



Effect of Different Mulches on Growth and Yield of Cauliflower in Southern Bangladesh

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Abstract

A field experiment was conducted at the research farm of Patuakhali Science and Technology University (PSTU), Patuakhali from November 2011 to April 2012 to find out the most adventitious mulch material for Cauliflower production. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Six different mulches (M) along with control were applied as treatment viz M₀ =Control (without mulches), M₁ =Black polythene, M₂ =White polythene, M₃ =Saw dust, M₄ =Water hyacinth and M₅ =Rice straw. Data were compared on plant height (cm); number of leaves/plant; leaf area (cm²)/plant; leaf area index (cm²); dry weight of root, leaf and stem (g/plant); total dry matter (g/plant); crop growth rate (g/m²/day); relative growth rate (g/cm²/day); diameter of curd (cm²); curd fresh weight (g/plant) and curd yield (t/ha). Significant variation was obtained in case of all the compared parameters among the treatments but water hyacinth mulch gave highest value compared to control and other mulches. Finally it can be concluded that water hyacinth mulch was found most effective for cauliflower production under AEZ-13 of the southern part of Bangladesh.

Key words: AEZ-13, Cauliflower, Mulching, Production

Introduction

Cauliflower (*Brassica oleracea* var. botrytis. sub var. cauliflora L.) is one of the most important vegetable crops throughout the world. In Bangladesh, it grows during winter season, generally from October to March at the time of scanty or no rainfall (Salim *et al.*, 2008). Salter (1959) reported that at least 25% of the available soil moisture could be depleted due to lack of irrigation which is essential to maintain maximum growth rate. He further reported that, when the cauliflower plants become established, they should be irrigated whenever the soil moisture reaches the deficit point. Mulching is a good means of conserving soil moisture through substantial reduction in evaporation (Roy and Singh, 1983; Djigma and Diemkouma, 1986; Mannan and Rashid, 1983). Various kinds of mulches are used in the field, a) organic mulches (rice straw, dry grass, forest, leaf etc.) and b) plastic mulches (transparent, black or yellow) depending on the purpose of the mulch (Rudich, 1979).

Characteristics of soil

Sample No	Lab No	Phosphorus (ppm)	Potassium (me 100g ⁻¹)	Sulphur (ppm)	pH	Salinity (ds m ⁻¹)	Organic Matter	Total N (%)
Soil	5784	16.1	0.30	10.8	7.0	0.65	1.53	0.077
Water	5785	-	-	-	7.3	0.56	-	-

Source: Soil Research Development Institute (SRDI), Barisal.

The information on the judicious use of different mulch materials for cauliflower production is not sufficient in Bangladesh. Therefore, the present experiment was undertaken to identify the most adventitious mulch that could be more efficient for better growth and higher yield of cauliflower in agro-ecological zone-13 of the southern part of (Patuakhali district) of Bangladesh.

Materials and Methods

Location and period

The research work was conducted at the research farm of Patuakhali Science and Technology University (PSTU), Patuakhali from November 2011 to April 2012. Geographically, the research farm is located at 22°37' N latitude and 89°10' E longitudes and is covered by Gangetic Tidal Floodplains and falls under Agroecological 'AEZ-13'. The area lies at 0.9 to 2.1 meter above mean sea level (Iftekhar and Islam, 2004).

Plant materials

Single cauliflower variety viz. *Brassica oleracea* var. botrytis was used for this study.

Treatments

Six different mulches (M) along with a control treatment were applied as a source of soil moisture and nutrient for growth and yield of cauliflower viz M₀, M₁, M₂, M₃, M₄, and M₅. The treatments were used as following.

M₀=Control (without mulches), M₁ =Black polythene, M₂=White polythene, M₃=Saw dust, M₄=Water hyacinth, M₅=Rice straw.

Design and layout of the experiment

The single factor experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The experimental area was divided into four blocks. Each block consisted of 6-unit plots. Thus, the total number of unit plot was 24 (Mulching treatment 6 × replication 4) where block to block and plot to plot spacing were at 0.6 m and 0.6 m, respectively. However, each plot was 9 m² where plot length and width was 4.5 m × 2.0 m.

Raising of seedlings

Twenty-gram seeds were sown in three seed beds of 5 m² size on 13 October. Seeds were completely germinated within 7-8 days after sowing.

Land preparation and seedling transplanting

The selected land for the experiment was opened on 1 November, 2011 with a power tiller and prepared by ploughing and cross ploughing followed by laddering. The experimental plots were treated with recommended dose of N, P and K received 250 kg urea, 125 kg TSP, 200 kg MP and 15 ton cowdung ha⁻¹ (BARC, 1997). Twenty seven days old healthy and uniform sized seedlings were transplanted in the experimental plots on 8 November, 2011 at a spacing of row to row and plant to plant distance as 50 and 50 cm, respectively where 24 plants were in plot.

Intercultural operations

Weeding, gap filling, earthing up and irrigation were performed as whenever necessary. Malathion 57 EC @ 2ml/litre and Ridomil MZ 68 @ 2 g/liter were sprayed to control cutworm attack and foot rot disease respectively.

Harvesting

Harvesting was done over a period from 18 February to 10 March 2012. Before harvesting curd, compactness of the cauliflower was tested by pressing with thumb.

Data collection

Ten plants were selected randomly from each unit plot for data collection.

i) The plant height (cm) was measured from the ground level to the tip of the largest leaf of an individual plant at 10 days interval from 20 to 70 DAT by using a meter scale.

ii) Number of leaves plant⁻¹ was counted at 20, 30, 50, 60 and 70 DAT.

iii) Leaf area plant⁻¹ was calculated at 30, 50 and 70 DAT by the following formula-

Leaf area =Length of leaf (cm) × width of leaf (cm)

iv) Leaf area index (LAI) was determined by the following formula-

$$LAI = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Soil surface area covered by each plant (cm}^2\text{)}}$$

v) The crop growth rate (CGR) values at different growth stages were calculated using the following formula-

$$CGR = \frac{1}{GA} \times \frac{W_2 - W_1}{T_2 - T_1} gm^{-2}day^{-1}, \text{ where,}$$

W₁= Total dry matter production at previous sampling date

W₂= Total dry matter production at current sampling date

T₁= Date of previous sampling, T₂= Date of current sampling, and GA=Ground area (m²)

vi) The relative growth rate (RGR) values at different growth stages were calculated using the following

$$\text{formula- } RGR = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} g \text{ cm}^{-2}day^{-1},$$

where,

W₁=Total dry matter production at previous sampling date

W₂= Total dry matter production at current sampling date

T₁=Date of previous sampling, T₂=Date of current sampling, and Log_e=Natural logarithm

vii) The curds were separated from the sample plants and the fresh weight of curd was recorded after harvesting and then converted into g plant⁻¹.

viii) The curds were separated from the sample plants from each plot and the fresh weight was recorded after harvesting and then converted into t ha⁻¹.

ix) The fresh roots, stem, leaves and curds of the sample plant were dried in direct sunlight for two days and were kept in an oven at 70°C for three days until constant weight. The dry weight was recorded in gram (g) at 30, 50 and 70 DAT and the mean value was calculated.

x) The total dry matter weight was recorded from the following formula at 30, 50 and 70 DAT. TDM=dry weight of root + leaf + stem + curd

Statistical analysis

The mean value for all the treatments was calculated and analysis of variance for each parameter was performed by E-test (Gomez and Gomez, 1984). Comparison of the

treatment means was done by Least Significance Difference (LSD) test at 5% level of probability/DMRT.

Results and Discussion

Plant height

Plant height was recorded at 10 days interval from 20 DAT to 70 DAT. Among the mulching treatments, highest value obtained from water hyacinth mulch (13.18, 26.74, 37.86, 46.74, 50.74 and 52.74 cm) at 20, 30, 40, 50, 60 and 70 DAT, respectively. On the other hand, untreated mulch was less efficient on plant height as well as shortest plant (10.54, 18.39, 27.22, 37.69, 41.09 and 44.09 cm) was recorded in control at those DAT, respectively (Fig.1). Besides, all the mulch

treatment showed better performance for plant height compare to control treatment.

Plant height is one of the most important growth contributing characters for cauliflower which are directly related to dry matter production. These results also indicated that water hyacinth as well as other mulching treatments were most efficient to uptake the soil nutrient and increased the soil moisture which will ensure the proper growth of cauliflower. Iriany *et al.* (2019) reported 72.18% higher yield in cauliflower by using organic mulch compared to treatment without mulch. Similar results also found in several crop plants (Damayanti *et al.*, 2013; Darmawan *et al.*, 2014; Islam, 2013; Law *et al.*, 2006; Salim *et al.*, 2008).

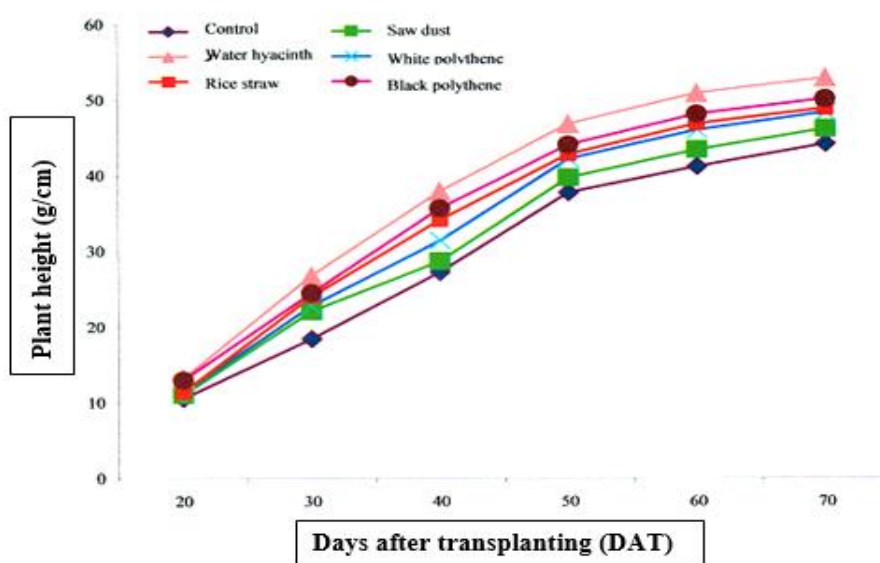


Fig. 1. Effect of different mulches on plant height at different days after transplanting (DAT).

Number of leaves/plants

The number of leaves/plants was recorded at 20, 30, 40, 50, 60 and 70 days after transplanting (DAT). In the present investigation it was found that different mulching application significantly affected number of leaves/plants at different DAT (Table 1). The maximum number of leaves (4.30, 6.875, 11.13, 13.13, 15.83 and 15.00) were produced at 20, 30, 40, 50, 60 and 70 DAT, respectively by water hyacinth mulch which were statistically different from the other mulching treatments while untreated mulch (control) produced the minimum leaves (2.575, 6.875, 11.13, 13.13, 15.83 and

15.00) at those DAT. Water hyacinth mulch recorded the maximum leaves/plant (15.825) which was closely followed by black polythene (15.400) at 60 DAT and statistically same (15.00) with black polythene (14.70) at 70 DAT (Table 1). These results also indicate that, water hyacinth mulch showed better performance on leaf production than other mulches by supplying more soil nutrient and moisture which will increase more growth of cauliflower. Similar results were also obtained by Mollah (2010) where he found that the black polythene mulch recorded the maximum number of leaves.

Table 1. Effect of different mulches on number of leaves/plants at different (DAT).

Mulching treatments	Number of leaves plant ⁻¹ at different DAT					
	20	30	40	50	60	70
Control	2.575 f	5.100 e	8.175 f	10.17 f	12.225 d	11.675 c
Saw dust	2.875 e	5.100 e	8.600 e	10.60 e	12.750 cd	12.750 c
Water hyacinth	4.300 a	6.875 a	11.13 a	13.13 a	15.825 a	15.000 a
White polythene	3.000 d	5.500 d	9.250 d	11.25 d	13.100 c	11.800 c
Rice straw	3.400 c	5.900 c	10.23 c	12.23 c	14.850 b	13.225 b
Blackpolythene	3.775 b	6.400 b	10.65 b	12.65 b	15.400 ab	14.700 a
LSD_(0.05)	0.06740	0.2077	0.3014	0.3370	0.7197	1.007
S \bar{x}	0.02236	0.0692	0.1000	0.1118	0.2397	0.3339
CV (%)	1.30	2.36	2.06	1.91	3.40	5.13

Values followed by same letter(s) are statistically similar as per DMRT at 5% level of probability

Leaf area plant⁻¹ and leaf area index (LAI)

Statistical analysis of the data revealed that differences in average leaf area were significant at different days after transplanting (Table 2). The maximum average leaf area of 263.2, 1551.0 and 2608.0 cm² was recorded in water hyacinth mulch while control or without mulch recorded the minimum leaf area of 167.4, 1063.0 and 1847.0 cm² at 30, 50 and 70 DAT respectively. Similarly, analysis of variance data on LAI indicated significant difference among the mulch application at different days after transplanting except 30 DAT (Table 2). Among the mulching treatments, the LAI at 30 DAT were statistically same in case of they did not differ significantly. Water hyacinth mulch also recorded the highest LAI (0.620) at 50 DAT which was statistically significant with rice straw (0.589) and followed by

white polythene (0.555) at 50 DAT. On the other hand, control treatment recorded the lowest LAI (0.425) at 50 DAT. At 70 DAT, LAI had higher (1.043) in water hyacinth mulch while control treatment had the lower LAI (0.739) which was closely followed (0.765) by black polythene at 70 DAT.

These results indicate that the LAI continuously increased up to harvest in case of the leaf area Plant⁻¹ showed statistically similar trend which instantly affected the variation of LAI. This variation was also indicated that the different mulch were different effect on LAI in case of the variation in soil moisture and nutrient availability in relation to the regional adaptability in southern part of Patuakhali. Tawfeeq *et al.* (2021) reported the highest leaf length in black polythene compared to control.

Table 2. Effect of different mulches on leaf area and leaf area index at different (DAT).

Mulching treatments	Leaf area (LA) plant ⁻¹ at different DAT			Leaf area index (LAI) plant ⁻¹ at different DAT		
	30	50	70	30	50	70
Control	167.4 f	1063.0 f	1847.0 f	0.067	0.425 d	0.739 e
Black polythene	175.2 e	1145.0 e	1926.0 e	0.070	0.458 cd	0.765 de
Water hyacinth	263.2 a	1551.0 a	2608.0 a	0.105	0.620 a	1.043 a
Saw dust	192.2 d	1265.0 d	2005.0 d	0.077	0.506 bc	0.842 d
White polythene	210.2 c	1389.0 c	2284.0 c	0.084	0.555 ab	0.913 c
Rice straw	235.0 b	1472.0 b	2453.0 b	0.094	0.589 a	0.981 b
LSD_(0.05)	4.497	63.39	62.72	0.04766	0.06740	0.04766
S \bar{x}	1.492	21.03	20.81	0.01581	0.02236	0.10581
CV (%)	2.10	3.20	1.90	8.16	9.26	4.37

Values followed by same letter(s) are statistically similar as per DMRT at 5% level of probability

Dry weight of root, leaf and stem

Significant variation was observed in relation to the dry weight of root, leaf and stem among the different treatments of mulch at different days after transplanting (Table 3). The topmost value of root dry weight (9.70) was found in water hyacinth mulch and least in control (8.19) treatment at 70 DAT. Similarly, the highest value of leaf dry weight (15.86) was observed in water hyacinth which is statistically same with black polythene (15.50) followed by rice straw (15.29), white

polythene (15.08), and saw dust (14.9) and the lowest value was obtained from control (14.39) at 70 DAT. Besides, maximum value of stem dry weight (21.60) was obtained from water hyacinth followed by black polythene (21.60), and rice straw (20.59) and the minimum from control (18.93) at 70 DAT. This result indicates better growth of root, leaf, and stem in different mulching treatments compared to the treatment without mulch and this could be due to soil mulching which caused the rising of soil temperature more than control, and that leads to an increase the

activity of soil microorganisms which improves the physical and chemical properties of soil (Roe *et al.*, 1994; Alemam *et al.*, 2017). Mulching also plays an important role in root development by increasing the availability of nutrition and preventing volatility outside of the soil (Wien *et al.*, 1993). Finally, it can be

concluded that mulching creates an optimum temperature for roots during the growing season and conserve soil moisture. Likewise, it caused an increase in the rate of photosynthesis which influence growth and maturity of the crop (Sibale *et al.*, 2015).

Table 3. Effect of different mulches on dry weight of root, leaf and stem at different (DAT).

Mulching treatments	Root dry weight (g plant ⁻¹) at different DAT			Leaf dry weight (g plant ⁻¹) at different DAT			Stem dry weight (g plant ⁻¹) at different DAT		
	30	40	70	30	40	70	30	40	70
Control	2.33 f	6.03 f	8.19 f	2.55 e	7.93 d	14.39 b	4.278 f	11.81 b	18.93 d
Saw dust	2.75 e	6.60 e	8.81 e	2.77 b	8.22 cd	14.91 ab	4.65 e	11.97 b	19.25 cd
Water hyacinth	3.12 a	7.48 a	9.70 a	3.35 a	9.243 a	15.86 a	6.05 a	13.58 a	21.60 a
White polythene	2.52 d	6.32 d	8.54 d	2.85 c	8.29bcd	15.08 ab	4.97 d	12.37 b	20.27 bc
Rice straw	2.69 c	6.60 c	8.82 c	2.98 b	8.70abc	15.29 ab	5.37 c	12.74 ab	20.59 ab
Black polythene	3.00 b	6.85 b	9.06 b	3.06 b	8.97ab	15.50 a	5.63 b	12.87 ab	21.00 ab
LSD_(0.05)	0.1066	0.2184	0.7005	0.1783	0.6824	1.002	0.1651	1.004	1.208
S \bar{x}	0.03536	0.7246	0.2324	0.05916	0.2264	0.3324	0.05477	0.3332	0.4006
CV (%)	2.49	2.19	5.26	4.11	5.30	4.38	2.11	5.31	3.95

Values followed by same letter(s) are statistically similar as per DMRT at 5% level of probability

Total dry matter (TDM)

Analysis of variance data on total dry matter showed significant difference among the mulch treatments at different days after transplanting (Fig. 2) where the highest TDM (12.51 and 579.30 g plant⁻¹) was found from water hyacinth mulch at 30 and 70 DAT respectively and the lowest TDM (9.163 and 425.30 g Plant⁻¹) was observed in control treatment at those stages respectively. Water hyacinth mulch also recorded

the highest TDM (30.30 g Plant⁻¹) at 50 DAT which was followed by black polythene much (28.68 g Plant⁻¹) and the lowest TDM (25.77 g Plant⁻¹) was observed in control which was closely followed by saw dust (26.79 g Plant⁻¹) and white polythene mulch (26.98 g Plant⁻¹) at 50 DAT (Fig. 2). This result indicates that different mulching increased the physiological properties of the soil and soil moisture which would provide better vegetative growth and resulting in the maximum TDM.

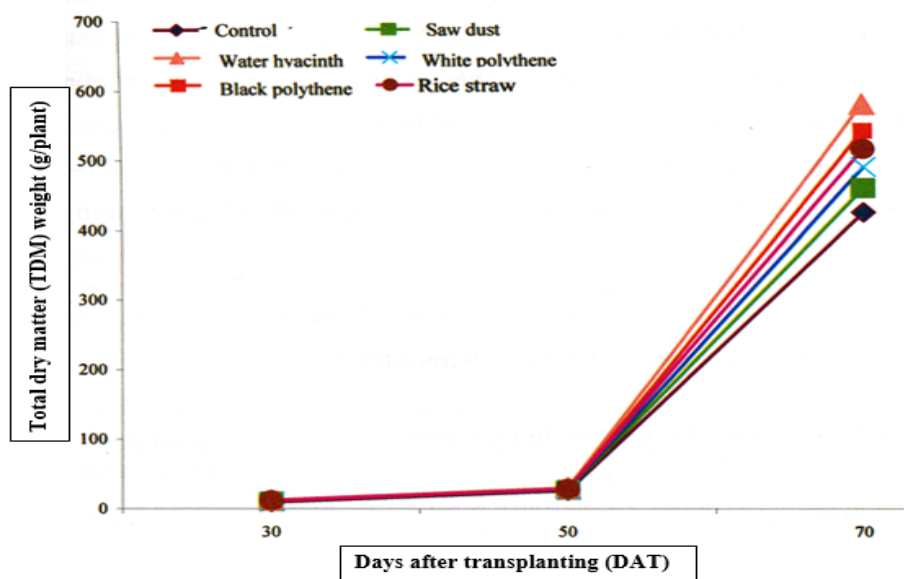


Fig. 2. Effect of different mulches on total dry matter at different days after transplanting (DAT).

Crop growth rate (CGR)

The statistical analysis data on crop growth rate (CGR) was significantly influenced by the effect of various mulches at the growing stage between 50 to 70 DAT while 30 to 50 DAT did not differ significantly (Table 4). So, all the mulch treatment produced statistically more or less similar results at the stage between 30 to 50 DAT due to its non-significant variation. However, the highest CGR ($1.098 \text{ g m}^{-2} \text{ day}^{-1}$) was obtained in water hyacinth mulch at 50-70 DAT which was statistically differed with other mulches. On the other hand, the lowest CGR ($0.799 \text{ g m}^{-2} \text{ day}^{-1}$) was found in untreated mulch AT 50-70 DAT (Table 4).

Relative growth rate (RGR)

Relative growth rate was significantly influenced by the effect of different mulches at different growing stage

(Table 4). Table 4 showed that water hyacinth mulch was more efficient on RGR than other mulches while the lowest in untreated mulch at all stages of growth. The higher RGR was recorded at the stage between to 50 to 70 DAT and the lower at the stage between 30 to 50 DAT. As a result, the highest RGR ($11.97 \text{ g cm}^{-2} \text{ day}^{-1}$) was found in water hyacinth mulch while control treatment noticed the lowest RGR ($8.709 \text{ g cm}^{-2} \text{ day}^{-1}$) at the stage between 50 to 70 DAT. Similarly, RGR was higher ($0.3877 \text{ g cm}^{-2} \text{ day}^{-1}$) in water hyacinth mulch compared to other mulches at the stage between 30 to 50 DAT. Among other mulch treatments the ranking were of control ($0.3623 \text{ g cm}^{-2} \text{ day}^{-1}$) < black polythene and saw dust ($0.3627 \text{ g cm}^{-2} \text{ day}^{-1}$) < rice straw ($0.3700 \text{ g cm}^{-2} \text{ day}^{-1}$) where they were statistically similar with each other at the stage between 30 to 50 DAT.

Table 4. Effect of different mulches on CGR and RGR at different (DAT)

Mulching transplanting	Crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$)		Relative growth rate $\text{g cm}^{-2} \text{ day}^{-1}$	
	30-50	50-70	30-50	50-70
Control	0.031	0.799 e	0.3623 b	8.709 f
Black polythene	0.033	0.856 d	0.3627 b	9.421 e
Water hyacinth	0.036	1.098 a	0.3877 a	11.97 a
Saw dust	0.033	0.927 c	0.3627 b	10.10 d
White polythene	0.034	1.027 b	0.3705 b	11.19 b
Rice straw	0.034	0.974 c	0.3700 b	10.62 c
LSD_(0.05)	0.04766	0.04766	0.01507	0.4766
S \bar{x}	0.01581	0.01581	0.0050	0.01581
CV (%)	7.58	4.29	4.29	0.15

Values followed by same letter(s) are statistically similar as per DMRT at 5% level of probability

Diameter of curd

Diameter of curd is an important yield contributing character of cauliflower. In the present experiment it was observed that curd diameter was influenced significantly due to the application of different mulches (Table 5). The highest diameter of curd (17.10 cm^2) was found in water hyacinth mulch which was statistically similar with rice straw mulch (16.33 cm^2). On the other hand the lowest diameter of curd (13.30 cm^2) was obtained in control which was also statistically similar (13.99 cm^2) with black polythene (Table 5). The variation in curd diameter of cauliflower was found due to the variation of mulching effect on soil nutrient and moisture where water hyacinth mulch was more efficient than other mulch. Similarly, Wahome *et al.* (2009) found significant variation among the mulch treatment where the highest cabbage head diameter (21.1 cm) was obtained in black plastic-grown plants.

Fresh weight of curd

Fresh weight of curd varied significantly among different mulch materials. Considering the fresh weight of curd, it was evident that water hyacinth mulch

produced the heaviest individual fresh weight of cauliflower curd (617.50 g) which was statistically differed with other mulch. On the other hand, the lowest individual fresh weight of curd (503.40 g) was obtained from the non-mulch treatment (Table 5). These results indicate that the highest weight of curd was found in case of water hyacinth which increased the soil moisture, fertility and control the soil temperature. Similar results were also found by Wahome *et al.* (2009) who reported highest head fresh mass (4.9 kg) in black plastic-grown plants.

Curd yield

Yield of cauliflower varied significantly among the mulch application for their behavior in this study. As a result, water hyacinth took the highest yield of cauliflower (16.47 t ha^{-1}) among the mulch treatments where rice straw mulch recorded the statistically more or less similar yield of cauliflower (15.82 t ha^{-1}). In contrast, the lowest yield of cauliflower (13.54 t ha^{-1}) was noticed in control which was also closely followed by black polythene (13.89 t ha^{-1}) and saw dust mulch (14.46 t ha^{-1}) where black polythene and saw dust were statistically same (Table 5).

These results indicate that the application of water hyacinth mulch performed better than other mulch. It was possible that the water hyacinth mulch kept the soil porous, increased soil fertility and water holding capacity, maintained good aeration and supplied sufficient plant nutrients which might helped in production of heaviest individual and total cauliflower curd. Similarly, Wahome *et al.* (2009) reported that, the highest yield (118.7 tons ha⁻¹) was obtained from black plastic-mulched plants. Salim *et al.* (2008) found a

positive impact of mulch on yield and yield attributes where the highest marketable yield (31.32 t ha⁻¹) was obtained from hybrid variety Snow with mulch and was 35.16% higher than without mulch which is consistent with Moniruzzaman *et al.* 2007 and Campiglia *et al.* 2000. Suwwan *et al.* (1988) found that plastic mulch increased marketable yield and total number of fruits in tomato. Similar results were also reported by Gunadi and Suwandi (1988).

Table 5. Effect of different mulches on curd diameter, curd fresh weight and curd yield.

Mulching treatments	Diameter of curd (cm ²)	Curd fresh weight (g plant ⁻¹)	Curd yield (t ha ⁻¹)
Control	13.30 c	503.4 f	13.54 d
Black polythene	13.99 c	521.2 e	13.89 cd
Water hyacinth	17.10 a	617.5 a	16.47 a
Saw dust	14.30 bc	542.3 d	14.46 cd
Water hyacinth	15.15 b	567.2 c	15.13 bc
Rice straw	16.33 a	593.3 b	15.82 ab
LSP (0.05)	1.004	9.904	1.222
S \bar{x}	0.3332	3.286	0.4053
CV (%)	4.43	1.18	5.45

Values followed by same letter(s) are statistically similar as per DMRT at 5% level of probability

Conclusions

The differences in morpho-physiological, growth and yield contributing characters due to mulch treatments were directly related to the variation of soil characteristics, temperature, humidity etc. Among the mulch, water hyacinth mulch was probably more efficient to increase soil fertility; maintenance the moisture and temperature which have ensured the higher yield of cauliflower under southern part of agro-ecological zone 13 in Patuakhali. Above results indicate that water hyacinth mulch was most advantageous mulch for better growth and higher yield of cauliflower. Considering the above observations of the experiment, the following recommendation may the suggested-

- All mulches performed positively on the growth and yield attributes of cauliflower.
- Among the mulches, water hyacinth mulch was found most effective for cauliflower production under AEZ-13 of the southern part of Patuakhali.
- Further investigation is needed to ensure the growth and yield performance of different mulches under different AEZ of Bangladesh for regional adaptability.

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