

Effect of Different Mulch Paper on Growth and Yield of Different High Value Vegetables in Bangladesh

Ferdouse Islam, AKM Quamruzzaman* , Sharmila Rani Mallick

Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh
Email: *akmqzs@gmail.com

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Abstract

The study 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 Olericulture research field of Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. The study was a randomized complete block design with 3 replications. Four vegetable varieties viz., tomato, brinjal, capsicum and broccoli 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. It was clear that fruit number, average fruit weight, fruit length, fruit diameter were strongly related to soil moisture content. The effect of different plastic mulches on fruit weight per plant and yield (t/ha) was significant. Mulching produced higher fruit yield per plant and fruit yield per hectare than for the control, indicating that the mulch had a positive effect in generating increased fruit yield. Silver over black plastic mulch produced the highest fruit yield viz., 98.05 t/ha (tomato), 54.11 t/ha (brinjal), 34.33 t/ha (capsicum), 26.09 t/ha (broccoli) followed by black and no mulches, while the control plot produced the lowest fruit yield.

Keywords

Mulch Paper, Growth, Yield, High Value Vegetables, Bangladesh

1. Introduction

Vegetable 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. The present vegetable production is 4.37 million tons from 0.45 million hectares 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. 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. In order to judicious water use efficiency by the plant and to improve the quality of produce, the use of mulch has become an important cultural practice for the commercial production of vegetable crops. A favorable soil-water-plant relation is maintained by using of mulch over the soil surface. The microclimate condition surrounding the plant and soil is significantly affected by mulch *i.e.* the physical soil structure, the moisture, the erosion, the thermodynamic environment, the incidence of pests and diseases, crop growth and yield.

Organic mulches are being used traditionally by the farmers. Organic mulches add nutrients to the soil as they decompose, improving its tilth and moisture-holding capacity [4]. The most commonly used organic mulches in Bangladesh are rice straw, wheat straw, a 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 has also been extended [4]. The plastic mulch may be transparent, black, red, yellow or others depending on the purpose of the mulch [5]. Mulches also help in reducing the fertilizer losses. 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. Mulch also helps reduce the disease incidence. Using mulch increased microbial activity and biomass to the soil [6] and reduced the infestation of diseases of plants in crops such as tomatoes [7].

Plastic mulch is considered useful for weed control, temperature control, reduced salinity which reduces water loss from the soil due to increased water resistance. Advantages of plastic mulching are weed control, temperature moderation, salinity reduction, which increases the popularity of using plastic mulching in vegetable cultivation [8]. In agricultural practices, it is also reported that mulching showed a good impact on good crop growth and yield [9]. It is also reported that grafted brinjal plastic mulch also gives a higher yield [10]. To produce quality vegetables and also for earliness with better yield use of plastic mulch is a good option [11] [12]. Mulching with crop residue like organic mulching is reported to be one of the best options for more yields in crop production likes groundnut and cassava [13] [14]. Common organic mulches are leaf stubble, maize stalk, paddy straw, husk and water hyacinth, etc. To improve soil proper-

ties and add organic matter to the soil organic mulches are used in agriculture on large scale [15]. Keeping in view, the present study was formulated to select the suitable mulch paper for quality high-value vegetable production.

2. Methods

2.1. Experimental Site

The experiment site was the 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, while the elevation was 8.2 m from sea level and situated under the agro-ecological zone (AEZ) 28 [16]. The site was situated in the sub-tropical climatic zone with scanty rainfall during the time. The average maximum and minimum temperature were 28.3°C and 18.4°C and the average relative humidity varied from 54.20% to 74.60%. The soil was sandy clay loam having a pH around 6.0.

2.2. Treatments and Plant Materials

Three types of much paper viz., Silver over black (M1), Black (M2), No much-Control (M3) and 4 types of vegetables viz., tomato (BARI Tomato-15), brinjal (BARI Hybrid Begun-4), capsicum (BARI Mistimorich-1) and broccoli (BARI Broccoli-1) were planted under UV stabilized polyethylene film net house. The Experiment was laid out with three replications.

2.3. 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 was applied in equal two installments at flowering and fruiting condition.

2.4. Intercultural Operation and Plant Protection

The required agronomic operations viz., irrigation, weeding, mulching, use of stick, crop protection measures and other intercultural operations were done as and when necessary following standard procedure.

2.5. Data Recorded

Different types of yield and yield contributing data of 4 types of vegetables viz.,

tomato, brinjal, capsicum and broccoli were collected from 5 randomly selected plant from each of replication.

For tomato the traits were—plant height (cm), days to first flowering, days to first harvest, fruit length (cm), fruit breadth (cm), number of fruits/plants, average fruit weight (g), yield/plant (kg), yield (t/ha) and TSS (%).

For brinjal the traits were—plant height (cm), days to first flowering, days to first harvest, fruit length (cm), fruit breadth (cm), number of fruits/plants, average fruit weight (g), yield/plant (kg) and yield (t/ha).

For capsicum the traits were—days to first harvest, fruit length (cm), fruit breadth (cm), number of fruits/plants, average fruit weight (g), yield/plant (kg) and yield (t/ha).

For broccoli the traits were—days to 50% curd initiation, days to curd harvest, curd length (cm), curd breadth (cm), whole plant weight (kg), only curd wt. (g), marketable curd wt. (g), marketable curd yield (t/ha).

2.6. Statistical Analysis

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 Tukey's test and standard error and coefficient of variation (CV %) were also estimated for each character.

3. Result

3.1. Tomato

The plant height was measured at days to last harvest and it was varied significantly due to different plastic mulches. T1 mulches showed better performance than T2 and control, indicating T1 mulches had a positive effect on the growth and development of tomatoes. **Table 1** reflects, the tallest plant (159 cm) was observed in T1, followed by T2 (144 cm), while the smallest plant (129 cm) was observed in the control plot. The earliest days to first harvest (98 days) were observed in T1 plot compare to the rest two treatments. There were significant changes in the fruit length, fruit breadth of the tomato. Longest fruit (7.2 cm) was produced in T1 followed by T2 (6.9 cm) and control (6.5 cm), while the maximum breadth fruit was also produced in T1 (5.8 cm). Number of fruits/plants was highest in T1 (33) followed by T2 (26) and control (23), while the maximum average fruit weight was also produced in T1 (90 g). The highest yield/plant (2.94 kg) and yield (98.05 t/ha) were obtained in T1 followed by T2 (2.10 kg and 70.13 t/ha, respectively) (**Table 1**). The control plot was the lowest performer in all cases. Mulched plants with T1 had a higher performance than that in Black (T2) at all growing stages.

3.2. Brinjal

Plant height was measured at days to last harvest and it was varied significantly

due to different plastic mulches. T1 mulches showed better performance in plant height than T2 and control, indicating T1 mulches had a better effect on the growth and development of brinjal. **Table 2** reflects, the tallest plant (139 cm) was observed in T1, followed by T2 (131 cm), while the shortest plant (119 cm) was observed in the control plot. The increased plant height in mulched plants was performed due to better availability of soil moisture and optimum soil temperature provided by the plastic mulches. [17] mentioned there were changes in the increased plant height of chilli, while using different mulches and plastic mulch. The earliest days to first flowering and first harvest (63 days and 94 days, respectively) were observed in T1 plot compare to the rest of two treatments. There were significant changes in the fruit length, fruit breadth of brinjal. Longest fruit (8.9 cm) was produced in T1 followed by T2 (8.2 cm) and control (7.5 cm), while the maximum breadth fruit was also produced in T1 (6.7 cm) followed by T2 (6.3 cm) and control (6.1 cm). Number of fruits/plant was highest in T1 (35) followed by T2 (30) and control (25), while the maximum average fruit weight was also produced in T1 (130 g) (**Table 2**). It meant that mulch had a positive influence on fruit set in brinjal. Mulching significantly improved the number of fruits per plant and reduced the percentage of fruit abortion compared

Table 1. Effect of different mulched on yield and yield contributing characters of tomato.

Treatments	Plant height (cm)	Days to first flowering	Days to first 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 (T1)	159 a	62.33 a	98 b	7.2 a	5.8 a	33 a	90 a	2.94 a	98.05 a	4.0 a
Black (T2)	144 b	65.33 a	100 ab	6.9 ab	5.5 ab	26 b	82 ab	2.10 b	70.13 b	4.0 a
No mulch (T3) (control)	129 c	66.33 a	103 a	6.5 b	5.2 b	23 b	72 b	1.63 c	54.34 c	3.8 a
Level of sig.	**	-	.	*	*	**	*	**	**	-
CV (%)	3.72	3.91	2.21	3.23	3.71	8.19	6.19	1.89	1.89	20.73

Level of sig. ** = 1%; * = 5%. Means followed by the same letter in a column do not significantly differ from each other at 5% level by HSD.

Table 2. Effect of different mulched on yield and yield contributing characters of brinjal.

Treatments	Plant height (cm)	Days to first flowering	Days to first harvest	Fruit length (cm)	Fruit breadth (cm)	Number of fruits/plant	Average fruit weight (g)	Yield/plant (kg)	Yield (t/ha)
Silver over black mulch (T1)	139 a	63 b	94 b	8.9 a	6.7 a	35 a	130 a	4.51 a	54.11 a
Black mulch (T2)	131 a	65 b	96 b	8.2 b	6.3 ab	30 b	117 b	3.47 b	41.66 b
No mulch (T3)	119 b	72 a	102 a	7.5 c	6.1 b	25 c	114 b	2.81 b	33.73 c
Level of sig.	*	*	*	**	*	**	*	**	**
CV (%)	4.14	3.78	2.28	2.68	3.21	7.46	4.19	10.05	3.17

Level of sig. ** = 1%; * = 5%. Means followed by the same letter in a column do not significantly differ from each other at 5% level by HSD.

to non-mulched control [18] that supported the present experimental results. The increase in the number of fruits per plant of the mulched plot was probably related to the conservation of optimum moisture and improved microclimate both beneath and above the soil surface. The highest yield/plant (4.51 kg) and yield (54.11 t/ha) were obtained in T1 followed by T2 (3.47 kg and 41.66 t/ha, respectively). The control plot was the lowest performer in all cases. Mulched plants with T1 had a higher performance than that in Black (T2) at all growing stages. At all growth stages, the plant without mulch (control) had the lowest performer. This result was similar to the report of [19] on forage maize. Fruit yield increased in the mulched plot because of an increased number of fruits per plant. These results also similar with [20], who pointed out that the yield and quality of the fruit for the fresh tomato market varies according to the type of mulch.

3.3. Capsicum

Table 3 reflects the earliest days to first harvest (72 days) were observed in T1 plot followed by T2 (75 days), while the delayed flowered treatment was T3 (no mulch) (79 days). There were significant changes in the fruit length, fruit breadth of capsicum. Longest fruit (8.7 cm) was produced in T1 followed by T2 (8.4 cm) and control (7.7 cm), while the maximum breadth fruit was also produced in T1 (4.8 cm) followed by T2 (4.4 cm) and control (4.0 cm). Number of fruits/plant was highest in T1 (8.7) followed by T2 (7.7) and control (6.0), while the maximum average fruit weight was also produced in T1 (120 g). It meant that mulch had a positive influence on fruit set in capsicum. Mulching significantly improved the number of fruits per plant and reduced the percentage of fruit abortion compared to non-mulched control [18] that supported the present experimental results. The increase in the number of fruits per plant of the mulched plot was probably related to the conservation of optimum moisture and improved microclimate both beneath and above the soil surface. The highest yield/plant (1.03 kg) and yield (34.33 t/ha) were obtained in T1 followed by T2 (0.76 kg and 25.24 t/ha, respectively). The control plot was the lowest performer in all cases. Mulched plants with T1 had a higher performance than that in Black (T2) at all growing stages. At all growth stages, the plant without mulch (control) had the lowest performer. This result was similar to the report of [19] on forage maize. Fruit yield increased in the mulched plot because of an increased number of fruits per plant. These results also similar with [20], who pointed out that the yield and quality of the fruit for the fresh tomato market varies according to the type of mulch.

3.4. Broccoli

The earliest days to 50% curd initiation and days to curd harvest (77 days and 92 days, respectively) were observed in T1 plot compare to the rest two treatments (**Table 4**). There were significant changes in the fruit length, fruit breadth of

Table 3. Effect of different mulched on yield and yield contributing characters of capsicum.

Treatments	Days to first harvest	Fruit length (cm)	Fruit breadth (cm)	Number of fruits/plant	Average fruit weight (g)	Yield/plant (kg)	Yield (t/ha)
Silver over black mulch (T1)	72 b	8.7 a	4.8 a	8.7 a	120 a	1.03 a	34.33 a
Black mulch (T2)	75 ab	8.4 a	4.4 a	7.7 a	100 b	0.76 ab	25.24 ab
No mulch (T3)	79 a	7.7 b	4.0 b	6.0 a	75 c	0.44 b	14.77 b
Level of sig.	*	*	*	-	**	*	*
CV (%)	2.95	2.67	4.62	28.60	5.13	24.33	24.71

Level of sig. ** = 1%; * = 5%. Means followed by the same letter in a column do not significantly differ from each other at 5% level by HSD.

Table 4. Effect of different mulched on yield and yield contributing characters of broccoli.

Treatments	Days to 50% curd initiation	Days to curd harvest	Curd length (cm)	Curd breadth (cm)	Whole plant weight (kg)	Only curd wt. (g)	Marketable curd wt. (g)	Marketable curd yield (t/ha)
Silver over black mulch (T1)	77 a	92 b	19.3 a	17.2 a	1.52 a	635 a	785 a	26.09 a
Black mulch (T2)	79 ab	95 ab	18.5 ab	16.8 b	1.46 a	617 a	690 b	22.93 b
No mulch (T3)	82 b	97 a	16.6 b	15.7 c	1.25 a	510 b	610 c	20.28 c
Level of sig.	*	*	*	*	-	**	**	**
CV (%)	3.18	2.65	6.23	7.64	15.74	2.48	2.09	2.57

Level of sig. ** = 1%; * = 5%. Means followed by the same letter in a column do not significantly differ from each other at 5% level by HSD.

Broccoli. Maximum curd length (19.3 cm) was produced in T1 followed by T2 (18.5 cm) and control (16.6 cm), while the maximum breadth fruit was also produced in T1 (17.2 cm) followed by T2 (16.8 cm) and control (15.7 cm). Only curd weight was highest in T1 (635 g) which is statistically significant with T2 (617 g) and followed by control (510 g). The highest marketable curd weight (785 g), followed by T2 (690 g) and T3 (610 g) while the marketable curd yield was maximum in T1 (26.09 t/ha), followed by T2 (22.93 t/ha) and T3 (20.28 t/ha). In the study, mulched plants with T1 had a higher performance than that in Black (T2), while the plant without mulch (control) had the lowest performer at all growth stages. This result was similar to the report of [19] on forage maize.

4. Discussion

The increased plant height in mulched plants was performed due to better availability of soil moisture and optimum soil temperature provided by the plastic mulches. [17] mentioned there were changes in the increased plant height of chilli, while using different mulches and plastic mulch. Longest fruit was produced in T1 followed by T2 and control, while the maximum breadth fruit was also produced in T1. Number of fruits/plants was highest in T1 followed by T2

and control, while the maximum average fruit weight was also produced in T1. It meant that mulch had a positive impact on the tomato fruit set. Mulching significantly improved the number of fruits per plant and reduced the percentage of fruit abortion compared to non-mulched control [18] that supported the present experimental results. The increase in the number of fruits per plant of the mulched plot was probably related to the conservation of optimum moisture and improved microclimate both beneath and above the soil surface. The highest yield/plant and yield per hectare were obtained in T1 followed by T2. The control plot was the lowest performer in all cases. Mulched plants with T1 had a higher performance than that in Black (T2) at all growing stages. At all growth stages, the plant without mulch (control) had the lowest performer. This result was similar to the report of [19] on forage maize. Fruit yield increased in the mulched plot because of an increased number of fruits per plant. These results also similar with [20], who pointed out that the yield and quality of the fruit for the fresh tomato market varies according to the type of mulch.

5. Conclusion

Considering the relationship between the different type of mulch and different agronomic traits of tomato, brinjal, capsicum, and broccoli, it was clear that fruit number, average fruit weight, fruit length, fruit diameter was strongly related with soil moisture content governed by the different types of mulch. The effect of different plastic mulches on fruit weight per plant and yield was significant. Mulching produced higher fruit yield per plant and fruit yield per hectare than for the control, indicating that the mulch had a positive effect in generating increased fruit yield. Silver over black plastic mulch produced the highest fruit yield viz., 98.05 t/ha (tomato), 54.11 t/ha (brinjal), 34.33 t/ha (capsicum), 26.09 t/ha (broccoli) followed by black and no mulches, while the control plot produced the lowest fruit yield due to open condition.

Recommendation

From the above discussion, it may be concluded that the plastic mulch has a positive effect for profitable crop production, among the plastic mulch, the silver over black plastic mulch produced the highest yield, so it could be recommended for the quality vegetables crop production.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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