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

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A B S T R A C T

The present investigation was carried out during *Rabi* season of 2017-2018 at the Horticulture complex, Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The treatments consisting of two-coloured polyethylene mulch (black, silver/black) and with bare soil (without mulch) as controls. Results showed that soil temperature under the various coloured mulches was 2 to 4˚C warmer compared to bare soil. The highest soil temperature was recorded under black mulch (20.63). The plants grown on silver/black mulch produced Maximum plant heights (48.83 cm.), primary branches/plant (13.74), secondary branches/plant (21.13),early flowering (17.19), fruit length (8.74 cm), Fruit diameter (0.88 cm), average weight of fruit (4.49 g), number of fruits/plant (155.25), fruit yield/plant (744.14 g), Fruit yield per plot (11.82 kg), Ascorbic acid (269.07 mg/100 g), water use efficiency (4.96 kg ha^{-1}-mm), moisture depletion pattern % and soil temperature under different stages. Under without mulch condition, recorded maximum days taken to 50% flowering (24.58), maximum total soluble solids (2.38 º Brix), weeds fresh weight (41.49 g) and weeds dry weight(11.48 g).In an attempt to reducing chemical input for weed control and increase to yield of chilli black and silver/black plastic mulch may be a good alternative for conventional without mulch.

Introduction

Chilli (*Capsicum annum* L.) is considered as one of the commercial spice crops. It is the most widely used universal spice, named as wonderspice. Different varieties are cultivated for various uses like vegetable, pickles, spice and condiments. In daily life, chillies are the most important ingredient in many different countries around the world as it adds pungency, taste, flavour and colour to the dishes. India is the largest producer, consumer and exporter of chilli and contributes to 25% of total world's production. In India, chilli is grown in almost all the states across the length and breadth of the country. Andhra Pradesh the largest producer of chilli in India, contributes about 30% to the total area under chilli, followed by Karnataka (20%), Maharashtra (15%), Orissa (9%), Tamil Nadu

(8%) and other states contributing 18 %. In India, it occupies an area of 792 MH with a production of 1376 MT with an average productivity of1643 kg/ha. (NHB 2015-16). Madhya Pradesh is the Chilli producing area with 88000 ha, production 70000 tonnes and productivity 795 kg/ha of Chilli (Anonymous, 2015-16). Chilli is increasing in its popularity for its pungent fruits and is highest in vitamin A &C, Iron and calcium. Chillies are used in making chilli vinegar, hot oil, tomato sauces, rice dishes, soups, hot condiments such as samber, beans, corn and curry powders. Chillies do well with several other spices including basil, ginger, oregano, cilantro, cinnamon, black pepper, fennel and cumin. Mulching is the practice of covering the soil around plants to make conditions more favourable for growth, development and efficient crop production (Nagalakshmi *et al.*, 2002). Mulches are used for the moderation of soil temperature, through the effects were highly variable. Colour of mulch affected soil temperatures. White (or) reflective plastic decreased temperatures (Unger 1984). Hot days, soil temperature under straw mulch was reduced as much as 17°C (30°F) lower than un-mulched plots (Yamaguchi, 1983). Mulches of plant material like straw, dry grass and leaves etc. reduced the soil temperatures (Dhesi *et al.*, 1964). Black polyethylene induces soil temperature, more moisture conservation higher soil microbial activity resulting in more mineralization and availability of nutrients to the plant (Patil and Bansod, 1972).

Materials and Methods

A field experiment was carried out during Rabi season of 2017-2018 at the Horticulture complex, Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh. The experiment was conducted for comparative study and influence of effect of mulch on performance of chilli cv. ArkaLohit, in Factorial Randomized Block Design experiment with three replications using three type of mulching as treatments *i.e.*, no mulch (M0), Black plastic mulch (M1) and silver plastic mulch (M2). The Black plastic mulch and silver plastic mulch (low density polyethylene) of 25 micron thickness was fixed tightly during the non-windy period without any crease to cover the soil surface both ends of the plastic were buried into the soil up to the depth of 10 cm. Seedlings were immersed in holes at 60 x 50 cm spacing of polyethylene of sheet. Plots were 4× 1.2 m on 15 cm high raised beds. Drip irrigation tubing was placed under mulches during the same process. The site was fertilized according to soil test recommendations. In control plots, no herbicides were applied and any weed escapes were controlled by bi-weekly hand weeding. Seeds of chillies were sown at nursery (low tunnel covered with clear plastic) on 5 sep. 2017. On 28 Oct., Fifty -day old seedlings were transplanted by making holes of 5 cm diameter. Soil temperature was measured at 10 cm depth for all treatments using soil thermometer.

Observations were recorded on the basis of five random competitive plants selected from each treatment separately for morphological, phenological and yield characters were evaluated. Weeds were collects from plots and took their fresh and oven dried weight at harvest time.

Results and Discussion

Effect of mulch on growth characters

The data on various growth parameters i.e. plant height, number of primary and secondary branches per plant, flowering as influenced by different mulching and irrigation levels are presented in the Table 1 and 2.

Effect of mulch

Among mulching treatments different growth parameters significantly influenced. The data among mulching treatments (Table 1 and 2) showed that plant height in silver plastic mulch recorded maximum height (32.0, 36.75, 40.20, 48.83 cm) followed by black plastic mulch (29.19, 35.20, 39.25, 46.28 cm) and minimum plant height (25.80, 31.57, 35.10, 41.39 cm) was observed in no mulch condition at 30, 45, 60 and 90 DAT respectively. In the case of primary branches per plant, recorded maximum number of primary branches per plant in silver plastic mulch (2.58, 6.56, 9.48, 13.74)followed by black plastic mulch (2.23, 6.10, 8.31, 12.12) and minimum primary branches in no mulch condition (1.56, 3.90, 6.63, 10.81) at 30, 45, 60 and 90 DAT respectively and in the secondary branches data indicated that in silver plastic mulch recorded maximum number of secondary branches (9.14, 17.86, 21.13) and minimum number of secondary branches (5.60, 12.40, 16.83) at 45, 60 and 90 DAT respectively.

Days to flowering initiation and days taken to 50% flowering were significantly influenced by different mulching treatment. Among mulching treatments, no mulch recorded maximum days taken to flowering initiation (17.19) and days taken to 50% flowering (24.58) and minimum days taken to flowering initiation (13.21), days taken to 50% flowering (20.68)has been observed at silver plastic mulch. Early flower initiation may be due to the surface colour of plastic mulch can change the quantity of light and spectral balance reaching plants, with resulting effects on early initiation of flowers. In the other hand, plastic mulches often enhanced soil temperatures under the mulch covering and provided plants early season growth boost and higher growth may be due to reflected sun light and less evapo-transpiration and maintain soil moisture compare to black mulch condition. The microclimate condition improved by the mulches might have provided a suitable condition for producing higher plant height and number of primary and secondary branches in the plants. Similar findings were reported by Ashrafuzzaman *et al.,* (2011) in chilli, Gordon *et al.,* (2010) in okra and Christopher *et al.,* (1996) in tomato.

Effect of mulch on fruit characters

The beneficial effects of mulching treatments were subsequently reflected in yield attributes like fruit length, average fruit weight, circumference of fruit, number of fruits per plant yield per plant and fruit yield per plot. A perusal of data given in Table 2, indicates that the fruit length, Fruit Diameters (cm), Average weight of fruit (g) were significantly influenced by different types of mulch.

Effect of mulch

Among mulching treatments, silver plastic mulch recorded maximum fruit length (8.74), maximum Fruit diameter (0.88), maximum average weight of fruit (4.49) followed by black plastic mulch (8.21, 0.85, 4.33) respectively and minimum fruit length (7.53), minimum Fruit diameter (0.80), minimum average weight of fruit (3.59) were observed in no mulch condition. Higher fruit length in mulch treatments might be due to its effects on soil temperature, soil moisture and weed suppression. Reflected sun light and less evapo-transpiration and maintain soil moisture compare to no mulch. Similar findings were reported by Singh and Kamal (2012) in tomato.

Effect of mulch on yield and quality characters

Data pertaining in Table 3 indicate the number of fruits per plant, fruit yield per plant, fruit yield per plot, total soluble solids (^{o}Brix),

ascorbic acid (mg/ 100 g) have been significantly influenced by different types of mulch.

Effect of mulch

Among mulching treatments, silver plastic mulch recorded maximum number of fruit plant, fruit yield per plant, fruit yield per plot (155.25, 744.14 g, 11.82 kg) respectively, followed by black plastic mulch (145.75, 665.50 g, 10.61 kg) respectively and minimum number of fruit plant, fruit yield per plant, fruit yield per plot (138.33, 579.22 g, 8.99 kg) respectively, were observed in no mulch condition.

The increase in the fruit yield 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. Similar finding was reported by Ashrafuzzaman *et al.,* (2011) in chilli.

Among mulching treatments, silver plastic mulch recorded maximum Ascorbic acid (269.07 mg) followed by black plastic mulch (258.46 mg) and minimum Ascorbic acid observed was (227.22 mg) in no mulch condition. Higher total soluble solids were recorded in no mulch condition (2.38ºBrix) followed by black plastic mulch (1.84ºBrix) and minimum total soluble solids (1.60ºBrix) was observed at silver plastic mulch. This may be due to more evaporations losses which resulted in high percentage in TSS.

Decrease of TSS percentage with mulches may be due to high moisture conservation through frequent irrigation levels. Minimum total soluble solids were obtained with no mulch can be attributed to low soil water tension maintained under no mulch which lead to higher water uptake and hence dilution of the concentration of the total soluble solids (Kere *et al.,* 2003).

Effect of mulch on weeds

A perusal of data given in Table 4 indicates that the weeds fresh weight, Weeds biomass (g), Water use efficiency (kg ha^{-1-mm}) were significantly influenced by different types mulching.

Effect of mulch

Among mulching treatments, no mulch recorded maximum weeds fresh weight (41.49 g), maximum weeds dry weight (11.48) followed by silver plastic mulch (8.40 g, 2.41 g) respectively and minimum weeds fresh weight and minimum weeds dry weight (7.26 g, 2.19 g) respectively, observed at black plastic mulch. It is due to 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 There was complete elimination of weeds under black polyethylene mulch. Similar findings were also reported by Ramakrishna *et al.,* (2006) in groundnut in tomato. Silver plastic mulch has recorded significantly maximum mean consumptive use of water followed by black plastic mulch. It may be due to reflected sun light and less evapotranspiration and maintain soil moisture compare to no mulch in plant. Similar findings were recorded by Mukherjee *et al*., (2010) in tomato.

Effect of mulch on soil moisture depletion pattern (%) and variation in soil temperature at different stage

A perusal of data given in Table 5 indicates that the soil moisture depletion pattern (%) and variation in soil temperature have been significantly influenced at different stage by different mulching treatment.

Table.1 Effect of mulch on growth characters

Treatment	Plant Height(cm)				Primary branches			
Mulching (M)	**30 DAT**	**45 DAT**	**60 DAT**	**90 DAT**	**30 DAT**	**45 DAT**	**60 DAT**	**90 DAT**
M_0	25.80	31.57	35.10	41.39	1.56	3.90	6.63	10.81
M_1	29.19	35.20	39.25	46.28	2.23	6.10	8.31	12.12
M_2	32.00	36.75	40.20	48.83	2.58	6.56	9.48	13.74
S.Em.±	**0.060**	**0.061**	**0.039**	**0.080**	**0.057**	**0.075**	**0.050**	**0.058**
C.D.@ 5%	**0.178**	**0.180**	**0.116**	**0.237**	**0.168**	**0.221**	**0.148**	**0.171**

Note: DAT- Days After Transplanting
Factor A- Mulching - M_O: No Mulch M_1: Black Mulch M_2: Silver Mulch

Table.2 Effect of mulch on growth characters

Treatment	Secondary branches			**Flowering initiation (From DAT)**	**Days taken to 50% flowering**
Mulching (M)	**45 DAT**	**60 DAT**	**90 DAT**		
M_0	5.60	12.40	16.83	17.19	24.58
M_1	7.74	15.61	19.22	14.13	21.70
M_2	9.14	17.86	21.13	13.22	20.68
S.Em.±	**0.062**	**0.033**	**0.042**	**0.045**	**0.061**
C.D.@ 5%	**0.183**	**0.097**	**0.123**	**0.133**	**0.180**

Table.3 Effect of mulch on Fruit characters

Treatment **Mulching (M)**	**Fruit length (cm)**	**Fruit Diameters (cm)**	**Average weight of fruit (g)**
M_0	7.53	0.80	3.59
M_1	8.21	0.85	4.33
M_2	8.74	0.88	4.49
S.Em.±	**0.051**	**0.005**	**0.042**
C.D.@ 5%	**0.149**	**0.016**	**0.125**

Table.4 Effect of mulch on yield and quality characters

Treatment **Mulching (M)**	**Number of fruits plant^{-1}**	**Fruit yield Plant^{-1} (g)**	**Fruit yield Plot^{-1} (kg)**	**Total soluble solids (°Brix)**	**Ascorbic acid content (mg/100 mg)**
M_0	138.33	579.22	8.99	2.38	227.22
M_1	145.75	665.50	10.61	1.84	258.46
M_2	155.25	744.14	11.82	1.60	269.07
S.Em.±	**0.451**	**4.182**	**0.047**	**0.068**	**2.079**
C.D.@ 5%	**1.330**	**12.350**	**0.140**	**0.201**	**6.136**

Table.5 Effect of mulch on weeds

Treatment Mulching (M)	Weeds fresh weight (g)	Weeds biomass (g)	Water use efficiency (kg ha^{-1} mm) (kg)
M_0	41.49	11.48	3.11
M_1	7.26	2.19	4.24
M_2	8.40	2.41	4.97
S.Em.±	**0.074**	**0.056**	**0.030**
C.D.@ 5%	**0.217**	**0.165**	**0.089**

Table.6 Effect of mulch on Soil moisture depletion pattern(%) and Variation in soil temperature at different stage

Treatment	Soil moisture depletion pattern (%)		Soil Temperature at different stage (˚C)		
Mulching (M)	**Fruit maturity stage (0- 15 cm depth)**	**Fruit maturity stage (15- 30 cm depth)**	**Vegetative phase at 30 DAT**	**Flowering initiation stage**	**Days to first harvest**
M_0	24.10	19.94	17.43	18.28	18.27
M_1	31.80	23.77	20.63	20.67	20.63
M_2	32.63	24.67	20.51	20.50	20.53
S.Em.±	**0.139**	**0.050**	**0.062**	**0.044**	**0.046**
C.D.@ 5%	**0.410**	**0.147**	**0.182**	**0.129**	**0.135**

Effect of mulch

Among mulching treatments, silver plastic mulch recorded maximum soil moisture depletion at fruit maturity stage in the depth of 0- 15cm and 15- 30 cm (32.63, 24.67), followed by black plastic mulch (31.80, 23.77) and minimum soil moisture depletion (24.10, 19.94) respectively, observed in no mulch condition (Table 6).

Among mulching treatments, black plastic mulch recorded maximum soil temperature at vegetative phase at 30 DAT, flowering initiation stage, days to first harvest (temp.) (20.63, 20.67, 20.63) respectively, followed by silver plastic mulch (20.51, 20.50, 20.53) respectively and minimum soil temperature (17.43, 18.28, 18.27) respectively, were observed in no mulch condition. It is due to using black plastic mulch increase 3.3 to 6.6 ˚C observed radiation to pass through and store in soil.

Similar results were reported by Decoteau *et al.*, (1990), Ham and Kluitenberg (1994), Tarara (2000) and Dodds *et al.*, (2003).

On the basis of present investigation, it is concluded that the chilli cv. ArkaLohit responded well in terms of morphological, phonological, yield attributing character and quality parameters.

Maximum yield the chilli crop can be silver mulch. Higher water productivity and yield can be obtained by application of silver/ black polythene mulch. To get maximum net profits, the chilli crop can be safely application of silver polythene mulch.

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