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## Effect of plastic mulches on the yield, soil temperature and soil moisture of tomato crop (*Solanum lycopersicum*)

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### Abstract

A field experiment was conducted on tomato (*Solanum lycopersicum*) at University of Agricultural Sciences, Raichur during (December-April) 2015-16, in a split plot design with three replications. This study investigated the combined effects of drip irrigation and mulches on number of branches per plant, soil temperature and soil moisture. The treatments of the study comprised different combinations of three drip irrigation levels (120, 100, 80 and 60 per cent of crop water requirement ET) and three mulches (white on black, silver on black and black). The use of polyethylene mulch in vegetable cultivation has increased in the last 15 years. It prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface. In this manner it plays a positive role in water conservation. Results of the study indicated the maximum number of branches per plant (19.17) were recorded under drip irrigation at 80 per cent ET with white on black plastic colour mulch as compared to other treatments in the experiment. The soil temperature under black plastic colour mulches was higher (3.69°C more) and also the soil moisture was higher in plastic coloured mulches compared to control plots.

**Keywords:** Plastic mulches, soil temperature, soil moisture, *Solanum lycopersicum*

### Introduction

As the world becomes increasingly dependent on the production of irrigated lands, irrigated agriculture faces serious challenges that threaten its suitability. It is prudent to make efficient use of water and bring more area under irrigation through available water resources. This can be achieved by introducing advanced and sophisticated methods of irrigation and improved water management practices (Zaman *et al.*, 2001) [6]. It is prudent to make efficient use of water and bring more area under irrigation through available water resources. Drip irrigation in combination with mulch is one of the best irrigation methods, which can improve the water management practice significantly. Any material spread on the surface of soil to protect it from rain drop, solar radiation or evaporation is called mulch. Different types of materials like wheat straw, rice straw, plastic film, grass, wood, sand, etc. are used as mulch (Khurshid *et al.*, 2006) [4]. Mulch provides a better soil environment, moderates soil temperature (Sarkar and Singh, 2007) [5], increases soil porosity and water infiltration during intensive rain (Glab and Kulig, 2008) [2], and controls runoff and soil erosion (Bhatt and Khera, 2006) [1].

Tomato (*Solanum lycopersicum*), native of South America is most widely grown vegetable crop in the world as well as in India. It is one of the most popular and widely grown vegetable in the world ranking second in importance. The present study was planned to evaluate the effect of mulch and amount of water on the yield of tomato under drip irrigation system and to assess the economic feasibility in relation to mulch used in tomato production. Keeping the above facts in consideration, a field trial was conducted at research plot, College of Agricultural Engineering, Raichur.

### Material and methods

A study was done to observe the effect of different plastic colour mulches on the growth and yield of tomato (F1-Hybrid US-800) against without mulch. This experiment was conducted at UAS-Raichur in 2015-2016, which is situated in Karnataka of India. The treatments were tested in split plot design with three replications. Each experimental plot has 16 beds. The main treatments were I<sub>1</sub>- Water application at 60 per cent ET using drip irrigation, I<sub>2</sub>- Water application at 80 per cent ET using drip irrigation, I<sub>3</sub>-Water application at 100 per cent ET using drip irrigation and I<sub>4</sub>- Water application at 120 per cent ET using drip irrigation and sub treatments were M<sub>0</sub>-Without mulch (control), M<sub>1</sub>-White on black plastic mulch, M<sub>2</sub>-Silver on black plastic mulch and M<sub>3</sub>-Black plastic mulch.

**Main treatments**

- I<sub>1</sub>: Irrigation at 60 per cent ET using drip irrigation  
 I<sub>2</sub>: Irrigation at 80 per cent ET using drip irrigation  
 I<sub>3</sub>: Irrigation at 100 per cent ET using drip irrigation  
 I<sub>4</sub>: Irrigation at 120 per cent ET using drip irrigation

**Main treatments****Sub treatments**

- M<sub>0</sub>: Without mulch  
 M<sub>1</sub>: White on black plastic mulch  
 M<sub>2</sub>: Silver on black plastic mulch  
 M<sub>3</sub>: Black plastic colour mulch

The experimental plots of 5 m x 1m were prepared for transplantation of tomato seedlings. The row-to-row and plant-to-plant spacing were 0.60 and 0.45 m respectively. The different plastic coloured mulches of 30-micron thickness like white on black, silver on black and black were cut as per the size of the plots. The data recorded of tomato crop was Number of branches per plant, Soil temperature and soil moisture. Five plants were tagged at random in each treatment for recording the number of branches at an interval of 30 days from the date of transplanting. Number of branches was counted at 30, 60, 90 and 120 days after transplanting (DAT). Soil temperature was recorded in the afternoon time. The soil temperature was measured using thermometer at surface and at 10 cm depth with mulch and without mulch treatments. The atmospheric temperature was also recorded simultaneously. The moisture content in the soil sample in different level of irrigations was determined at 10 cm depth before irrigation. The samples were collected at 30, 60, 90 and 120 DAT using standard procedure. Gravimetric method was used to determine the soil moisture.

**Results and discussion****1. Number of branches per plant**

The data on number of branches per plant at 30, 60, 90 and 120 DAT as influenced by different drip irrigation levels and plastic colour mulches and their interaction are presented in Table 1 (a), 1(b)) and in Fig. 1.

Significantly among irrigation levels, maximum number of branches (17.29) were recorded under the treatment drip irrigation with 80 per cent of ET followed by drip irrigation with 100 per cent ET (16.49) respectively. Due to effect of plastic mulch colours, maximum number of branches were observed in treatment, white on black plastic colour mulch (17.41) followed by silver on black plastic colour mulch (16.54) at different dates i.e. 30, 60, 90 and 120 DAT respectively. As regards of interaction effect significantly maximum number of branches was recorded in treatment of

drip irrigation with 80 per cent ET in combination with white on black plastic colour mulch (19.17) at 120 DAT.

**2. Soil temperature**

The weekly average soil temperature at the surface during the afternoon time under with and without mulch along with weekly atmospheric temperature were recorded (Table 2), (Fig. 2) and (Fig. 3).

It can be inferred that the average soil temperature recorded in afternoon hours at ground surface level was 33.91<sup>0</sup>C against atmospheric temperature of 32.75<sup>0</sup>C. The highest average soil temperature was observed in black plastic mulch treatment throughout the crop season (36.44<sup>0</sup>C) followed by silver on black mulch (35.46<sup>0</sup>C) and finally white on black plastic mulch (35.00<sup>0</sup>C) compared to atmospheric temperature of 32.75<sup>0</sup>C.

It also can be inferred that the average soil temperature recorded in afternoon hours at ground surface level was higher by 1.16<sup>0</sup>C compared to atmospheric temperature. The highest average soil temperature was observed in black plastic mulch treatment throughout the crop season (3.69<sup>0</sup>C more) followed by silver on black mulch (2.71<sup>0</sup>C more) and then by white on black plastic mulch (2.25<sup>0</sup>C more) compared to average atmospheric temperature. These are in line with the findings of Kayla Snyder, *et al.*, 2015 [3].

**3. Soil moisture**

The soil moisture study was undertaken to know the effects of volume of water applied under different levels of drip irrigation and plastic colour mulches on soil moisture availability at crop root zone at 30, 60, 90 and 120 DAT (Table 3).

The results indicated that variation in soil moisture availability was significantly influenced by different irrigation levels compared to control plots (without mulch). The variation in soil moisture due to effect of plastic mulches was significantly same, only moisture content with and without plastic colour mulch (bare soil) showed difference.

Among the interaction effects at 30 DAT in the treatment drip irrigation with 120 per cent of ET in combination with white on black plastic colour mulch (18.08) recorded the maximum soil moisture content followed by black plastic colour mulch with 120 per cent of ET (18.02). Later 90 DAT, the treatment drip irrigation with 120 per cent of ET in combination with white on black plastic colour mulch (18.33) recorded the maximum soil moisture content. Finally, 120 DAT, the treatment drip irrigation with 120 per cent of ET in combination with white on black plastic colour mulch (17.28) recorded the maximum soil moisture content.

**Table 1(a):** Effect of different irrigation levels and plastic colour mulches on number of branches per plant

Treatment	30 DAT					60 DAT				
	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	Mean	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	Mean
I <sub>1</sub>	6.72	7.22	7.17	6.98	7.02	9.52	11.12	10.82	10.40	10.46
I <sub>2</sub>	7.60	8.43	7.65	6.80	7.62	11.62	13.15	12.28	11.50	12.14
I <sub>3</sub>	6.88	7.63	7.41	7.12	7.26	11.23	12.17	10.93	11.00	11.33
I <sub>4</sub>	6.66	6.72	7.18	6.79	6.84	9.67	10.83	10.85	10.38	10.43
Mean	6.96	7.50	7.35	6.92		10.51	11.82	11.22	10.82	
		SEM ±		CD at 5 per cent		SEM ±		CD at 5 per cent		
Main treatment		0.10		0.35		0.28		0.98		
Sub treatment		0.09		0.27		0.28		0.82		
I at same M		0.19		0.61		0.56		1.64		
M at the same or different I		0.98		2.94		1.02		3.09		

**Table 1(b):** Effect of different irrigation levels and plastic colour mulches on number of branches per plant

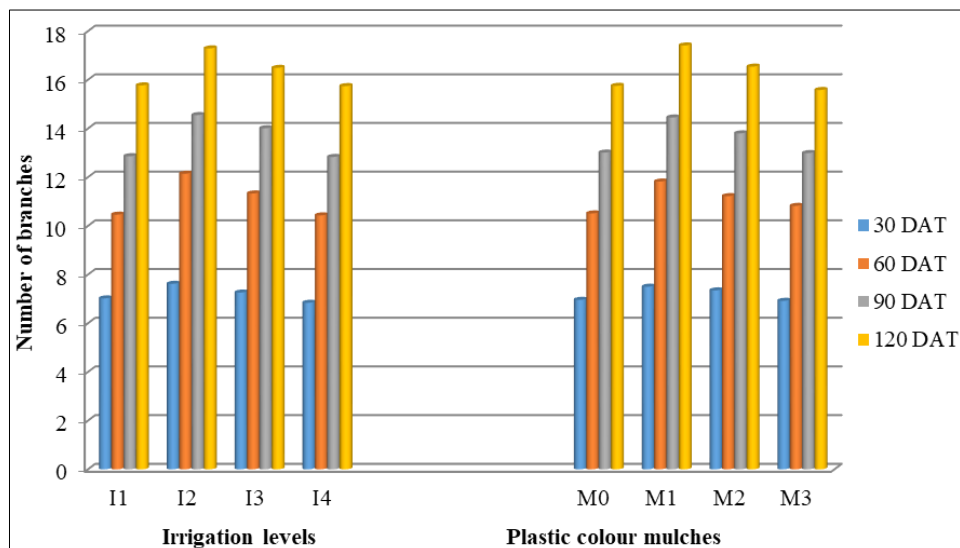
Treatment	90 DAT					120 DAT				
	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	Mean	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	Mean
I <sub>1</sub>	12.02	13.93	13.20	12.30	12.86	15.14	17.05	16.07	14.82	15.77
I <sub>2</sub>	14.06	15.81	14.84	13.48	14.55	16.39	19.17	17.34	16.24	17.29
I <sub>3</sub>	13.79	14.82	13.98	13.44	14.01	15.69	17.27	16.67	16.32	16.49
I <sub>4</sub>	11.19	13.22	13.17	12.75	12.83	15.79	16.16	16.07	14.93	15.74
Mean	13.01	14.45	13.80	12.99		15.75	17.41	16.54	15.58	
	SEM ±		CD at 5 per cent			SEM ±		CD at 5 per cent		
Main treatment	0.19		0.66			0.27		0.92		
Sub treatment	0.26		0.76			0.26		0.78		
I at same M	0.52		1.58			0.54		1.59		
M at the same or different I	1.10		3.32			1.06		3.22		

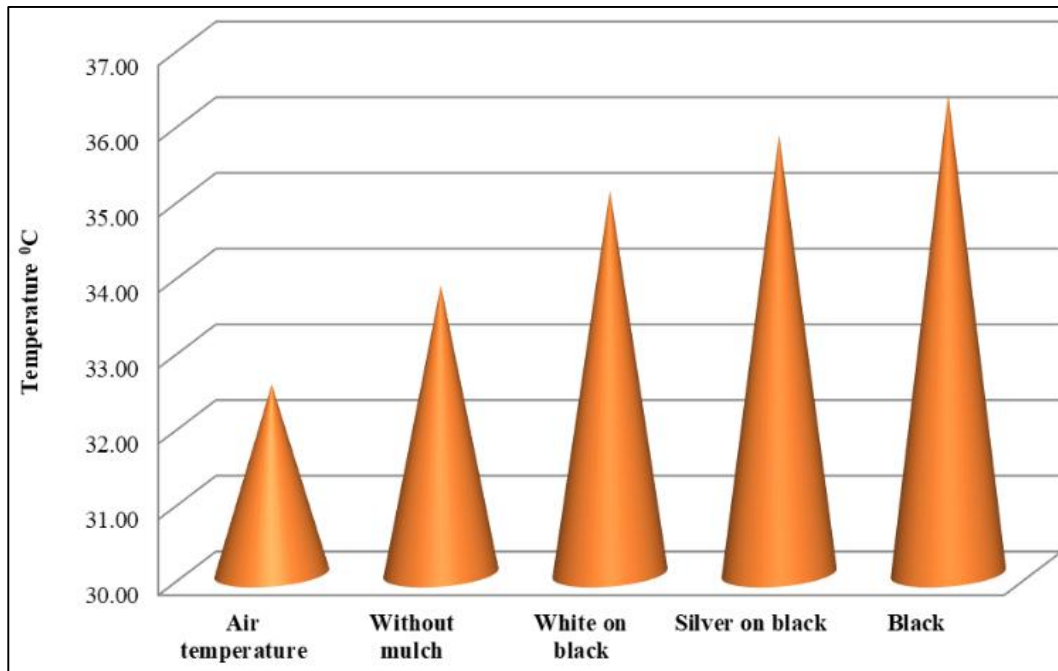
**Table 2:** Weekly average temperatures at surface level with and without plastic colour mulches during crop period

Week No. (as per calendar)	Atmospheric Air temperature (°C)	Average temperatures under different plastic colour mulches			
		M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>
45	33.03	34.23	35.33	35.68	36.53
46	32.40	33.52	34.51	34.91	35.92
47	30.31	31.42	32.35	33.00	34.43
48	31.89	33.21	34.20	34.76	35.88
49	30.90	32.08	32.90	33.46	34.47
50	32.29	33.40	34.36	34.83	35.78
51	33.01	34.00	35.61	35.84	35.99
52	31.90	33.10	34.12	34.91	35.49
1	31.60	32.72	33.77	34.49	35.45
2	30.86	31.97	34.11	33.40	34.88
3	29.60	30.92	31.90	32.47	33.45
4	32.24	33.42	34.35	34.80	36.02
5	34.97	36.08	37.01	37.51	38.15
6	34.91	35.90	37.22	37.43	38.60
7	34.67	35.99	36.67	37.68	38.67
8	37.06	38.24	39.13	39.95	41.16
9	35.10	36.21	37.41	37.64	38.67
Mean	32.75	33.91	35.00	35.46	36.44

**Table 3:** Effect of different irrigation levels and plastic colour mulches on soil moisture content at different DAT

Treatments	30 DAT				60 DAT				90 DAT				120 DAT			
	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>
I <sub>1</sub>	15.81	16.77	16.22	16.09	14.52	15.48	14.93	14.80	16.06	17.02	16.47	16.34	15.01	15.97	15.42	15.29
I <sub>2</sub>	16.42	17.86	17.63	17.16	15.13	16.64	16.35	15.88	16.67	18.18	17.89	17.42	15.62	17.13	16.84	16.37
I <sub>3</sub>	17.08	17.97	17.74	17.44	15.79	16.69	16.45	16.15	17.33	18.23	17.99	17.69	16.62	17.18	16.94	16.64
I <sub>4</sub>	17.21	18.08	17.83	18.02	15.92	16.79	16.54	16.74	17.46	18.33	18.08	18.28	16.41	17.28	17.03	17.23
Mean	16.63	17.97	17.73	17.54	15.61	16.71	16.45	16.26	17.15	18.25	17.99	17.80	16.22	17.20	16.94	16.75
	SEM		CD @5%		SEM		CD @5%		SEM		CD @5%		SEM		CD @5%	
	0.55		NS		0.40		NS		0.40		NS		0.37		NS	

**Fig 1:** Effect of irrigation levels and plastic colour mulches on number of branches at different DAT



**Fig 2:** Effect of plastic colour mulches on average soil temperature compared to atmospheric air temperature.

### Conclusions

In conclusion, the use of mulch with drip irrigation is a good option and the study indicated the maximum number of branches per plant (19.17) were recorded under drip irrigation at 80 per cent ET with white on black plastic colour mulch as compared to other treatments in the experiment. The soil temperature was higher under black plastic colour mulches (3.69°C more as compared to control plot without mulch). The soil moisture was higher under plastic coloured mulches compared to control plots as evaporation losses are minimized.

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