Original Research Article

EFFECT OF PLASTIC MULCHING AND IRRIGATION LEVELS ON YIELD OF TOMATO (*Solanum lycopersicum*)

Abstract

Plastic mulches are widely used for cultivation of vegetables. An experiment was conducted to observe the impact of plastic colour mulches on soil temperature, water use efficiency (WUE) and produce of tomato (*Solanum lycopersicum)* under drip irrigation from 2015-2016. The treatments were laid out in split plot design with three replications. The plastic coloured mulches used were white on black, silver on black and black. 60, 80, 100 and 120% evapotranspiration (ET) used as irrigation levels and a non-mulched treatment as control. Due to the interaction effects, treatment white colour on black plastic mulch with 80% ET i.e., I_2M_1 recorded the maximum yield (93.54 t ha^{-1}) followed by silver colour on black plastic mulch with 80% ET (I_2M_2) produced 87.65 t ha^{-1}. Plastic colour mulching improved production compared to bare soil. as the plants grown in white colour on black plastic colour mulch resulted 40 to 54% increase in yield compared to control treatment.

Key words: Bare soil, plastic mulch, irrigation levels, evapo-transpiration

1. Introduction

Mulching and irrigation water management is among the vital practices that are being applied in commercial vegetable production. Use of plastic mulch in agriculture known as plasticulture is becoming popular in Indian agriculture for boosting crop production. By using high yielding variety, intensive fertilizer and pesticides, the agricultural strategies today geared towards boosting crop yield through ecologically sensitive technologies and better management of water. In our country generally organic mulches are used for moisture conservation and soil temperature moderation but they have partial control over weed growth. The disadvantages of organic mulch could be explained by examples that to spread saw dust 2.54 cm deep covering 20 per cent of a hectare would require 50 m^3. An equivalent volume of plastic mulch film would more than 250 ha. Plastic colour mulch is a product similar to mulch that is used to control weeds and save water in crop cultivation. Mulching is an example of a management approach that may be utilized to boost water use efficiency (Rashidi and Keshavarzpour, 2011). Mulch's benefits in the production of vegetable crops are well recognized in general (De Pascale et al., 2011). Mulches have numerous benefits, including reduced nutrient leaching, reduced soil evaporation, increased soil moisture conservation, and weed control (Kumar and Lal, 2012). As a result of the rapid and consistent crop soil coverage, large and uniform yields are produced (De Pascale et al., 2011). As a result of the increased soil temperature, earlier harvests are also one of the most significant advantages of using plastic mulch (Hochmuth et al., 2012).

Plastic mulches also act as a barrier to prevent methyl bromide, a potent fumigant and ozone depleter, out of the soil (Ghosh and Bera 2015). Plastic mulching allows crops to grow through slits or holes in thin plastic sheets. To maximize WUE, plastic mulch is frequently utilized in conjunction with drip irrigation. It boosts plant growth by raising soil warmth and keeping soil moisture stable (Jimenez et al., 2004). However, it is now necessary to determine the correct plastic colour mulch for a specific crop. As a result, in 2015-16, an experiment was planned to investigate the influence of various plastic coloured mulches, such as black, white on black, and silver on black, on the growth and yield of tomato plants.

The present investigation was planned to assess the effect of colour mulch and yield of tomato under various irrigation levels and to analyse the economic feasibility in relation to mulch used in tomato production. It's also one of India's most popular vegetable crops, and it's well-suited to drip watering and plastic colour mulch. The impact of mulching with black plastic sheets on soil temperature and tomato productivity was studied by (Kamal and Singh 2011). When compared to bare soil, the output increased from 20.7 to 29.8% with black plastic mulch. The modifying influence of black plastic mulch on the growing environment of the crop, crop growth, and yield of cassava varieties (TMS 30572 and TMS 4(2) 1425) was investigated by (Aniekwe et al., 2004). Cassava cultivars' fresh root tuber yields were raised to 40.7 percent (TMS 30572) and 48 percent (TMS 4(2) 1425). As a result, an experiment was conducted to determine the influence of double-layered mulches on tomato crops under various conditions.

2. Material and Methods

Two-season field experiment was conducted to compare the effects of different plastic colour mulches on tomato (F1-Hybrid US-800) growth and yield against no mulch. This location is located at 16 15' N latitude and 77 20′ E longitude in Raichur Zone II region-1 of Karnataka state, at an elevation of 389 m above mean sea level (MSL). The soil in the experimental field is clay-textured, has a pH of 7.9, and has an excellent electrical conductivity (EC) of 0.98 dS m^{-1}. Three replications were used to test the treatments in a split plot design. There are 16 beds in each experimental plot. Irrigation levels (60 percent, 80 percent, 90 percent, and 120 percent ET) were the major plots, whereas varied plastic colour mulches were the sub main plots.

The seedlings of tomato were transplanted into 5 m × 1 m experimental plots. Plant-to-plant spacing was 0.60 m and row-to-row spacing was 0.45 m. The diverse plastic colour mulches of 25-micron thickness, such as white on black, silver on black, and black, were cut and spread out according to the size of the plots.

Main treatments:	**Sub treatments:**
I_1: Irrigation at 60 % ET using drip irrigation	$M_{0:}$ Without mulch condition

I_2: Irrigation at 80 % ET using drip irrigation

I_3: Irrigation at 100 % ET using drip irrigation

I_4: Irrigation at 120 % ET using drip irrigation

M_1: White on black plastic mulch

M_2: Silver on black plastic mulch

M_3: Black plastic colour mulch

Recommended cultural practices were followed during the crop growing period. Data were collected at 30, 60, 90, and 120 days after transplantation (DAT). The observations were observed on five plants in each plot that were chosen at random. The daily crop water requirement (CWR) was computed using data from the Main Agricultural Research Station (MARS)-Raichur's evapotranspiration (ET).

2.1 Assessment of crop water requirement

The water requirement of a plant was determined for drip irrigation using one of the numerous irrigation scheduling algorithms (Jadhav et al., 2002).

$$WR = \frac{A \times B \times C}{E} \qquad \ldots (2.1)$$

Where,

WR = Water requirement of a plant, (mm/day)

A = Evaporation, (mm) = Pan coefficient (0.7) × Pan evaporation

B = Amount of area covered with foliage (canopy factor), fraction

C = Crop co-efficient, fraction

E = Efficiency of drip irrigation, (considered as 90 per cent)

The water requirement for each irrigation level was calculated using the aforementioned equation, and the same was used to determine irrigation supply.

2.2 Crop *yield per plant*

The crop yield obtained from selected five plants were weighed separately. The data from these plants were averaged to workout yield per plant at once-over harvest, in kg.

2.3 Crop yield per plot

Fruits were picked plot wise, treatment wise and then weighed and stated in kg.

2.4 Crop yield per hectare

Yield per hectare was computed from the fruit yield per net plot.

2.5 Statistical analysis

The data from the observations and characters evaluated were statistically analyzed and the critical difference at the 5% level was calculated and shown wherever the results were significant. The analysis of the data was done using the Microsoft Excel software.

3. Results and Discussions

3.1 Crop yield per plant

Plastic colour mulches, irrigation levels and their interactions shown significant effect on crop yield per plant are shown in Table 1. Among the interaction effects the treatment I_2M_1 (3.90 kg) recorded the maximum yield per plant followed by I_2M_2 (3.65 kg) and I_3M_1 (3.48 kg). The minimum yield per plant was reported in I_4M_3 (2.34 kg), the other interaction effects has showed significant yield per plant. Higher soil temperature under plastic colour mulches and better thermal conductivity between soil surface and the plastic mulch resulted in increased yield per plant.

Table 1. Effect of levels of irrigations and plastic colour mulches on yield per plant (g)

Treatment	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**
I_1	2.52	2.68	2.56	2.35	2.53
I_2	2.93	3.90	3.65	3.05	3.38
I_3	2.97	3.48	3.14	2.55	3.03
I_4	2.44	2.62	2.43	2.34	2.46
Mean	2.71	3.17	2.94	2.57	
		SEM ±		CD at 5 per cent	
Main treatment		0.06		0.22	
Sub treatment		0.06		0.18	
I at same M		0.12		0.39	
M at the same or different I		0.47		1.43	

3.2 Crop yield per plot

The results of crop yield per plot due to effect of irrigation levels and plastic colour mulches were recorded as shown in Table 2. Among the interaction effects the treatment I_2M_1 (70.16 kg) recorded the maximum yield per plot followed by I_2M_2 (65.74 kg) and I_3M_1 (62.70 kg). The minimum yield per plot was recorded in I_4M_3 (42.20 kg), the other interaction effects significantly differed in case of yield per plot. Crop yield traits were higher in mulched plants due to the conservation of soil moisture content and temperature maintenance as compared to bare soil plants (Mahadeen, 2014).

Table 2. Effect of levels of irrigations and plastic colour mulches on yield per plot (kg)

Treatment	**M_0**	**M_1**	**M_2**	**M_3**	**Mean**
I_1	45.37	48.29	46.07	42.30	45.51
I_2	52.74	70.16	65.74	54.87	60.88
I_3	53.41	62.70	56.44	45.89	54.61
I_4	43.86	47.13	43.69	42.20	44.22
Mean	48.84	57.07	52.98	46.32	
		SEM ±		CD at 5 per cent	
Main treatment		1.15		3.98	
Sub treatment		1.09		3.19	
I at same M		2.18		6.73	
M at the same or different I		2.42		7.85	

3.3 Crop yield per hectare

Due to the interaction effects, treatment I_2M_1 (93.54 t ha^{-1}) recorded the maximum yield per hectare followed by I_2M_2 (87.65 t ha^{-1}) and I_3M_1 (83.60 t ha^{-1}) as shown in Table 3. The minimum yield per hectare was recorded in I_4M_3 (56.27 t ha^{-1}), the other interaction effects differed significantly in case of yield per hectare. Drip irrigation provided appropriate moisture at field capacity, better root development in terms of number and spread of roots, which facilitate luxuriant growth of plant due to better nutrient uptake resulting better fruit growth and development, ultimately higher yield. The abovementioned findings are consistent with those of Mukherjee et al., 2010.

Table 3. Effect of levels of irrigation and plastic colour mulches on yield per hectare ($t\ ha^{-1}$)

Treatment	M_0	M_1	M_2	M_3	Mean
I_1	60.49	64.39	61.42	56.40	60.88
I_2	70.31	93.54	87.65	73.16	81.17
I_3	71.21	83.60	75.25	61.18	72.81
I_4	58.47	62.84	58.26	56.27	58.96
Mean	65.12	76.09	70.65	61.75	
		SEM ±		CD at 5 per cent	
Main treatment		1.53		5.31	
Sub treatment		1.46		4.25	
I at same M		2.91		8.61	
M at the same or different I		3.01		9.10	

Conclusion

The highest yield was obtained in 80 per cent ET (81.17 $t\ ha^{-1}$) and among the mulches highest was recorded in white on black plastic colour mulch (76.09 $t\ ha^{-1}$). Among the interaction maximum yield was recorded in the 80 per cent ET in combination with the white on black plastic colour mulch (93.54 $t\ ha^{-1}$). Eighty per cent of ET through drip and white on black plastic colour mulch independently as well as jointly was effective to produce highest yield of tomato. It had primitive effect on yield attributes. Overall, it can be concluded that plastic mulching has good impact on productivity of tomato. Soil parameters such as temperature, moisture content, bulk density, aggregate stability and nutrient availability improved when plastic mulch was used.

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