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Effect of Plastic Mulch on Growth and Yield of Chilli (*Capsicum annuum* L.)

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ABSTRACT

In this work a field study was conducted to evaluate the effect of coloured plastic mulch on growth and yield of chilli from October 2005 to April 2006. The plastic mulches were transparent, blue, and black and bare soil was the control. Different mulches generated higher soil temperature and soil moisture under mulch over the control. Transparent and blue plastic mulches encouraged weed population which were suppressed under black plastic. Plant height, number of primary branches, stem base diameter, number of leaves and yield were better for the plants on plastic. At the mature green stage, fruits had the highest vitamin-C content on the black plastic. Mulching produced the fruits with the highest chlorophyll-a, chlorophyll-b and total chlorophyll contents and also increased the number of fruits per plant and yield. However, mulching did not affect the length and diameter of the fruits and number of seeds per fruit. Plants on black plastic mulch had the maximum number of fruits and highest yield. Thus, mulching appears to be a viable tool to increase the chilli production under tropical conditions.

Key words: *Capsicum annum*, chilli, growth, plastic mulch, yield, yield attributes

INTRODUCTION

Chilli pepper (*Capsicum annuum* L.) is an important spice and cash crop in many countries of the world. In Bangladesh, chilli is grown round the year in all parts of the country while winter chilli is grown between the months of October to April and accounts for about 70% of total production. At least 32 local varieties are cultivated in Bangladesh (BBS, 2005).

Water deficit often limits the crop growth and development. Chilli is sensitive to water stress. Young chilli seedlings cannot withstand either water deficit or excess soil moisture while older plants can withstand deficit or excess water (Ayoub, 1986). The average yield of chilli in Bangladesh is very low compared to other chilli growing countries in the world (FAO, 2003) due to erratic rainfall and inefficient use of fertilizer. Heavy rainfall is a problem for chilli cultivation because chilli cannot tolerate heavy rainfall. In the winter, production is hampered due to lack of irrigation as well as minimum rainfall. Most determinate crops are sensitive to water stress especially at the time of floral initiation, during flowering, and to a lesser extent, during fruit development (Hegde, 1989). In crops, where the vegetative growth and reproductive processes overlap the reason for water stress becomes difficult to explain (Begg and Turner, 1976). To

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improve the productivity of crops where either water deficiency or excess frequently occurs, proper water management is necessary (Hale and Orcutt, 1987). In the winter season, the conservation of soil moisture may help in preventing the loss of water through evaporation from the soil facilitating maximum utilization of moisture by the plants. Mulching with plastic is a method by which soil moisture can be conserved (Sandal and Acharya, 1997).

Mulching stimulates the microbial activity in soil through improvement of soil agro-physical properties (Strizaker et al., 1989). Mulching also minimizes the use of N fertilizer (Jones et al., 1977), warms the soil (Singh et al., 1988), improves the soil physical condition (Kwon et al. 1988; Lal, 1989), and suppresses weed growth (Iruthayaraj et al., 1989; Mohler and Calloway, 1992) and could account for increased yield (Siti et al., 1994; Ravinder et al., 1997; Nagalakshmi, 2002).

The present study was undertaken to evaluate the changes in temperature and soil moisture and to evaluate the growth and yield of chilli under tropical conditions grown with plastic mulches.

MATERIALS AND METHODS

The experiment was conducted during the period of October 2005 to April 2006. The field is located at 24°75′ N latitude and 95°75′E longitude at 18 m above sea level in the agro-ecological Zone-9 (AEZ-9) termed Old Brahmaputra Floodplain. The soil is a non-calcareous dark grey floodplain. The soil was neutral in pH and silty loam in texture.

Three mulching treatments (transparent, black and blue plastic sheets) along with a control (bare soil) were imposed on a local variety of chilli. The land was prepared by tilling in two directions with a power tiller. Weeds and crop stubble were removed. Plots were 2 × 2 m on 15 cm high raised beds. Urea, triple superphosphate (TSP) and muriate of potash (MP) were applied (260, 200 and 150 $kg \cdot ha^{-1}$, respectively). Total amount of TSP, MP and half of urea were broadcast and incorporated to the soil at final land preparation. The rest of urea was top-dressed at 40 days after transplanting (DAT). Well decomposed cowdung was applied (5 $t \cdot ha^{-1}$) prior to final tilling. Plastic mulches were carefully spread over the plots and holes were punched where seedlings were to be established.

Transplant establishment

Thirty-day old seedlings were transplanted at 25 cm × 25 cm spacing on 21 November 2005. Seedlings were watered after transplanting. Guard rows were established around the entire plot. Gap filling of seedling was with healthy seedlings previously planted in the border area. No additional irrigation was applied during the growing season. At 40 days after transplanting (DAT), weeds were collected from the plots and their fresh and oven dried weights were recorded. The pesticides Actara-25WG at 2.5 g/10L and Kinalux at 2 $mL \cdot L^{-1}$ were applied at 40 and 65 DAT to prevent insect and disease infestation.

Harvest

Green fruit were harvested at weekly intervals when fruit length was at least 4.5 cm. Harvesting was started on 5 February 2006 and continued till 25 April 2006.

Data collected

Plant height, number of primary branches per plant, main stem base diameter and number of leaves per plant were recorded from four the plants at 15 day intervals. One plant from each plot was carefully uprooted and the roots were gently washed with water to remove the soil. The plant was placed on white paper and the root circumference was marked and measured. Root length, fresh and dry weight of plants, and fresh and dry weight of the weeds at 40 DAT were recorded. The length and diameter of 20 randomly selected mature green fruit were measured from each plot. Number of fruits per plant, fruit yield per plant, fruit yield per plot, fruit yield per hectare, and number of seeds per fruit were recorded at final harvest. Ascorbic acid content of green fruit was estimated with the indophenol dye method (Sadasivam and Manickam, 1992). Chlorophyll content was estimated according to the method described by Yoshida et al. (1976). Soil moisture content was determined gravimetrically from the 0-10 cm soil depth on 21 February 2006 (90 DAT). On this day, the diurnal variation of soil temperature was recorded with a thermometer at the 5 and 10 cm depths starting from 7AM to 5AM at 2 h intervals. Also, air temperature was recorded with a thermometer from 7AM to 6PM at 1 h intervals.

The experiment was arranged in Randomized Complete Block Design (RCBD) with four replications. The data were analyzed using

MSTAT-C Statistical Computer Package Programme for a Randomized Completely Block Design. Duncan's Multiple Range Test (DMRT) was performed to separate means.

RESULTS AND DISCUSSION

Soil temperature

Soil temperature at the 5 to 10 cm depth was different due to the presence of mulch and mulch colour (Table 1). Soil temperature varied significantly with type of mulching, time of the day and the depth of soil. Soil temperature was low in the early morning and gradually increased until peaking at 3PM in all the treatments and then declined. Temperature under mulches was higher than that of the control plots for all the times. The maximum difference in temperatures between mulched and control plots was 5.1 to 5.7^{o}C at 5 cm soil depth at 3PM. The transparent plastic mulch produced higher soil temperatures. In general, soil temperature was higher at 5 cm than at 10 cm depth. Suwon and Judah (1985) reported that soil temperature increased with the use of plastic mulch. The polythene mulches allowed part of the radiation to pass through it but acted as barriers against outgoing thermal radiation (Park et al., 1987). Variability of soil temperature in the upper few cm of the soil was likely due to the color of the mulch (Fortnum et al., 1995; Petrov and Al-Amiri, 1976).

Air temperature

Temperature over the plot surfaces and within the plant canopy varied (Table 2). Canopy and plot surface temperatures increased and peaked at 1PM and 2PM, respectively, followed by a decline. The soil surface temperature ranged from 15.0 to 34.6^{o}C; canopy temperature ranged from 15.2 to 33.7^{o}C. There were higher air temperatures over the plastic mulch than bare soil. The highest surface temperature was recorded over the black plastic mulch, followed by the blue and transparent mulches. Mulched plots retained comparatively higher air and canopy temperature than did the control, which might be due to trapping of more solar radiation. Among the mulches, there was little variation between the surface and canopy temperatures. The mulches conserved heat from solar radiation and released it slowly at night resulting in higher surface temperature compared to the control. Increased air temperature at the canopy level at mid-day might be due to stomatal closure resulting in reduced transpirational cooling allowing the heat to escape. Similar results were obtained by Easson and Fearnehough (2000) who reported that plastic mulches increased daily air temperature compared to the control.

Table 1 - Change in soil temperature ($^{\circ}$C) at different soil depths recorded on 21February 2006.

Mulch	Depth (cm)	Hour of day											
		07	09	11	13	15	17	19	21	23	01	03	05
None	5	13.5	14.0	17.3	21.6	24.9	21.8	19.5	17.5	16.9	15.2	14.8	13.9
	10	13.0	13.7	16.9	20.4	21.8	21.3	20.6	18.5	16.9	16.3	15.2	14.5
Transparent	5	14.9	15.9	19.5	26.8	30.6	28.8	26.4	20.9	18.8	17.7	16.4	15.8
	10	14.6	15.1	18.8	23.9	27.0	25.0	23.0	19.8	18.6	17.0	15.8	15.0
Black	5	14.7	15.8	18.8	26.3	30.0	28.2	23.8	19.8	18.8	17.0	16.2	15.6
	10	14.4	15.2	18.1	23.3	26.8	25.4	22.9	19.0	18.6	16.6	15.7	15.2
Blue	5	14.8	15.7	18.8	26.5	30.2	28.5	24.0	20.8	18.7	17.5	16.3	15.7
	10	14.4	15.0	18.1	23.1	26.9	25.1	22.8	20.0	18.4	17.2	15.9	15.1

Table 2 - Temperature ($^{\circ}$C) at soil/mulch surface and within the canopy as measured on 21 February 2006.

Mulch	Level	Hour of day											
		07	08	09	10	11	12	13	14	15	16	17	18
None	Surface	15.3	20.5	23.0	27.4	28.5	29.0	29.8	30.2	28.1	26.9	24.0	21.1
	Canopy	15.5	20.1	22.1	26.9	27.6	28.4	29.5	29.0	27.8	26.1	23.7	21.0
Transparent	Surface	16.2	21.7	24.8	29.0	29.8	32.0	33.2	34.0	31.8	29.6	26.5	21.4
	Canopy	16.5	21.0	23.5	27.9	29.0	31.5	33.0	32.4	30.6	28.5	25.7	21.2
Black	Surface	16.0	21.9	25.7	29.8	31.3	32.8	33.5	34.6	32.4	30.6	27.5	21.8
	Canopy	16.3	21.1	24.1	28.6	30.4	32.2	33.7	32.9	31.0	29.3	26.6	21.5
Blue	Surface	16.1	21.5	25.0	29.5	31.1	32.5	33.4	34.4	32.0	30.5	27.0	21.6
	Canopy	16.4	21.0	23.6	28.1	30.2	32.0	33.5	32.7	30.9	28.7	26.0	21.4

Soil moisture

The soil moisture content in the experimental plots under different mulches was measured within 0–10 cm depth. Results revealed that all the mulches retained higher amount of soil moisture compared to the control (Fig 1). But among the mulches, there was no significant difference in soil moisture content. The transparent polythene mulch apparently showed highest moisture (21.1%), followed by black (20.4%) and blue (19.2%) polythene mulch. The lowest moisture (14.6%) was recorded in the control plot. Increased moisture retention capacity due to mulching with polythene could be attributed to less evaporation from the soil. Because of vapours, the water was further trapped within the mulches, resulting in fog which again dropped into the upper soil layer. Wang et al. (1998) reported that all type of polythene mulch increased the soil moisture content in chilli field compared to control.

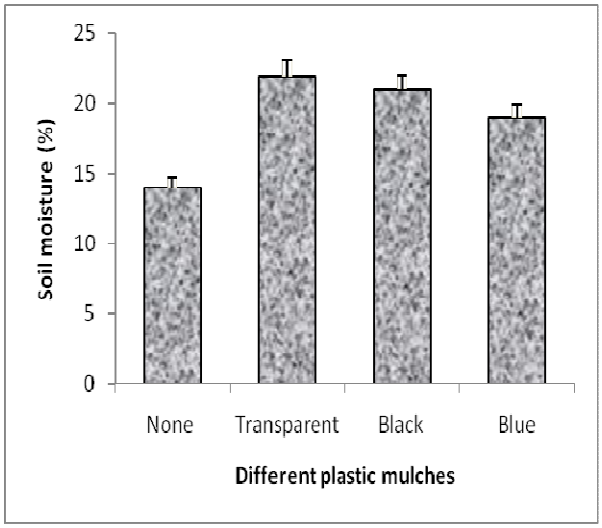

Figure 1 - Soil moistuire (%) at 0-10 cm depth under different polythene mulches. Vertical bar represents LSD at 5% level.

Plant height

Plant height was measured from 30 DAT to 105 DAT at 15 days interval. As shown in Fig. 2, the plant height varied significantly due to different plastic mulches at different growth stages and increased with plant age. Plastic mulches showed superior performance in plant height than control, indicating mulches had positive effect on the growth and development of chilli. Transparent plastic mulch always showed superior performance than the others. At the maturity, the tallest plant (78.45 cm) was observed in transparent, followed by black (77.58 cm) and blue (77.03 cm) plastic. The smallest plant (61.15 cm) was observed in control plot. The increased plant height 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 (Shinde et al., 1999).

Number of structural branches

Table 3 showed that the mulches had a significant effect on the number of structural branches per plant. The number of structural branches per plant continually increased with plant age. All the mulches had the positive effect on generating and retaining higher number of branches per plant. The highest number of structural branches per plant was observed in black plastic, followed by blue and transparent plastic. Control always showed the least number of structural branches. Favourable weather condition and moisture of the soil are the important parameters affecting the number of branches per plant. It was reported that mulched tomato plants had more branches than that of unmulched plants, which supported the present results (Srivastava et al., 1994).

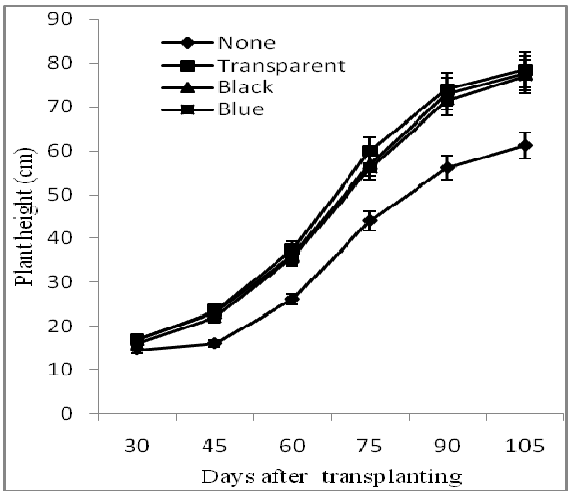

Figure 2 - Effect of different polythene mulches on plant height at different growth stages of chilli. Vertical bar represents LSD at 5% level.

Table 3 - Effect of different plastic mulches on the number of structural branches per plant at different ages

Mulches	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT
None	0.01d	2.03b	5.63b	12.88b	16.82b	17.05b
Transparent	0.50c	4.11a	9.20a	17.38a	20.85a	21.58a
Black	0.99a	4.64a	10.25a	18.03a	21.97a	22.58a
Blue	0.75b	4.33a	9.57a	17.73a	21.38a	21.94a
LSD(0.05)	0.10	0.77	1.27	2.90	3.63	2.83

In a column figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.

Stem base diameter

Stem base diameter at all growth stages in chilli plants was influenced by the treatments (Table 4). Base diameter increased gradually with the advancement of time up to 105 DAT. Mulched plants had a higher base diameter than that in controls at all growth stages, followed by blue and transparent plastic. The plant without mulch had the smallest base diameter at all growth stages. This result was in conformity with the report of Easson and Fearnehough (2000) on forage maize.

Number of leaves per plant

Mulching produced significantly higher number of leaves per plant than that of controls, except at 30 DAT throughout the whole growth period (Fig. 3). The number of leaves per plant increased gradually till through 60 DAT and ther after increased rapidly up to 105 DAT. The maximum number of leaves per plant was found on the plants mulched with black plastic at all growth stages, followed by the blue plastic mulch. The microclimate condition improved by the mulches might have provided a suitable condition for producing higher number of leaves in the plants. The effectiveness of plastic mulches for the production of leaves in maize was better than control as reported by Izakovic (1989).

Root length

Root length in the mulched plants was not different, but higher than the control plants (Table 6). Mulches had significant primitive effects on root elongation. This might be due to the conservation of enough soil moisture (Fig. 1), suitable soil temperature (Table 2) as well as suitable microclimate condition.

Table 4 - Plastic mulch effect on stem base diameter (cm) at different ages

Mulches	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT
None	0.29b	0.39c	0.60b	0.84b	1.05b	1.12b
Transparent	0.34ab	0.51ab	0.81a	1.16a	1.44a	1.56a
Black	0.35a	0.54a	0.82a	1.23a	1.50a	1.61a
Blue	0.34ab	0.49b	0.77a	1.20a	1.47a	1.58a
Lsd (0.05)	0.05	0.05	0.05	0.07	0.07	0.15

In a column figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.

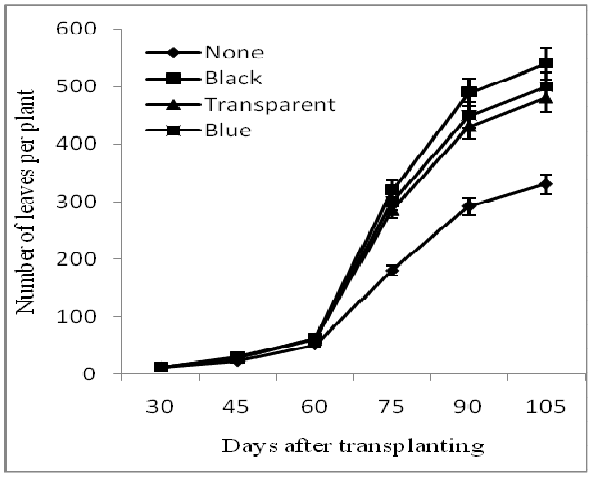

Figure 3 - Effect of different polythene mulches on number of leaves per per plant at different growth stages of chilli.

Root volume

The effect of plastic mulch on root spread was significant (Table 5). Mulch produced significantly higher root volume compared to the control. The black plastic mulches produced the highest root volume (121.59 cm^3), followed by blue plastic mulch. In contrast, control produced the lowest root volume (90.32 cm^3). These results coincide with those of Wien (1993) where he reported that polythene mulch stimulates really root growth of transplanted tomatoes.

Fresh and dry weight of root

Mulching produced significantly higher fresh and dry root weights than the controls (Table 5). The highest fresh and dry weight of root was recorded in black plastic mulch (60.56 and 26.23g, respectively), followed by blue (58.54 and 24.51 g, respectively) and transparent plastic (57.58 and 24.34g, respectively). In contrast, control showed the lowest fresh and dry weight of root per plant.

Table 5 - Effect of different plastic mulches on root length, volume, fresh and dry matter production of chilli plant

Mulches	Root length (cm)	Root volume (cm^3)	Root weight (g)		Stem weight (g)		Leaves weight (g)	
			Fresh	Dry	Fresh	Dry	Fresh	Dry
None	25.49	90.33c	32.31b	13.1c	238.30c	78.31b	72.50b	22.32b
Transparent	31.94a	115.56b	57.59a	24.34b	398.38b	141.20a	128.81a	40.16a
Black	32.93a	121.59a	60.56a	26.23a	419.38a	148.93a	113.38a	43.18a
Blue	32.36a	117.79ab	58.59a	24.51ab	407.35ab	144.33a	131.48a	41.19a
$LSD_{(0.05)}$	4.33	5.13	3.20	0.18	19.59	12.69	11.37	3.43

In a column figures bearing same letter (s) do not differ significantly at 5% level of probability by DMRT.

Fresh and dry weight of stem

All plastic mulches produced significantly higher fresh and dry weight of stem compared to the control (Table 5). However, among the mulches, there was no significant difference in stem weight. The highest fresh and dry weight of stem was observed in black plastic mulch, followed by blue and transparent plastic mulch. In contrast, control showed the lowest fresh and dry weight of stem. Mulching increased stem dry weight of tomato as reported by Wien (1993).

Fresh and dry weight of leaf

All mulches produced significantly higher fresh and dry weight of leaf compared to the control (Table 5). However, among the mulches, there was no significant difference in fresh and dry weight of leaf. The highest fresh and dry weight of leaf was observed in black plastic, followed by blue and transparent. Apparently sufficient soil moisture was conserved under black plastic mulch that might have improved the plant growth. The result of the present study supported the finding of Suh et al. (1991). Cooper and Law (1978) found that the soil temperature raised by plastic mulching led to a greater rate of growth and development of leaf.

Chlorophyll content in leaf

The effect of plastic mulches on chlorophyll-a, chlorophyll-b, total chlorophyll and their ratio are presented in Table 6. Results revealed that these were significantly influenced by the plastic mulches; chlorophyll a/b ratio did not differ significantly. The highest value of chlorophyll-a, chlorophyll-b and total chlorophyll was recorded in black plastic mulch (1.73, 0.53 and 2.26 $mg \cdot g^{-1}$ fw, respectively), followed by blue plastic mulch (1.59, 0.492 and 2.086 $mg \cdot g^{-1}$ fw, respectively). In contrast, the lowest chlorophyll-a, chlorophyll-b and total chlorophyll were recorded in control (1.302, 0.413 and 1.723 $mg \cdot g^{-1}$ fw, respectively). Similar result was also reported by Panchal et al. (2001) who found that mulch had significant effect on total chlorophyll contents in chilli and black plastic mulch was the best for total chlorophyll content among the mulches.

Table 6 - Effect of different plastic mulches on chlorophyll and vitamin-C contents in green fruit of chilli.

Mulch	Chl.-a	Chl-b	Total Chl.(a+b)	Chl. (a/b)	Vit-C (mg/100g)
			$mg \cdot g^{-1}$ fresh weight		
None	1.302d	0.413c	1.723d	3.155a	112.51b
Transparent	1.468c	0.455dc	1.920c	3.229a	121.38a
Black	1.725a	0.530a	2.260a	3.257a	123.01a
Blue	1.595b	0.492ab	2. 085b	3.238a	122.28a
$LSD_{(0.05)}$	0.05	0.05	0.152	0.16	7.10

In a column figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.

Vitamin-C content in fruit

The change in vitamin-C in chilli due to plastic mulch is presented in Table 6. Increased amount of vitamin-C in chilli fruit was observed in all the mulch treated plants compared to control. But among the mulch treatments, there was no significant difference in vitamin-C content of the fruits. The findings were in agreement with Panchal et al. (2001) who reported that black mulches produced higher vitamin-C content in chilli.

Yield and yield attributes

Mulching produced more fruits per plant compared to control (Table 7). It meant that mulch had positive influence on fruit setting in chilli. The highest number of fruits per plant was observed in black plastic mulch (472 $plant^{-1}$), followed by blue (443 $plant^{-1}$) and transparent mulch (434 $plant^{-1}$). In contrast, control showed the lowest fruits per plant (335 $plant^{-1}$). Ravinder et al. (1997) 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 suitable condition enhanced the plant growth and development and produced increased fruit bearing nodes compared to the control. Considering relationship between the soil moisture

content and fruit number, it was clear that fruit number was strongly related with soil moisture content (Fig. 1). Fruit length, fruit diameter and number of seeds per fruit were statistically similar over the treatments (Table 7), indicating these traits were mainly genetically, not environmentally controlled.

The effect of different plastic mulches on fruit weight per plant and per unit area was significant (Table 7). 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. Black plastic mulch produced the highest fruit weight per plant (533.4 g) and per hectare (21.3 ton), followed by blue and transparent plastic mulches. Obviously, control plot showed the lowest fruit yield both in per plant (336.3 g) and per unit area (13.45 $t \cdot ha^{-1}$). Fruit yield increased in mulched plot because of increased number of fruits per plant. These results coincide with those of Siborlabane (2000), 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 7 - Effect of different plastic mulches on yield attributes of chilli

Mulch	No. of fruits per plant	No. of seeds per fruit	Fruit length (cm)	Fruit diameter (cm)	Fruit wt ($g \cdot plant^{-1}$)	Fruit wt. ($kg \cdot plot^{-1}$)	Yield ($t \cdot ha^{-1}$)
None	335c	69.38a	4.51a	0.76a	336.3c	5.38c	13.46c
Transparent	434b	72.33a	4.66a	0.81a	461.43b	7.38b	18.45b
Black	472a	76.83a	4.73a	0.84a	533.45a	8.53a	21.33a
Blue	443b	73.33a	4.68a	0.82a	479.33b	479.33b	19.15ab
$LSD_{(0.05)}$	14.31	5.54	0.47	0.11	22.79	0.74	2.45

In a column figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.

Weed population

Weed populations were counted at 40 DAT (Table 8). The highest number of weeds per m^2 was recorded in transparent plastic mulch (186.5) and the lowest was in black plastic mulch (54.25). Similar results were found for weeds fresh and dry weight. The weed population increased 11, 5 and 3 times in transparent plastic, blue plastic and control, respectively compared to black, indicating black plastic mulch was more effective than the other mulches in suppressing weed growth.

Transparent plastic mulch produced maximum weed population and dry matter which might be due to direct entrance of solar radiation through them and as well as due to higher soil temperature and soil moisture content, especially at the upper 5 cm depth. The blue plastic also allowed easy entrance of solar radiation through it, hence, produced moderate weed density and biomass. Black plastic mulch produced weeds only through the punch and no weed was found under the plastic, which might be due to lack of percentage of light through black plastic. Black plastic mulch blocked the weeds, except a few, which emerged through the planting holes (Schonbeck, 1998). Zhang et al. (1992) reported that black plastic film mulch resulted in 100% control of all the weeds in maize that supported the present experimental result.

Table 8 - Effect of different plastic mulches on weed infestation at 40 DAT.

Mulch	Number of weeds per m^2	Fresh weight ($g \cdot m^{-2}$)	Dry weight ($g \cdot m^{-2}$)
None	75.88c	82.33c	19.18c
Transparent	186.50a	251.78a	76.20a
Black	54.25d	42.80d	7.28d
Blue	123.50b	135.80b	35.97b
$LSD_{(0.05)}$	11.55	5.61	2.83

In a column figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.

CONCLUSION

Based on the experimental results, it could be concluded that plastic mulches had tremendous effects on the growth, and yield of chilli, and black plastic showed superior performance among the plastic mulches. Black plastic mulch was suppressed the weed growth and thereby, increased the fruits yield. Therefore, the cultivation of chilli using black plastic mulch could bring an ample scope for producing more spices.

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