EFFECT OF ORGANIC MULCHES ON YIELD OF TOMATO

A Thesis

By

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Student No. 1705011

MASTER OF SCIENCE
IN
CROP PHYSIOLOGY AND ECOLOGY

DEPARTMENT OF CROP PHYSIOLOGY AND ECOLOGY
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY
DINAJPUR-5200, BANGLADESH

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DECEMBER 2018

DEDICATED

TO

MY BELOVED PARENTS

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December 2018 The Author

ABSTRACT

A field experiment was conducted at the research field of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period from 1st October to December 2018 to investigate the effects of different mulching materials on the yield of tomato. The experiment consisted of 3 mulching treatments, viz. Water hyacinth, Ash and Straw and ii) Three varieties, viz. Maharaza, Bipul and BARI Tomato-4. The experiment was laid out in RCBD with 3 replications. There was a significant variation in plant height, number of leaves per plant and number of branch per pant of different tomato varieties with different mulches at different days after transplanting. In most cases, the tallest plant, highest number of leaves per plant and branch number per plant at different days after transplanting were observed in V_3 (BARI Tomato-4) with M_1 (Water hyacinth) mulch and the shortest plant, lowest number of leaves per plant and branch number per plant were observed in V_1 (Moharaza) with M_3 (Straw) mulch combination. The maximum days to flowering and fruit setting were observed in V_2 (Bipul) with M_1 (Water hyacinth) combination and the minimum days to flowering and fruit setting were observed in V_1 (Moharaza) with M_3 (Straw). All the yield contributing parameters like number of fruit cluster, number of fruit per cluster, fruit length, individual fruit weight, yield per plant and yield per hectare of different tomato varieties with different mulches showed significant variation. In all cases, the best performance was observed in V_3 (BARI Tomato-4) with M_1 (Water hyacinth) combination and the lowest performance was observed in V_1 (Moharaza) with M_3 (Straw) combition. BARI Tomato-4 growing with water hyacinth mulch produced produced the maximum yield (100 t/ha) in the present study.

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ACONYMS

AEZ = Agro-Ecological Zone

BARI = Bangladesh Agriculture Research Institute

et al. = And others

ha = Hectare

PE = Pan Evaporation

RCBD= Randomized Complete Block Design

CHAPTER I

INTRODUCTION

Tomato (*Lycopersicon esculentum* 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.

In Bangladesh, tomato is grown during the months from September to April, when rainfall is scarce, and soil moisture is exhausted by evapotranspiration. Water is the single factor, which directly influence the yield of tomato. 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 September to April in Bangladesh when growers have to depend either on natural precipitation or irrigation for tomato cultivation. Moreover, many of the farmers can not afford the expenses of irrigation. Under this situation indigenous mulching could be a good substitute for irrigation. Indigenous mulches like straw, rice husk, water hyacinth, crop residues are generally practiced in the production of horticultural crops. Different types of mulch play an important role in conserving soil moisture (Suh and Kim 1991). Mulch regulates soil temperature, creates suitable condition for germination, improves soil moisture,

suppresses weed growth, saves labour cost (Patil and Basad 1972) and improves soil physical conditions by enhancing biological activity of soil fauna and thus increases soil fertility (Lal 1989) which ultimately increases the yield of tomato. In addition, mulching has the unique character of reducing the maximum soil temperature and increasing the minimum temperature (Singh *et al*. 1987).

Mulching is the effective means to reduce weed infestation and conserve moisture in the root zone. This practice also encourages deeper and denser rooting. Mulches have been found to decrease soil moisture losses by reducing soil temperature and evaporation, promoting favorable soil biotic activities, reducing hard soil setting and contributing plant nutrients (Pal *et al*. 1994, Bhella 1988, Chakraborty and Sadhu and Hooda *et al.* 1999). Mulching has also been identified by many workers as a method to provide a favourable soil environment by minimizing crusting at the soil surface and keep it stable (Mehta and Prihar 1973). Little information regarding mulching on tomato cultivation is available. Therefore, the present study was conducted to find out the following objectives-

ii. To evaluate the effect of different types of organic mulch materials on yield of tomato;

ii. To find out the suitable combination of tomato variety with mulch for higher yield of tomato.

CHAPTER II

REVIEW OF LITERATURE

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

Effect of mulching on growth and yield of tomato

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 drip 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.

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/ m2) 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.

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/ m2 on a tomato crop in a Sicilian countryside. Applying PE mulch and planting at a density of 2.2 plants/ m2 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/ m2).

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 6 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 m2 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.

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.

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). 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.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from 1st October to December 2018 to find out the effect of mulching on the growth and yield of tomato variety. This chapter presents a brief description of the experimental site, soil, climate, experimental design, treatments, cultural operations, data collection and analysis of different parameters under the following headings:

3.1 Location

The experiment was conducted in the research field of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The experimental site is situated under the Dinajpur Sadar Upazila and located at 25º39′ N latitude and 88º41" E longitude with an elevation of 37.58 meter above the sea level.

3.2 Characteristics of soil and climate

The soil was collected from 15cm depth of the research field of CPE department. The soil was non-calcareous red brown terrace with loamy texture belonging to the AEZ (Old Himalain Piedmont plain). The collected soil was well pulverized and dried in the sun and Decomposed cowdung was mixed with the soil. The soil is sandy loam under the Order Inceptisol. The experimental site is situated in the sub-tropical region characterized by heavy rainfall during the months from May to September and scantly rainfall in the rest of the year.

3.3 Treatment of the experiment

The experiment considered of two factors. Details of the treatments are presented below:

Factor A: Three different varieties

i. Moharaza

ii. Bipul

iii. BARI tomato-4

Factor B: Three different organic mulches

i. Water hyacinth

ii. Ash

iii. Straw

3.4 Layout of the experiment

The experiment was laid out in two factors Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the treatments in each plot of each block. There were 27 unit plots altogether in the experiment. The size of the plot was 2 m × 2.5 m. The distance between two blocks and two plots was 50 cm each.

3.5 Land preparation

The experimental field was first opened on 1st October 2018 with the help of a power tiller and prepared by three successive ploughing and cross-ploughing. Each ploughing was followed by laddering to have a desirable fine tilth. The

visible larger clods were hammered to break into small pieces. All kinds of weeds and residues of previous crop were removed from the field. Individual plots were cleaned and finally leveled with the help of wooden plank.

3.6 Fertilizer application

The experimental plot were fertilized at 400 kg, 275 kg and 200 kg N, P and K per hectare, respectively. In addition, farmyard manure at the rate of 10 t ha^{-1} was applied to all plots (Rashid 1999). All farmyard manure, TSP and one third of Urea and MP were applied during final land preparation and rest Urea and MP were applied in two equal installments at 25 and 40 days after transplanting.

3.7 Transplanting of seedlings

Healthy and uniform 25 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots on 25 October, 2018. 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 and to check the border effect.

3.8 Application of mulches

Three types of mulches, viz. water hyacinth, ash and straw were placed on the respective plots per layout of the experiment 7 days after transplanting. The fresh water hyacinth, ash and straw were dried in the sun for seven days before placing over the plot. The crop was raised under rain-fed condition.

3.9 Intercultural operations

After transplanting of the seedlings, different intercultural operations were accomplished for better growth and development of the plants.

i. Gap filling

Gap filling was done by healthy seedlings of the same stock previously planted in the border area on the same date of transplanting.

ii) Staking and pruning

When the plants were established, each plant was staked with Dhaincha' (*Seshunia* sp.) sticks to keep them erect. Within a few days of staking, as the plants grew up, they were given a uniform moderate pruning.

3.10 Harvesting

Fruits were harvested at 4 days interval during early ripe stage where they attained slightly red colour.

3.11 Data collection

Three 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 15, 30, 45, 60, 75, and 90 days after transplanting to observe the growth rate of plants. The average height was computed and expressed in centimeters.

3.11.2 Number of leaves per plant

The number of leaves per plant was counted at 15, 30, 45, 60, 75, and 90 after transplanting tagged plants. The average of three plants were computed and expressed in average number of leaves per plant.

3.11.3 Number of branches per plant

The number of branches per plant was counted at 15, 30, 45, 60, 75, and 90 days after transplanting from tagged plants. The average of three plants were computed and expressed in average number of branch per plant.

3.11.4 Days to first flowering initiation, 50% flowering and days to fruiting was counted

3.11.5 Number of fruit clusters per plant

The number of fruits clusters was counted from the sample plants and the average number of fruit clusters produced per plant was recorded at the time of final harvest

3.11.6 Number of fruit per clusters

The number of fruit per clusters was counted and the average number of fruit per clusters produced per plant was recorded at harvest.

3.11.7 Fruit length and fruit diameter

Length and diameter of tomato was measured by measuring scale and slide calipers at harvest.

3.11.8 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.

3.11.9 Yield of fruits per plant (kg):

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

3.11.10 Yield of fruits per hectare (ton/ha)

It was calculated by the following formula:

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

3.12 Data Analysis

The data were analyzed by partitioning the total variance with the help of computer by using MSTAT program. The treatment means were compared using Tukey′s test at $P \leq 1\%$ level.

CHAPTER IV

RESULTS AND DISCUSSION

The influence of different mulches on the growth and yield of tomato varieties are presented in several tables and figures and discussed in this chapter.

4.1 Plant height

The interaction of mulching and tomato variety influenced the height of plant significantly at 15, 30, 45, 60 and 90 days after transplanting but not significant at 75 DAT (Fig.1). In general the height of plant increased with the advanced of time after transplanting. At 15 days after transplanting, the tallest plant (20.83 cm) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2, V_2M_1, V_3M_3 which was statistically similar to those observed in V_1M_1 combination and the shortest plant (12.50 cm) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_2M_2, V_1M_2 and V_2M_3 combination. At 30 days after transplanting, the tallest plant (31.5 cm) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2 which was statistically similar to those observed in V_1M_1, V_2M_3 combination and the shortest plant (22.83 cm) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_3M_3 and V_1M_2 combination. At 45 days after transplanting, the tallest plant (45.5 cm) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was

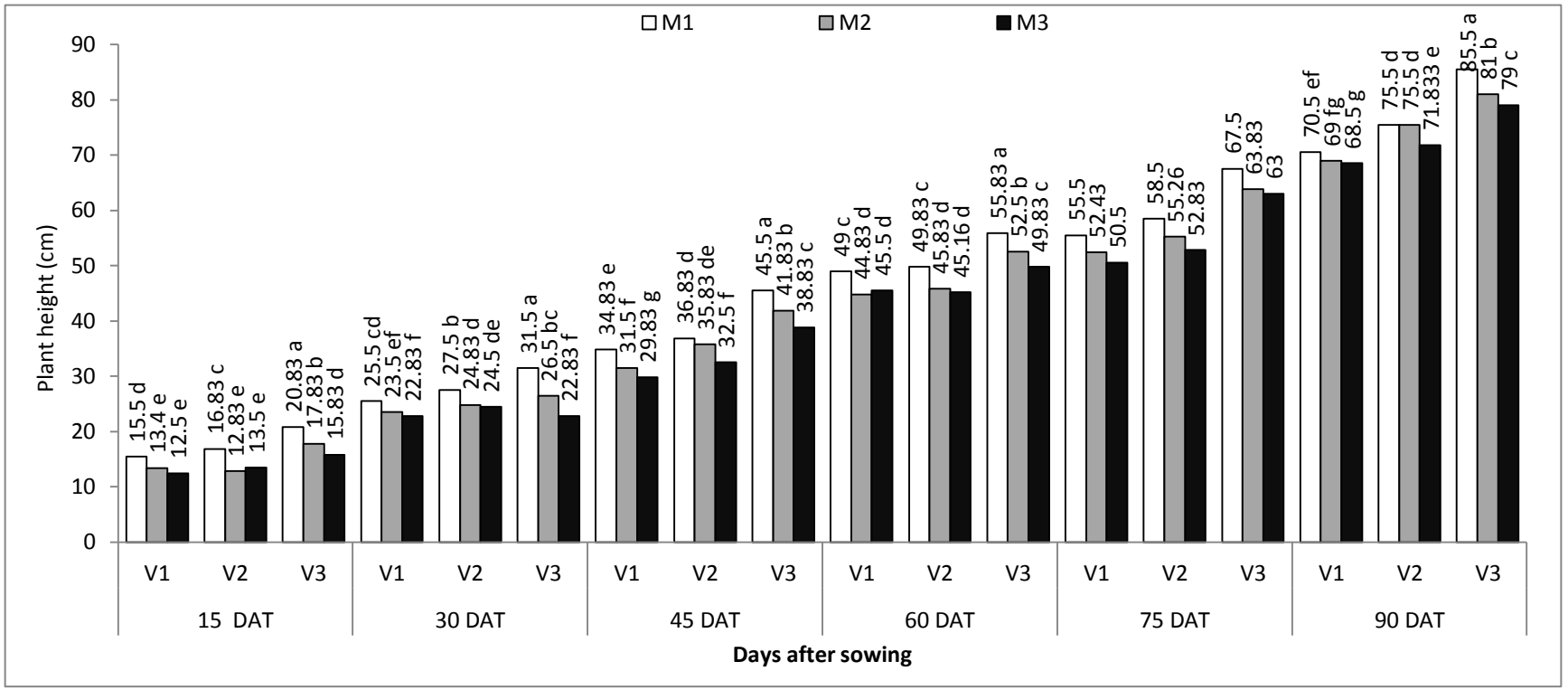

Fig.1. Plant height as influenced by mulching and tomato varieties at different days after transplanting.

In a column, means followed by different letter(s) differed significantly by Tukey's test at P ≤ 5% level of probability.

V_1= Moharaza M_1 = water hyacinth

V_2= Bipul M_2 = ash

V_3= BARI tomato-4 M_3= straw

followed by V_3M_2, V_3M_3, V_2M_1 combination and the shortest plant (29.83 cm) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_1M_2 and V_2M_3combination. At 60 days after transplanting, the tallest plant (55.83 cm) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2, V_3M_3 which was statistically similar to those observed in V_2M_1, V_1M_1 combination and the shortest plant (44.83 cm) was observed in V_1 (Moharaza) with M_2 (ash) which was statistically similar to those observed in V_2M_3 , V_1M_3 and V_2M_2 combination. At 75 days after transplanting, the tallest plant (67.5 cm) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) and the shortest plant (50.5 cm) was observed in V_1 (Moharaza) with M_3 (straw) combination. At 90 days after transplanting, the tallest plant (85.5 cm) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2, V_3M_3, V_2M_1, V_2M_3 which was statistically similar to those observed in V_1M_1 combination and the shortest plant (68.5 cm) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_1M_2 combination.

Water hyacinth mulch conserved sufficient soil moisture and maintained higher temperature which might be responsible for increased plant growth and development. Baten *et al*. (1995) also obtained similar findings in garlic with indigenous mulches and greater plant height found from favorable temperature and moisture in the soil in mulching treatments.

4.2. Leaf number

The interaction of mulching and tomato variety influenced the number of leaves significantly at 15, 30, 45 and 90 days after transplanting but not significant at 60

and 75 DAT (Fig. 2). In general the number of leaves increased with the advanced of time after transplanting. At 15 days after transplanting, the highest leaf number (15.16) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2, V_2M_1, V_3M_3, V_1M_1 combination and the lowest leaf number (8.5) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_2M_3 and V_1M_2 combination. At 30 days after transplanting, the highest leaf number (25.5) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_2M_1, V_3M_2 which was statistically similar to those observed in V_3M_3, V_2M_2 combination and the lowest leaf number (17.76) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_1M_2 combination. At 45 days after transplanting, the highest leaf number (45.5) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_2M_2, V_3M_3 which was statistically similar to those observed in V_1M_1 combination and the lowest leaf number (39.33) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_2M_3, V_1M_2 combination. At 60 days after transplanting, the highest leaf number (55) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) and the lowest leaf number (43.5) was observed in V_1 (Moharaza) with M_3 (straw) combination. At 75 days after transplanting, leaf number (65.56) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) and the lowest leaf number (54) was observed in V_1 (Moharaza) with M_3 (straw) combination. At 90 days after transplanting, the highest leaf number (70.5) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2 which was statistically similar to those observed in V_2M_1, V_3M_3 combination and

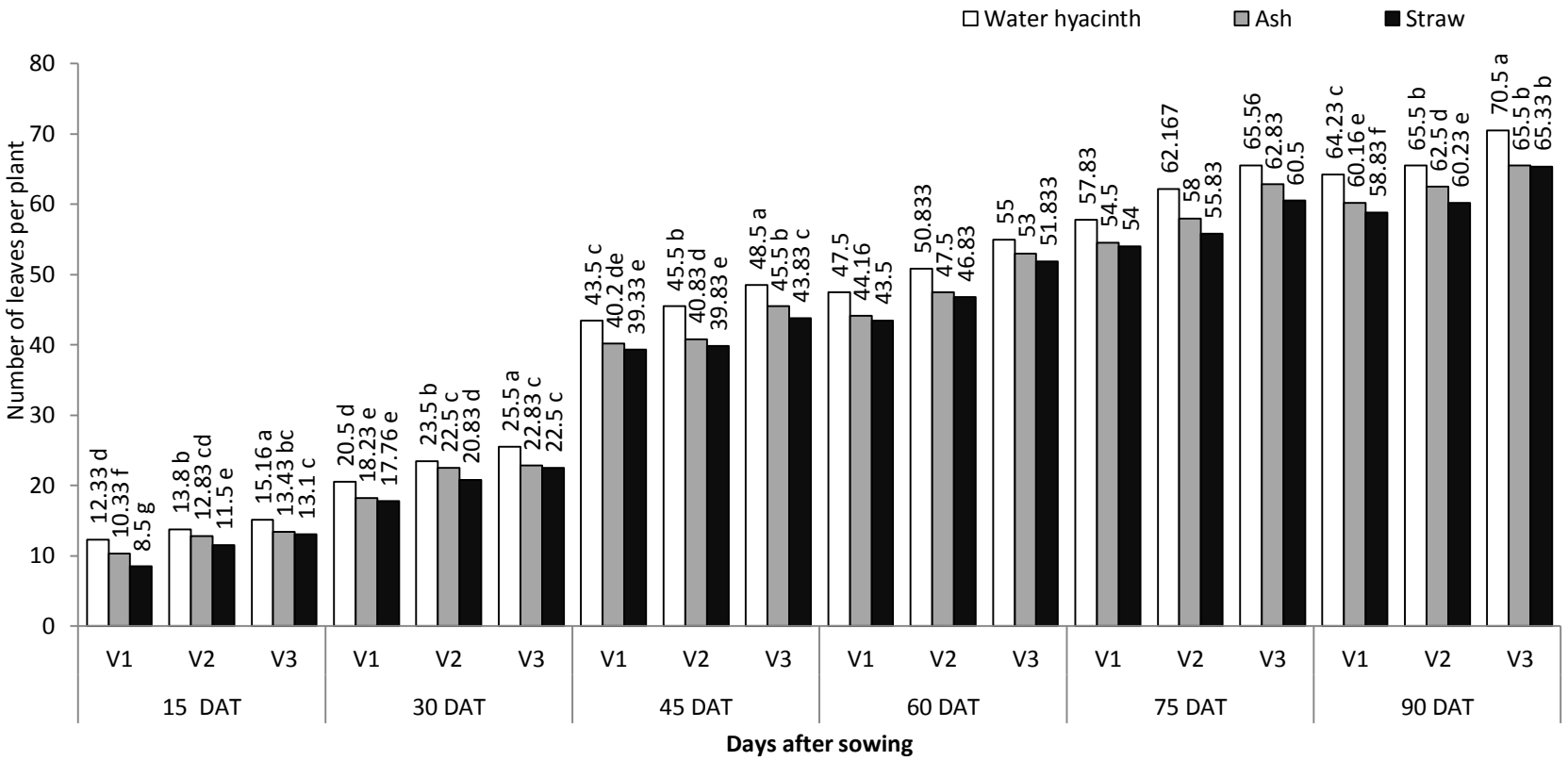

Fig.2. Number of leaves per plant as influenced by mulching and tomato varieties at different days after transplanting. In a column, means followed by different letter(s) differed significantly by Tukey's test at P ≤ 5% level of probability.

V_1= Moharaza M_1 = water hyacinth

V_2= Bipul M_2 = ash

V_3= BARI tomato-4 M_3= straw

the lowest leaf number (58.83) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_2M_3, V_1M_2 combination. This is in agreement with Calvert (1957). He found that high temperature and low light intensity accelerated the number of leaves per plant. Baten *et al.* (1995) also obtained similar findings in garlic with indigenous mulches. The highest number of leaves per plant produced in mulching treatments was possibly due to greater plant height resulting from favourable temperature and moisture in the soil.

4.3 Branch number

The interaction of mulching and tomato variety influenced the number of branches significantly at 15, 30, 45, 60 and 90 days after transplanting but not significant at 75 DAT (Fig. 3). In general the number of branches increased with the advanced of time after transplanting. At 15 days after transplanting, the highest branch number (4.8) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was statistically similar to those observed in V_2M_1 followed by V_1M_1, V_3M_2, V_2M_2, V_3M_3 combination and the lowest branch number (3.1) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_2M_3 and V_1M_2 combination. At 30 days after transplanting, the highest branch number (8.4) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_1M_1 which was statistically similar to those observed in V_2M_1 followed by V_3M_2, V_2M_2 and V_1M_2 combination and the lowest branch number (5.33) was observed in V_2 (Bipul) with M_3 (straw) which was statistically similar to those observed in V_3M_3 combination. At 45 days after transplanting, the highest branch number (12.5) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which

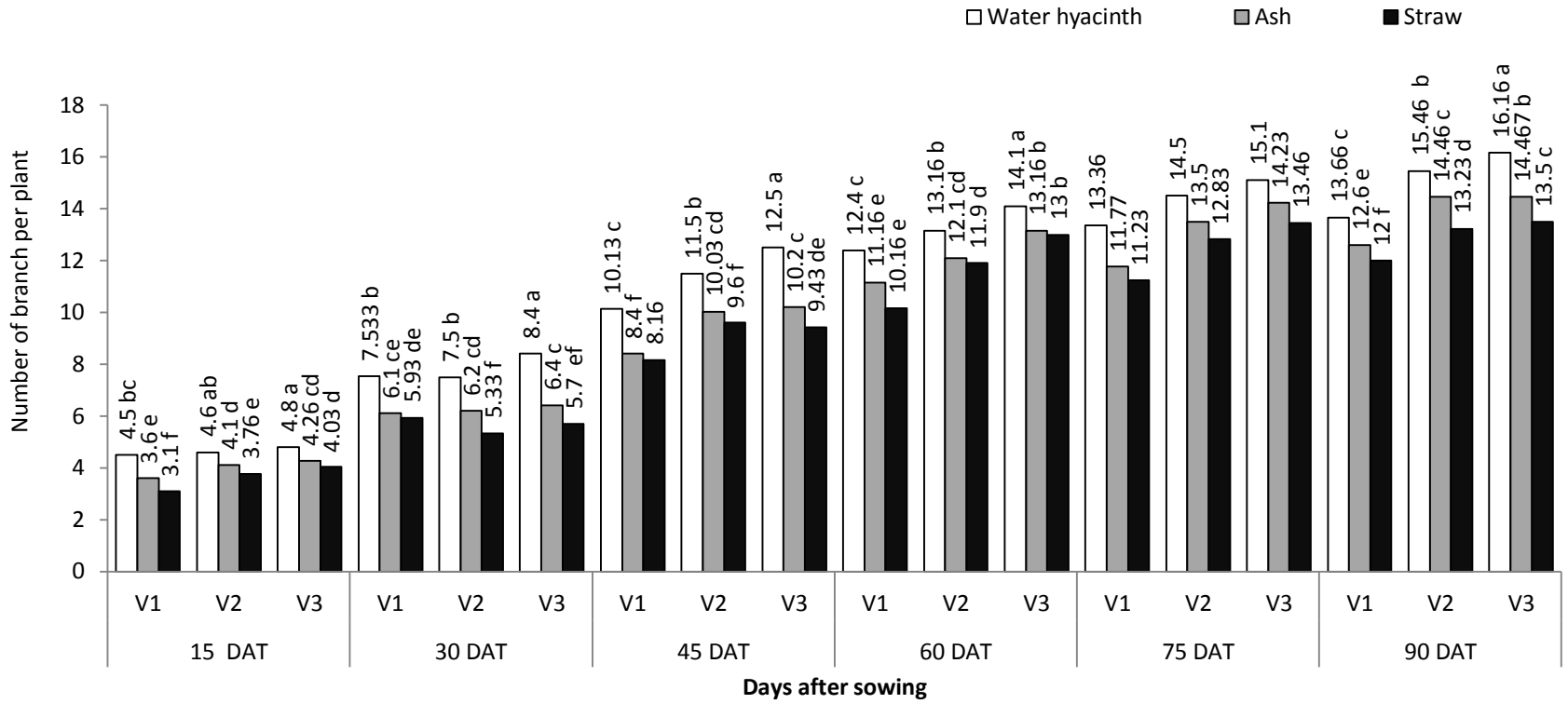

Fig.3. Number of branch per plant as influenced by mulching and tomato varieties at different days after transplanting.
In a column, means followed by different letter(s) differed significantly by Tukey's test at P ≤ 5% level of probability.

V_1= Moharaza M_1 = water hyacinth

V_2= Bipul M_2 = ash

V_3= BARI tomato-4 M_3= straw

was followed by V_2M_1, V_1M_1 and V_2M_2 combination and the lowest branch number (8.16) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_1M_2 and V_2M_3 combination. At 60 days after transplanting, the highest branch number (14.1) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_2M_1, V_3M_2, V_3M_3 and V_1M_1 and the lowest branch number (10.16) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_1M_2 combination. At 75 days after transplanting, the highest branch number (15.1) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) and the lowest branch number (11.23) was observed in V_1 (Moharaza) with M_3 (straw) which combination. At 90 days after transplanting, the highest branch number (16.16) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_2M_1 ,V_2M_1 and V_3M_2, V_2M_2 which was statistically similar to those observed in V_1M_1 and V_3M_3 combination. The lowest branch number (12) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_2M_3, V_1M_2 combination. Wien *et al.* (1993) reported that mulching increased the secondary branching on main branches compared to the control in tomato.

4.4 Flower initiation

Flower initiation was not significantly influenced by the interaction effect of mulching and tomato variety (Fig. 4). The maximum days (42.5) to flowering was observed in V_2 (Bipul) with M_1 (water hyacinth) and minimum days (32.16) to flowering was observed in in V_1 (Moharaza) with M_3 (straw) combination.

The results was similar with Singh *et al.* (2017)

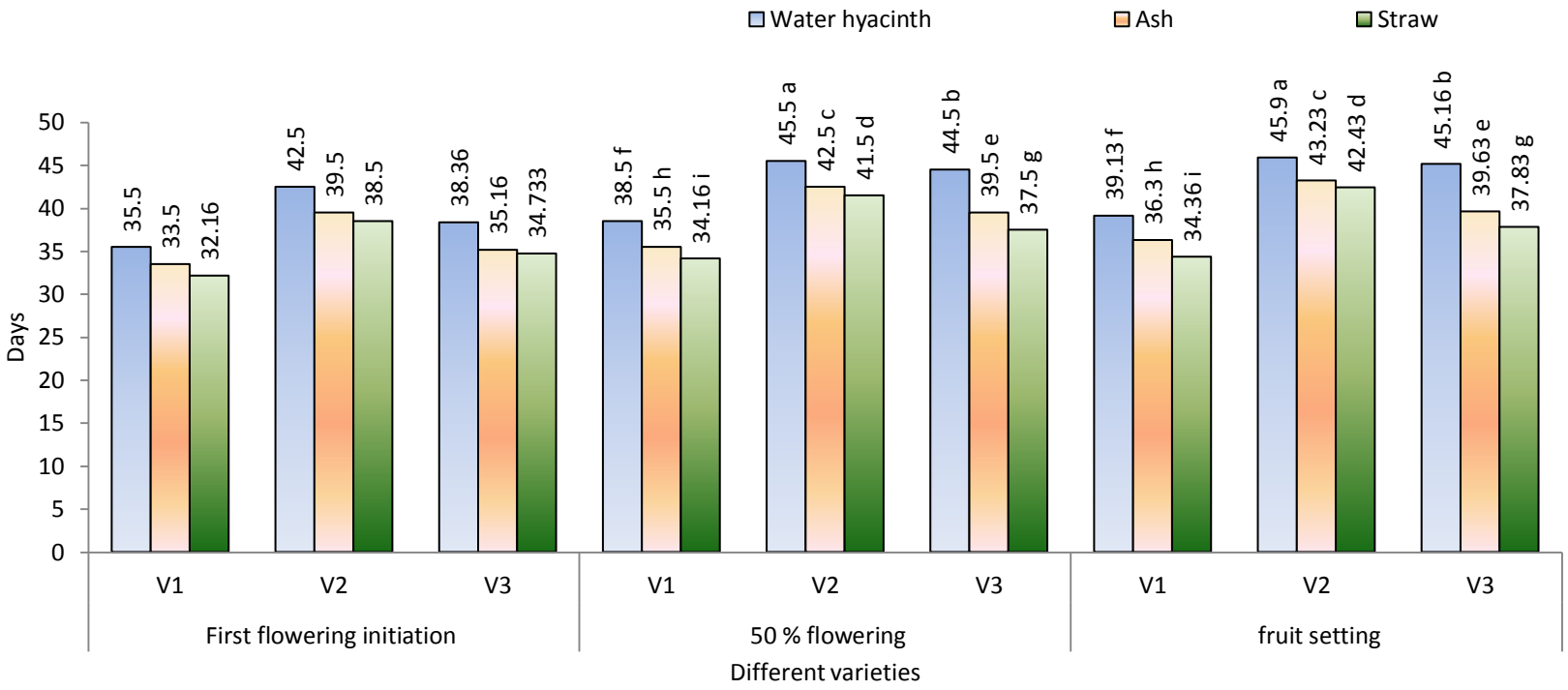

Fig. 4. Days to flower initiation, 50% flowering and fruit setting as influenced by mulching and tomato varieties at different days after transplanting.

In a column, means followed by different letter(s) differed significantly by Tukey's test at P ≤ 5% level of probability.

V_1= Moharaza M_1 = water hyacinth

V_2= Bipul M_2 = ash

V_3= BARI tomato-4 M_3= straw

4.5 Fifty percent flowering

Fifty percent flowering was significantly influenced by the interaction effect of mulching and tomato variety (Fig. 4). The maximum days (45.5) to flowering was observed in V_2 (Bipul) with M_1 (water hyacinth) which was followed by V_3M_1, V_2M_2, V_2M_3, and V_3M_2. The minimum days (43.16) to flowering was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_3M_3, V_1M_2 combination. The results was similar with Singh *et al.* (2017)

4.6 Days to fruit setting

Days to fruit setting was significantly influenced by the interaction effect of mulching and tomato variety (Fig. 4). The maximum days (45.9) to fruit setting was observed in V_2 (Bipul) with M_1 (water hyacinth) which was followed by V_3M_1, V_2M_2, V_2M_3, and V_3M_2. The minimum days (34.36) to fruit setting was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_2M_3 andV_1M_2 combination. The results was similar with Tipu *et al.* (2014)

4.7 Number of fruit cluster per plant

Number of fruit cluster per plant was significantly influenced by the interaction effect of mulching and tomato variety (Table 1). The highest number of fruit cluster (7.33) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_2M_1, V_1M_1, V_3M_2, and V_2M_2 combination. The lowest fruit cluster (5) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_3M_3 and V_1M_2 combination. This may be attributed to the enhanced

Table 1. Yield attributes of tomato as influenced by different mulches and varieties

Variety	Organic Mulches	No. of fruit cluster plant^{-1}	No. of fruit cluster^{-1}	Fruit diameter (cm)	Fruit length (cm)
Moharaza (V_1)	M_1	6.10 bc	3.9 de	4.10	4.60 c
	M_2	5.10 e	3.5 fg	3.70	4.13 e
	M_3	5.00 e	3.26 g	3.60	4.06 e
Bipul (V_2)	M_1	6.33 b	4.2 bc	4.16	4.83 b
	M_2	5.43 d	3.86 de	3.90	4.13 e
	M_3	5.03 e	3.7 ef	3.83	4.03 e
BARI Tomato-4(V_3)	M_1	7.33 a	5.20 a	3.76	5.20 a
	M_2	5.96 c	4.46 b	3.50	4.33 d
	M_3	5.20 de	4.10 cd	3.46	4.03 e
Level of significance		**	*	NS	**
CV (%)		4.97	4.93	3.53	4.26

In a column, means followed by different letter(s) differed significantly by Tukey's test at $P \leq 5\%$ level of probability.

M_1 = water hyacinth

M_2 = ash

M_3= straw

vegetative growth as observed in the treatment. Wien, *et al.* (1993) reported that mulching increased number of flower clusters on main branches and secondary' branches compared with no mulch. Kumer *et al*. (1995) observed that mulching significantly increased the number of fruits cluster per plant compared to the control.

4.8 Number of fruit per cluster

Number of fruit per cluster was significantly influenced by the interaction effect of mulching and tomato variety (Table 1). The highest number of fruit cluster (5.2) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2, V_2M_1, V_3M_3, V_1M_1 and V_2M_2 combination. The lowest fruit per cluster (3.26) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_2M_3 and V_1M_2 combination. This happened possibly due to the effect of soil temperature resulting from mulching. Baldev *et al.* (1988) reported that mulching with rice straw decreases the soil temperature.

4.9 Fruit diameter

Fruit diameter was not significantly influenced by the interaction effect of mulching and tomato variety (Table 1). The highest number of diameter (4.16 cm) was observed in V_2 (Bipul) with M_1 (water hyacinth) combination and the lowest fruit diameter (3.5 cm) was observed in V_3 (BARI Tomato-4) with M_2 (Ash) combination. The results was similar with Tipu *et al.* (2014).

4.10 Fruit length

Fruit length was significantly influenced by the interaction effect of mulching and tomato variety (Table 1). The highest fruit length (5.2 cm) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_2M_1, V_1M_1 and V_3M_2 combination. The lowest fruit length (4.03 cm) was observed in V_3 (BARI Tomato-4) with M_3 (straw) which was statistically similar to those observed in V_2M_3, V_2M_3 and V_2M_2 combination. The results was similar with Tipu *et al.* (2014).

4.11 Individual fruit weight

Individual fruit weight was significantly influenced by the interaction effect of mulching and tomato variety (Table 2). The highest Individual fruit weight (71.00 gm) was observed in V_2 (Bipul) with M_1 (Water hyacinth) which was followed by V_1M_1, V_1M_1, V_3M_2 and V_1M_2 combinations. The lowest individual fruit weight (60.83 gm) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_3M_3 combination.

4.12 Yield per plant

Yield per plant was significantly influenced by the interaction effect of mulching and tomato variety (Table 2). The highest yield per plant (2.20 kg) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_2M_1, V_3M_2, V_1M_1 and V_3M_3 combination. The lowest yield per plant (1.20 kg) was observed in V_1 (Moharaza) with M_3 (straw) which was followed by V_2M_3 and V_1M_2 combination. Singh *et al.* (1987) reported that mulching by paddy straw

Table 2. Yield attributes and yield of tomato as influenced by different mulches and varieties

Variety	Organic mulches	Individual fruit weight (gm)	Yield per plant (kg)	Yield (Ton/ha)
Moharaza (V_1)	M_1	66.83 b	1.83 cd	83.33 d
	M_2	62.43 d	1.50 f	75.33 e
	M_3	60.83 e	1.20 g	70.66 f
Bipul- 8 (V_2)	M_1	71.00 a	2.03 b	90.33 bc
	M_2	65.50 c	1.76 d	83.16 d
	M_3	63.50 d	1.66 e	73.16 ef
BARI Tomato-4(V_3)	M_1	65.50 c	2.20 a	100.00 a
	M_2	62.50 d	1.90 c	93.00 b
	M_3	61.00 e	1.80 d	88.16 c
Level of significance		**	**	**
CV (%)		5.97	4.55	5.25

In a column, means followed by different letter(s) differed significantly by Tukey's test at $P \leq 5\%$ level of probability.

M_1 = water hyacinth

M_2 = ash

M_3 = straw

decreased soil water depletion and increased water uses efficiency. The highest weight of fruits per plot was obtained from water hyacinth with BARI Tomato-4.

4.13 Yield (t/ha)

Yield was significantly influenced by the interaction effect of mulching and tomato variety (Table 2). The highest yield (100.00 t/ha) was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) which was followed by V_3M_2 which was statistically similar to those observed in V_2M_1 followed by V_3M_3, V_1M_1 and V_2M_2 combination. The lowest yield (70.66 t/ha) was observed in V_1 (Moharaza) with M_3 (straw) which was statistically similar to those observed in V_2M_3 combination.

Water hyacinth mulch conserved sufficient soil moisture and maintained higher temperature which might be responsible for increased plant growth and development which ultimately increased yield. Streek *et al.* (1995) also reported soil temperature and yield were generally higher under mulching condition.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out to study the effect of mulches on the growth and yield of three tomato varieties at the research field of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period from 1st October to December 2018. There were three mulches and three varieties. The treatments of the experiment comprised of two factors namely i) Three mulches, viz. Water hyacinth, Ash and Straw and ii) Three varieties, viz. Maharaza, Bipul and BARI Tomato-4 and thus there were all together 9 treatment combinations. The experiment was laid out in the Randomized Complete Block Design (RCBD) with 3 replications. The size of each unit plot was 2m x lm. Tomato varieties were transplanted in the field on 25 October 2018. From each plot, 3 plants were randomly selected for collection of data of fruits on yield contributing characters and fruit yield. Observations were made on height of plant, number of leaves per plant, number branches per plant, first flowering initiation, 50 % flowering, days to fruit setting, number of fruit cluster per plant, number of fruit per cluster, fruit diameter, fruit length, individual fruit weight, yield per plant and yield per hactre.

There was a significant variation in plant height, number of leaves per plant and number of branch per pant of different tomato varieties with different mulches at different days after transplanting. In most cases, the tallest plant, highest number of leaves per plant and branch number per plant were observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) and the shortest plant, lowest number of

leaves per plant and branch number per plant were observed in V_1 (Moharaza) with M_3 (straw) combination.

First flowering initiation was not significantly influenced by the interaction effect of mulching and tomato variety. Fifty parcent flowering and days to fruit setting was significantly influenced by the interaction effect of mulching and tomato variety in both cases The maximum days to flowering and fruit setting were observed in V_2 (Bipul) with M_1 (water hyacinth) combination and the minimum days to flowering and fruit setting were observed in V_1 (Moharaza) with M_3 (straw).

All the yield contributing parameters like number of fruit per cluster, number of fruit per cluster, fruit length, individual fruit weight, yield per plant and yield per hectare of different tomato varieties with different mulches showed significant variation except fruit diameter where it was insignificant. In all cases, the best performance was observed in V_3 (BARI Tomato-4) with M_1 (water hyacinth) combination and the lowest performance was observed in V_1 (Moharaza) with M_3 (straw) combition except individual fruit weight where the highest individual fruit weight was observed in V_2 (Bipul) with M_1 (water hyacinth) and the lowest Individual fruit weight was observed in V_1 (Moharaza) with M_3 (straw) combination.

From the overall results it can be concluded water hyacinth have the potentiality to influence the yield of tomato and therefore it can be suggested that the yield of tomato may be increased by using water hyacinth as mulches in tomato cultivation.

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APPENDICES

Appendix I. Characteristics of soil of the experimental site

General characters	**Description**	
Location	Crop Physiology and Ecology, HSTU, Dinajpur	
AEZ	Old Himalayan Piedmont Plain (AEZ-1)	
General Soil type	Non-Calcareous Brown Floodplain Soil	
Parent material	Piedmont alluvium	
Soil series	Ranishankail	
Drainage	Moderately well drained	
Flood level	Above flood level	
Topography	High land	
Physical characteristics	**Value**	
Bulk density (g cm-3)	0.86-1.07	
Particle size (%)		
Sand (2-0.02mm)	60.0	
Silt (0.02-0.002mm)	27.0	
Clay (< 0.002mm)	13.0	
Textural class	Sandy loam	
Chemical characteristics	**Content**	**Interpretation**
pH	5.40-5.50	Moderately acidic
Organic carbon (%)	0.69	Low
Organic matter (%)	1.19	Low
CEC (meq/100g soil)	5.60	Low
Total N (%)	0.07	Very low
Available P (ppm)	16.75	Medium
Exchangeable K (meq/100g soil)	0.17	Medium low

Source: Analysis of initial soil samples was done in SRDI, Dinajpur, Bangladesh

Appendix II: Weather data for growing season of mungbean, October to December, 2018

Month	Relative humidity (%)	Temperature		Total rainfall (mm)
		Minimum (^{o}C)	Maximum (^{o}C)	
October	70	13.20	28.10	5.20
November	81	16.10	30.0	0.00
December	85	12.10	26.4	7.00

Source: Wheat Research Centre, Dinajpur.