2 (Poultry manure) and minimum (7.00 days) was found in M_0 (control). In full ripen condition the maximum shelf life (11.80 days) of tomato was found in M_2 (Poultry manure) and minimum (5.00 days) was found in M_0 (control).

Shelf life of tomato in polyethylene bag at refrigerator in half ripens condition ranged from 12.00 to 20.47 days and in full ripen condition ranged from 10.00 to 16.00 days. In half ripen condition the maximum shelf life (20.47 days) of tomato was found in M_2 (Poultry manure) and minimum (12.00 days) was found in M_0 (control). In full ripe condition the maximum shelf life (16.00 days) of tomato was found in M_2 (Poultry manure) and minimum (10.00 days) was found in M_0 (control).



Open at room temperature

Polyethylene bag at room temperature (24^0C)

Polyethylene bag at refrigerator (10^0C)

Plate 1. Post harvest analysis

Different varieties exhibited a significant influence on shelf life of tomato at different storage conditions, viz. open at room temperature, polyethylene bag at room temperature and polyethylene bag at refrigerator (Appendix VIII Table 10).

Shelf life of tomato in open room temperature in half ripen condition ranged from 5.15 to 11.40 days and in open room temperature in full ripen condition ranged from 2.48 to 8.90 days. In half ripen condition the maximum shelf life (11.40 days) of tomato was found in V_1 (BARI tomato 15) and minimum (5.15 days) was found in V_3 (BARI tomato 2). In full ripen condition the maximum shelf life (8.90 days) of tomato was found in V_1 (BARI tomato 15) and minimum (2.48 days) was found in V_3 (BARI tomato 2).

Shelf life of tomato in polyethylene bag at room temperature in half ripen condition ranged from 8.40 to 14.32 days and in full ripen condition ranged from 5.40 to 11.90 days. In half ripen condition the maximum shelf life (14.32 days) of tomato was found in V_1 (BARI tomato 15) and minimum (8.40 days) was found in V_3 (BARI tomato 2). In full ripen condition the maximum shelf life (11.90 days) of tomato was found in M_2 (Poultry manure) and minimum (5.40 days) was found in V_3 (BARI tomato 2).

Shelf life of tomato in polyethylene bag at refrigerator in half ripen condition ranged from 13.40 to 19.33 days and in full ripen condition ranged from 10.40 to 16.90 days. In half ripen condition the maximum shelf life (19.33 days) of tomato was found in V_1 (BARI tomato 15) and minimum (13.40 days) was found in V_3 (BARI tomato 2). In full ripen condition the maximum shelf life (16.90 days) of tomato was found in M_2 (Poultry manure) and minimum (10.40 days) was found in V_3 (BARI tomato 2).

Table 9. Effect of different levels of organic manure and storage condition on shelf life (days) of tomato

Treatments	Storage condition on shelf life (days) of tomato					
	Open at room temperature (24^0C)		Polyethylene bag at room temperature (24^0C)		Polyethylene bag at refrigerator (10^0C)	
	Period (days)		Period (days)		Period (days)	
	Half ripe	Full ripe	Half ripe	Full ripe	Half ripe	Full ripe
M_0	4.00 d	2.00 c	7.00 d	5.00 c	12.00 d	10.00 c
M_1	7.30 c	5.30 b	10.20 c	8.30 b	15.20 c	13.30 b
M_2	12.13 a	8.80 a	15.47 a	11.80 a	20.47 a	16.80 a
M_3	9.00 b	6.44 b	12.00 b	9.33 b	17.00 b	14.33 b
LSD $_{(0.05)}$	1.69	1.69	1.69	1.69	1.69	1.693
CV (%)	5.54	6.21	7.21	6.32	6.54	6.24

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance

Where, M_0 = Control, M_1 = Cow dung, M_2 = Poultry manure and M_3 = Vermicompost

Table 10 . Effect of different levels of variety and storage condition on shelf life (days) of Tomato

Treatments	Storage condition on shelf life (days) of tomato.					
	Open at room temperature (24^0C)		Polyethylene bag at room temperature (24^0C)		Polyethylene bag at refrigerator (10^0C)	
	Period (days)		Period (days)		Period (days)	
	Half ripe	Full ripe	Half ripe	Full ripe	Half ripe	Full ripe
V_1	11.40 a	8.90 a	14.32 a	11.90 a	19.33 a	16.90 a
v_2	7.77 b	5.52 b	10.77 b	8.52 b	15.77 b	13.52 b
V_3	5.15 c	2.48 c	8.40 c	5.40 c	13.40 c	10.40 c
LSD $_{(0.05)}$	1.69	1.69	1.69	1.69	1.69	1.69
CV (%)	5.54	6.21	7.21	6.32	6.54	6.24

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance

Where, V_1= BARI tomato 15, V_2= BARI tomato 14, and V_3= BARI tomato 2.

Among the three storage condition it was found that the shelf life of tomato increased in the polyethylene bag at refrigerator condition. This could be due the effect of low temperature in refrigerator. Low temperature minimizes the respiration of tomato as well as polyethylene bag also minimize the respiration process. The positive effect of polymeric film was also reported by Dennis, *et al*. (1979).

Combined application of variety and organic manure exhibited a significant influence on shelf life of tomato at different storage conditions, viz. open at room temperature, perforated polyethylene bag at room temperature and polyethylene bag at refrigerator (Table 11 & Appendix VIII). Shelf life of tomato in open at room temperature in half ripen condition ranged from 3.00 to 15.80 days and in full ripen condition ranged from 1.00 to 12.80 days. The maximum shelf life in half ripen (15.80 days) of tomato was found in M_2V_1 which was statistically similar to that of $M_3V_1$and the minimum (3.00 days) was found in M_0V_3.

Table 11. Combined effect of variety, organic manure, stage of maturity and Storage condition on shelf life (days) of tomato

Treatment	Storage condition on shelf life (days) of tomato					
	Open at room temperature (24^0C)		Polyethylene bag at room temperature (24^0C)		At refrigerator (10^0C)	
	Period (days)		Period (days)		Period (days)	
	Half ripe	Full ripe	Half ripe	Full ripe	Half ripe	Full ripe
M_0V_1	5.00 e	3.00 d	8.00 e	6.00 d	13.00 e	11.00 d
M_0V_2	4.00 ef	2.00 de	7.00 ef	5.00 de	12.00 ef	10.00 de
M_0V_3	3.00 f	1.00 e	6.00 f	4.00 e	11.00 f	9.00 e
M_1V_1	10.30 bc	8.30 b	13.00 c	11.30 b	18.00 c	16.30 b
M_1V_2	7.30 d	5.30 c	10.30 d	8.30 c	15.30 d	13.30 c
M_1V_3	4.30 ef	2.30 de	7.30 ef	5.30 de	12.30 ef	10.30 de
M_2V_1	15.80 a	12.80 a	18.80 a	15.80 a	23.80 a	20.80 a
M_2V_2	11.80 b	8.80 b	14.80 b	11.80 b	19.80 b	16.80 b
M_2V_3	8.800 cd	4.80 c	12.80 c	7.80 c	17.80 c	12.80 c
M_3V_1	14.50 a	11.50 a	17.50 a	14.50 a	22.50 a	19.50 a
M_3V_2	8.00 d	6.00 c	11.00 d	9.00 c	16.00 d	14.00 c
M_3V_3	4.50 ef	1.83 de	7.50 ef	4.50 de	12.50 ef	9.50 de
LSD $_{(0.05)}$	1.69	1.69	1.693	1.693	1.69	1.693
CV (%)	5.54	6.21	7.21	6.32	6.54	6.24

Means in the column followed by different letter(s) differed significantly by DMRT at 5% levels of significance.

Where, M_0 = Control, M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost; V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2.

Shelf life of tomato in polyethylene bag at room temperature in half ripens condition ranged from 6.00 to 18.80 days. The maximum shelf life (18.80 days) of tomato was found in M_2V_1 which was statistically similar to that of M_3V_1 and the minimum (6.00 days) was found in M_0V_3. Shelf life of tomato in polyethylene bag at room temperature full ripens condition ranged from 4.00 to 15.80 days. The maximum shelf life (15.80 days) of tomato was found in M_2V_1 which was statistically similar to that of M_3V_1 and the minimum (4.00 days) was found in M_0V_3.

Shelf life of tomato in polyethylene bag at refrigerator in half ripens condition ranged from 11.00 to 23.80 days. The maximum shelf life (23.80 days) of tomato was found in M_2V_1 which was statistically similar to that of M_3V_1 and the minimum (11.00 days) was found in M_0V_3. Shelf life of tomato in polyethylene bag at refrigerator in full ripens condition ranged from 9.00 to 20.80 days. The maximum shelf life (20.80days) of tomato was found in M_2V_1 which was statistically similar to that of M_3V_1 and the minimum (9.00 days) was found in M_0V_3.

It was revealed that the shelf life of tomato increased dependent with different organic manures (M) and varieties (V) application in all the three storage condition. Among the three storage condition it was found that the shelf life of tomato increased in the polyethylene bag at refrigerator condition. This could be due the effect of low temperature in refrigerator. Low temperature minimizes the respiration of tomato as well as polyethylene bag also minimize the respiration process. Similar results reported by Beard (1990) and suggested that application of organic manures in excess of 180 kg/ha must be avoided for better storage in cabbage.

13. Economic analysis

Input costs for land preparation, seed cost, fertilizer, irrigation and man power required for all the operations from sowing to harvesting of tomato were recorded for unit plot and converted into cost per hectare (Appendix VIII & Table 12). Price of tomato was considered in market of Gorgon, Dhaka 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 the following headings:

4.13.1 Gross return

In the combination of organic manures and variety showed different gross return under the trial (Table 12). The highest gross return (Tk. 431250) per hectare was recorded from M_2V_1 (Poultry manure and BARI tomato 15) and the second highest gross return (Tk. 364600)) was recorded from M_2V_3 (Poultry manure and BARI tomato 2). The lowest gross return (Tk. 156250) was recorded from M_0V_1 treatment combination no fertilizer and BARI tomato 15.

4.13.2 Net return

In case of net return different treatment combination showed different amount of net return. The highest net return (Tk.286705 tk.) was recorded from M_2V_1 and the second highest net return (Tk.220055 tk.) was recorded from M_2V_3. The lowest net return (Tk.45155) was recorded from M_0V_1 (Table 12).

14.13.3 Benefit cost ratio

The combination of organic manures and variety for benefit cost ratio was different for treatment combination (Table 12). The highest (2.98) benefit cost ratio was recorded from M_2V_1 and the lowest benefit cost ratio (1.41) was recorded from M_3V_3. From economic point of view, it was apparent from the above results treatment combination of M_2V_1 was more profitable compare to others.

Table 12. Cost and return in tomato production as influenced by organic manures and variety

Treatment Combination	Total cost of production (Tk./ha) [Input cost (A) + overhead cost (B)]	Yield (t/ha)	Gross income (Tk)	Net Return (Tk.)	Benefit cost Ratio (BCR)
M_0V_1	111095	49.17	156250	45155	2.21
M_0V_2	111095	42.92	214600	103505	1.93
M_0V_3	111095	31.25	245850	134755	1.47
M_1V_1	133395	49.58	247900	114505	1.86
M_1V_2	133395	57.92	289600	156205	2.17
M_1V_3	133395	62.5	312500	179105	2.34
M_2V_1	144545	86.25	431250	286705	**2.98**
M_2V_2	144545	70.42	352100	207555	2.44
M_2V_3	144545	72.92	364600	220055	2.52
M_3V_1	241550	71.25	356250	111355	1.45
M_3V_2	244895	70.83	354150	109255	1.45
M_3V_3	244895	71.25	356250	114700	1.41

Price of tomato@ Tk. 5,000 per ton

Where, M_0 = Control, M_1 = Cowdung, M_2 = Poultry manure and M_3 = Vermicompost ; V_1 = BARI tomato 15, V_2 = BARI tomato 14 and V_3 = BARI tomato 2 .

CHAPTER V

SUMMERY AND CONCLUSION

In field experiment was conducted in the Horticultural farm and laboratory of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka -1207 during the period from October 2010 to March 2011 to asses the shelf-life of tomato. Two factors were used in the experiment, viz. factor A : four types of organic manure such as M_0=Control (No organic manure application), M_1= Cowdung (20 t/ha), M_2 = Poultry manure (16 t/ha) and M_3 = Vermicompost (14 t/ha), factor B: varieties such asV_1 = BARI tomato 15, V_2=BARI tomato 14 and V_3 = BARI tomato 2. The experiment was laid out in two factors Randomized complete Block Design (RCBD) with three replications. Data on different yield contributing characters and yield were recorded.

At final harvest, the highest plant (83.90 cm) was obtained from M_2, while the lowest (67.44 cm) was recorded from M_0. The maximum (57.20) number of leaves per plant was recorded from M_2 and the minimum (49.79) was found from M_0 at final harvest. The maximum number of flower clusters per plant (9.74) was recorded from M_2 (Poultry manure), while the minimum (8.27) was obtained from M_0 (Control treatment). The maximum number of flower per cluster (9.24) was recorded from M_2 (Poultry manure), while the minimum (8.41) was obtained from control (M_0). The maximum number of flowers per plant (58.25) was recorded from M_2 (Poultry manure), while the minimum (36.11) was obtained from control treatment (M_0). The maximum (42.07) number of fruits per plant was recorded from M_2 (Poultry manure), while the minimum (26.83) was recorded from M_0 (Control). The maximum length of individual fruit (7.97 cm) was recorded from M_2 (Poultry manure), while the minimum (6.29 cm) was recorded from M_0 (Control). The maximum (10.43 cm) diameter of individual fruit was recorded from M_2 (Poultry manure), while the minimum (8.84 cm) was recorded from M_0 (Control treatment). The maximum (123.33 g) weight of individual fruit was recorded from M_2 (Poultry manure), while the minimum (91.69 g) was found from M_0 (Control treatment). The maximum (2.06

kg/plant) yield was recorded from M_2 (Poultry manure), while the minimum (91.69 g) was found from M_0 (Control treatment). M_0 (Control treatment). The maximum M_0 (Control treatment). (2.o6 kg/plant)yield was recorded from M_2 (Poultry manure), while the minimum (0.99 kg/plant) was found from M_0 (Control treatment). The maximum (44.08 kg/plot) yield was recorded from M_2 (Poultry manure), while the minimum (23.68 kg/plot) was recorded from M_0 (Control treatment). The maximum (67.36 t/ha) yield was obtained from M_2 (Poultry manure), while the minimum (50.56 t/ha) was recorded from M_0 (Control treatment).

At final harvest, the highest plant (78.12 cm) was recorded from V_1 (BARI Tomato 15), while the lowest (71.88 cm) was recorded from V_3 (BARI Tomato 2). The maximum (54.62) number of leaves per plant was recorded from V_1 while the minimum (52.81) number of leaves per plant was recorded from V_3 at harvest. The maximum number of flower cluster per plant 10.61) was recorded from V_1 (BARI Tomato 15) and the minimum number of flower cluster per plant (7.49) was obtained from V_3 (BARI Tomato 2). The maximum number of flower per cluster (10.52) was recorded from V_1 (BARI Tomato 15) and the minimum number of flowers per cluster (7.07) was found from V_3 (BARI Tomato 2). The maximum number of flower per plant (48.05) was recorded from V_1 (BARI Tomato 15) and the minimum number of flower per plant (44.47) was found from V_3 (BARI Tomato 2). The maximum (36.65) number of fruit per plant was recorded from V_1 (BARI Tomato 15) and the minimum (31.63) number of fruits per plant was observed in V_3 (BARI Tomato 2). The maximum (7.66 cm) length of individual fruit was recorded from V_1 (BARI Tomato 15) and the minimum (6.66 cm) length of individual fruit was obtained from V_3 (BARI Tomato 2). The maximum (10.18 cm) diameter of individual fruit was recorded from V_1 (BARI Tomato 15) and the minimum (9.18 cm) diameter of individual fruit was obtained from V_3 (BARI Tomato 2). The maximum (134.58 g) weight of individual fruit was recorded from V_1 (BARI Tomato 15) and the minimum (99.18 g) weight of individual fruit was recorded from V_3 (BARI Tomato 2). The maximum (1.75 kg/plant) yield was recorded from V_1 (BARI Tomato 15) and the minimum (1.37 kg/plant) yield was obtained from V_3 (BARI Tomato 2). The

maximum yield (63.85 t/ha) was recorded from V_1 (BARI Tomato 15) and the minimum yield (59.48t /ha) was recorded from V_3 (BARI Tomato 2).

At harvest, the maximum plant height (97.80 cm) was recorded from the treatment combination M_2V_1 whereas the minimum (58.90 cm) was recorded from the treatment combination of M_0V_3. The maximum (62.82) number of leaves per plant was recorded from the treatment combination 0f M_2V_1 whereas the minimum (43.91) was recorded from the treatment combination of M_0V_3 At harvest. The maximum number of flower cluster per plant (11.64) was recorded from the treatment combination of M_2V_1 (Poultry manure + BARI Tomato15), while the treatment combination of M_0V_1 (Control + BARI Tomato 15) gave the minimum (6.34) number of flower clusters per plant. The maximum number of flower per cluster (11.43) was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination M_2V_3 (Poultry manure + BARI Tomato 2) gave the minimum number of flowers per cluster (5.58). The maximum number of flower per plant (91.16) was recorded from the treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control +BARI Tomato 2) performed the minimum number of flower per plant (26.40). The maximum (55.91) number of fruit per plant was recorded from the treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 (Control +BARI Tomato2) gave the minimum (15.70) number of fruits per plant. The maximum (10.94cm) length of individual fruit was recorded from the treatment combination of M_2V_1 (Poultry manure + BARI tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) performed the minimum (4.08 cm) length of individual fruit. The maximum (13.31 cm) diameter of individual fruit was recorded from treatment combination of M_2V_1 (Poultry manure +BARI Tomato 15), while the treatment combination of M_0V_3 (Control treatment + BARI Tomato 2) gave the minimum (6.60 cm) diameter of individual fruit. The maximum (176.66 g) weight of individual fruit was recorded from treatment combination of M_2V_1 (Poultry manure + BARI Tomato 15), while the treatment combination of M_0V_3 performed the minimum (73.41g) weight of individual fruit.

The maximum (2.07 kg/plant) yield was recorded from treatment combination of M_2V_1 while the treatment combination M_0V_3 gave the minimum yield (0.75 kg/plant). The maximum (49.64kg/plot) yield was recorded from treatment combination of M_2V_1 while the treatment combination of M_0V_3 gave the minimum yield (18.00 kg/plot). The maximum yield (86.25 t/ha) was recorded from treatment combination of M_2V_1 while the treatment combination of M_0V_3 gave the minimum yield (31.25 t/ha).

In case of storage conditions Tomato kept in polyethylene bag in refrigerator in half ripe at 10^0C showed highest shelf life (23.80 days) while the lowest shelf life (1.00 days) was observed when the tomato were open at room temperature without polyethylene bag in full ripe condition.

The maximum cost of production (Tk. 244895.00) was involved in the treatment combination Vermicompost and BARI Tomato 2 and minimum cost of production (Tk. 111095.00) was involved in no manure and BARI Tomato 15.The highest gross income (Tk. 431250.00) was found from the treatment combination of Poultry manure and BARI Tomato 15 and the lowest gross income (Tk. 156250.00) was obtained from the treatment combination no manure and BARI Tomato 15. Poultry manure and BARI Tomato 15 gave the highest net return (Tk.286705.00) and the lowest net return (Tk. 45155.00) was recorded from the treatment combination no manure with BARI Tomato 15. The highest benefit cost ratio (2.98) was obtained from the treatment combination of poultry manure and BARI Tomato 15 and the lowest benefit cost ratio (1.41) was found from the treatment combination of vermicompost with BARI Tomato 2.

The following conclusions could be drawn:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performances;

2. Another Organic manure may be included in the future program;

3. Among the storage condition, the highest shelf life of tomato was observed when the fruit was harvested at half ripe condition and kept in polyethylene bag in refrigerator at 10^0 c.

4. Another varieties may be included in the further program before final recommendation.

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APPENDICES

Appendix I. Monthly average temperature, relative humidity and total Rainfall of the experimental site during the period from September 2010 to 2011

Month	Air temperature (^{0}C)		R. H. (%)	Total rainfall (mm)
	Maximum	Minimum		
October ,10	29.18	18.26	81	39
November,10	25.82	16.04	78	0
December,10	22.4	13.5	74	0
January,11	24.5	12.4	68	0
February ,11	27.1	16.7	67	3
March ,11	31.4	19.6	54	11

Source: Bangladesh Metrological Department, Climate and weather division Agargaon, Dhaka

Appendix II. Results of mechanical and chemical analysis of soil of experimental plot

A. Morphological Characteristics

Morphological features	characteristics
Location	Horticulture Garden, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land Type	Medium high land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood Level	Above flood level
Drainage	Well drained

B. Mechanical analysis

Constituents	Percent
Sand	27
Silt	43
Clay	30

C. Chemical analysis

Soil properties	Amount
Soil pH	5.8
Organic carbon (%)	0.45
Total nitrogen (%)	0.03
Available P (ppm)	20
Exchangeable K (%)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix-III. Analysis of variance of data on plant height at different DAT of tomato

Source of variation	Degrees of freedom (df)	Mean square of plant height (cm) at			
		30 DAT	45 DAT	60 DAT	Final harvest
Factor A (Organic manures)	3	230.29**	421.57**	501.98**	413.99*
Factor B (Varieties)	2	54.20*	.8539*	75.89 *	146.90*
Interaction (A X B)	6	528.92**	561.43**	527.95**	541.52*
Error	22	522.43	66.54	51.78	11.69

** : Significant at 0.01 level of probability; * : Significant at 0.05 level of probability

Appendix-IV. Analysis of variance of data on leaf number at different DAT of tomato

Source of variation	Degrees of freedom (df)	Mean square of leaf number at			
		30 DAT	45 DAT	60 DAT	Final harvest
Factor A (Organic manures)	3	0.19**	70.77**	263.31**	84.15*
Factor B (Varieties)	2	3.64*	21.70*	21.71*	10.55*
Interaction (A X B)	6	40.71**	202.14**	201.66**	151.40*
Error	22	4.20	3.65	4.45	78.00

Appendix-V. Analysis of variance of data on yield characteristics of tomato

Source of variation	Degrees of freedom (df)	Mean square of			
		Number of flower cluster /plant	Number of Flower/ cluster	Number of Flower/ Plant	Number of Fruit/ plant
Factor A (Organic manures)	3	235.27*	26.38 NS	772.22*	315.85**
Factor B (Varieties)	2	69.53 **	37.16*	38.82 NS	19.54 NS
Interaction (A X B)	6	464.45 **	523.58*	1872.77*	96.27 **
Error	22	20.51	23.24	132.10	14.21

** : Significant at 0.01 level of probability; * : Significant at 0.05 level of probability

NS: No significant

Appendix- V. (cont'd)

Source of variation	Degrees of freedom (df)	Mean square of			
		Length of individual fruit	Diameter of individual fruit	individual fruit weight	Yield/ plant (kg)
Factor A (Organic manures)	3	5.24**	5.22NS	2043.37*	1.74**
Factor B (Varieties)	2	3.21*	37.13.26 NS	4049.53**	0.45**
Interaction (A X B)	6	23.62**	23.54*	1371.92**	0.54**
Error	22	0.142	1.08	4101.40	0.77

** : Significant at 0.01 level of probability; * : Significant at 0.05 level of probability

Appendix- V. (cont'd)

Source of variation	Degrees of freedom (df)	Mean square of			
		Yield /plot (kg)	Yield (t/ha)	Dry mater of fruit (%)	Dry mater of leaf (%)
Factor A (Organic manures)	3	183.53**	203.37**	185.81*	142.76*
Factor B (Varieties)	2	21.79 NS	1222.67**	114,83*	73.54*
Interaction (A X B)	6	218.67**	1398.79**	585.53*	398.17*
Error	22	71.21	578.88	36.78	18.83

** : Significant at 0.01 level of probability; * : Significant at 0.05 level of probability

NS: No significant

Appendix-VI. Analysis of Variance of data on stage of maturity and storage condition on shelf life of tomato

Treatment	Degrees of freedom	Storage condition on shelf life (days) of tomato					
		Open at room temperature (24^0C)		Polyethylene bag at room temperature (24^0C)		At refrigerator (10^0C)	
		Half ripe	Full ripe	Half ripe	Full ripe	Half ripe	Full ripe
Factor A	3	92.80**	72.92**	83.72**	56.77**	97.25**	68.37**
Factor B	2	0.10*	3.18*	0.39*	1.32*	0.27 *	1.29*
Interaction (A X B)	6	0.713**	6.40**	3.05**	3.56**	2.90**	4.59**
Error	22	10.238	10.345	11.641	12.29	12.313	13.877

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix- VII. Input cost									
Treatments	Labour	Ploughing	Seedling cost	Irrigation	Pesticides cost (TK.)	Manure and fertilizers cost (TK.)			Sub Total
Combination	Cost (TK.)	Cost (TK.)	(TK.)	Cost (TK.)		Cow dung	Poultry manure	Vermi compost	(A)
M_0V_1	20000	10000	5000	8000	10000	0	0	0	53000
M_0V_2	20000	10000	5000	8000	10000	0	0	0	53000
M_0V_3	20000	10000	5000	8000	10000	0	0	0	53000
M_1V_1	20000	10000	5000	8000	10000	20000	0	0	73000
M_1V_2	20000	10000	5000	8000	10000	20000	0	0	73000
M_1V_3	20000	10000	5000	8000	10000	20000	0	0	73000
M_2V_1	20000	10000	5000	8000	10000	0	30000	0	83000
M_2V_2	20000	10000	5000	8000	10000	0	30000	0	83000
M_2V_3	20000	10000	5000	8000	10000	0	30000	0	83000
M_3V_1	20000	10000	5000	8000	10000	0	0	120000	173000
M_3V_2	20000	10000	5000	8000	10000	0	0	120000	173000
M_3V_3	20000	10000	5000	5000	10000	0	0	120000	170000

Appendix- VIII. Total cost of production

Treatments Combination	Cost of lease of land for 6 months (13% of value of land Tk. 8,00000/year	Interest on running capital for 6 months(Tk. 13% of cost/year	Miscellaneous cost(Tk. 5% of the input cost	Sub Total Cost of production (B)	Total Cost of production (A+B)
M_0V_1	52000	3445	2650	58095	111095
M_0V_2	52000	3445	2650	58095	111095
M_0V_3	52000	3445	2650	58095	111095
M_1V_1	52000	4745	3650	60395	133395
M_1V_2	52000	4745	3650	60395	133395
M_1V_3	52000	4745	3650	60395	133395
M_2V_1	52000	5395	4150	61545	144545
M_2V_2	52000	5395	4150	61545	144545
M_2V_3	52000	5395	4150	61545	144545
M_3V_1	52000	11245	8650	71895	244895
M_3V_2	52000	11245	8650	71895	244895
M_3V_3	52000	11050	8500	71550	241550