EFFECT OF POULTRY MANURE AND MULCHING ON GROWTH AND YIELD OF TOMATO

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EFFECT OF POULTRY MANURE AND MULCHING ON GROWTH AND YIELD OF TOMATO

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CERTIFICATE

This is to certify that thesis entitled, **"EFFECT OF POULTRY MANURE AND MULCHING ON GROWTH AND YIELD OF TOMATO"** submitted to the Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M. S.) in HORTICULTURE**, embodies the result of a piece of *bona fide* research work carried out by **MST. MARZIA BEGUM**, Registration No. **10-02519** 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 duly been acknowledged.

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ABSTRACT

A field experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October 2012 to March 2013 to study the effect of different doses of poultry manure and mulching on the growth and yield of tomato. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three

replications and consisted of two factors, Factor A:(Four doses of poultry manure), viz: P_0 = Control, P_1 = 5 t/ha, P_2 = 7.5 t/ ha and P_3 = 10 t/ha and Factor B: (Three types of mulching), viz: M_0 = Control, M_1 = Black Polythene and M_2 = Rice Straw respectively. Application of different doses of poultry manure and mulches influence independently and also in combination on the growth and yield of tomato. The highest marketable fruit yield (82.91 t/ha) was obtained from P_2 which was significantly different from other treatments, and the lowest yield (60.27 t/ha) was from P_0. The highest marketable fruit yield (81.10 t/ha) was found from M_1, while the lowest yield (64.20 t/ha) was from M_0. In case of combined effect, the highest (95.41 t/ha) yield was obtained from P_2M_1 and the lowest (54.16 t/ha) was from P_0M_0. The highest BCR (2.39) was from P_2M_1 and the lowest (1.21) from P_0M_0. So, 7.5 t//ha poultry manure with black polythene was the best for growth and yield of tomato.

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ABBREVIATIONS AND ACRONYMS

DAT	= Days after Transplanting
SRDI	= Soil Resources Development Institute
AEZ	= Agro-Ecological Zone
LSD	= Least Significant Difference
CV	= Coefficient of Variation
ANOVA	=Analysis of Variance
df	= Degrees of freedom

CHAPTER I

INTRODUCTION

Tomato (Lycopersiconesculentum Mill.) is a solanaceous self pollinated vegetable crop. Tomato fruit can be consumed either fresh, cooked or in the form of processed products such

as jam, jelly, juice, ketchup, sauce etc. It is considered as ‘poor man’s apple’ because of its attractive appearance and very high nutritive value, containing vitamin A, vitamin C and minerals like calcium, potassium etc. It is much popular for consumption as salad in the raw state and as processed soups, juice, ketchup, pickles, sauces and other products.

Tomato is mostly grown in Bangladesh during the months from October to March, when rainfall is scare, and about 20-50 mm of soil moisture is exhausted by evapotranspiration. But irrigation facilities are not sufficient in all the regions of the country. Sometimes pumps cannot lift water in dry season due to low water table. On the other hand, successful tomato cultivation largely depends on the judicious application of manures and fertilizers, efficient use of available soil moisture, spacing, time of planting, weed control etc. Out of these factors, efficient use of soil moisture is very important. Rainfall is scanty during tomato cultivation in Bangladesh when growers have to depend either on natural precipitation or irrigation for tomato cultivation. Under this situation indigenous mulching could be a good substitute for irrigation such as straw, rice husk, water hyacinth, crop residues are generally practiced in the production of horticultural crops.

Mulch regulates soil temperature, creates suitable condition for germination, improves soil moisture, suppresses weed growth, saves labor cost (Patil and Basod, 1972) and improves soil physical conditions by enhancing biological activity of soil fauna and thus increases soil fertility which ultimately increases the yield of tomato. Black polyethylene mulch is the standard plastic mulch used in vegetable production. Researchers using black plastic instead of bare soil have recorded higher yields at earlier harvests. Perry and Sanders (1986) reported the black polythene for early and total yield of large and total marketable fruit of tomato. Black mulch effectively stops weed growth by intercepting nearly all-incoming radiation. Mulching is used principally as moisture conservation practice which not only reduces the number of irrigations required but has other benefits like increasing the root zone temperature and improving the nutrient uptake.

This higher yield with black polyethylene mulch may be owing to complete elimination of weeds, higher soil moisture availability and better soil temperature during crop season. Fertilizers are substances which when added to the soil supply one or more plant nutrients. Organic manure (OM) improves soil structure, water, air and nutrient retention in the soil, buffers soil chemical imbalances, supports living organisms, etc . Poultry manure is a source of organic material that enriches the soil; it does not only increase the nutrient status of the soil but improves the soil structure. Poultry manure contains high percentage of

nitrogen and phosphorus for the healthy growth of plants (Ewulo, 2005). Poultry manure application improves the physical properties of the soil. Addition of poultry manure has been shown to improve the fertility of the cultivated soil by increasing the organic matter content, water holding capacity, oxygen diffusion rate and the aggregate stability of the soils (Mahimairaja *et al*., 1995a; Adeli *et al*., 2009). Large quantities of organic wastes such as poultry manure are available especially in urban centers and are an effective source of nutrients for vegetables such as tomato (Adediran *et al*., 2003).

Therefore, in accordance with recent agriculture to increase yield vertically, an attempt was made to study the effects of different doses of poultry manure and mulches on plant growth and yield of tomato with the following objectives**:**

i. To standardize the poultry manure dose for the maximum yield of tomato.
ii. To evaluate the effect of different types of mulch materials on growth and yield of tomato
iii. To find out the suitable combination of poultry manure with mulch practice for higher yield of tomato.

CHAPTER II

REVIEW OF LITERATURE

Tomato is one of the most popular and quality vegetables grown in Bangladesh, which received much attention to the researchers throughout the world. Tomato is one of the most important vegetable crops grown under field and greenhouse condition, which received much attention- to the researchers throughout the world. Numerous investigators in various parts of the world have investigated the response of tomato at different levels of poultry dropping and mulching practices for its successful cultivation. However, the available research findings in this connection over the world have been reviewed in this chapter under the following headings.

Effect of mulch

Effect of mulching on growth and yield of tomato

Mulches have various effects on the plant growth and yield. Many researchers noted that plants were greatly influenced by mulching.

Vazquez *et al*., (2006) reported that high irrigation frequency ensured appropriate soil water content at planting, and reduced both the amount of water applied and lost by drainage to actual needs of dreep irrigated tomato under plastic mulching conditions.

Rastiano *et al.,* (2006) observed that straw mulching enhanced microbial biomass, activity and potential N availability by 42, 64 and 30% respectively, relative to none mulched soils via improving C and water availability for soil microbes.

Akintoye *et al*., (2005) reported that the use of mulches in vegetable production is undergoing a radical change away from high input, nonrenewable resources, such as plastic, to the use of high residue organic mulches from cover crops. The purpose of this study was to compare the yield of three tomato varieties when grown under different live mulches.

Dharmesh-gupta *et al.,* (2005) studies the efficiency of blue, yellow, white, green and black polythene mulches in tomato leaf curl virus in infecting tomatoes in the field experiment in Himachal Pradesh, India 1997-1998. Mulching with yellow polythene film resulted in the lowest disease incidence and highest crop yield.

Singh *et al.* (2005) conducted an experiment on the effect of transplanting time and mulching on growth and yield of tomato in Abohar, Punjab, In diaduring the winter of (1998-200) to study the effect of transplanting time(10 and 30 December, and 20 January) and mulching (black and clear polythene, sugarcane trash and rice straw) on the growth and yield of tomato cv. Rupali. Early planting (10 December) resulted in the height vegetative growth, yield attributes, early and total fruit yield, whereas the lowest values for the parameters measured were lowest with 20 January transplanting. Among different mulching materials, black polythene retained higher soil moisture and temperature compared to another mulching materials and the control. Fruit yield was also highest with black polythene mulching. The highest net returns (Rs.52700/ha) were recorded with transplanting 10 December and mulching with black polythene treatment combination, which was significantly superior to all other treatment combinations.

Experiment on the effect of transparent polythene mulching and different planting densities on tomato grown for processing on Sicily. Tomato cultivation is steadily increasing in Sicilian countryside (Italy) where careful management of clay soils allows successful yields. The study was to verify the effects of transparent polythene mulching vs. bare soil and of three different plant densities' (0.74, 1.1 or 2.2 plants/ $m^{2)}$ on a tomato crop in a Sicilian countryside. Applying PE mulch and planting at a density of 2.2 plants/ m resulted in highest yield (58.6) tones/ha. The lowest production (15 tones/ha) was obtained on bear soil and by planting at a density of 0.74 plants/m^2.

Incalcaterra*et al* (2004) carried out an experiment on the effect of transparent polythene mulching and different planting densities on tomato grown for processing on Sicily. Tomato cultivation is steadily increasing in Sicilian countryside(Italy) where careful management of clay soils allows successful yields. The study was to verify the effects of transparent polythene mulching vs bare soil and of three different plant densities(0.74,1.1 or 2.2 plants/ $m^{2)}$ on a tomato crop in a Sicilian countryside. Applying PE mulch and planting at a density of 2.2 plants/ mresulted in highest yield(58.6) tones/ha. The lowest production(15 tones/ha) was obtained on bear soil and by planting at a density of 0.74 plants/m^2.

Ghorbani (2004) reported that plastic mulch is an effective way to conserve water in soil reservoir so that it can be taken up gradually by plants. The plastic mulch was used with furrow irrigation on cucumber and tomato yield, in the yield, at flowering and production stage. Using plastic mulch in conjunction with furrow irrigation system increased moisture retention by 75%, whereas no conservation was observed with black polythene mulch. Considerable yield increases (60 and 49%) and (66 and 47%) were achieved for tomato and cucumber crops under both clear and black plastic mulches respectively at flowering and production stage.

Radics and Bongar (2004) observed that mulching provides weed control and reduces evaporation. Eight types of mulches were examined for weed control and their effect on green bean (*Phaseolus*vulgaris*)* and tomato yields. Plastic sheet, paper mulch and straw mulch showed the best results in weed control and tomato yield. The use of Plastic sheet, paper mulch grass clippings caused the lowest weed cover. However highest yield was found in paper mulched plots. As for green bean, weed control was higher in plastic sheet, paper mulch and straw mulch treated plots but was no significantly different from those in control treatments.

Vetrano *et al*., (2004) observed that the effect of transplant polythene (PE) mulching vs. bear soil and three different plant densities (0.74, 1.1, 2.2, plants/ m^2 on a tomato crop in a Sicilian countryside. Applying PE mulch and planting at a density of 2.2 plants/ m^2 resulted in the highest yield (58.6 t/ha). The lowest production (15 t/ha) was obtained on bear soil and by planting at a density of (0.74 plants/ m^2).

Aydin *et al*., (2003) studied the effects of reflective and black on the yield, quality and pest populations on tomato cv. DR 055 in Turkey during 200. The total yield reflective mulch, black and no mulch treatment were 122.85, 104.99 and 85.68 t/ha respectively. Earliness percentage was higher in the mulch treatments compared to the control. The highest color values were obtained in the reflective mulch treatment. The lowest pest population was observed in reflective mulch treatment.

Sannigrahi and Borath (2002) conducted field experiments in Assam, India to evaluate the effectiveness of different organic mulches including black polythene sheet on tomato production under rain fed conditions. The mulch treatment was black polythene sheet, rice straw, spent straw, water hyacinth (*Eichhornia crasipes*), thatch grass (*Imperata cylindraca*) and no mulch (control mulch). Mulching increase the tomato fruits per plant and had higher yield than the crop yield in both years. Water hyacinth mulch gave the highest increase in tomato yield by (91 %). The rate of weed emergence was low in tomato plots, while black polythene mulch was the most effective treatment for weed control (83.5).

Hudu *et al*., (2002) observed that plant height, number of flowers per plant, fruit sets per plant, number of fruits per plant and harvested total marketable fruit yield/ ha were significantly (0.05) higher in the mulch treated plots than unmulched control treatment. It was also observed that the optimum mulch thickness is at 7.5 t/ ha of grass material in this area in the terms effective weed suppression, better crop growth, optimum root temperatures and ultimate yield of tomato.

Hedau and Mahesh Kumar (2002) studied the effect of different mulches (black polythene, silver polythene, silver black polythene, pea straw and no mulch) on the productivity of tomato hybrid. Fruit yield was highest with silver black polythene mulch (76.42 t/ha), followed by black polythene mulch (73.51t/ha. The highest N uptake was recorded with a silver black polythene mulch (90.38 kg/ha), followed by black polythene mulch (89.82 kg/ha). This treatment was also recorded the lowest number of weeds (3.24 and 3.06/.5 m^2 respectively and the highest benefit cost ratio (2.82 and 2.66 respectively). Soil moisture retention was highest in pea straw mulch plots and lowest in unmulched plots.

Field experiment was conducted by Ramalan *et al*., (2000) during the dry season at the Irrigation Research, samara, Nigeria to evaluate water management options on the performance of tomato. The trial involved three furrow irrigation methods (conventional furrow, conventional furrow with cutback and alternate furrow), two mulch treatment (without mulch and straw mulch) and three irrigation schedules (5 days – interval, irrigation at 30 and 60 kPa soil moisture suction. The 18 treatments were laid out in split plot design in three replications. The irrigation methods were assigned to main plot while the mulch and irrigation schedule were in the sub plots. Days to 50% flowering and fruiting of tomato were unaffected by furrow irrigation methods. But the application of mulch and irrigation at the specified suction levels influenced the growth of tomato. The rice straw mulch and furrows significantly delayed the attainment of 50% fruiting by 6 days compared to the un-mulched plot. Fruit size at the age of 17, 19 and 21 weeks after planting, marketable fruit yield, crop water use efficiency was significantly affected by all three factors. Fruit weight was affected only by soil water suction. The interaction of furrow irrigation method, mulch and soil water suction had a significant effect on water use efficiency (WUE) of the crop. Use of alternate furrow method was statistically at par, in time of WUE with the conventional furrow method if it was mulched and irrigated at 5 days interval.

Ojeniyi *et al.,* (2000) was conducted an experiment on the effect of tillage and mulching on the growth and yield of tomato. The growth, development and yield of tomato grown on mulched and unmulched hand –hoed, raised beds and ridged sandy loam soil during the late copping seasons of 1994, 1995 and 1996 in Akure, Nigeria, were investigated. Hand hoaing reduced soil temperature conserved more soil temperature than ridging and raised bed while grass mulch increase soil temperature and soil moisture regime compared with ground. Root biomass and root and shoot ratio increased in the order ridging, raised bed and hand- hoaing while root biomass .leaf area/ plant and percentage fruit set decreased in order the raised bed ridging and hand hoaing. Number of fruit and fruit yield/plant produced by raised beds were significantly higher than those produced by ridging and hand hoeing. Mulch ameliorated the hydrothermal regime of the soil, improved the vegetative and flowering performance and significantly increased the fruit yield of tomato over bear ground.

Hooda *et al.* (1999) conducted an experiment on influence of direct seeding, transplanting time and mulching on tomato yield. The effect of the date of direct sowing or transplanting(15 December, 30 December, 16 January, 15 February) and mulching(black polythene, white polythene and sugarcane trash) on tomato were studied in Haryana, India during 1993-94 and 1994-95. Plots mulched with black polythene recorded significantly

higher soil temperature and moisture percentage compared to other mulch materials and the control (no mulch). Direct sowing on 15 December and mulching with black polythene recorded highest yield attributes and lowest diseases incidence. The lowest, however, was observed for transplantation on15 February and in the control plots. The combination of sowing on 15 December and with black polythene recorded the earliest fruit ripening/ picking, where one month earlier compare to other treatment of transplanting on 15 February and the control. The highest early and late marketable yields, and the lowest unmarketable yield, were observed under sowing on 15 December and mulching with black polythene. This treatment was significantly superior to all other treatment combination, except on the aspect of late marketable and unmarketable yield observed under sowing on 15 December and mulching with white polythene.

Teasdale and Baki, (1997) reported the growth analysis of tomatoes on black polythene and hairy vetch. They described that grown was better early in the season for plant growth with black polythene than with hoity vetch mulch. The rate of fruit growth per unit leaf area was higher with black polythene than with vetch mulch.

Monks *et al*. (1997) conducted an experiment on tomato and mulches (shredded newspaper, chopped newspaper, black plastic and plastic landscape fabric) they observed that chopped newspaper provided higher tomato yield than shredded newspaper.

An experiment was conducted by Pramanik (1997) at the horticulture Farm, BAU, Mymensingh in order to study the effect of mulching and starter and its form of application on the plant growth, fruits and seed yield of tomato. Black polythene mulch gives the highest yield than water hyacinth and control treatment.

The growth analysis of tomatoes in black polythene and hairy vetch production systems were studied by Teasdale and Baki, (1997) and described that growth was better early in the season for plants growth with black polythene than with hairy vetch mulch. Tile rate of fruit growth per unit leaf area was higher with black polythene than with hairy vetch.

Hussain *et al.,*1996. Conducted an experiment on mulching and pruning on the growth and yield of tomato and they found that combined effect was significant. However mulching with black polythene and tow time pruning (21 and 35 days after transplanting) in combination gave the highest yield (76.32 t/ha from the cv. Ratan).

Fortnum *et al.,* (1995) conducted an experiment using different colored polythene mulches on quantity spectra of reflected light, plant morphology and root knot- disease reported that soil

temperature was warmer under black and red mulch than white. In a similar investigation Decoteau *et al.,* (1989) also reported that mulch color affected the yield and growth of plant. Plants grown under mulch generally had a greatest early marketable yield and produced the least amount of foliage.

Elkner (1995) noticed that black polythene mulch increased total and marketable yield by about 0 and 24 % respectively.

Kumar *et al.* (1995) observed that Mulching significantly improved the number of fruits per plant and fresh weight per fruit and reduced the percentage of unmarketable fruit compared with the unmulched control. Significant increases in percent early and total fruit yield were recorded due to mulching. Black polyethylene of 200 gauges was the best mulch. The volume and specific gravity of fruits were significantly influenced by mulching but total soluble solids and ascorbic acid content did not respond to mulching materials.

Rice straw, rice hulls, mature maize leaves and dried grass mulches increased the leaf number of potato as compared to control in Peru (Miedmore, 1983). Baten *et al.* (1995) reported that garlic treated with water hyacinth mulches produced the higher number of leaves/plant and higher leaf lengths than the control plants.

Shrivastava *et al.,(*1994) conducted experiment with cv. Rupali on a Vertical Ustrochrept soil, 63% clay and 15% (by weight) available moisture content, during three successive winter seasons. Three moisture regimes (drip irrigation at 0.4, 0.6 or 0.8 of pan evaporation (PE) were combined with 3 mulch treatments (no mulch, black plastic or sugarcane trash). Three others treatments combined surface flood irrigation with no mulch, black plastic or sugarcane trash; the recommended irrigation schedule, i.e. watering to a depth of 8cm 100 mm cultivate pan evaporation, was followed. The highest crop yield, about 51 t/ha and 44% saving in irrigation water were obtained using the combination of drip irrigation at 0.4 PE and a mulch of sugarcane trash. This treatment also gave the maximum yield of 163 kg ha-^{1} mm-^{1} of water applied. Weed growth was also assured, in g/ m superscript 2, in each treatment. The treatment combining drip irrigation at 0.4 PE with black plastic mulch reduced weed infestation by 95%, increased yield by 53% and resulted in a 44% saving in irrigation water compared with surface flooding without mulch.

In untreated green house trial in Rio Grande do sul, Brazil 1994 seedling of tomato cv. Marte Carlo at the 4- leaf stage were planted in loamy soil on 22 August by Steck *et al.,* 1995. They stated that the highest temperature was recorded under transparent mulch. Yield was

generally higher in transparent mulch and fresh weight per fruit and reduced the unmarketable fruit compared with the unmulched control.

Similar results were obtained Shrivastava *et al.,* (1994). Singh *et al.,* (1987) observed that mulching by paddy straw decreased soil water depletion and increased water use efficiency under both irrigated and rain fed conditions. Firake *et al.,*1990. Stated that plastic tunnel conserved 47.08%of water and increased yield but 47.67% over the control.

Kaniszewski (1994) found that mulching increased marketable and total yield but higher yield was obtained with black polythene mulch than with white and nonwoven black polythene. Total yield was 36% and marketable 53% higher for plants grown with black polythene mulch and trickle irrigation than for control. Brown or black biodegradable paper or black plastic improved marketable yields by over 50%, compared with no mulched plants (Paterson and Earhart, 1975*).* Elkner and Kaniszewski (1995) noticed that black polythene mulch increased total and marketable yield by about 20 and 24% respectively. They also reported that black polythene mulch increased fruit comparison resistance Gunadi and Suwanti (1988) recorded that mulch increased 16.3% yield over non-mulched plant spaced at 60 X 50 cm in single row.While working with tomato plant grown on polythene mulch in New Work State, Wien *et al.,* (1993) reported that the plants had more branches and higher mineral nutrient uptake and yield than the plants not mulched. They also found that mulching increased branching hastened flowering on basal branches and increased the concentration of major nutrients in the above ground parts. Trials with organic and white polythene mulches on tomato had very little on plant height Shrivastava et al.,(1994), but clear plastic mulch resulted in most rapid growth (Geneva, 1981). Both polythene and straw mulch appeared to have a considerable increasing effect on plant height (Gunadi and Suwanti, 1988, Olasanta, 1985).

Shaheen *et al.* (1993) from their experiment at SRTI, Ishurdi, Pabna, reported that straw mulch played a positive role to increase the yield of both potato and sugarcane. Similarly, Imam *et al.* (1990) reported that sugarcane and potato yields were increased by the use of rice straw mulch.

Biswas, (1993) observed that all mulches increased plant height, number of branches and fruits, fruit size (by weight), enhanced earlier flowering, fruit setting and ripening and yielded more than double over the control. At the Crop Botany field Laboratory, BAU, and Mymensingh. During the Rabi season.

In West Virginia during 1993 and 1994 an experiment was conducted by Monks *et al.*, (1997) on tomato and mulches (shredded newspaper, chopped newspaper, and wheat straw, black plastic and plastic landscape fabric). They observed that chopped newspaper provided higher tomato yield than shredded newspaper applied at the same rates.

Rurledge-AD(1992) conducted an experiment on the effect of fertilization and black plastic mulch. The large fruited and vigorous tomato cultivar Mountain Pride was grown in 1990 and 1991 trials to evaluate the effects of black plastic mulch. Drip irrigation and different rates of NPK fertilizer on the fruit yield and quality. The results, with details of treatments and climatic condition are shown in tables. In 1990, which was a colder season than 1991, tomato yields did not differ significantly between treatments. In 1991 a broadcast application of 1000 Ib of a 10:10:10 NPK fertilizer before planting, in combination with mulching and drip irrigation produced yields equal to those with higher rates of fertilizer applied partly before planting and partly via the irrigation system. The sandy loam soil,which has been supplied with organic matter form the crops of winter wheat, appeared to maintain the sufficient nutrient availability throughout the growing season. Drip irrigation+ mulching improved yields of grade 1 quality fruits compared with no irrigation+no mulching. There was no indication that fertilization improved yields beyond those obtained with planting application (all rates) combined with mulching and irrigation. In both season fruits were generally excellent.

Mulches had a significant effect on plant height of maize (Quayyirm and Ahmed, 1993). Water hyacinth mulch produced taller plants in potato (Rashid *et al.,* 1981). Straw mulching was found to increase plant heights in many crops like cotton (Villamayor, 1976) and potato (Miedmore, 1983).

While working with tomato plant grown on polythene mulch in New York State Wien *et al.* (1993) reported that the plants had more branches and higher mineral nutrient uptake and yield than the plants not mulched. They also found that mulching increased branching hastened flowering on basal branches and increased the concentration of major nutrients in the above ground parts. Trials with organic and white polythene mulches on tomato had very, little effect on plant height (Shrivastava *et al.,* 1981) but clear plastic mulch resulted in most

rapid growth (Geneve, 1981). Both polythene and straw mulches appeared to have considerable increasing effect on plant height (Olasanta, 1985; Gunadi and Suwanti, 1988 and Buitellar, 1989).

Firake *et al.,* 1991. Reported that sugarcane trash mulch can save 44.34% of irrigation water.

Decoteau *et al.,* (1989) reported that mulch color affected the yield and growth of plants. Plants grown under mulch generally had the greatest early marketable yield and produced the least amount of foliage.

Gunadi and Suwanti *et al.,* (1988) observed that 25 days old seedling were transplanted and not mulched or mulched with rice strawat 6 t/ha. The plants were spaced at 60 X 40 or 60 X 50 in a single row or at 50 X 40 or 50 X50 cm in double rows. The highest yield increase (16.3) over the non mulched control was obtained with mulched plants spaced at 60 X 50 cm in a single row.

In an investigation on mulch surface color affects yield of fresh market tomatoes, Decoteau *et al.* (I989) reported that mulch color affected the yield and growth of plants. Plants grown under mulch generally had the greatest early marketable yield and produced the least amount of foliage.

In greenhouse trials, plants of the cv. Mountain Pride grown in sunlight over black polyethylene mulch had fewer axillary shoots and were taller than plants grown over white polyethylene mulch. The black surface reflected less total light and less blue light, but a higher ratio of far-red (FR) to red (R) light. The effect of FR on plant height could be reversed by R (Decoteau *et al,* 1988).

Al-Jebori *et al.* (1987) studied on the effectiveness of black polythene, silver polythene, newspaper, straw and no mulch or control, mulching treatments under two nitrogen fertilizer sources (Ammoniumsulphate and Urea) at 100 kg N/ha on tomato plants (Super Armando cultivar) results indicated that black and silver polythene mulches significantly increased early production and total yield. Similarly, Perry and Sanders (1986) reported that black polythene mulch increased early and total yield of large and marketable fruits of tomato.

Perry and Sanders (1986) reported that black polythene early and total yield of large and total marketable fruit of tomato.

Famoso and Bautista (1983) conducted an experiment on tomato production, mulching with sugarcane truss and straw. They stated that mulching with rice straw increased the number of

flowers and the chlorophyll content of the leaves in tomato as a result enhanced the yield of tomato. On the other hand, Petrov and Al-Amiri (1976) reported that black or transparent films for mulching led to higher early and over all yields of tomato.

An experiment was performed by Perrella *et al.* (1983) on mulching with photodegradable plastic films. They used photodegradable plastic mulches including 0.05 mm Alkatene (brick colored) and Fertene (black, ranging in thickness from 0.03 to 1.0 mm). These were compared with crops mulched with black, brown and colorless polythene films and with un-mulched controls. The tomatoes ripened earlier and yielded best (452 q/ha) with black Fertene.

An experiment was conducted by Gonzalez and Vives (1980) with tomato and mulches (black polythene, blue polythene, red polythene, rice husk and saw dust). They found that black, blue and red polythene mulches increased tomato yield and quality more than rice husk or sawdust mulches. While conducting an experiment on tomato using black and clear plastic and grass clipping mulches, Geneve (1981) reported that the plastic mulches yielded the highest whereas grass clipping reduced it.

Collins (1977) studied in a mulching experiment, which was conducted on a riverbank sandy loam soil with the cultivars Netted Gem and Kennebec. He observed that all mulch treatments substantially advanced plant emergence compared to plants from seed pieces in bare soil. This was apparently in response to higher soil temperatures under the mulches compared to bare soil during the first three week from planting.Polythene mulch has positive effect on plant growth. Black polythene mulch in cauliflower induced maximum growth (Singh and Mishra, 1975). From another trial with potato at Bangalore, India by Khalak and Kumaraswamy, (1992) found that mulching with straw and polythene gave average tuber yields of 18.2 and 16.7 t/ha higher than without mulching.

Chaudhary and Prihar (1974) reported significant increase in plant height of maize plants in plots covered with water hyacinth or straw mulch than those in die soil-mulched plot or control at Regional Agricultural Research Station, Jamalpur. Similar results were also obtained by Quayyum and Ahmed (1993) and Jones *et al*., (1969).

Mulch application also produced the taller plant in tobacco (Murty and Rao, 1969), cotton (Villa mayor, 1976), Sorghum (Ravindranath *et al.,* 1974; Mane and Umrani, 1981), wheat

(Kapur *et al.,* 1978; Sharma and Chakor, 1989; Kataria and Bassi, 1997), barley (Agarwal and Rajat, 1977), moong (Kumar *et al.,* 1995), Garlic (Baten *et al.,* 1995) and Potato (Rashid *et al.,* 1981).

Water hyacinth and rice straw mulches had significant promotive effect on root spread and development (Awal and Khan, 1999). Mulching induced increased root growth was also reported in barley (Agarwal and Rajat, 1977). Mulches improved the root development of maize as compared to unmulched plot (Aina, 1981). But Wang *et al.* (1994) obtained the greatest root weight and spread of the root system without plastic cover in a field trial.

Effect on soil environment

Mulches have a dramatic effect on soil temperature and moisture regimes. Many researchers noted that soil environments were greatly, influenced by mulching.

Jamiokowska (2005) emphasized the importance on cover crops for protection of soil from water and aerial erosion, as well as leaching of nutrients from soil. Use of green manures as a mechanical barrier again weeds, and beneficial effects of exudates of green manures on control of weed, pests and diseases of vegetables were discussed. Recommendations are included for autumn and spring sowing of cover crops (e.g. ray, wheat, oat, barley, sorghum, vetch, rape and mustard), which are cut or desiccated in the spring and are left in the field as mulch. It is also stated that yield of some vegetables, can be lower in the no-tillage cultivation compared with traditional cultivation. However, the dry matter content in Lublin, Poland to study the effect of cover crops, such as ray, while, red clover and field pea on the health of tomato. Data on tabulated on fungi isolated from soil under tomato grown ray and field pea as mulch crops compared with traditional cultivation system during 1998-2000. This result showed that use of cover crop resulted in a good control of plant pathogens, specially *Fusariumo xysporium* f sp, lycopersici, and an increase in the number of antagonistic fungi, e.g. *Trichoderma* spp. They concluded that use of cover crops allows decrease of the number of mechanical cultivars, as well as decrease of use of fertilizers, fungicides, insecticides and herbicides.

Plastic mulching with transparent polythene film mulch or linear low density polythene also increased the soil moisture content (Mohapatra *et al.,* 1.998). On the other-hand Bragugnolo and Mielniczuk (1990) reported that temperature and moisture regimes of soil were greatly influenced by mulching.

Another experiment was conducted by Wen *et al.,* (1997) with plastic mulch and tomato. They reported that plastic film mulch improved soil aeration, delayed plant senescence and accelerated leaf photosynthesis and the nutrient up takes capacity of the roots resulting in high, early and total yields.

Conservation tillage like mulching is very effective to moderator alters the soil moisture regimes. Mulches (Viz. maize stubble, rice straw, wheat straw, saw dust, crop residues) increased or conserve the soil moisture content (Sandal and Acharya, 1997)

Fortnum *et al.,* (1995) conducted an experiment using different colored polythene mulches on quantity spectra of reflected light, plant morphology and root-knot disease and reported that soil temperature was warmer under black and red mulch than white.

In green house tests carried out during 1994-95 by Chang *et al.,* (1995). They stated that mulching with pan paper membrane enhanced the levels of organic matter in the soil by 14.29% and 23.47% for tomato and cucumber, respectively. Pan paper membrane also had an effect on the control of pathogenic fungi in the soil.

An experiment was conducted by Shrivastava *et al.* (1994) on the fine textured heavy soils of western India from 1989-1991. They stated that Black plastic mulch reduced 95% weed infestation, Black plastic mulch and drip irrigation increased 53% higher yield and 44% saving in irrigation water when compared with the surface flood without mulch treatment. Also stated that mulch alone could increase the yield about 30%. The net income could be increased by about 86% over the normal method by adopting drip along with sugarcane trash as mulch. As high as 98% weed control could be affected by the use of drip with black plastic mulch.

A 2-year field study with the cv. Sunny was conducted on a fine sandy loam soil near Vincennes, India. Use of trickle irrigation with mulching, Bhella, (1988) stated that Mg concentrations were higher in soils mulched with polyethylene than in soils without mulch. The use of trickle irrigation increased plant height whereas polyethylene mulch increased plant spread and dry matter production. Early, late and total yields were improved with all trickle irrigation and polyethylene mulch treatments. Total yields were 66, 70 and 123% greater for plants grown with polyethylene mulch, trickle irrigation and polyethylene mulch plus trickle irrigation, respectively, than in the control plants.

Ammonification and nitrification were increased by mulching as deliberated by Boyajieva and Rankov (1989) who also observed enhanced CO_2 levels and reduced redox potential in mulched soil.

In a field experiment, this was conducted for two years (1980-1981) in India by Singh *et al.* (1987). They observed that mulching by paddy straw decreased soil water depletion and increased water use efficiency under both irrigated and rain fed conditions. Baldev *et al.* (1988) mentioned that mulching with, 6 ton rice-straw per hectare decreased soil temperature at 10 cm depth by 1-6°C, conserved soil water, suppressed weed growth and increased water use efficiency.

In general mulching conserves the soil moisture (Prihar, 1986; Devaun and Haverkort, 1987 and Ifnekwe and Tong, 1987). Polythene mulch conserves more moisture in soil than the control (Harris, 1965). Straw mulch also improves soil water retention (Taja and Vander-Zaag, 1991).

Manrique and Meyer (1984) in their experiment at Manila Agricultural Experiment station, Lima, Peru, reported that in summer, plastic mulches significantly increased day soil temperature to above 30°C. Whereas, rice straw mulch reduced the maximum daily soil temperature and increased the soil microbial population (Famoso and Bautista, 1983).

Working on nutritional variation of mulched soils, Chen and Katan (1980) focused that nitrate, ammonium, potassium, calcium, magnesium, chlorine, sodium-bi-carbonate ions and extractable P were found to be increased by mulch application. In case of soil pH, Famoso Bautista, (1983) reported that mulching had no significant effect on soil pH.

Amador and Vives (1978) carried out an experiment on different mulch and reported that transparent plastic mulch was inferior owing to abundant weed growth compared to black polythene, rice-husks and saw-dust mulch. Kiss (1976) mulching with plastic sheet reduced weed growth and improved soil and air temperature, soil moisture relations and yield and earliness in straw-berries, melons tomatoes and grape vines.

Petrov and Al-Amirri (1976) noticed that temperature at 10 cm depth was highest in May and June in soil covered with black polythene, followed by transparent film but in the straw mulched soil it was lower than the control.

Patil and Basod (1972) found in an experiment in India during winter season of 1963-64 with tomato variety Sioux and different mulches like black polythene, saw dust and grass reduced the fluctuations in soil temperature at. 4.5 inches depth and retained more moisture then unmulched plots. Black & polythene retained more moisture over the rest of the mulches. Weeds were suppressed to certain extent; black polythene was more efficient in this respect.

Effect of Poultry manure on growth and yield of tomato

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

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

Application of poultry manure additions on nutrient availability, soil physical and chemical properties and yield of tomato, five levels of the manure, namely 0, 10, 25, 40 and 50 t /ha were

Applied at Akure, Southwest Nigeria. The soil at the two experimental sites were slightly acidic, low in organic matter, N, P, and Ca. Poultry manure increased soil organic matter, N and P. Soil bulk density were reduced and moisture content increased with levels of manure. Manure applications increased leaf N, P, K, Ca and Mg concentrations of tomato, plant height, and number of branches, root length, number and weight of fruits. The 25 t/ha poultry manure gave highest leaf P, K, Ca and Mg (Ewulo *et al.,* 2008).

Field experiments were conducted at the Teaching and Research Farm of Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Nigeria in the cropping seasons of 2004 and 2005. The treatments consisted of two levels of urea (0 and 60 kg N/ha) and five levels of poultry manure (Pm) (0, 3.0, 4.5, 6.0, 7.5 t/ha). The growth parameters (plant height and number of leaves) showed increasing response as the amount of fertilizer

applied increased. The combined application of the two types of fertilizers resulted in the highest marketable fruit yield. The content of essential nutrient elements increased and was also influenced by fertilizer treatments, except K in all the treatments (Olaniyi and Ajibola, 2008).

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

Application of different levels (0, 10, 20, 40, 50 t/ha) of poultry manure on tomato, the 20 t/ha poultry manure gave highest value of number and weight of fruits and increase height, number of branches, leaf area and taproot length (Akanni and Ojeniyi, 2007).

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

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

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

Poultry manure application improves the physical properties of the soil. It significantly decreases bulk density and increases total porosity, infiltration capacity, water holding capacity, add soil organic matter and increase soil productivity. Many researchers noted that soil environments were greatly, influenced by poultry manure.

Addition of poultry manure has been shown to improve the fertility of the cultivated soil by increasing the organic matter content, water holding capacity, oxygen diffusion rate and the aggregate stability of the soils (Mahimairaja *et al*., 1995a; Adeli *et al*., 2009).

Poultry waste contains all essential nutrients including micronutrients and it has been well documented that it provides a valuable source of plant nutrients (Kelley *et al*., 1996; Williams *et al.,* 1999; Chan *et al*., 2008; Harmel *et al.,* 2009), especially for organic growers (Preusch *et al.,* 2002). Addition of poultry manure to soils not only helps to overcome the disposal problems but also enhances the physical, chemical and biological fertility of soils (Friend *et al.,* 2006; Mc Grath *et al*., 2009).

Poultry manure application could be attributed to easy solubilisation effect of released plant nutrient leading to improved nutrient status of the soil the results obtained were in agreement with the findings of Sanwa *et al*., (2007) and Premsekhar and Rajashree (2009) in which they reported that higher yield response of crop due to organic manure application.

Poultry manure contains high percentage of nitrogen and phosphorus for the healthy growth of plants (Ewulo, 2005). Nitrogen is equally said to be the motor of plant growth (IFA, 2000). Organic matter is the ultimate determinant of the soil fertility in most tropical soils and this account for its use to raise seedling in tropical areas, the fertility of the soil could be sustained with the addition of poultry manure (Ikpe and Powel, 2002)

Application of chicken manure acts as a good soil amendment and/or fertilizer (e.g. provides N, P and K) and can also increase the soil and leaf N, P, K Ca, and Mg concentrations (Duncan, 2005; Agbede *et al*., 2008). These soil chemical properties provide information on the chemical reactions, processes controlling availability of nutrients and ways of replenishing them in soils (Prasad and Power, 1997).

The potential impacts of chicken manure on soil chemical properties and crop yield and in particular evaluating the critical application levels. Moreover, the need and utilization of

chicken manure has overtaken the use of other animal manure (e.g. pig manure, kraal manure) because of its high content of nitrogen, phosphorus and potassium (Warman, 1986; Schjegel, 1992).

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in carrying out the experiment.

3.1 Location of the experiment field

The experiment was conducted at The Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from November 2012 to March 2013. The location of the experimental site was at 23.75^0 N latitude and 90.34^0 E longitudes with an elevation of 8.2 meter from sea level.

3.2 Experimental period

The experiment was carried out during the Rabi season from November 2012 to March 2013. Seedlings were sown on 28 November, 2012 and fruits were harvested up to21 March, 2013.

3.3 Climate of the experimentalarea

The experimental area was characterized by subtropical rainfall during the month of May to Septemberand scattered rainfall during the rest of the year. The climate of the experimental area was subtropical in nature. In appendix II (A) it was characterized by heavy rainfall, high temperature, high humidity, relatively long day during kharif season (April to September) and scanty rainfall associated with low temperature, low humidity and short day period during Rabi season (October to March).Details of weather data in respect of temperature (^{0}C), rainfall (cm), relative humidity (%) for the study period were collected from The Bangladesh Meteorological Department (climate division) Agargoan, Dhaka-1207.

3.4. Soil of the experimental field

The experimental site was situated in the subtropical zone. Soil of the study site was clayloam in texture belonging to series and olive gray with common fine to medium distinct dark yellowish brown mottlies. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ No. 28) with pH 4.47 to 5.63 showed in appendix II (B). 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 (B).

3.5 Plant materials collection

The tomato variety used in the experiments was "BARI Tomato14". This is a high yielding determinate type, the seeds were collected from Olericulture Division of The Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI) Gazipur.

3.6. Raising of seedlings

The land selected for nursery bed was well drained and was of sandy loam soil. Tomato seedlings were raised in two seedbeds of 2 m x 1m size. The soil was well prepared and converted into loose friable and dried mass condition in obtaining good tilth. All weeds, stubbles and dead roots were removed. Twenty gram of seeds was sown on each seedbed on 25 October 2012. After sowing, seeds were covered with light soil and shading was provided by bamboo mat (chatai) to protect young seedlings from scorching sunshine and rainfall. The emergence of the seedlings took place within 5 to 6 days after sowing. Light watering, weeding and mulching were done as and when necessary to provide seedlings with a good condition for growth.

3.7 Treatments of the experiment

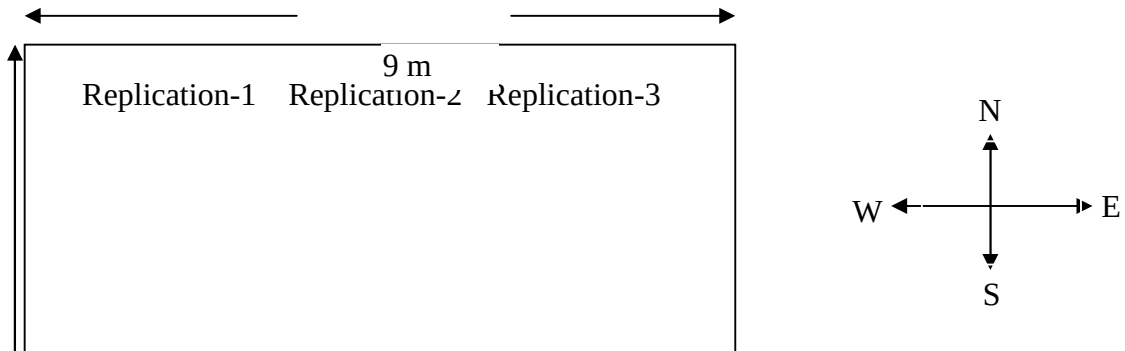
The two factor experiment consisted of four levels of poultry manure (Factor A) and three levels mulching (Factor B). The factors were as follows:

Factor A: Four doses of poultry manure	**Factor B: Mulching**
P_0 = Control (No manure)	M_0 = Control
P_1 = 5 ton/ha (1.8 kg/plot)	M_1 = Black Polythene
P_2 = 7.5 ton/ha (2.7 kg/plot)	M_2 = Rice straw
P_3 = 10 ton/ha (3.6 kg/plot)	

There were altogether 12 treatments combination used in each block were as follows; P_0M_0, P_0M_1, P_0M_2, P_1M_0, P_1M_1, P_1M_2, P_2M_0, P_2M_1, P_2M_2, P_3M_0, P_3M_1, P_3M_2.

3.8 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) having two factors with three replications. An area of 29.4 m x 9 m was divided into three equal blocks. Each block consists of 12 plots where 12 treatments were allotted randomly. There were 36 unit plots in the experiment. The size of each plot was 1.8 m x 2 m. The distance between two blocks and two plots were kept 1 m and 0.6 m respectively. A layout of the experiment has been shown in figure 1.



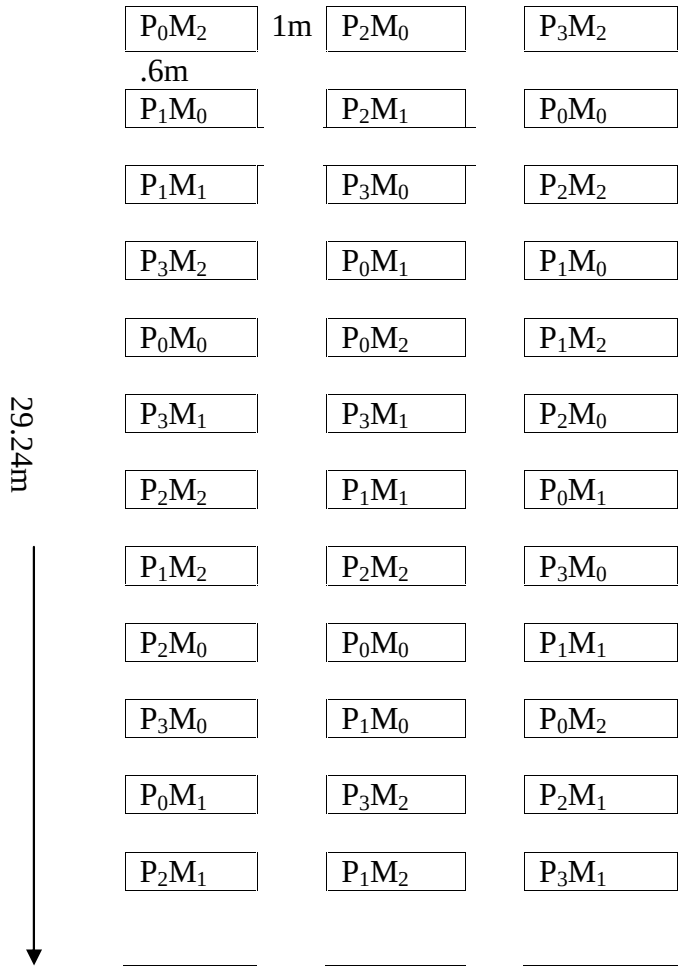


Fig. 1: Field layout of the experiment

Plot size: 1.8 m x 2 m
Spacing: .60 m x .40 m
Spacing between plots: .60 m
Spacing between replication: 1 m

Factors:
A: Poultry manure
P_0: Control
P_1: 5t/ha
P_2: 7.5t/ha
P_3: 10t/ha

B: Mulching
M_0: Control
M_1: Black polythene
M_2: Rice straw

P_3 : Three stem pruning

3.9 Cultivation procedure

3.9.1 Land preparation

The soil was well prepared and good tilth was ensured. The land of the experimental field was ploughed with a power tiller on November 2012. The experimental field was thoroughly ploughed and cross ploughed and cleaned prior to seed sowing and application of fertilizers and manure was done in the field. Later on the land was ploughed three times followed by laddering to obtain desirable tilth. The corners of the land were spaded and larger clods were broken into smaller pieces. After ploughing and laddering, all the stubbles and uprooted weeds were removed and then the land was made ready. The field layout and design or the experiment was followed after land preparation.

3.9.2 Application of mulching and poultry manure

Two types of mulching, viz. black polythene and rice straw were placed on respective plots as per layout of the experiment before transplanting. Then small hole was prepared on plotted polythene sheet for planting seedling. Poultry manure was added in respective plots as per layout of the experiment during final land preparation.

3.9.3 Transplanting of seedlings

Healthy and uniform 33 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots on 28 November, 2012 maintaining a spacing of 60 cm x 40 cm. This allowed an accommodation of 15 plants in each plot. The seedbed was watered before uprooting the seedlings from the seedbed so as to minimize damage to the roots. The seedlings were watered after transplanting. Seedlings were also planted around the border area of the experimental plots for gap filling.

3.9.4. Intercultural operations

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

3.9.4.1 Gap filling

When the seedlings were well established, the soil around the base of each seedling was pulverized. A few gaps filling was done by healthy seedlings of the same stock where initial planted seedling failed to survive.

3.9.4.2 Weeding

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

3.9.4.3 Staking

When the plants were well established, staking was given to each plant by rope and iron wire to keep them erect. Within a few days of staking, as the plants grew up, other cultural operations were carried out.

3.9.4.4 Irrigation

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

3.9.4.5 Plant Protection

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

3.10 Harvesting

Fruits were harvested at 3 to 4 days intervals during early ripe stage when they attained slightly red color. Harvesting was started from 22February, 2013 and was continued up to 21 March 2013.

3.11 Data collection

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

3.11.1 Plant height

The plant height was measured in centimeters from the base of plant to the terminal growth point of main stem on tagged plants were recorded at 15 days interval starting at 25, 40, 55,and 70 days after transplanting to observe the growth rate of plants. The average height was computed and expressed in centimeters

3.11.2 Plant root length

The maximum length of roots was measured in centimeter with a meter scale at harvestingstage.

3.11.3 Number of leaves per plant

The number of leaves per plant was counted at 25, 40, 55, and 70 after transplanting and at harvesting on tagged plants. The average of five plants were computed and expressed in average number of leaves per plant.

3.11.4 Number of flowers per plant

Total number of flowers was counted from 5 selected plants at 25, 40, 55, 70 days after transplanting and their average was taken as the number of flowers per plant.

3.11.5 Number of branches per plant

The number of branches per plant was counted at 25, 40, 55, and 70 days after transplanting from tagged plants. The average of five plants were computed and expressed in average number of branch per plant.

3.11.6 Number of clusters per plant

The number of clusters was counted at 25, 40, 55 and 70 days after transplantation from the 5 sample plants and the average number of flower cluster produced per plant was recorded.

3.11.7 Fresh weight of leaves

Fresh weight of leaves was taken at harvesting from the 5 selected plants and there average was taken as the weight of fresh leaves per plant.

3.11.8 Dry matter of leaves

After harvesting, randomly selected 100 gram of leaf sample previously sliced into 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:

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

3.11.9 Number of fruits per plant

The number of fruits per plant was counted at all stages from fruiting period, even at harvesting from selected 5 plants. The averages of five sample plants fruit were considered as number of fruits per plant.

3.11.10 Weight of individual fruit

Among the total number of fruits harvested during the period from first to final harvest, the fruits, except the first and last harvest, were considered for determining the individual fruit weight in gram. The weight was calculated by dividing total weight of fruits by total number of fruits.

3.11.11 Dry matter of fruits

After harvesting, randomly selected 100 gram of fruit sample previously sliced in to very thin pieces. The fruits were then dried in the sun for one day and placed in oven maintaining at 70^0c 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 calculated by the following formula:

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

3.11.12 Yield of fruits per plot (kg):

An electric balance was used to measure the weight of fruits per plot. The total fruit yield of each unit plot measured separately during the harvest period and was expressed in kilogram (kg).

3.11.13 Yield of fruits per hectare (ton)

It was calculated by the following formula:

$$\text{Fruit yield (t/ha)} = \frac{\text{Fruit yield per plot (kg) x 10000}}{\textbf{Area of plot in square meter x 1000}}$$

3.12 Statistical analysis

The recorded data on various parameters were statistically analyzed using MSTAT-C statistical package programme. The mean for all the treatments was calculated and analysis of variance for all the characters were performed by F- Difference between treatment means were determined by Duncan`s Multiple Range Test (DMRT) according to Gomez and Gomez, (1984) at 5% level of significance.

3.13 Economic analysis

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

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

CHAPTER IV

RESULTS AND DISCUSSION

The present study was conducted to determine the effect of different doses of poultry manure and mulches on growth and yield of tomato. 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

4.1.1 Effect of poultry manure on plant height

The result showed that the effect of different doses of poultry manure on plant height was significant at all growth stages such as 25, 40, 55, 60, 70 DAT and at harvest (Fig. 2). Different doses of poultry manure showed different plant height at different growth stages and P_3(10 t/ha poultry manure) produced the significantly the tallest plant height (35.42, 52.39, 69.47, 88.69 and 97.97 cm at 25, 40, 55, 60, 70 DAT and at harvest respectively) which was superior from all other poultry manure doses.

P_0 =Control (0 t/ha), P_1 = 5 t/ha, P_2 = 7.5t/ha, P_3 = 10 t/ha

Fig. 2.Main effect of poultry manure on the plant height of tomato

On the other hand, P_0 (Control) produced the shorter plant stature (32.4, 44.37, 55.6, 72.61and 85.31 cm) at 25, 40, 55, 70 DAT and harvesting respectively. Similar results were advocated by Ayeni *et al*., (2010).

4.1.2Effect of mulching on plant height

The plant height differed significantly among the different mulching materials Fig.3. It was found that the tallest plant height was obtained fromM_1(black polythene) at all growth stages (35.21, 53.65, 68.18, 86.05 and 97.72 cm at 25, 40, 55, 70, DAT and at harvest respectively). On the other hand, the shorter plant structure was found in M_0(control) treatment (32.11, 45.34, 59.33, 78.91, 86.38 cm at 25, 40, 55, 70 DAT and at harvest respectively). Hudu *et al*., (2002) observed similar results.

M_0 =Control mulching, M_1 = Black polythene, M_2 = Rice straw

Fig.3Main effect of mulching on the plant height of tomato

4.1.3 Combined effect of poultry manure and mulching on plant height

The plant height differed significantly due to the interaction effect of different doses of poultry manure and mulching at all sampling dates Table1. Results showed that the tallest plant was obtained from P_3M_1(10 t/ha poultry manure and black polythene mulch)at 25, 40, 55, 70 and at harvesting (38.57, 58.20, 74.53, 92.40 and 101.8 cm respectively. On the other hand, the shortest plant (30.90, 39.47, 48.00, 65.60 and 75.23 cm) was obtained from P_0M_0(control) combination at 25, 40, 55, 70 DAT and at the time of harvesting.

Table.1. Interaction effect poultry manure and mulch on plant height of tomato

Treatment	Plant height(cm) at different days after transplanting (DAT) and harvesting				
	25	40	55	70	Harvest
P_0 M_0	30.90 f	39.47f	48.00g	65.60f	75.23e
P_0 M_1	33.80bcd	48.57bcd	61.40ef	77.57de	91.90cd
P_0 M_2	32.53de	45.07def	57.40efg	72.67ef	88.27de
P_1 M_0	31.97def	46.80cde	60.33cd	80.93cd	87.57de
P_1 M_1	34.98bc	51.67b	66.20c	84.47abcd	96.50b
P_1 M_2	32.95abc	47.57bcde	64.73cd	82.07bcd	94.87bc
P_2 M_0	32.50de	46.73de	63.20de	82.20bcd	89.23d
P_2 M_1	37.50ab	56.17a	70.60b	91.77a	100.7a
P_2 M_2	33.40cd	48.77bcd	66.40c	85.57abcd	97.33ab
P_3 M_0	33.07cde	48.37bcd	65.80cd	86.93abc	93.50bcd
P_3 M_1	38.57a	58.20a	74.53a	90.40ab	101.8a
P_3 M_2	34.73bc	50.60bc	68.13bc	88.73abc	98.60ab
$LSD_{0.05}$	1.19	4.15	2.12	7.73	4.96
CV%	7.33	5.04	5.35	5.53	5.03

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

P_0= Control
P_1= 5 t/ha
P_2=7.5 t/ha
P_3=10 t/ha
DAT= Days after transplanting

M_0= Control
M_1= Black polythene
M_2= Rice straw

4.2. Tap root length (cm)

4.2.1. Effect of poultry manure tap on root length

The result revealed that the effect of different doses of poultry manure on the root length was differed significantly at all growth stages Table. 2. Different doses of poultry manure showed different length of root. The long root length (27.76 cm) was obtained from P_3 (10 t/ha poultry manure) and the shorter root length (22.14 cm) was obtained from P_0 (control). Similar investigation recorded by Akanni and Ojeniyi, 2007.

Table2. Main effect of poultry manure on growth of tomato

Treatment	Root length(cm)	No. of leaves/plant	No. of branches/plant
Poultry			
P_0	22.14	34.13	5.94
P_1	25.15	38.48	6.01
P_2	23.75	39.72	6.67
P_3	27.76	39.98	6.92
Level of significance	**	**	**
CV%	0.53	9.18	1.71

Foot notes of table**Significant at 1 % level of probability

P_0= Control
P_1= 5 t/ha
P_2=7.5 t/ha
P_3=10 t/ha
DAT= Days after transplanting

4.2.2 Effect of mulching on tap root length

The result revealed that the effect of mulching on root length was differed significantly at all growth stages Table. 3. Different doses of poultry manure showed different length of root. The long root length (25.52cm) was obtained from M_1 (black polythene mulch) and the shorter root length (23.13cm) was obtained from M_0 (control).

4.2.3 Combined effect of different doses of poultry manure and mulching on tap root length

Combined effect of different doses of poultry manure and mulching showed statistically significant differences on root length of plant. From Table 4.It was found that longest the root length (29.60 cm) was recorded from P_3M_1 (10 t/ha poultry manure and black polythene mulch). The shorter root length (20.3 cm) was recorded from P_0M_0 (control).

4.3 No. of leaves/plant

4.3.1 Effect of poultry manure on leaves/plant

The result revealed that the effect of poultry manure on number of leaves/plant was significantly affected at all growth stages Table. 2. Different doses of poultry manure showed different number of leaves/plant. The maximum number of leaves/plant (39.98) was obtained from P_3 (10 t/ha poultry manure). On the other hand, the minimum no of leaves/plant(34.13) was produced from P_0 (control).

4.3.2. Effect of mulching on leaves/plant

The result revealed that the effect of mulching on number of leaves/plantwas significantly differed at all growth stages (Table 3). Mulching showed different number of leaves/plant. The maximum number (41.04)of leaves/plant was obtained from(M_1) Black polythene mulch. The minimum no of leaves/plant(34.26) produced at M_0 (control).

Table3. Main effect of mulches on growth of tomato

Treatment	Root length(cm)	No. of leaves/plant	No. of branches/plant
Mulching			
M_0	23.13	34.26	5.83
M_1	25.62	41.04	6.84
M_2	25.05	38.92	6.49

Level of significance	**	**	**
CV %	0.53	9.18	1.71

Foot notes of table**Significant at 1 % level of probability

M_0= Control(No mulching)
M_1= Black polythene
M_2= Rice straw

4.3.3 Combined effect of different doses of poultry manure and mulching on leaves/plant

Combined effect of different doses of poultry manure and mulching showed statistically significant differences on number of leaves/plant. From Table 4. it was found that large number of leaves/plant(42.57) was recorded from P_3M_1 (10 t/ha poultry manure and black polythene mulch) which was statistically similar with P_2M_1 (7.5 t/ha poultry manure and black polythene mulch) producing (42.53) leaves/plant. The minimum no of leaves/plant(29.90) was obtained from P_0M_0 (control).

4.4 No. of branches/plant

4.4.1 Effect of poultry manure on branches/plant

The result revealed that the effect of different doses of poultry manure on number of branches per plant was significant at all growth stages. Different doses of poultry manure showed different number of branches/plant. From Table 2. the maximum number of branches/plant(6.92) was recorded from P_3(10 t/ha poultry manure). On the other hand, the minimum no of branches/plant(5.94) was recorded from P_0 (control).

4.4.2 Effect of mulching on branches/plant

The result revealed that the effect of mulching on number of branches/plant was significant at all growth stages Table 3. Mulching showed different number of branches/plant.Black polythene mulch (M_1) produced the maximum number of branches/plant(6.84) which was statistically similar with M_2 (rice straw mulch) producing (6.49) branch/plant. On the other hand, the minimum no of branches/plant(5.83) was produced in M_0 (control). Similar results were also advocated by Wien *et al*., (1993).

4.4.3 Combined effect of different doses of poultry manure and mulching on branches/plant

Combined effect of different doses of poultry manure and mulching showed statistically significant difference on number of branches/plant. From Table 4 it was found that maximum number of branches/plant(7.50) was recorded from P_3M_1 (10 t/ha poultry manure and black polythene mulch) .The minimum number of branches/plant(5.50) was recorded from P_0M_0(0

t/ha poultry manure and control mulching) which was statistically similar to P_0M_0 (control) producing (5.53) branches/plant.

Table 4. Interaction effect poultry manure and mulches on growth of tomato

Treatment	Root length(cm)	No. of leaves/plant	No. of branches/plant
P_0 M_0	20.37j	29.90c	5.50g
P_0 M_1	23.63g	38.20ab	6.30e
P_0 M_2	22.50i	34.30bc	6.03f
P_1 M_0	24.47f	34.90bc	5.53g
P_1 M_1	25.70c	40.87ab	6.30e
P_1 M_2	25.30d	39.67ab	6.20ef
P_2 M_0	22.77h	35.97abc	6.03f
P_2 M_1	24.80e	42.53a	7.26b
P_2 M_2	23.70g	40.67ab	6.73d
P_3 M_0	25.00e	36.30abc	6.26e
P_3 M_1	29.60a	42.57a	7.50a
P_3 M_2	28.70b	41.07ab	7.00c
$LSD_{0.05}$	0.2208	.918	0.185
CV%	0.53	9.18	1.71

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

P_0= Control
P_1= 5 t/ha
P_2=7.5 t/ha
P_3=10 t/ha

M_0= Control
M_1= Black polythene
M_2= Rice straw

4.5 No. of Flower cluster/plant

4.5.1 Effect of poultry manure on cluster/plant

Number of flower clusters/plant was significant due to the application of different levels of poultry manure. From Table 5 the maximum (10.79) number of flower clusters/plant was

recorded from P_2 (7.5t/ ha poultry manure), while the minimum (7.91) number of flower clusters/plant was obtained from P_0 (control).

Table5. Main effect of poultry manure on flowering and fruiting of tomato

Treatment	No. of Flower cluster/plant	No. of flower/cluster	No. flower/plant	No. of fruit /plant	Individual fruit weight(g)
Poultry manure					
P_0	7.91	8.43	66.70	19.73	73.48
P_1	10.15	8.79	89.22	21.13	80.68
P_2	10.79	9.62	103.80	24.06	82.53
P_3	10.30	8.96	92.30	23.00	82.10
Level of significance	**	NS	*	NS	NS
CV %	10.07	11.76	9.97	13.75	8.02

Foot notes of table: NS = no significant,*****Significant at 5 % level of probability, ******Significant at 1 % level of probability

P_0= Control
P_1= 5 t/ha
P_2=7.5 t/ha
P_3=10 t/ha

4.5.2 Effect of mulching on cluster/plant

Number of flower clusters/plant was significant due to the application of different mulching materials. From table 6, the maximum (10.05) number of flower clusters/plant was recorded from M_1 (Black polythene mulch), while the minimum (9.52) number of flower clusters/plant was obtained from M_0 (control).

4.5.3 Combined effect of different doses of poultry manure and mulching on Flower clusters/plant

There had a significant variation on number of flower clusters/plant due to the combined effect of different doses of poultry manure and mulching. FromTable 7, it was found that the maximum (11.30) number of flower clusters/plant was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene) and the minimum (7.73) number of flower clusters/plant was recorded from P_0M_0 (control).

4.6 No. of flowers/cluster

4.6.1 Effect of poultry manure on flowers/cluster

There had no significant variation on number of flowers/cluster due to the effect of different doses of poultry manure. The maximum (9.62) number of flowers/cluster was recorded from P_2 (7.5 t/ ha poultry manure), while treatment P_0 (0 t/ha poultry manure) showed the minimum (8.43) number of flowers/clusterTable 5.

4.6.2 Effect of mulching on flowers/cluster

There had no significant variation on number of flower/cluster due to the effect of different doses of mulching .From Table 6 the maximum (9.63) number of flowers/clusterwas recorded from M_1 (black polythene mulching). On the other hand the minimum (8.10) number of flowers/clusterwas obtained from M_0 (control mulching) showed in Table 6.Similar result was observed by Hudu *et al*., (2002), Biswas, (1993) they found that all mulches increased plant height, number of branches and fruits, fruit size (by weight), enhanced earlier flowering, fruit setting and ripening and yielded more than double over the control.

Table6. Main effect of mulches on flowering and fruiting of tomato

Treatment	No. of Flower cluster/plant	No. of flower/cluster	No. flower/plant	No. of fruit/plant	Individual fruit weight(g)
Mulching					
M_0	9.52	8.10	77.2	20.01	77.15
M_1	10.05	9.63	96.78	23.65	82.22
M_2	9.80	9.20	90.16	22.28	79.71
Level of significance	*	NS	**	**	**
CV %	10.07	11.76	9.97	13.75	8.02

Foot notes of tableNS = no significant**, ***Significant at 5 % level of probability, ******Significant at 5 % level of probability

M_0= Control
M_1= Black polythene
M_2= Rice straw

4.6.3 Combined effect of different doses of poultry manure and mulching on flowers/cluster

Combined effect of different doses of poultry manure and mulching showed statistically significant differences on number of flowers/cluster. From Table 7, the maximum (10.13) flowers/cluster was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene mulch). The minimum (7.06) number of flowers/clusterwas recorded from P_0M_0 (control).

4.7 No. flower/plant

4.7.1 Effect of poultry manure on flowers/plant

Significant variation was recorded on number of flowers/plant due to the application of different doses of poultry manure. The maximum (103.80) number of flowers/plant was recorded from P_2 (7.5 t/ ha poultry manure), while treatment P_0 (control) showed the minimum (66.70) number of flowers/plant as shown in Table 5.

4.7.2 Effect of mulching on flower/plant

Significant variation was recorded on number of flowers/plant due to the application of mulching. The maximum (96.78) number of flowers/plant was recorded from M_1 (black polythene mulch). While treatment M_0 (control) producing the minimum (77.2) no of flowers/plant as shown in Table 6.

4.7.3 Combined effect of different doses of poultry manure and mulching on flowers/plant

Combined effect of different doses of poultry manure and mulching showed statistically significant differences on number of flowers/plant. From Table 7, the maximum (114.47) number of flowers/plant was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene mulch) and the minimum (54.56) number of flowers/plant was recorded from P_0M_0 (control).

Table 7. Interaction effect poultry manure and mulches on flowering and fruiting of Tomato

Treatment	No. of Flower cluster/plant	No. of flower/cluster	No. flower/plant	No. of fruit /plant	Individual fruit weight (g)
P_0 M_0	7.73d	7.06cd	54.56e	17.77d	73.51c
P_0 M_1	8.20bc	9.37abc	76.8d	21.14bcd	73.78c
P_0 M_2	7.8cd	8.86b	69.12cd	20.28bcd	73.16c

$P_1 M_0$	9.83bc	7.63c	74.7de	19.76cd	75.83bc
$P_1 M_1$	10.33abc	9.50abc	98.1b	22.45abcd	84.74a
$P_1 M_2$	10.31bc	9.24a	95.2bc	21.20bcd	81.48ab
$P_2 M_0$	10.35abc	9.31ab	96.37bc	21.40bcd	79.84b
$P_2 M_1$	11.30a	10.13a	114.47a	26.8a	85.50a
$P_2 M_2$	10.72ab	9.42abc	100.9d	23.99abc	82.27ab
$P_3 M_0$	10.21abc	8.14bc	83.1c	21.14bcd	79.45b
$P_3 M_1$	10.36abc	9.51abc	98.53b	24.2ab	84.89a
$P_3 M_2$	10.32abc	9.25abc	95.4bc	23.66ab	81.96ab
$LSD_{0.05}$	1.747	1.862	5.83	2.304	4.88
CV%	10.07	11.76	9.97	13.75	8.02

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

P_0= Control
P_1= 5 t/ha
P_2=7.5 t/ha
P_3=10 t/ha

M_0= Control
M_1= Black polythene
M_2= Rice straw

4.8 No. of fruits/plant

4.8.1 Effect of poultry manure on fruits/plant

There had no significant variation on number of fruits /plant due to the application of different doses of poultry manure. The maximum (24.06) number of fruits/plant was recorded from P_2 (7.5 t/ha poultry manure), while treatment P_0 (control) showed the minimum (19.73) number of fruit/plant as shown in Fig. 4.

P_0 =Control (0 t/ha), P_1 = 5 t/ha, P_2 = 7.5t/ha, P_3 = 10 t/ha

Fig.4Main effect of poultry manure on number of fruits/plant

4.8.2 Effect of mulching on fruits/plant

Number of fruits/plant varied significantly due to different types of mulching. The maximum (23.65) number of fruits/plant was recorded from M_1 (black polythene mulch), while the minimum (20.01) number of fruits/plant was obtained from M_0 (control)showed in Fig.5.

M_0 =Control mulching, M_1 = Black polythene, M_2 = Rice straw

Fig. 5 Main effect of mulching on the number of tomato fruit/plant

4.8.3 Combined effect of different doses of poultry manure and mulching on fruit/plant

Combined effect of different doses of poultry manure and mulching showed significant differences on number of fruits/plant. The maximum (26.80) number of fruits/plant was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene mulch) and the minimum (17.77) number of fruits/plant was obtained from the treatment combination of P_0M_0 (control) showed in Table 7.

4.9 Individual fruit weight (g)

4.9.1 Effect of poultry manure on individual fruit weight

There had no difference significant in individual fruit weight due to the application of different doses of poultry manure. The maximum (82.53g) weight of individual fruit was recorded from P_2 (7.5 ton/hapoultry manure) while the minimum (73.48 g) weight of individual fruit was recorded from P_0 (control) showed in Fig. 6.

P_0 =Control (0 t/ha), P_1 = 5 t/ha, P_2 = 7.5t/ha, P_3 = 10 t/ha

Fig 6. Main effect of poultry manure on individual fruit weight of tomato

4.9.2 Effect of mulching on individual fruit weight

Weight of individual fruit showed significant difference due to application of different types of mulching. The maximum (82.22 g) weight of individual fruit was recorded from M_1 (black polythene mulch) while the minimum (77.15g) weight of individual fruit was found from M_0 (control mulching). Biswas (1993) observed that all mulches increased the plant height, number of branches and fruits, fruit size enhanced earlier flowering, fruit setting, ripening and yielded more than double over the control.

M_0 =Control mulching, M_1 = Black polythene, M_2 = Rice straw

Fig 7. Main effect of mulching on individual fruit weight of tomato

4.9.3 Combined effect of different doses of poultry manure and mulching on individual fruit weight

Combined effect of different doses of poultry manure and mulching showed significant difference for weight of individual fruit. The maximum (85.50 g) weight of individual fruit was recorded from P_2M_1 (7.5 t/ha poultry manure and black polythene) treatment combination of P_0M_0 (control) performed the minimum (73.51 g) weight of individual fruit Table 7.

4.10 Fruit yield/plant (kg)

4.10 1 Effect of poultry manure on fruit yield/plant

There was significant difference due to the application of different doses of poultry manure. The maximum (1.99 kg) fruit yield/plant was recorded from P_2 (7.5 t/ha poultry manure), while the minimum (1.44g) fruit yield/plant was found from P_0 (0 t/ha poultry manure) showed in table 8. Olaniyi and Ajibola, (2008) were also observed similar consequences as shown in Table 8.

Table8. Main effect of poultry manure on yield of tomato

Treatment	Yield/plant (kg)	Fruit weight/plot (kg)	Yield (t/ha)	100 g fruit dry weight (%)	100 g leaf dry weight (%)
P_0	1.44	21.65	60.27	4.91	13.30
P_1	1.70	25.55	70.86	5.70	9.31
P_2	1.99	29.85	82.91	5.70	10.94
P_3	1.88	28.25	78.47	5.29	11.12
Level of significance	**	**	**	NS	**
CV %	9.91	9.45	5.62	11.41	8.66

Foot notes of table: NS = no significant,*****Significant at 5 % level of probability, ******Significant at 1 % level of probability

P_0= Control
P_1= 5 t/ha
P_2=7.5 t/ha
P_3=10 t/ha

4.10.2 Effect of mulching on fruit yield/plant

Significant differences were recorded on yield of fruit yield/plant due to application of mulching in tomato. From Table 9, the maximum (1.94kg) fruit yield/plant was recorded from M_1 (Black polythene mulch),while the minimum (1.54 kg) fruit yield/plant was obtained from M_0 (control). Elkner and Kaniszewski (1995) found similar result and they noticed that black polythene mulch increased total and marketable yield by about 20 and 24% respectively. They also reported that black polythene mulch increased fruit comparison resistance. Gunadi and Suwanti (1988) recorded that mulch increased 16.3% yield over non-mulched plant spaced at 60 X 50 cm in single row.

Table9. Main effect of mulch on yield of tomato

Treatment	Yield/plant (kg)	Fruit weight/plot (kg)	Yield (t/ha)	100 g fruit dry weight (%)	100 g leaf dry weight (%)
M_0	1.54	23.13	64.20	5.13	12.20
M_1	1.95	29.10	81.10	5.60	10.75
M_2	1.77	26.55	73.75	6.12	10.55
Level of significance	**	**	**	**	**
CV %	9.91	9.45	5.62	11.41	8.66

Foot notes of table: ******Significant at 1 % level of probability

M_0= Control
M_1= Black polythene
M_2= Rice straw

4.10.3 Combined effect of different doses of poultry manure and mulching on fruit yield/plant

There had significant difference on fruit yield/plant was recorded due to the combined effect of different doses of poultry manure and mulching. The maximum (2.29 kg) fruit yield/plant was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene mulching), and the minimum (1.30kg) fruit yield/plant was obtained from the treatment combination of P_0M_0 (control) as shown in Table 10.

4.11 Fruit weight/plot (kg)

4.11.1 Effect of poultry manure on fruit weight/plot

Fruit weight/plot differed significantly due to the application of different doses of poultry manure. The maximum (29.85 kg) fruits/plot was recorded from P_2 (7.5 t/ha poultry manure),

while the minimum (21.65 kg) fruit weight/plotwas found from P_0 (control) as shown in Table 8.

4.11.2 Effect of mulching on fruit weight/plot

Significant differences were recorded on the yield of fruit weight/plot due to application of mulching in tomato. The maximum (29.10 kg) fruit weight/plot was recorded from M_1 (black polythene mulching), while the minimum (23.13 kg) fruit weight/plot was obtained from M_0 (control) showed in Table 9.

4.11.3 Combined effect of different doses of poultry manure and mulching fruit weight/plot

There was significant difference on the fruit weight/plot was recorded due to the combined effect of different doses of poultry manure and mulching. The maximum (34.35 kg) fruit weight/plot was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene mulch), and the minimum (19.50 kg) fruit weight/plot was obtained from the treatment combination of P_0M_0 (control) as shown in Table10.

Table10. Interaction effect poultry manure and mulch on yield of tomato

Treatment	Yield/plant(kg)	Fruit weight/plot (kg)	Yield (t/ha)	100 g fruit dry weight (%)	100 g leaf dry weight (%)
P_0 M_0	1.30f	19.50g	54.16gh	4.80cdef	14.37a
P_0 M_1	1.55cde	23.25cdef	65.00cd	4.17fg	13.40ab
P_0 M_2	1.48ef	22.22efg	61.66def	5.77bcd	12.13bc
P_1 M_0	1.49ef	20.35fg	62.08fg	4.63def	10.60cde
P_1 M_1	1.90bcd	28.50bc	79.16b	3.17g	8.40f
P_1 M_2	1.72cde	25.80cdef	71.66cd	8.30a	8.93ef
P_2 M_0	1.71def	25.65defg	71.25d	5.70bcde	10.27de
P_2 M_1	2.29a	34.35a	95.41a	6.80b	12.33bc
P_2 M_2	1.97b	29.55b	82.08b	4.60ef	10.23de
P_3 M_0	1.67ef	25.05efg	69.58d	5.43cde	13.57ab
P_3 M_1	2.05bc	23.75bc	85.41b	4.60ef	8.87ef
P_3 M_2	1.93cde	28.95cde	80.41c	5.83bc	10.93cd
$LSD_{0.05}$	0.27	3.98	6.95	1.02	1.63
CV%	9.91	9.45	5.62	11.41	8.66

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

P_0= Control
P_1= 5 t/ha
P_2=7.5 t/ha
P_3=10 t/ha

M_0= Control
M_1= Black polythene
M_2= Rice straw

4.12 Yield (t/ha)

4.12.1 Effect of poultry manure yield (t/ha)

Different doses of poultry manure showed significant variation for yield (t/ha) of tomato.The highest yield (82.91t/ha) was recorded from P_2 (7.5 t/ha poultry manure) which was statistically higher (74.21 t/ha) to P_3 (10 t/ha poultry manure), while the lowest (60.27 t/ha) yield was found from P_0 (control) as shown in Fig. 8.

P_0 =Control (0 t/ha), P_1 = 5 t/ha, P_2 = 7.5t/ha, P_3 = 10 t/ha

Fig. 8 Main effect of poultry manure on the yield of tomato

4.12.2 Effect of mulching yield (t/ha)

Yield (t/ha) showed significant differences due to the application of mulching. The highest (81.10 t/ha) yield was recorded from M_1 (black polythene mulch), while the lowest (64.20 t/ha) yield was recorded from M_0 (control) as shown in. Mulches effect on tomato yield was also reported Al-Jebori *et al.* (1987), Perry and Sanders (1986), Sannigrahi and Borath (2002).

M_0 =Control mulching, M_1 = Black polythene, M_2 = Rice straw

Fig 9. Main effect of mulching on the yield of tomato

4.12.3 Combined effect of different doses of poultry manure and mulching on yield (t/ha)

There had a significant difference due to different doses of poultry manure and mulching on yield/ha. The highest (95.41 t/ha) yield was obtained from P_2M_1 (7.5 t/ha poultry manure t/ha + black polythene) and the lowest (54.16 t/ha) yield was recorded from P_0M_0 (control) as shown in Table 10.

4.13 .100 g fruit dry weight (%)

4.13.1 Effect of poultry manure on 100 g fruit dry weight

There was no significant difference on dry matter content of fruits due to the application of different doses of poultry manure. The maximum (5.70 %) dry matter content of fruit was recorded from P_2 (7.5 t/ha poultry manure), while the minimum (4.91 %) dry matter content of fruits was found from P_0(control) as shown in Table 8.

4.13.2 Effect of mulching on 100 g fruit dry weight

Dry matter content of fruits varied significantly due to the application of mulching. The maximum (6.10 %) dry matter content of fruit was recorded from M_2 (rice straw mulching), while the minimum (5.13 %) dry matter content of fruit was obtained from M_0 (control) as shown in Table 9.

4.13.3 Combined effect of different doses of poultry manure and mulching on 100 g fruit dry weight

Combined effect of different doses of poultry manure and mulching showed significant differences on dry matter content of fruit. The maximum (8.30 %) dry matter content of fruits was recorded from P_1M_2 (5 t/ha poultry manure + rice straw mulch) and the minimum (3.17%) dry matter content of fruits was found from P_1M_1 (5 t/ha poultry manure and black polythene mulch) as shown in Table 10.

4.14.100 g leaf dry weight (%)

4.14.1 Effect of poultry manure100 g leaf dry weight

Dry matter content of leaves varied significantly due to the application of different doses of poultry manure. The maximum (13.30%) dry matter content of leaves was recorded from P_0

(control) and while the minimum (9.31 %) dry matter content of leaves was recorded from P_1 (5 t/hapoultry manure) as shown in Table 8.

4.14.2 Effect of mulching100 g leaf dry weight

Dry matter content of leaves varied significantly due to the application of mulch materials. The maximum (12.20%) dry matter content of leaves was recorded from M_0 (control mulching), while the minimum (10.55%) dry matter content of leaves was found from M_2 (rice straw mulch) as shown in Table 9.

4.14.3 Combined effect of different doses of poultry manure and mulching 100 g leaf dry weight

Combined effect of different doses of poultry manure and mulches showed significant differences on dry matter content of leaves. The maximum (14.37%) dry matter content of leaves was recorded from the treatment combination of P_0M_0 (control) and the minimum (8.4 %) dry matter content of leaves was obtained from P_1M_1 (5 t/ha poultry manure +black polythene mulch) as shown in Table 10.

4.15 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 as shown in Table 11. Prices of tomato were considered as per market of Agargaon, 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.

4.16 Cost of Production (Tk. /ha)

In the combination of poultry manure and mulching showed cost of production under the trial showed in Table11. The highest cost of production (2, 83,504Tk /ha) per hectare was recorded from P_3M_1 (10 t/ha poultry manure +black polythene mulch) and the second highest cost of production (2,80,950.Tk/ha) was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene mulch). The lowest cost of production (2, 44,666Tk./ha) was recorded from P_0M_0 (control) as shown in Table11.

4.17 Yield of Tomato (t/ha)

The yield (t/ha) due to the combined effect of poultry manure and mulching was shown in Table 11.The highest yield of tomato (95.41t/ha) was recorded from P_2M_1 (7.5 t/ha poultry manure +black polythene mulch) and the second highest yield of tomato (85.43 ton/ha) was recorded from P_3M_1 (10 t/ha poultry manure + rice straw mulch). The lowest yield of tomato (54.16 t/ha) was recorded from P_0M_0 (control).

4.18. Gross return

The combined effect of poultry manure and mulching showed different gross return under the trial showed in Table 11. The highest gross return (9,54,100Tk./ha) per hectare was recorded from P_2M_1 (7.5 t/ha poultry manure +black polythene mulch) and the second highest gross return (8,54,100Tk./ha) was recorded from P_3M_1 (10 t/ha poultry manure + rice straw mulch). The lowest gross return (Tk.5,41,600Tk./ha) was recorded from P_0M_0 (control).

4.19 Net return

In case of net return different treatment combination showed different amount of net return. The highest net return (6,73,150Tk. /ha) was recorded from P_2M_1 (7.5 t/ha poultry manure and black polythene mulch), the second highest net return (5,70,596 40Tk. /ha) was recorded from P_3M_1(10 t/ha poultry manure and rice straw mulch). The lowest net return (2,96,934Tk./ha) was recorded fromP_0M_0 (control) as shown in Table 11.

14.20 Benefit cost ratio

The combination of poultry manure and mulching for benefit cost ratio was different for treatment combination showed in Table 11. The highest (2.39) benefit cost ratio was recorded from P_2M_1 (7.5 t/ha poultry manure and black polythene mulch) the second highest (2.12) was recorded from P_2M_2 (7.5 t/ha poultry manure and rice straw mulch) and the lowest benefit cost ratio (1.21) was recorded from P_0M_0(control). From economic point of view, it was apparent from the above results that the treatment combination of P_2M_1 was more profitable compare to others.

Table11. Cost and return of tomato production influenced by poultry manure and mulching

Treatment combination	Cost of Production (Tk. /ha)	Yield of Tomato (t/ha)	Gross return (Tk. /ha)	Net Return (Tk. /ha)	BCR
$P_0 M_0$	2,44,666	54.16	541600	296934	1.21
$P_0 M_1$	2,65,660	65.00	650000	384340	1.44
$P_0 M_2$	2,58,850	61.66	616600	357750	1.38
$P_1 M_0$	2,49,759	62.08	620800	371041	1.48
$P_1 M_1$	2,77,143	79.16	791600	514457	1.85
$P_1 M_2$	2,62,345	71.66	716600	454255	1.73
$P_2 M_0$	2,53,250	71.25	712500	459250	1.61
$P_2 M_1$	2,80,950	95.41	954100	673150	2.39
$P_2 M_2$	2,65,100	82.08	820800	562900	2.12
$P_3 M_0$	2,54560	69.58	695800	441240	1.73
$P_3 M_1$	2,83,504	85.41	854100	570596	2.01
$P_3 M_2$	2,68,120	80.41	804100	535980	1.99

CHAPTER V

SUMMARY AND CONCLUSION

The effect of different doses of poultry manure and mulches on the growth and ld ofyie tomato (BARI tomato14 (at the Horticultural farm of Sher-e-Bangla Agricultural University Dhaka 1207 were studied during October2012 to March 2013. The experimental site belongs to Tejgaon series under AEZ No.28 soil having clay loam in texture a 0.68% organic carbon in top soil and a .Four levels of poultry manure (0 t/ha, 5 t/ha, 7.5 t/ha and 10 t/ha) and three levels of mulching (control, black polythene and rice straw) were used in the study. Levels of these two factors made 12 treatment combinations. The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 2 m x 1.8 m which accommodated 15 plants. The crop was harvested from 20 February to 21 March, 2013.

Data on growth and yield contributing parameters were recorded, and the collected data were statistically analyzed to evaluate the treatment effects.

At harvesting poultry manure had a significant effect on plant height. Plants grown with higher doses of poultry manure showed a gradual increase in plant height. The tallest plant (97.97 cm) was produced by using P_3 (10 t/hapoultry manure), while the shortest (85.31 cm) plant was observed from P_0 (control).

In case of black polythene, the tallest plant (97.72 cm) was produced by M_1 (black polythene) and the shortest plant (86.38 cm) was shown by M_0 (control mulching) plant. The treatment combinations demonstrated significant variation in plant height at 25, 40, 55, 70 DAT and at Harvesting. At harvesting the tallest plant (101.8 cm) was produced by P_3M_1 (10 t/ha poultry manure and black polythene mulch) while the shortest (75.23 cm) was shown from P_0M_0 (control).

Significant variation was observed in respect of root length influenced by different doses of poultrymanure and mulching. The longest length of root length (27.76 cm) was obtained from the dose 10 t/ha of poultry manure (P_3), and the lowest (22.14 cm) was obtained from P_0(control). In case of mulching the height root length (25.62 cm) was found fromM_1(black polythene mulch), but the shortest root length (23.13 cm) was obtained fromM_0(control).

The longest root length (29.60 cm) was obtained fromP_3M_1(10t/ha poultry manure and black polythene mulch), while the shortest root length (20.3 cm) was recorded from P_0M_0 (control).

The maximum number of branches/plant (6.92) was found at P_3 (poultry manure 10 t/ha), and the minimum value (5.94) was obtained from control P_3 (control). On the other hand, this parameter was also significantly influenced by different levels of mulching. It was the maximum (6.84) in M_1 (black polythene mulching plants), but the minimum (5.83) in M_0(control). The maximum total number of branches/ plant (7.50) was given by the combination ofP_3M_1 (10 t/hapoultry manure and black polythene mulch). The minimum number of branches/plant(5.50) was recorded fromP_0M_0(control).

Significant variation was observed in respect of the number of flower clusters/plant and flowers/clusteras influenced by different doses of poultry manure and mulching. The highest flower clusters/plant (10.79) was obtained from P_2(7.5 t/hapoultry manure, and highest flowers/cluster (9.62) was obtained from P_2 (7.5 t/ha poultry manure). On the other hand, the lowest number of flower clusters /plant (7.91) was obtained from P_0 (control) and the lowest

number of flowers/cluster (8.43) was obtained from P_0 (control). In case of mulching the maximum number of flowers/cluster and flowers/plant (10.05) and (9.63) were found from M_1 (black polythene mulch)plant, but the minimum values (9.52) and (8.10) were obtained fromM_0(control). The highest number of flower clusters/plant (11.30) and flowers /cluster (10.13) were combinedly produced from P_2M_1 (7.5 t/ha poultry manure and black polythene mulch), while the minimum number of flower clusters/plant (7.73) and the minimum number of flowers/cluster (7.06) were obtained from P_0M_0 (control).

The maximum values (24.06) ofthe number of fruits/plant was found at P_2 (7.5 t/ha poultry manure) and the minimum value (19.73) was obtained from P_0 (0control*)* treatment. On the other hand, the parameters were also significantly influenced by mulching. The maximum value of this character (23.65) was found in M_1 (black polythene mulched) plants, but the minimum (20.01) from M_0(control). The maximum (26.80) number of fruits/plant was recorded from P_2M_1 (7.5 t/ha poultry manure + black polythene mulching) and the minimum (17.77) number of fruits /plant was obtained from the treatment combination of P_0M_0 (0 t/ha poultry manure and control mulching).

The maximum value (1.99 kg) of yield/plant was found from P_2(7.5 ton/ha poultry manure) and the minimum value (1.44 kg) was obtained from P_0(control*)* treatment. In case of mulching the values of these character were maximum (1.94 kg) in M_1(black polythene mulched) plant, but the minimum (1.54 kg) was from M_0 (control) plants. The maximum fruit yield/plant (2.29kg) was obtained by the combination P_2M_1(7.5 t/ha poultry manure and black polythene mulch). The highest fruit yield/ha (95.41 ton) was obtained from P_2M_1 (7.5 poultry manure t/ha + black polythene) and the lowest (54.16 t/ha) was recorded from P_0M_0 (control).

The highest gross return (9,54,100 Tk./ha), net return (6,73,150 Tk/ha), benefit cost ratio (2.39), were recorded from the combination ofP_2M_1(7.5 t/ha poultry manure and black polythene mulch) whereas, the lowest gross return (5,41,600Tk./ha), net return (296934 Tk./ha) and the lowest benefit cost ratio (1.21) were recorded from the combination of P_0M_0(control).

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

- Poultry manure a played important role on the growth and fruit yield of tomato. In respect of all the yield attributes and yield, poultry manure showed better performance @ 7.5 t/ha.

- The plants produced the maximum growth and yield of tomato due application of black polythene mulch.
- It may be drowning the conclusion from above fact that 7.5 t/ha poultry manure and black polythene mulch is a suitable combination for the higher yield of tomato.

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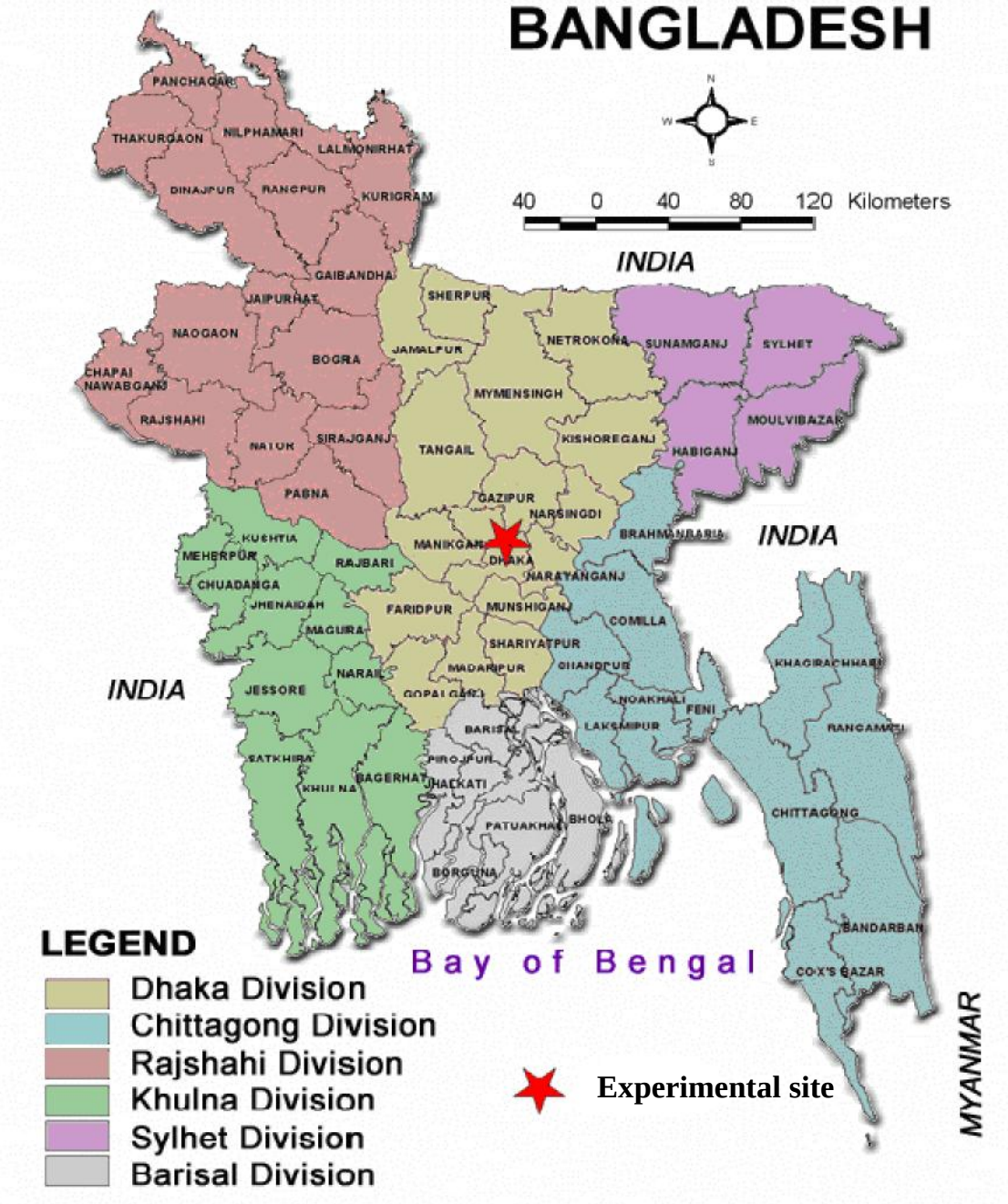
APPENDICES

Appendix I .: Experimental site at Sher-e-Bangla Agricultural University, Dhaka-1207



The map of Bangladesh showing experimental site

Appendix II. (A) Records of meteorological information (monthly) during the period from October 2012 to March 2013

Name of Months	Air temperature (^{0}C)		Relative humidity	Rainfall (mm)
	Maximum	Minimum		
October, 2012	30	18	81	37
November, 2012	25	16	78	0
December, 2012	22	14	74	0
January, 2013	24	12	68	0
February, 2013	27	17	67	3
March, 2013	31	19	56	11

Source: Bangladesh Meteorological Department (Climate and weather division) Agargaon, Dhaka

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

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 fairly leveled
Topography	Fairly level
Flood Level	Above flood level
Drainage	Well drained

Appendix III. Main effect of poultry manure on growth of tomato

Treatment	Plant height(cm) at different days after transplanting and at harvest				
	25	40	55	70	Harvest
Poultry					
P_0	32.40	44.37	55.66	72.61	85.31
P_1	33.33	48.70	63.75	82.49	92.79
P_2	34.42	50.55	66.72	86.51	95.77
P_3	35.42	52.39	69.47	88.69	97.97
Level of significance	*	NS	**	**	**
CV %	7.33	5.04	5.35	5.53	5.03

Appendix IV. Main effect of mulching on growth of tomato

Treatment	Plant height(cm) at different days after transplanting and at harvest				
	25	40	55	70	Harvest
Mulch					
M_0	32.17	45.48	59.33	78.91	86.38
M_1	35.35	53.15	68.18	86.05	97.72
M_2	34.00	47.62	64.16	82.26	94.63
Level of significance	**	**	**	**	**
CV %	7.33	5.04	5.35	5.53	5.03

Appendix V. Analysis of variance of data on plant height and growth of tomato

Source of variance	Degree of freedom	Mean square						
		Plant height (cm) at different days after translanting (DAT)					Tap root length(cm)	No. o leaves/p
		25	40	55	70	Harvest		
Replication	2	6.30**	17.87	63.72**	8.526**	39.48	2.83**	82.21**
Factor A	3	33.91*	70.45**	145.59**	456.477**	275.39**	50.76**	66.09**
Factor B	2	221.906**	145.020**	223.24**	132.906**	243.47**	24.27**	144.16*
A x B	6	4.38**	14.04	17.19	10.344**	8.50**	2.03**	1.30**
Error	22	9.42	6.00	10.91	20.866	22.13	0.01	12.21

Foot notes of table:

*Significant at 5 % level of probability

**Significant at 1 % level of probability

Appendix- VI. Analysis of variance of data on flowering and fruiting of tomato

Source of variance	Degree of freedom	Mean square				
		No. of Flower cluster/plant	No. of flower/cluster	No. flower/plant	No. of fruit/plant	Individual fruit weight(g)
Replication	2	4.26*	1.19**	388.87*	7.53**	61.27
Factor A	3	9.56**	2.31	310.68*	28.1	113.61
Factor B	2	4.76*	1.24	5.17**	5.01**	26.51**
A x B	6	0.54**	2.67	370.98**	33.65*	19.84**
Error	22	1.06	1.20	87.38	9.81	41.28

Foot notes of table:

*Significant at 5 % level of probability,**Significant at 1 % level of probability

Appendix- VII. Analysis of variance of data on the yield of tomato

Source of variance	Degree of freedom	Mean square				
		Yield/plant (kg)	Fruit weight/plot (kg)	Yield(t/ha)	100 g fruit dry weight (g)	100 g leaf dry weight (g)
Replicati	2	0.07	17.09	94.33*	1.02	0.23**
Factor A	3	0.44**	109.2**	790.28**	0.94	24.14**
Factor B	2	0.90**	201.37**	765.31**	6.51**	9.66**
A x B	6	0.06	12.32	42.52	7.08**	6.34**
Error	22	0.02	5.52	16.87	0.36	0.93

Foot notes of table:

*Significant at 5 % level of probability

**Significant at 1 % level of probability

Appendix-- V III. Input cost

Foot notes of table:

* Significant at 5 % level of probability

Treatments Combination	Labor Cost (TK.)	Ploughing Cost (TK.)	Seed cost (TK.)	Irrigation Cost (TK.)	Poultry Manure cost	Mulch Materials cost	pesticides	Sticking	Sub total
P_0M_0	116000	10000	15000	18000	0	0	11000	6000	176000
P_0M_1	123000	10000	15000	12000	0	25000	4000	6000	195000
P_0M_2	120000	10000	15000	12000	0	15000	70000	6000	189000
P_1M_0	118000	10000	15000	18000	10000	0	4000	6000	181000
P_1M_1	125000	10000	15000	12000	10000	25000	4000	6000	207000
P_1M_2	121000	10000	15000	12000	10000	15000	4000	6000	193000
P_2M_0	118000	10000	15000	18000	12000	0	4000	6000	183000
P_2M_1	125000	10000	15000	12000	12000	25000	4000	6000	209000
P_2M_2	120000	10000	15000	12000	12000	15000	4000	6000	194000
P_3M_0	117000	10000	15000	18000	15000	0	4000	6000	185000
P_3M_1	124000	10000	15000	12000	15000	25000	4000	6000	211000
P_3M_2	121000	10000	15000	12000	15000	15000	4000	6000	198000

**Significant at 1 % level of probability

Appendix- IX. Grand Total cost of production

Treatments Combination	Cost of lease of land for 6 months (13% of value of land Tk. 6,00000/year(B)	Sub Total Cost of production (A+B)	Interest on running capital for 6 months(Tk. 13% of cost/year (C)	Total (A+B+C) (TK.)	Miscellaneous cost(Tk. 5% of the input cost	Grand Total Cost of Production (TK.)
P_0M_0	48000	224000	11646	235646	9000	244666
P_0M_1	48000	243000	12700	255705	9960	265660
P_0M_2	48000	237000	12285	249550	9565	258850
P_1M_0	48000	229000	11569	240569	9190	249759
P_1M_1	48000	255000	12663	267763	9480	277143
P_1M_2	48000	241000	12095	253495	9250	262345
P_2M_0	48000	231000	12900	243900	9350	253250
P_2M_1	48000	257000	13500	270500	10450	280950
P_2M_2	48000	242000	13000	255010	10100	265100

P_3M_0	48000	233000	12225	245225	9335	254560
P_3M_1	48000	259000	13815	272815	10689	283504
P_3M_2	48000	246000	12570	147691	9550	268120

Foot notes of table:

*Significant at 5 % level of probability

**Significant at 1 % level of probability