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Effect of different colour mulches on the growth and yield of tomato under Chhattisgarh region

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ABSTRACT

Field experiment was carried out in the experimental field of Horticulture department, IGKV, Raipur (Chhattisgarh) during the year 2003-2006. The experiment was laid out in Randomized Block Design with four treatments i.e. 1) Red plastic mulch, 2) Black plastic mulch, 3) White plastic mulch and 4) Surface irrigation without mulch was treated as control (recommended cultivation). The experiment was laid out to assess their importance as mulching component in Tomato cultivation. The study revealed that drip irrigation with red plastic mulch of 25-micron thickness showed superior yield and yield attributing characters as compared to other mulched treatments. The yield of tomato in red plastic mulch, black plastic mulch, white plastic mulch and control plots were 335.75, 324.62 312.18 and 230.72 q/ha respectively. These results showed that the red, black and white plastic mulch increased the yield of tomato by 45.52, 40.06 and 35.30 % respectively over the control. The vegetative growth flowering and quality parameters were best under red-mulched plants as camped to control. Water use efficiency and water savings were found to be highest under red plastic mulch and lowest under non-mulch condition. The net income was recorded higher under red plastic mulch (Rs.85800) and lowest in without plastic mulch (Rs. 38020). Similarly benefit cost ratio was also recorded most economical in red plastic mulch as compared to non-mulch condition.

INTRODUCTION

Population explosion and shrinking of available land for horticultural; there is an urgent need to enhance the productivity and quality of fruits and vegetables. Generally consumers do not prefer poor quality produce, which fetches less price in the market. Hence, protected cultivation like mulching, green house, low tunnel, high density planting etc. is one of the best alternative to raise the high quality vegetables, fruits as well as off season crops. Covering of the plant basin with organic waste materials, black polyethylene strips or emulsions is termed as mulching. Mulch is a material spread in the field to cut off direct sun to soil. Mulching reduces the water evaporation by interfering the radiation falling on the soil surface and thus delays the drying of the soil and reduces the soil thermal regime during the day time. It also reduces the weed population and improves the microbial activity of the soil by improving the environment around the root zone. Continuous use of mulches is helpful in improving the organic matter content of the soil, which in turn improves the water holding capacity of the soil.

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Many times the farmers loose the entire crop in Rabi and summer due to inadequate irrigation facility. It is therefore, necessary to minimize the losses due to evaporation and to conserve the moisture. Evaporation from soil is mainly due to the degree of saturation of soil surface, temperature of air and soil, humidity and wind velocity. Several factors are greatly influenced only by the vegetative cover. Therefore, the only way to conserve the moisture in such conditions is to spread mulch over the crop area. However, it is today's needed to find out the proper mulch. Extra investment over mulch must be compensated by additional crop yield. Therefore, the experiment was planned in 2003-2006 to study the effect of different colored mulches like red, black and white on the growth and yield of tomato.

MATERIALS AND METHODS

A field experiment was undertaken to observe the effect of different colour mulches on the growth and yield of tomato (F1-Hybrid Avinash-2) against without mulch. This experiment was conducted at PFDC, Horticulture Farm, IGKV, Raipur, which is situated in the central part of Chhattisgarh in India. In this location the mean minimum and maximum temperature ranges from 6.5°C to 25°C and 26°C to 48°C respectively and relative

humidity ranges from 21 to 51% and 53 to 73% respectively. The experimental site has sandy-loam soil and falls under the semiarid zone. The properties of the soil such as field capacity, wilting point, bulk density and soil depth were determined by usual standard methods. The moisture content was taken at 0.15, 0.30 and 0.45 m depths of soil in each plot. The experimental plots of 8 x 2m were prepared for transplantation of the seedlings of tomato. The row-to-row and plant-to-plant spacing were 0.60 and 0.45 m respectively. The different colour mulches of 25-micron thickness like red, black and white was cut as per the size of the plots.

Recommended cultural practices were followed in raising the crops. The observations were recorded on 10 randomly selected plants in each replication on 18 quantitative characters., viz. plant height, number of primary branches, days to appearance of the first flower, days required to 50% flowering, number of flower per cluster, number of fruits per cluster, stem thickness, diameter of fruits, number of locules, pericarp thickness, specific gravity, total soluble solids, acidity, juice percentages, moisture percentage, dry matters, number of fruits per plant, weight of fruits and yield. The mean values obtained were used for estimating analysis of critical difference. These investigations were carried out using four treatments with five replications. Treatments were tested in random black design. The details of four treatments are given below:

T1 = Red plastic mulch
T2 = Black plastic mulch
T3 = White plastic mulch
T4 = Control (Recommended cultivation)

Reference crop evapotranspiration (ET_0) was calculated using Modified Penman Method (Doorenbos and Pruitt, 1977). The crop co-efficient (Kc) for different growth stages of Tomato was selected .The actual crop evapotranspiration was estimated by multiplying reference crop evapotranspiration, crop co-efficient, area under each plant and wetting fraction. The crop water requirement of Tomato crop was estimated by using the following equation:

$$V = ETo \times Kc \times Ap - Ap \times Re$$

Where,
V = Net depth of irrigation (litre/day/plant)
ETo = Reference crop evapotranspiration (mm/day)
Kc = Crop co-efficient
Ap = A x W = Effective area to be irrigated (Sq.m)
A = Area allocated to each plant (Sq.m)
W = Wetting fraction (0.3-0.5 for fruit crop
Re = Effective rainfall (mm/day).

The water requirement was estimated for the growing season of Tomato. Daily time of operation of drip irrigation system was worked out. Drip irrigation was scheduled on alternate days; hence total quantity of water delivered was cumulative water requirement of two days minus effective rainfall (if rain occurred).

The lateral lines of 12 mm diameter LDPE pipes were laid along the crop rows and each lateral served each row of crop. The laterals were provided with 'in line' emitters of 4 lph discharge capacity in such a manner that water emitting out of emitter wet the entire root zone of the plant. HDPE pipes of 75 mm diameter were used for main and 50 mm diameter was used for sub-main lines. The main line was directly connected to a 5-HP centrifugal pump installed to lift water from the tank. The manifold unit consisted of a screen filter, pressure gauge and control valve. The duration of delivery of water to each treatment was controlled with the help of gate valves provided at the inlet end of each lateral. In case of surface irrigation, irrigation was scheduled at weekly interval. The cumulative depth of water required for seven days was estimated and supplied to each plant. The water (through surface method of irrigation) was directly applied in the furrow with the help of PVC pipes.

Benefit-cost analysis was carried out to determine the economic feasibility of using drip irrigation. The cost of drip irrigation system includes depreciation, prevailing bank interest rate, repair and maintenance of the system. The interest rate and repair and maintenance cost of the system were 12 and 1% per anum of the fixed cost respectively. The useful life of drip system was considered to be 10 years. The cost of cultivation includes expenses incurred in field preparation, cost of seedlings, fertilizer, weeding, crop protection measures, irrigation water and harvesting with labour charges. The income from produce was estimated using prevailing average market price as Rs. 400, 390, 385 and 375 per quintal for red, black, white mulch and control respectively as per the quality of the fruits. The benefit–cost ratio, total cost of production and net return from cultivation of Tomato over 1 ha were then estimated.

RESULTS AND DISCUSSION

The observations on vegetative growth and quality parameters of tomato in each plot were taken in order to know the effect of individual mulch. The field capacity, wilting point and bulk density of the existing sandy-loam soil were observed as 39.28%, 18.47% and 1.28 gm/cc respectively. The soil depth was 0.15m to 0.45m. The average soil moisture content before irrigation of 35.38, 30.71, 29.94 and 24.58% were observed in red, black, white plastic mulch and control respectively. The results obtained from the study are discussed below:

Table 1 and Fig. 1 shows the various growth and flowering characters affected by different colour mulches of tomato. The data reveals that the vegetative growth

Table 1. Effect of mulches on the growth and flowering characters of tomato.

Treatment / Mulch	Plant height (cm)	No. of primary branches	Stem thickness (cm)	Days reqd. to first flowering	Days reqd. to 50 % flowering	No. of flower per cluster	No. of locules
T1 (Red)	90.74	7.31	1.87	45.18	64.13	7.02	5.17
T2 (Black)	85.54	6.22	1.40	47.35	72.25	6.73	4.76
T3 (White)	83.42	5.27	1.13	49.32	74.27	6.38	4.32
T4 (Control)	75.67	4.02	0.94	55.24	83.26	5.16	4.14
CD at 5%	4.44	0.99	0.28	3.07	5.58	0.58	0.32

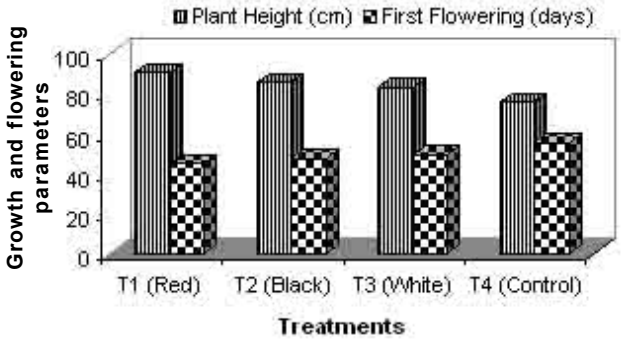

Fig. 1. Effect of different coloured mulches on the growth and flowering of tomato.

parameters like plant height (90.74 cm), number of primary branches (7.31), stem thickness (1.87), number of flowers per cluster (7.02), number of locules (5.17) were recorded maximum in treatment T1, followed by T2 and T3, whereas the same characters was obtained lowest in control treatments T4.

From the table the days required to first and 50% flowering times of each mulched plot were found nearly the same and was earlier than that in controlled plot. This increase in tomato may be due to warmness produced and conserve the moisture by mulch application and resulted in mulched plots have good vegetative growth of tomato as compared to no mulch plot. Decoteau *et al.* (4) reported that tomato plant grown over red mulch has more flowers, number of fruits, fruit fresh weight, earlier flowering and marketable yield than black and white mulch. Black and red mulch treatments produced similar temperature trends with red having less than 0.2°C cooler hourly average temperature difference than black. Chakraborty and Sadhu (2) found that among the mulch colour red polyethylene increased the plant height by 30.9% and leaf number by 42% compared with control. Early flowering, greater number of fruits per plant and larger fruit size with red polyethylene resulted in 73.3% higher yield compared with the control in tomato.

Table 2 shows that the yield of tomato in red, black, white plastic mulch and control plot were 458.75, 365.62, 312.18and 230.72 q/ha respectively. These results showed that the red, black and white plastic mulch increased the yield of tomato by 45.52, 40.06 and 35.30% respectively over control. The data also reveals that the yield and yield attributing characters like number of fruits per cluster (6.89), diameter of fruit (6.73 cm), number of fruits per plant (27.10) and weight of fruits (33.45g) under red mulch were found to be highest and same characters were lowest in control. This increase in tomato yield may be due to the better development of roots and vegetative growth (Myhre, 6), better nutrients uptake in mulched plots (Adam), and less normal leaching of nitrogen as explained by Jones *et al.* (5), Thakur *et al.* (11) reported that different mulching material like grass, lantana and plastic helped bell pepper to perform better at water deficits from 25, 50 and 75%. The plant height, leaf area, leaf area index, flower number and fruit yield were significantly maintained at higher level in mulched plants than unmulched ones up to 75% water deficit. Yield was significantly higher in plastic mulch at 25, 50 and 75% water deficit.

Table 3 and Fig-3 shows the quality parameters of tomato crop. The quality parameters like total soluble solids (6.94%), acidity (0.96%), juice (47.83%), moisture (96.76%), dry matter (9.87%), were recorded maximum in treatment T1 i.e. red mulch and the same characters were recorded lowest in control treatment T4 i.e. no mulch. Cooper compared the red plastic mulch with standard black plastic mulch in tomato and reported that the positive effect with slight increase in average fruit weight on red mulched plants. The reason also explained by Chakraborty (2).

The depth of irrigation water applied in each mulch plot and no mulch is given in Table 4. The seasonal water requirements in red, black, white plastic mulch and control plots were 58.45, 76.38, 82.23 and 105.84 cm, respectively. It is clear from the table that the red, black and white mulch saved 44.77, 27.83 and 22.30% of irrigation water respectively over control. Also seen from

Table 2. Effect of mulches on the yield and yield attributing characters of tomato.

Treatment / Mulch	No. of fruit per cluster	Dia. of fruits (cm)	Paricarp thickness (cm)	No of fruits per plant	Weight of fruits (g)	Yield (q/ha)	Increase in yield (%) over controlled plot
T1 (Red)	6.89	6.73	0.64	27.10	33.45	335.75	45.52
T2 (Black)	6.42	5.46	0.58	26.70	32.82	324.62	40.06
T3 (White)	6.11	5.30	0.51	26.11	32.27	312.18	35.30
T4 (Control)	5.04	5.04	0.44	24.60	25.32	230.72	-
CD at 5%	0.55	0.53	0.06	1.84	4.55	67.99	-

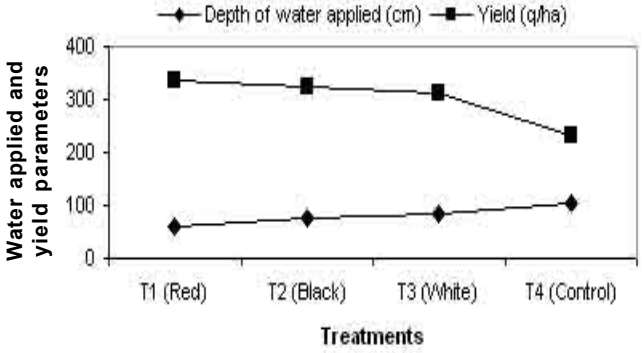

Fig. 2. Effect of different coloured mulches on the water applied and yield of tomato

Fig. 2 highest yield was observed with lowest application of water under red plastic mulch. Rajput and Singh (8), in their studies on efficacy of different mulches in conserving soil moisture in cotton, found that moisture conservation in red mulch, black polyethylene mulch and petroleum mulch were 40, 25 and 15% respectively.

The average daily pan evaporation (PE) values for a crop season were worked out for each mulched plot and are presented in Table 3. PE/MD ratio for red, black, white mulch and control plot were 1.89, 1.48, 1.35 and 1.04 respectively. PE/MD ratio was observed to be maximum as 44.97% in case of red mulch plot over control which maybe due to the fact that the retardation of evapo-transpiration was better as shown in Table 4.

The water use efficiencies of 0.57, 0.42, 0.37 and 0.21 q/ha-mm was observed in red, black, white mulch and control plots respectively. It is clear from Table 4 that the water uses efficiency was increased by 63, 50 and 43% in red, black and white mulch respectively as compared to the no mulch plot. In case of no mulch plots, low water use efficiency was observed because of high weed infestation between crop rows. Patil and Basod reported that use of black polyethylene as mulch in tomato suppressed weed growth. With the highest water application it recorded the lowest water use efficiency (Shrivastava *et al.* 10).

Table 5 shows the cost economics of tomato. The data reveals that the net income of Rs. 85,800 78,101.80, 71,689.30 and 38,020 were obtained in red, black, white mulch and control respectively. These results showed that the net income of red mulch was 2.25 times of control. The benefit cost ratio was also obtained higher under mulched treatments (1.76-red), (1.61-black) and (1.47-white) and in control the benefit cost ratio was found to be lowest (0.49). Due to poor quality of tomato vegetables in control treatment the market price was less as compared to different mulching treatments. The reason explained by Shrivanappan that drip irrigation system give a long way to solve some extent the problem of water shortage, increase the productivity/ production and bring more income to the farming community.

Table 3. Effect of mulches on the quality parameters of tomato.

Treatment / Mulch	Specific gravity	TSS (%)	Acidity (%)	Juice (%)	Moisture (%)	Dry matter (%)
T1 (Red)	1.24	6.94	0.96	47.83	96.76	9.87
T2 (Black)	2.21	6.56	0.85	44.92	94.53	9.46
T3 (White)	2.27	5.71	0.81	42.35	93.34	8.91
T4 (Control)	2.35	4.34	0.74	35.46	89.27	8.46
CD at 5%	0.37	0.81	0.07	3.75	2.23	0.43

Table 4. Effect of coloured mulch on water-conserved percentage, increase in yield and water use efficiency.

Treatment / Mulch	Actual total depth of water applied (cm)	Water conserved (%) over controlled plot	Mean daily depletion (MD) cm/day	PE/ MD ratio	Yield of tomato obtained (q/ha)	Water use efficiency (q/ha/mm)
T1 (Red)	58.45	44.77	0.456	1.89	335.75	0.57
T2 (Black)	76.38	27.83	0.582	1.48	324.62	0.42
T3 (White)	82.23	22.30	0.638	1.35	312.18	0.37
T4 (Control)	105.84	-	0.828	1.04	230.72	0.21

Mean daily pan evaporation (PE) = 0.862 cm/day

Table 5. Cost economics of tomato experiment.

S.No.	Particular/Treatment	T1	T2	T3	T4
1.	Fixed costa. Cost of system	80,000	80,000	80,000	-
	b. Life (yrs.)	10	10	10	-
	c. Depreciation	8000	8000	8000	-
	d. Interest cost @ 12 %	9600	9600	9600	-
2.	Operation coste. Repair & Maintenance @ 1%Including labour charge	800+600	800+600	800+600	-
3.	Total of operational cost (Rs.)	19000	19000	19000	-
4.	a. Cost of cultivation	17000	17000	17000	17000+8000*
	b. Cost of mulching	12500	12500	12500	-
5.	Total cost of cultivation (Rs.)	48500	48500	48500	25000
6.	Yield (q/ha)	335.75	324.62	312.18	230.72
7.	Selling price (Rs./q.)	400	390	385	375
8.	Income from produce (Rs.)	134300	126601.80	120189.30	86520
9.	Net income (Rs.)	85800	78101.80	71689.30	38020
10.	Benefit-Cost ratio	1.76	1.61	1.47	0.78

* Due to surface irrigation labour charges extra for weeding, fertilizer, application of water through labours etc.

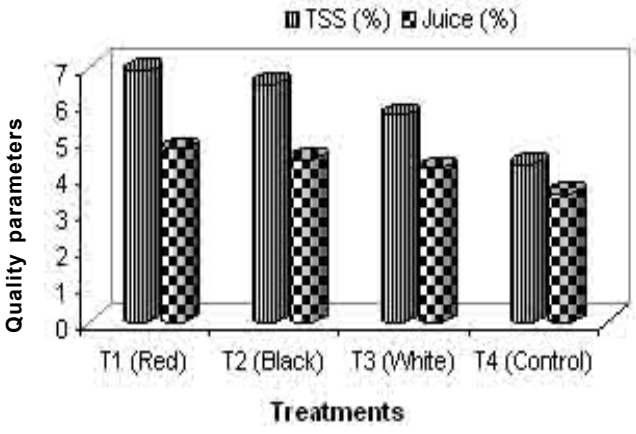

Fig. 3. Effect of different mulches on the quality of tomato.

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