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Response of chilli (*Capsicum annuum* L.) to organic and inorganic mulches

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Abstract
A field study was conducted to evaluate the effect of different mulch materials on growth, yield and qualitative characters of chilli (cv. Bullet) from Feb to June 2013. Different mulches used were black polyethylene mulch, yellow polyethylene mulch, transparent polyethylene mulch, mango leaf, paddy straw, saw dust and sun grass and bare soil was the control. Different mulches generated higher soil temperature and moisture regimes over the control. Weed population was significantly suppressed under black polyethylene mulch. Days to 50 per cent flowering and days to first harvest were recorded at 44.93 and 46.23 days after transplanting under black polyethylene mulch as compared to rest of the treatments.. Plant height, number of primary branches per plant, number of leaves, fruit yield, average fruit weight recorded higher values under black polyethylene mulches however, it failed to have significant impact on fruit quality parameters.

Keywords: *Chilli, mulching, yield, qualitative traits*

Introduction

Chilli (*Capsicum annuum* L.) is an important vegetable crop and belongs to the family Solanaceae. Chilli is widely cultivated throughout tropical and subtropical zones and is native to Mexico. In West Bengal, chilli is cultivated round the year. The growth and development of this crop is influenced by many edaphic factors but optimum soil temperature and moisture are the two most crucial inputs. Water deficit often limits the crop growth and development. Young chilli seedlings cannot withstand either water deficit or excess soil moisture while older plants can withstand deficit or excess water (Ayoub, 1986). Similarly, heavy rains too pose a constraint as the plants are incapable of tolerating too damp a situation or submergence. In the winter, production is hampered due to lack of irrigation as well as minimal 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 improve the productivity of crops where either water deficiency or excess frequently occurs, proper water management is necessary (Hale and Orcutt, 1987).During the summer months, 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.

Organic mulch (plant materials) and synthetic mulches (plastic of different colours) are widely used in vegetable production for their efficacy to conserve soil moisture by altering water distribution between soil evaporation and plant transpiration, and modifying soil temperature. Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and checks the water evaporation. Thus, it facilitates better retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Dilipkumar et al., 1990).The present study was undertaken to evaluate the changes in temperature and soil moisture and to evaluate the growth, yield and quality of chilli under humid tropical conditions grown under different mulch materials.

Materials and Methods

The field experiment was laid out during Feb to June 2013 at Agricultural experimental farm of Calcutta University at Baruipur, 24- Parganas (South). The soil was uniform, fertile medium texture, clay loam having pH 6.4. The experiment was laid out in a randomized block design (RBD) having three replications. The seeds were sown in challi pots on 2nd December, 2012. Before sowing, the seeds were treated with Bavistin @ 2g/kg seeds to check the damping off, to enhance germination and to get a healthy crop stand. The experimental land was ploughed and cross ploughed 2 to 3 times. Split application of NPK was applied @ 50:25:25 kg/ha. Full dose of phosphorus, potassium and one third of nitrogen were applied after preparation of pits. The remaining nitrogen was applied in 2 split doses successively at one month interval from transplanting. Mulched layers were placed before transplanting and an "x" cut was given at a spacing of 45 x 45 cm, to accommodate ten plants per plot. After 45 days, transplanting was carried out in the mulched field. Requisite cultural practices in form of timely irrigation, weeding and pesticides application were done. When the plants attained an optimum height, bamboo stakes were tied to support the crops for proper stand. The data were recorded on five randomly selected plants in each plot for the entire morphological feature, and yield attribute characters as well as estimation of

some qualitative parameters. For qualitative characters the observations were recorded from composite samples of five fruits in each plot.

To study the qualitative parameters like total chlorophyll content of leaves and ascorbic acid content was done following the method of Arnon and Witham (1949 and 1971) and Rangana (1986).

Data collected on various parameters were statistically analysed (Panse and Sukhante, 1978) to evaluate the treatment effects on morphological traits, yield and qualitative performance of chilli.

Data on weed counts were collected from each plot of all replicates. For weed count half square meter area (0.5m x 0.5 m) was fixed randomly before emergence of weeds. Total amount of weeds growing within the area were weighed on fresh weight basis. These observations were recorded 45 days after transplanting.

Data on soil temperature was measured by use of Fisher band bimetal dial thermometer. Thermometers were installed between rows in centre of one replication of each treatment at 10 cm depth. The temperatures in °C were recorded daily for maximum at 2.30 hrs. Soil moisture estimation was carried out through gravimetric method.

Results and Discussion

Organic as well as synthetic mulches significantly increased the plant height, number of primary branches per plant, leaf area and fruit yield over the control (Table 1and Table 2). The effect of synthetic mulches was more pronounced on fruit yield than the organic mulches. Higher fruit yield under black polyethylene was ascribed to favourable and integrated effect of moderation in hydrothermal regime that enhanced the root growth for better uptake of water nutrients and lesser weed population thus producing better height and plant spread (Munguia *et al.* 1998 and Gollifer 1993).

Minimum days to 50 percent flowering (44.93 days) and days from fruit set to fruit maturity were observed in plants grown under black polyethylene mulch. Organic mulches and unmulched ones exhibited delayed 50 percent flowering. It is well known fact that mulches create favourable condition such as higher temperature, conserves soil moisture and reduces weed population, which accelerates plant growth and early flowering. Similar findings were reported by Vos and Sumarmi (1997).

Estimation of important qualitative components viz, total chlorophyll content of leaf (mg/g) and ascorbic acid content (mg/g) were done as depicted in Table3. Chlorophyll is one of the major chloroplast components for photosynthesis and relatively higher chlorophyll content (stay green) had a positive relationship with photosynthesis (Shangguan *et al.*, 2000). In chilli, mulching with black polyethylene exhibited higher total chlorophyll content with respect to other treatments followed by yellow polythene mulch and mango leaf mulch. Least chlorophyll content was observed in transparent polyethylene mulch. Similar to present findings, earlier Bahadur *et al.*(2009) observed significant increase in chlorophyll content. An optimum soil moisture and hydrothermal soil regime with relative water content might have contributed for improved physiological attributes of plant under mulched condition.

Ascorbic acid content of fruit was least affected by different mulch materials.

Dry weight content of weed (g/m²)

The dry weight of weeds per plot was significantly influenced by different mulch materials (Table 4). The average dry weight of weed was least under black polyethylene mulch. Transparent polyethylene mulch showed higher dry weight of weed among the mulches. Straw mulch was also found to be most effective in controlling weed growth as compared to other organic mulches and control (Singh, 1994 and Srivastava *et al,* 1994).

Soil temperature (°C)

Soil temperature at 10cm depth (Fig-1) was markedly influenced by different mulch materials. The maximum increase in soil temperature at noon was observed under transparent polyethylene mulch (1.98°C to 3.23°C). Increase in soil temperature under transparent polyethylene mulch is attributed to its greenhouse effect (Hanks *et al.* 1961, Mahrer *et al.*, 1984). It has been observed that transparent mulch permits the incoming short wave radiation to pass through but its transmissivity to long wave radiation is highly reduced due to formation of water droplets on its lower surface. These observations are in accordance to the findings of Gupta and Acharya (1993) and Ashworth and Harrison (1983). Organic mulches lowered the soil temperature by 0.75°C to 2.74°C. The decrease in soil temperature under such vegetative mulches is partially due to their higher albedo (not measured) partially due to greater conservation of solar energy into evaporative flux and increase in diffusion path of heat transfer to the soil (Gupta and Acharya 1993).

Soil moisture (per cent)

Maximum soil moisture content (Fig 2) during the cropping season was recorded under black polyethylene mulch which conserved 18.34 percent higher moisture level than control, followed by yellow and transparent mulch. Increased soil moisture in the synthetic mulch treatments might be due to increased infiltration capacity, reduced atmospheric losses from soil surface and increased resistance to vapour transfer from soil surface to the atmosphere. Among the organic mulches, paddy straw was found most effective followed by mango leaf. It is an established fact that mulching the soil surface with vapour barrier or with reflecting materials can reduce the intensity with which external factors such as radiation and wind act upon the surface. Similar findings were observed by Srivastava *et al.* (1984). Beneficial effect of organic mulches in reducing evaporation as reflected by

Table 1. Effect of different mulch materials on morphological traits of chilli (*Capsicum annuum*, L. var. Bullet

Treatments	Plant height (cm)	Number of Primary branches per plant	Total number of leaves per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Days to 50 percent flowering	Days from fruit set to fruit maturity
T_1	57.50	4.61	260.25	8.26	3.49	13.25	44.93	46.23
T_2	54.73	4.33	252.10	7.85	3.07	12.85	49.60	49.83
T_3	56.00	4.60	259.46	8.11	3.40	13.22	46.66	46.89
T_4	54.10	4.33	252.21	7.99	3.08	13.10	49.00	49.00
T_5	53.46	4.26	255.33	7.99	3.34	13.13	48.66	47.93
T_6	54.23	3.66	249.43	7.73	3.06	12.59	51.33	50.43
T_7	53.16	3.66	243.70	7.58	3.14	12.66	53.13	50.00
T_8	48.70	2.66	225.76	7.44	2.99	12.84	56.73	54.23
C.D. at 5%	2.53	0.89	6.51	NS	0.32	NS	3.56	3.43

Note: T1-Black polyethylene mulch, T2-Mango leaf mulch, T3-Yellow polyethylene mulch, T4-Paddy straw mulch, T5-Transparent polyethylene mulch, T6-Saw dust mulch, T7-Grass mulch, T8- Control (without any treatment).

Table 2. Effect of different mulch materials on fruit characters and yield of chilli (*Capsicum annuum* L. Var. Bullet

Treatments	Number of fruits per plant	Individual fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Pedicel length (cm)	Average fruit weight per plant (g)
T_1	47.51	3.38	3.75	3.44	2.76	152.23
T_2	42.53	3.22	3.37	3.25	2.37	139.58
T_3	44.73	3.33	3.65	3.36	2.47	144.82
T_4	43.73	3.31	3.38	3.35	2.27	140.78
T_5	44.03	3.32	3.58	3.31	2.63	142.02
T_6	41.00	3.22	3.37	3.31	2.51	130.36
T_7	41.66	3.21	3.25	3.14	2.36	129.50
T_8	32.60	3.19	3.23	3.15	2.26	107.41
C.D. at 5%	1.82	NS	NS	NS	NS	14.40

Note: T1-Black polyethylene mulch, T2-Mango leaf mulch, T3-Yellow polyethylene mulch, T4-Paddy straw mulch, T5-Transparent polyethylene mulch, T6-Saw dust mulch, T7-Grass mulch, T8- Control (without any treatment).

Table 3. Effect of different mulch materials on qualitative characters of chilli (*Capsicum annuum* L. Var.Bullet

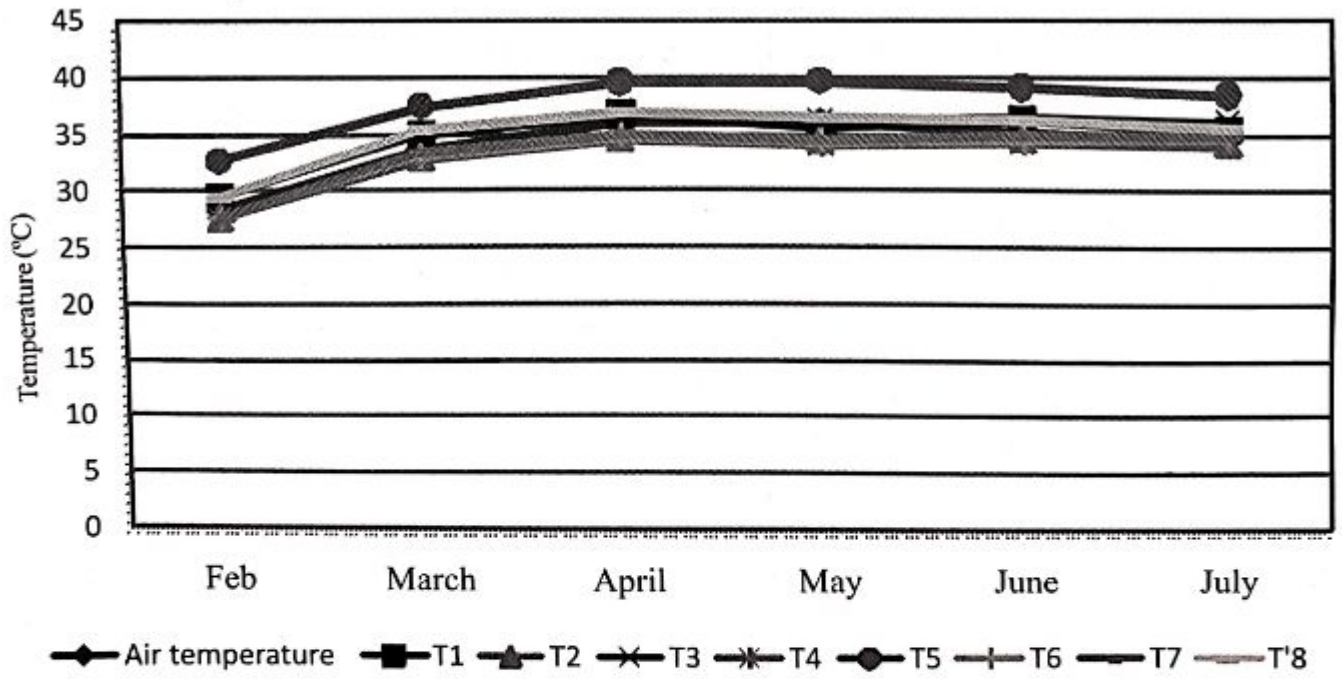
Treatments	Total chlorophyll content of leaf (mg/g)	Ascorbic acid content (mg/g)
T_1	1.04	102.86
T_2	0.87	101.46
T_3	0.88	102.30
T_4	0.78	101.80
T_5	0.64	102.50
T_6	0.73	101.54
T_7	0.76	101.68
T_8	0.75	101.69
C.D. at 5%	0.10	NS

Note: T1-Black polyethylene mulch, T2-Mango leaf mulch, T3-Yellow polyethylene mulch, T4-Paddy straw mulch, T5-Transparent polyethylene mulch, T6-Saw dust mulch, T7-Grass mulch, T8- Control (without any mulch).

Table 4. Effect of different mulch materials on weed populations of Chilli (*Capsicum annum* L. var., Bullet

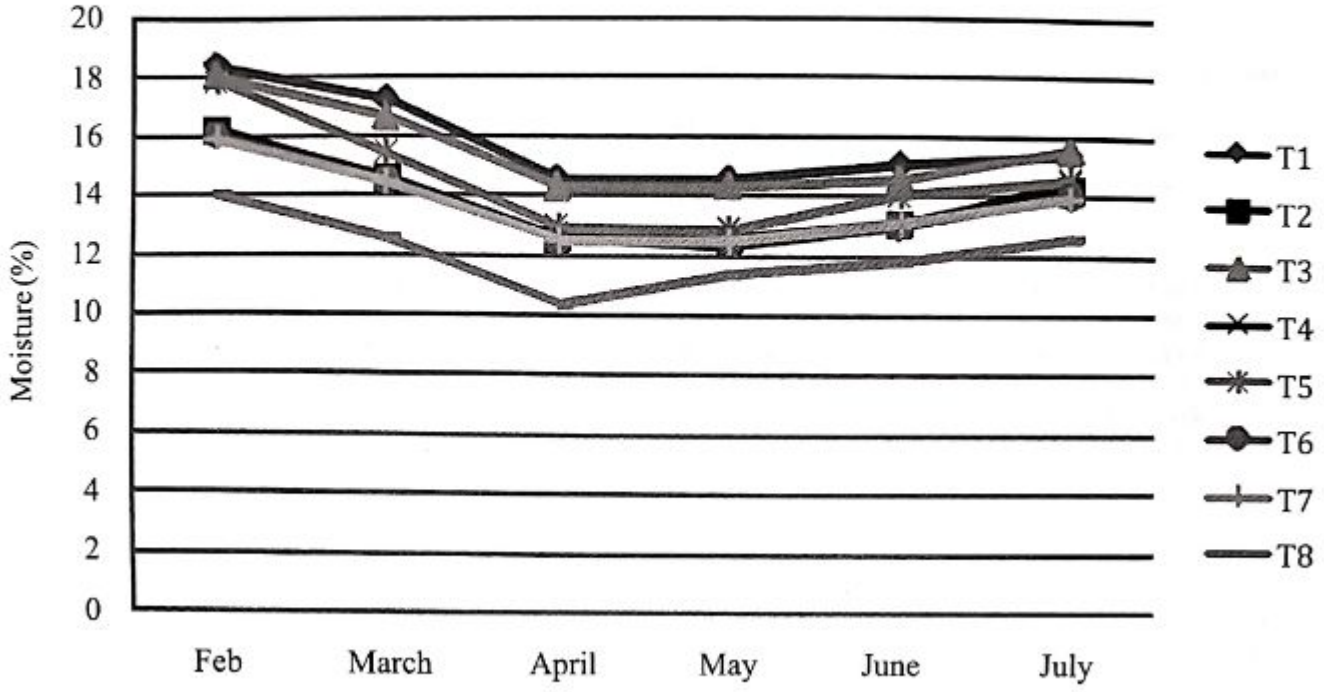
Treatments	Weed content (g)
T_1	16.62
T_2	20.90
T_3	17.62
T_4	20.26
T_5	30.93
T_6	22.23
T_7	22.00
T_8	43.83
C.D. at 5%	2.21

Note: T1-Black polyethylene mulch, T2-Mango leaf mulch, T3-Yellow polyethylene mulch, T4-Paddy straw mulch, T5-Transparent polyethylene mulch, T6-Saw dust mulch, T7-Grass mulch, T8- Control (without any mulch).



T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3- Yellow polyethylene mulch, T_4- Paddy straw mulch, T_5- Transparent polyethylene mulch, T_6- Saw dust mulch, T_7- Sun grass Mulch, T_8- Control (without any mulch).

Fig.-1:- Mean monthly Soil Temperature at 10 cm depth under different mulch materials and unmulched control in Chilli (*Capsicum annuum* L.), cv. Bullet.



T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3. Yellow polyethylene mulch,
T_4. Paddy straw mulch, T_5. Transparent polyethylene mulch, T_6- Saw dust mulch,
T_7- Sun grass mulch, T_8. Control (without any mulch).

Fig-2: - Soil Moisture content (%) at 15 cm depth under different mulches and unmulched control in Chilli (*Capsicum annuum* L.), cv. Bullet.

increased moisture storage in soil has also been reported by various workers (Sterk and Spaan. 1997).

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