Mulch Effect on Growth and Yield of Vine Vegetables

A. K. M. Quamruzzaman, Ferdouse Islam and S. R. Mallick

ABSTRACT

An experiment was undertaken to identify the suitable mulch paper for different high value vegetables during the winter season of November 2019 to March 2020 at the research farm of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. The experiment was randomized complete block design with 3 replications. Three vegetables varieties viz., netted melon, watermelon, cucumber and 3 mulch treatments viz., T1=Silver over black mulch; T2= Black mulch; T3= No mulch were included in this study. Different vegetables responded differently with the changes of mulches irrespective of different characters. Considering relationship between the soil moisture content and fruit number it was clear that fruit number, average fruit weight, fruit length, fruit diameter was strongly related with soil moisture content. The effect of different plastic mulches on fruit weight per plant and yield (t/ha) were significant. Mulching produced higher fruit yield per plant and fruit yield per hectare than for the control, indicating that the mulch had positive effect in generating increased fruit yield. Silver over black plastic mulch produced the highest fruit yield viz., 24.22 t/ha (cucumber), 26.37 t/ha (netted melon), 43.59 t/ha (watermelon) followed by black and no mulches. Obviously, control plot produced the lowest fruit

Keywords: Mulch, yield, soil moisture, weed, vine vegetables, Bangladesh.

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I. INTRODUCTION

The present vegetables production is 4.37 million tons from 0.45 million hectare of land [1]. In Bangladesh the agriculture sector contributes to about 12.68% of the GDP [2] and 60% of the working population are directly or indirectly involved in agriculture [3]. The income is quite far better than any other crops i.e., 2-4 times more cash than other crops. Vegetables production is one of the emerging businesses in Bangladesh both in on season and off season. But the yield of the vegetables is low as compared to the other countries in Bangladesh. Although many efforts had laid out for its improvement the desired level of the expectation cannot be met till now. Efforts have been made to increase the production per unit area. Vegetables have much importance as economic, nutritional, medicinal, and industrial and also have employment opportunities. It needs 1.5 times more labor than other crops. Since the beginning of civilization, the man had developed technologies to increase the efficiency of food production. The use of plastic mulch in commercial vegetable production is one of these traditional techniques that have been used since 1950's. A favorable soil-water-plant relation is created by placing mulch over the soil surface. The microclimate surrounding the plant and soil is significantly affected by mulch i.e. the thermodynamic environment, the moisture, the erosion, the physical soil structure, the incidence of pests and diseases, crop growth and yield. In order to maximize water use efficiency by the plant and to improve the quality of produce, the use of mulch has become an

important cultural practice in many regions of the world for the commercial production of vegetable crops.

Mulching is an agricultural cropping technique that involves placing organic or synthetic materials on the soil around plants to provide a more favorable environment for growth and production. Organic mulches are being used traditionally by the farmers. The most commonly used organic mulches in Bangladesh are: rice straw, wheat straw, dried maize plant, sugarcane leaves, grass clippings, etc. The use of plastic mulch has brought a considerable change in vegetable production in many countries. In temperate countries the year-round production of vegetables has been possible with the use of plastic mulches. The growing period of crops with a tropical origin have also been extended. The plastic mulch may be transparent, black, red, yellow or others depending on the purpose of the mulch [4]. Mulches also help in reducing the fertilizer losses. Flood and furrow irrigation techniques tend to leach nitrogen and other water-soluble nutrients below the root zone. Since plastic mulch techniques generally include drip irrigation, nutrient loss is kept to a minimum. Nutrients can be injected into the drip system and accurately delivered to the root zone. Organic mulches add nutrients to the soil as they decompose, improving its tilth and moisture holding capacity [5]. Mulch also helps reduce the disease incidence, increased microbial activity and biomass in soil and reduced the severity of some above ground diseases of plants in crops such as tomatoes [6].

Desirable effects of plastic mulching are Weed control, temperature moderation, salinity reduction, which increases the utilization of plastic mulching in vegetable cultivation [7]. In agricultural for more plant height, crop growth, yield farmers use different type of mulch like plastic sheet, biodegradable films etc. It is to be reported that mulching showed good influence on crop growth, crop yield and cropping species [8]. Plastic mulch like HDPE, LDPE AND LLDPE is considered useful for better growing condition like weed control, temperature control, reduced salinity which reduces water loss from soil due to increased water resistance. In grafted brinjal mulching with plastic mulch of thickness 25µ gives higher yield [9]. Earliness, yield and quality of the vegetables crop can be improved by the use of plastic mulch [10] and [11]. In organic mulching soil surface is covered with crop remains of harvested crop such as leaf stubble, maize stalk, paddy straw and husk. Mulching with crop residue is reported to be best for more yield in crop likes groundnut and cassava [12] and [13]. Organic mulches improve soil properties, add organic matter to the soil and attracts many insects like cut worm, slugs etc. that is why these are used in agriculture on large scale [14]. Keeping in view, the present study was formulated to select the suitable mulch paper for quality high value vegetables production.

II. MATERIALS AND METHODOLOGY

A. Experimental Site

The evaluation site was the research farm of Olericulture Division, Bangladesh Agricultural Research Institute (BARI) during November 2019 to March 2020. The field was at 23.9920° N Latitude and 90.4125° E Longitudes having an elevation of 8.2 m from sea level under agroecological zone (AEZ) 28 [15]. The farm was situated in the sub-tropical climatic zone and characterized by scanty rainfall during the experimental time. The average minimum and maximum temperature were 18.4°C and 28.3°C and the average relative humidity varied from 54.20 to 74.60 %. The soil of the experimental field was sandy clay loam in texture having a pH range around 6.0.

B. Treatments and Plant Materials

Three types of many papers viz., Silver over black (M1), Black (M2), No much- Control (M3) and 3 types of vegetables viz., cucumber, netted melon and water melon were planted under UV stabilized polyethylene film net house. The Experiment was laid out with three replications.

C. Land Preparation and Fertilization

The unit plot size was 3.0×1.00 m in a RCBD (Randomized Complete Block Design) with three replications. Row to row and plant to plant distance was maintained with standard practice. The land was fertilized with organic fertilizer-N-P-K-S-Zn-B @ 10,000-170-50-125-18-4.3-1.70 kg/ha, respectively. One third of the organic fertilizer and half of TSP and full of gypsum, zinc and borax were applied during final land preparation. Rest of organic fertilizer and TSP and 1/3 of MoP were applied as basal in pit. After land preparation, the land was covered with mulch paper. Then the proper sized seedlings were transplanted with proper distance. One third of urea and MoP were applied in liquid form after 20 days of transplanting in the hole where the plant is standing. Rest of urea and MoP were applied in equal two installments at flowering and fruiting condition.

D. Intercultural Operation and Plant Protection

Irrigation, weeding, crop protection measures and other intercultural operations were done following standard practice. Different cultural operations such as irrigation, weeding, mulching and plant protection measures etc. were done as and when needed.

E. Data Collection and Statistical Analysis

Different types of yield and yield contributing data of 3 types of vegetables viz., cucumber, netted melon and water melon was collected from 5 randomly selected plant from each of replication. The recorded data for different characters were analyzed statistically using MSTAT-C program to find out the variation among the different genotypes by F-test. Treatment means were compared using Duncan's Multiple Range Test (DMRT) and standard error and coefficient of variation (CV %) were also estimated for each character.

III. DISCUSSION

A. Cucumber

Days to first harvest was varied significantly due to different plastic mulches. T1 mulches showed superior performance in days to first harvest than T2 and control, indicating T1 mulches had positive effect on the growth and development of cucumber. The earliest days to first harvest (67 days) was observed in T1, statistically significant with T2 (70 days) and followed by T3 (73 days). The increased vine length in mulched plants was possibly due to better availability of soil moisture and optimum soil temperature provided by the mulches. Changes in the plant height of chilli have been observed by using different mulches and plastic mulch increased the plant height than other mulches [23]. There were significant changes in the fruit length of cucumber. Longest fruit (19.1 cm) was produced in T1 statistically similar with T2 (18.1 cm) and followed by control (15.6 cm). Highest number of fruits/ plant was observed in T1 (9.9), statistically similar with T2 (7.4) and followed by control plot (5.4), while the maximum average fruit weight was also produced in T1 (200 g) followed by T2 (165 g) and control (145 g). It meant that mulch had positive influence on fruit setting in cucumber. [16] reported that mulching significantly improved the number of fruits per plant and reduced the percentage of fruit abortion compared to unmulched control that supported the present experimental results. The increase in the number of fruits per plant of mulched plot was probably associated with the conservation of moisture and improved microclimate both beneath and above the soil surface. The highest yield/ plant (1.86 kg) and yield (24.22 t/ha) were obtained in T1 followed by T2 (1.15 kg and 14.93 t/ha, respectively). The control plot was the lowest performer (0.74 kg and 9.64 t/ha, respectively). Mulching is favorable for maximum yield with very low input resources [17], [18], [19], [20]. In our study mulched plants with T1 had a higher performance than that in Black (T2) at all growth stages, while the plant without mulch (control) had the lowest performer at all growth stages. This result was in conformity with the report of [21] on forage maize. Fruit yield increased in mulched plot because of increased number of fruits per plant. These results coincide with those of [22], who pointed out that the yield and quality of the fruit for the fresh tomato market varies according to the type of mulch used on the plantation.

TABLE 1: EFFECT OF DIFFERENT MULCHED ON YIELD AND YIELD CONTRIBUTING CHARACTERS OF CUCUMBER

Treatments	Days to first harvest	Fruit length (cm)	Fruit breadth (cm)	Number of fruits / plants	Average fruit weight (g)	Yield/ plant (kg)	Yield (t/ha)	Cavity diameter (cm)	Flesh thickness (cm)
Silver over black mulch (T1)	67 b	19.1 a	6.3 a	9.9 a	200 a	1.86 a	24.22 a	2.3 a	0.93 a
Black mulch (T2)	70 ab	18.1 a	6.1 a	7.4 ab	165 b	1.15 b	14.93 b	2.3 a	0.88 a
No mulch (T3)	73 a	15.6 b	5.3 a	5.4 b	145 b	0.74 b	9.64 b	2.4 a	0.79 a
Level of sig.		*	-	•	*	*	*	-	-
CV (%)	3.18	6.47	5.97	25.79	8.20	22.45	22.45	10.58	29.07

Level of sig.= *** = 0.1%; ** = 1%; * = 5%.

B. Netted Melon

The earliest days to first harvest (60 days) was observed in T1 plot followed by T2 (62 days), while the delayed flowered treatment was T3 (no mulch) (67 days). There were significant changes in the fruit length, fruit breadth of netted melon. Longest fruit (15.6 cm) was produced in T1 followed by T2 (15.1 cm) and control (13.8 cm), while the maximum breadth fruit was also produced in T1 (16.3 cm) followed by T2 (15.5 cm) and control (14.1 cm). Number of fruits/ plant was highest in T1 (2.3) followed by T2 (1.7) and control (1.2), while the maximum average fruit weight was also produced in T1 (1.7 kg). It meant that mulch had positive influence on fruit setting in netted melon. [16] reported that mulching significantly improved the number of fruits per plant and reduced the percentage of fruit abortion compared to unmulched control that supported the present experimental results. The increase in the number of fruits per plant of mulched plot was probably associated

with the conservation of moisture and improved microclimate both beneath and above the soil surface. The highest yield/ plant (3.99 kg) and yield (26.37 t/ha) were obtained in T1 followed by T2 (2.60 kg and 17.14 t/ha, respectively). The control plot was the lowest performer in all the cases. Mulching is favorable for maximum yield with very low input resources [17], [18], [19], [20]. In our study mulched plants with T1 had a higher performance than that in Black (T2) at all growth stages, while the plant without mulch (control) had the lowest performer at all growth stages. This result was in conformity with the report of [21] on forage maize. Fruit yield increased in mulched plot because of increased number of fruits per plant. These results coincide with those of [22], who pointed out that the yield and quality of the fruit for the fresh tomato market varies according to the type of mulch used on the plantation.

TABLE 2: EFFECT OF DIFFERENT MULCHED ON YIELD AND YIELD CONTRIBUTING CHARACTERS OF NETTED MELON

Treatments	Days to first female harvest	Fruit length (cm)	Fruit breadth (cm)	Number of fruits / plants	Average fruit weight (kg)	Yield/ plant (kg)	Yield (t/ha)
Silver over black mulch (T1)	60 b	15.6 a	16.3 a	2.3 a	1.7 a	3.99 a	26.37 a
Black mulch (T2)	62 ab	15.1 a	15.5 b	1.7 b	1.5 ab	2.60 b	17.14 b
No mulch (T3)	67 a	13.8 b	14.1 c	1.2 c	1.2 b	1.46 c	9.64 c
Level of sig.	*	*	*	**	*	***	***
CV (%)	3.99	7.67	8.27	13.02	10.68	2.11	2.77

Level of sig.= *** = 0.1%; ** = 1%; * = 5%.

C. Watermelon

Vine length was measured at 60 days of sowing and it was varied significantly due to different plastic mulches. T1 mulches showed superior performance in vine length than T2 and control, indicating T1 mulches had positive effect on the growth and development of water melon. The longest vine length (154 cm) was observed in T1, followed by T2 (143 cm), while the smallest plant (130 cm) was observed in control plot. The increased vine length in mulched plants was possibly due to better availability of soil moisture and optimum soil temperature provided by the mulches. Changes in the plant height of chilli have been observed by using different mulches and plastic mulch increased the plant height than other mulches [23]. The earliest days to first female flowering (58 days) was observed in T1 plot compare to rest two treatments. There were significant changes in the fruit length, fruit breadth of water melon. Longest fruit (25.1 cm) was produced in T1 statistically similar with T2 (24.1 cm) and followed by control (20.1 cm), while the maximum breadth fruit (22.1 cm) was produced in T1 statistically similar with T2 (22.0 cm) and followed by control (18.6 cm). The maximum average fruit weight was also produced in T1 (2.9 kg) statistically similar with T2 (2.4 kg) and followed by control (2.1 kg). It meant that mulch had positive influence on fruit setting in water melon. Ravinder et al. [16] reported that mulching significantly improved the number of fruits per plant and reduced the percentage of fruit abortion compared to unmulched control that supported the present experimental results. The increase in the number of fruits per plant of mulched plot was probably associated with the conservation of moisture and improved microclimate both beneath and above the soil surface. The highest yield/ plant (6.61 kg) and yield (43.59 t/ha) were obtained in T1 followed by T2 (4.60 kg and 30.36 t/ha, respectively). The control plot was the lowest performer (2.50 kg and 16.52 t/ha, respectively). Mulching is favorable for maximum yield with very low input resources [17], [18], [19], [20]. In our study mulched plants with T1 had a higher performance than that in Black (T2) at all growth stages, while the plant without mulch (control) had the lowest performer at all

growth stages. This result was in conformity with the report of [21] on forage maize. Fruit yield increased in mulched plot because of increased number of fruits per plant. These results coincide with those of [22], who pointed out that the yield and quality of the fruit for the fresh tomato market varies according to the type of mulch used on the plantation.

TABLE 3: EFFECT OF DIFFERENT MULCHED ON YIELD AND YIELD CONTRIBUTING CHARACTERS OF WATERMELON

Treatments	Vine length (cm) (60 DAS)	Days to first female harvest	Fruit length (cm)	Fruit breadth (cm)	Number of fruits /plant	Average fruit weight (g)	Yield/ plant (kg)	Yield (t/ha)	TSS (%)
Silver over black mulch (T1)	154 a	58 b	25.1 a	22.1 a	2.2 a	2.9 a	6.61 a	43.59 a	11.0 a
Black mulch (T2)	143 b	61 ab	24.1 a	22.0 a	1.9 a	2.4 ab	4.60 b	30.36 b	10.1 b
No mulch (T3)	130 c	65 a	20.1 b	18.6 b	1.2 a	2.1 b	2.50 c	16.52 c	10.0 b
Level of sig.	**	*	**	*	-	*	*	*	**
CV (%)	3.77	4.10	4.93	6.02	55.70	9.99	43.99	43.99	2.43

Level of sig.= *** = 0.1%; ** = 1%; * = 5%.

IV. CONCLUSION AND RECOMMENDATION

Different mulching exhibited significant impacts on growth, yield, and quality of various crops. However, it can be concluded from the literature that mulches are a cheap source to reduce weed populations and to conserve the soil moisture contents to a substantial level. Therefore, the properly managed mulching strategies could compensate the water requirement of crops in water deficit/drought conditions. Considering relationship between the soil moisture content and fruit number, it was clear that fruit number, average fruit weight, fruit length, fruit diameter was strongly related with soil moisture content. The effect of different plastic mulches on fruit weight per plant and yield (t/ha) were significant. Mulching produced higher fruit yield per plant and fruit yield per hectare than for the control, indicating that the mulch had positive effect in generating increased fruit yield. Silver over black plastic mulch produced the highest fruit yield viz., 24.22 t/ha (cucumber), 26.37 t/ha (netted melon), 43.59 t/ha (watermelon) followed by black and no mulches, while the control plot produced the lowest fruit yield due to open condition.

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