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Effect of plastic mulching and irrigation levels on plant growth parameters of tomato crop (*Solanum lycopersicum*)

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Abstract

An experiment was conducted to examine the effect of colour plastic mulches on plant height, number of branches per plant, days to fifty per cent flowering, leaf area index (LAI) under different irrigation levels of drip irrigation in combination with plastic colour mulches. The treatments were laid out in split plot design with three replications and a non-mulched treatment as control. The plastic coloured mulches used were white on black, silver on black and black. The irrigation levels used were 60, 80, 100 and 120 per cent ET. The results indicated that soil temperature increased under the various coloured plastic mulches about 2 to 5°C more as compared to bare soil. Growth components of tomato such as plant height, number of branches per plant, days to fifty per cent flowering and leaf area index were significantly influenced by drip irrigation levels and plastic colour mulches. The maximum plant height (94.15 cm), number of branches per plant (19.17), least days to 50 per cent flowering (43.67 days) and highest leaf area index (2.85) 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.

Keywords: Bare soil, mulch, plastic mulch, crop growth, drip irrigation

Introduction

Population explosion and shrinking of available land for horticultural leads to an urgent need of enhancing the productivity and quality of fruits and vegetables. Generally consumers do not prefer poor quality produce, which fetches fewer prices in the market. Hence, protected cultivation like mulching, green house and 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 (Atif, 2014) [2].

Plastic colour mulch is a product used in a similar fashion to mulch for suppressing the weeds and conserve water in crop production. In plastic mulching crops grow through slits or holes in thin plastic sheeting. It is beneficial to adjust the soil microclimate to prolong the growing season and increase plant growth (Tarara, 2000) [9]. Plastic mulch is also used in conjunction with drip irrigation to increase water use efficiency. It conserves moisture efficiently because water that evaporates from the soil under the plastic film condenses on the lower surface of the film and falls back to the soil as droplets. A variety of colour mulches has been used by growers and researchers in vegetable production. White plastic mulch has been shown to generate cooler soil temperatures than black plastic (Diaz-Perez and Batal, 2002) [4].

Tomato (*Solanum Lycopersicum*), native of Peru-Ecuador-Bolivian area of South- America is most widely grown vegetable crop in the world as well as in India. Tomato is an important solanaceous vegetable that belongs to the nightshade family of plants, a family that includes the potato, tomato and tobacco. Tomato plays a vital role in providing a substantial quantity vitamin C and A in Indian diet by virtue of its nutrients, delicious taste and various modes of consumption and uses. It is popular due to preparing processed food such as soup, ketchup and flavour to the food. In India tomato crop occupies an area of 0.90 million hectares with an estimated production of 19.10 million tonnes. Karnataka accounts for an area of 0.06 million hectare with 1.99 million tonnes production (Anon., 2007) [1]. It was also reported that mulched tomato plants had more branches than that of unmulched plants, which supported the present results (Srivastava *et al.*, 1994) [8].

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Materials and methods

A field experiment was undertaken 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 maximum temperature of 41.3°C was recorded in the month of March, 2016 and lowest temperature of 13.2°C was recorded in the month of December, 2015. The treatments were tested in split plot design with three replications. Each experimental plot has 16 beds. The main treatments were I₁- Water application at 60 per cent ET using drip irrigation, I₂- Water application at 80 per cent ET using drip irrigation, I₃-Water application at 100 per cent ET using drip irrigation and I₄- Water application at 120 per cent ET using drip irrigation and sub treatments were M₀-Without mulch (control), M₁-White on black plastic mulch, M₂-Silver on black plastic mulch and M₃-Black plastic mulch.

The experimental plots of 5 m x 1m 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 plastic colour mulches of 30-micron thickness like white on black, silver on black and black were cut as per the size of the plots. Data recorded of tomato crop was plant height, number of branches per plant, days to fifty per cent flowering and leaf area index. The height of tomato plant was measured in centimetre from the base of the plant to the top of the plant with the help of scale. Number of days taken from the Days After Transplanting (DAT) to the initiation of flowering in fifty per cent of the total plants in the entire plot was considered as days to fifty per cent flowering and expressed in days. The leaf area index (LAI) was measured with an Accu PAR 80 Ceptometer (Decagon Devices, Inc., Pullman, WA, USA) between 11:30 am and 3:30 pm.

Results and Discussions

1. Plant height

The effect of irrigation levels, plastic colour mulches and their interactions on plant height recorded in different dates i.e. 30, 60, 90 and 120 DAT are shown in Table 1 (a), 1 (b) and presented in (Fig. 1).

Among the irrigation levels, drip irrigation at 80 per cent ET (89.57 cm) resulted in maximum plant height followed by drip irrigation at 100 per cent ET (84.98 cm) and at 60 per cent ET (84.08 cm). Significantly due to effect of plastic colour mulches, maximum plant height was observed in treatment white on black plastic colour mulch (88.95 cm) followed by silver on black plastic mulch (86.81 cm) and in without mulch condition (83.87 cm) at different dates i.e. 30, 60, 90 and 120 DAT respectively.

As regards of interaction effect maximum plant height of 94.15 cm was recorded under drip irrigation at 80 per cent ET with white on black plastic colour mulch, when compared to other treatments throughout the growing period. The influence on plant height by the white on black plastic mulch might be due to the fact that sun radiation entered through the white plastic mulch, but very little amount of radiation could have gone back to the environment, which slightly improved the soil temperature underneath the white mulch. Similar trend was also reported by Kumar *et al.*, (2010)^[7].

2. 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 interactions are presented in Table 2 (a), 2 (b) and presented in Fig.2.

Significantly among irrigation levels, maximum number of branches were recorded under the treatment of drip irrigation at 80 per cent ET (17.29) followed by 100 per cent ET (16.49). Due to effect of plastic colour mulches, maximum number of branches were recorded in treatment white on black plastic colour mulch (17.41) followed by silver on black mulch (16.54).

In the interaction effect maximum number of branches were recorded under drip irrigation at 80 per cent ET with white on black plastic colour mulch (19.17) followed by 80 per cent ET with silver on black plastic colour mulch (17.34). Mulch (19.17) followed by 80 per cent ET with silver on black plastic colour mulch (17.34).

3. Days to 50 per cent flowering

The data pertaining to numbers of days taken to 50 per cent flowering are presented in Table 3 and depicted in Fig 3.

The number of days taken for 50 per cent flowering at different irrigation levels was recorded minimum in treatment drip irrigation with 80 per cent ET (45.67 days) followed by treatment drip irrigation with 100 per cent ET (47.25 days) and drip irrigation with 60 per cent ET (51.58 days) respectively. Similarly due to effect of plastic colour mulches, treatment white on black plastic colour mulch has taken significantly minimum days (47.17 days) to 50 per cent flowering followed by silver on black plastic colour mulch (47.67 days).

The interaction effect revealed that number of days taken to 50 per cent flowering was minimum in treatment with drip irrigation at 80 per cent ET in combination with white on black plastic colour mulch (43.67 days) and maximum days taken was in treatment with drip irrigation at 120 per cent ET in combination with black plastic colour mulch (55.67 days). The results were in agreement with the findings of Chakraborty *et al.*, (1994)^[5] and Hooda *et al.*, (1998)^[5].

4. Leaf area index

The data on Leaf area index (LAI) as influenced by different drip irrigation levels and plastic colour mulches and their interaction effects were calculated and presented in Table 4 (a), 4 (b) and in Fig. 4. The LAI goes on increasing up to 90 DAT and later reduces.

Due to different irrigation levels, the maximum LAI values were recorded under the treatment with drip irrigation at 80 per cent ET (2.84) followed by drip irrigation at 100 per cent ET (2.67) and drip irrigation at 120 per cent ET (2.63). Due to effect of plastic colour mulches, maximum LAI values were observed in treatment white on black plastic colour mulch (2.80) followed by silver on black plastic mulch (2.72) and without mulch condition (2.61).

Among the interaction effects, maximum LAI values were observed in the treatment of drip irrigation at 80 per cent ET with white on black plastic colour mulch (3.01 at 90 DAT) followed by 100 per cent ET with silver on black plastic colour mulch (2.83 at 90 DAT). These results were in line and agreement with the findings by Konyeha *et al.*, (2013)^[6].

Table 1(a): Effect of different irrigation levels and plastic colour mulches on plant height (cm)

Treatment	30 DAT					60 DAT				
	M ₀	M ₁	M ₂	M ₃	Mean	M ₀	M ₁	M ₂	M ₃	Mean
I ₁	41.61	47.59	46.53	42.93	44.66	69.82	75.03	72.30	71.48	72.16
I ₂	48.59	50.94	49.91	46.66	49.03	76.48	80.50	78.52	76.46	77.99
I ₃	46.59	50.07	49.80	46.21	48.17	73.33	77.15	76.67	69.61	74.19
I ₄	41.53	44.11	42.98	38.26	41.72	73.63	74.70	71.81	66.19	71.58
Mean	44.58	48.18	47.31	43.51		73.32	76.84	74.83	70.94	
	SEM ±		CD at 5 per cent			SEM ±		CD at 5 per cent		
Main treatment	1.14		3.95			1.11		3.82		
Sub treatment	0.65		1.91			0.85		2.48		
I at same M	1.31		3.54			1.70		5.19		
M at the same or different I	1.45		4.38			1.82		5.46		

Main treatments: Sub treatments

- I₁: Irrigation at 60 per cent ET using drip irrigation M₀: Without mulch condition
 I₂: Irrigation at 80 per cent ET using drip irrigation M₁: White on black plastic mulch
 I₃: Irrigation at 100 per cent ET using drip irrigation M₂: Silver on black plastic mulch
 I₄: Irrigation at 120 per cent ET using drip irrigation M₃: Black plastic colour mulch

Table 1(b): Effect of different irrigation levels and plastic colour mulches on plant height (cm)

Treatment	90 DAT					120 DAT				
	M ₀	M ₁	M ₂	M ₃	Mean	M ₀	M ₁	M ₂	M ₃	Mean
I ₁	78.16	81.28	80.86	76.71	79.52	82.31	87.14	84.69	82.17	84.08
I ₂	81.62	86.04	85.13	80.32	83.28	86.13	94.15	91.26	86.76	89.57
I ₃	81.16	84.16	83.24	81.64	82.55	84.41	89.37	86.54	79.58	84.98
I ₄	78.38	80.94	79.67	76.92	78.98	82.63	85.13	84.75	81.87	83.60
Mean	79.83	83.10	82.23	78.90		83.87	88.95	86.81	82.60	
	SEM ±		CD at 5 per cent			SEM ±		CD at 5 per cent		
Main treatment	0.60		2.08			0.69		2.38		
Sub treatment	0.68		1.99			0.61		1.79		
I at same M	1.37		4.12			1.23		3.74		
M at the same or different I	1.51		4.52			1.34		4.02		

Main treatments: Sub treatments

- I₁: Irrigation at 60 per cent ET using drip irrigation M₀: Without mulch condition
 I₂: Irrigation at 80 per cent ET using drip irrigation M₁: White on black plastic mulch
 I₃: Irrigation at 100 per cent ET using drip irrigation M₂: Silver on black plastic mulch
 I₄: Irrigation at 120 per cent ET using drip irrigation M₃: Black plastic colour mulch

Table 2 (a): Effect of different irrigation levels and plastic colour mulches on number of branches per plant

Treatment	30 DAT					60 DAT				
	M ₀	M ₁	M ₂	M ₃	Mean	M ₀	M ₁	M ₂	M ₃	Mean
I ₁	6.72	7.22	7.17	6.98	7.02	9.52	11.12	10.82	10.40	10.46
I ₂	7.60	8.43	7.65	6.80	7.62	11.62	13.15	12.28	11.50	12.14
I ₃	6.88	7.63	7.41	7.12	7.26	11.23	12.17	10.93	11.00	11.33
I ₄	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		

Main treatments: Sub treatments

- I₁: Irrigation at 60 per cent ET using drip irrigation M₀: Without mulch condition
 I₂: Irrigation at 80 per cent ET using drip irrigation M₁: White on black plastic mulch
 I₃: Irrigation at 100 per cent ET using drip irrigation M₂: Silver on black plastic mulch
 I₄: Irrigation at 120 per cent ET using drip irrigation M₃: Black plastic colour mulch

Table 2(b): Effect of different irrigation levels and plastic colour mulches on number of branches per plant

Treatment	90 DAT					120 DAT				
	M ₀	M ₁	M ₂	M ₃	Mean	M ₀	M ₁	M ₂	M ₃	Mean
I ₁	12.02	13.93	13.20	12.30	12.86	15.14	17.05	16.07	14.82	15.77
I ₂	14.06	15.81	14.84	13.48	14.55	16.39	19.17	17.34	16.24	17.29
I ₃	13.79	14.82	13.98	13.44	14.01	15.69	17.27	16.67	16.32	16.49
I ₄	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		

Main treatments: Sub treatments

- I₁: Irrigation at 60 per cent ET using drip irrigation M₀: Without mulch condition
 I₂: Irrigation at 80 per cent ET using drip irrigation M₁: White on black plastic mulch
 I₃: Irrigation at 100 per cent ET using drip irrigation M₂: Silver on black plastic mulch
 I₄: Irrigation at 120 per cent ET using drip irrigation M₃: Black plastic colour mulch

Table 3: Effect of different irrigation levels and plastic colour mulches on days to 50 per cent flowering

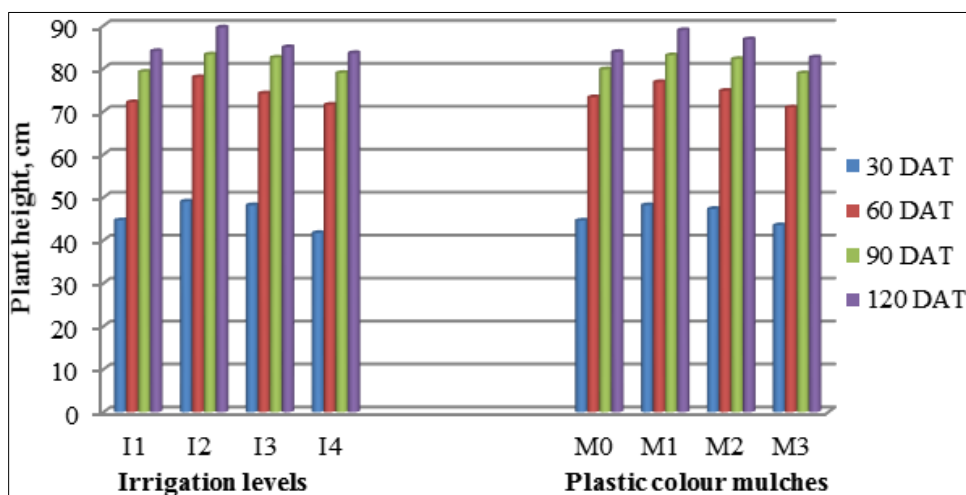
Treatment	M ₀	M ₁	M ₂	M ₃	Mean
I ₁	53.33	49.00	49.67	54.33	51.58
I ₂	46.67	43.67	45.33	47.00	45.67
I ₃	48.00	45.33	46.00	49.67	47.25
I ₄	52.00	50.67	49.67	55.67	52.00
Mean	50.00	47.17	47.67	51.67	
		SEM ±		CD at 5 per cent	
Main treatment		0.83		2.88	
Sub treatment		0.54		1.56	
I at same M		1.07		3.28	
M at the same or different I		0.95		2.82	

Main treatments: Sub treatmentsI₁: Irrigation at 60 per cent ET using drip irrigation M₀: Without mulch conditionI₂: Irrigation at 80 per cent ET using drip irrigation M₁: White on black plastic mulchI₃: Irrigation at 100 per cent ET using drip irrigation M₂: Silver on black plastic mulchI₄: Irrigation at 120 per cent ET using drip irrigation M₃: Black plastic colour mulch**Table 4(a):** Effect of different irrigation levels and plastic colour mulches on LAI

Treatment	30 DAT					60 DAT				
	M ₀	M ₁	M ₂	M ₃	Mean	M ₀	M ₁	M ₂	M ₃	Mean
I ₁	1.00	1.24	1.21	0.98	1.11	1.86	2.29	2.10	2.02	2.07
I ₂	1.20	1.33	1.30	1.25	1.27	2.09	2.39	2.36	2.24	2.27
I ₃	0.96	1.30	1.26	0.96	1.12	1.94	2.32	2.26	1.80	2.08
I ₄	1.15	1.19	1.07	0.99	1.10	2.03	2.04	2.00	1.54	1.90
Mean	1.08	1.26	1.21	1.05		1.98	2.26	2.18	1.90	
		SEM ±		CD at 5 per cent		SEM ±		CD at 5 per cent		
Main treatment		0.01		0.03		0.04		0.13		
Sub treatment		0.02		0.06		0.04		0.12		
I at same M		0.03		0.09		0.08		0.24		
M at the same or different I		0.18		0.54		0.49		1.56		

Main treatments: Sub treatmentsI₁: Irrigation at 60 per cent ET using drip irrigation M₀: Without mulch conditionI₂: Irrigation at 80 per cent ET using drip irrigation M₁: White on black plastic mulchI₃: Irrigation at 100 per cent ET using drip irrigation M₂: Silver on black plastic mulchI₄: Irrigation at 120 per cent ET using drip irrigation M₃: Black plastic colour mulch**Table 4(b):** Effect of different irrigation levels and plastic colour mulches on LAI

Treatment	90 DAT					120 DAT				
	M ₀	M ₁	M ₂	M ₃	Mean	M ₀	M ₁	M ₂	M ₃	Mean
I ₁	2.65	2.70	2.61	2.56	2.63	2.01	2.40	2.35	2.10	2.21
I ₂	2.74	3.01	2.83	2.77	2.84	2.50	2.85	2.60	2.42	2.59
I ₃	2.46	2.82	2.79	2.63	2.67	2.25	2.51	2.33	2.14	2.31
I ₄	2.58	2.69	2.66	2.32	2.56	1.84	1.98	2.13	1.88	1.96
Mean	2.61	2.80	2.72	2.57		2.15	2.44	2.35	2.14	
		SEM ±		CD at 5 per cent		SEM ±		CD at 5 per cent		
Main treatment		0.02		0.07		0.07		0.24		
Sub treatment		0.03		0.10		0.06		0.19		
I at same M		0.07		0.23		0.11		0.38		
M at the same or different I		0.15		0.48		0.17		0.58		

Main treatments: Sub treatmentsI₁: Irrigation at 60 per cent ET using drip irrigation M₀: Without mulch conditionI₂: Irrigation at 80 per cent ET using drip irrigation M₁: White on black plastic mulchI₃: Irrigation at 100 per cent ET using drip irrigation M₂: Silver on black plastic mulchI₄: Irrigation at 120 per cent ET using drip irrigation M₃: Black plastic colour mulch**Fig 1:** Effect of irrigation levels and plastic colour mulches on plant height at different DAT

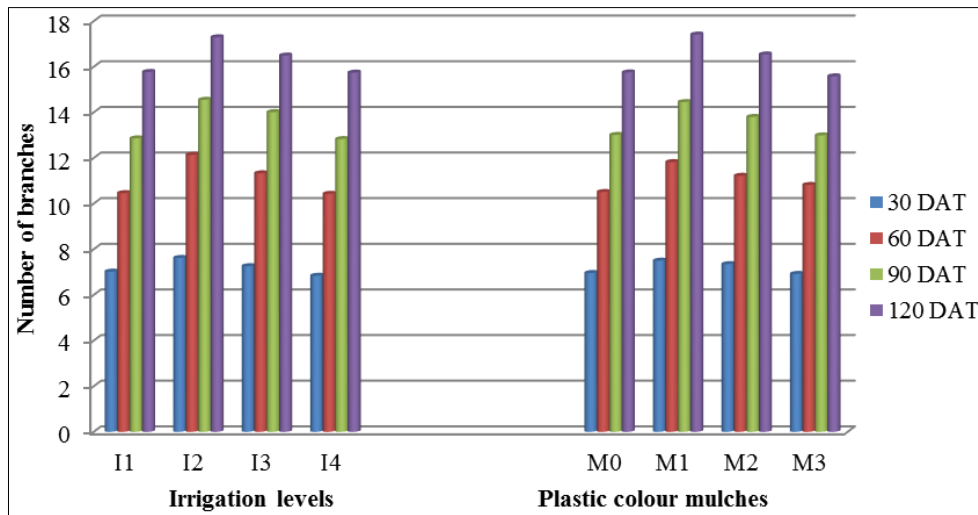


Fig 2: Effect of irrigation levels and plastic colour mulches on number of branches at different DAT

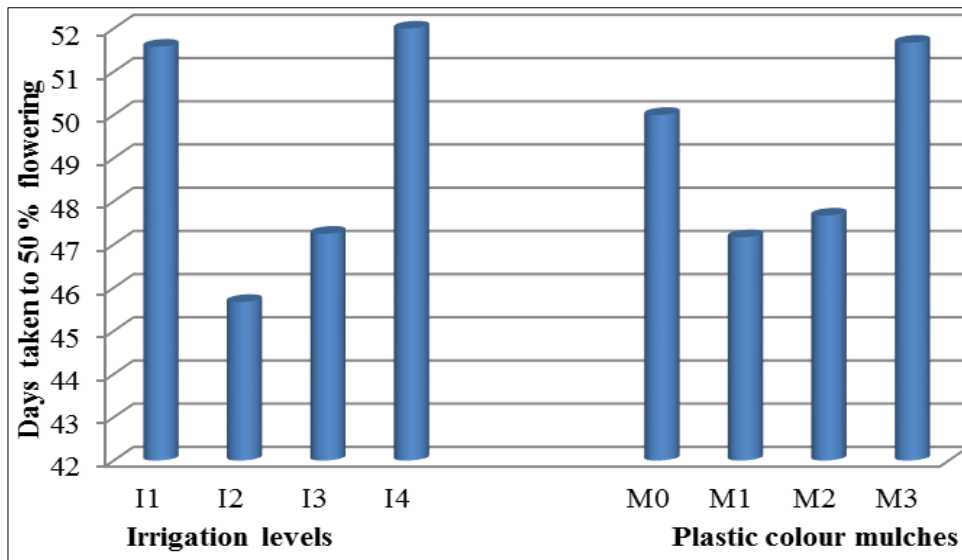


Fig 3: Effect of irrigation levels and plastic colour mulches on days to 50 per cent flowering

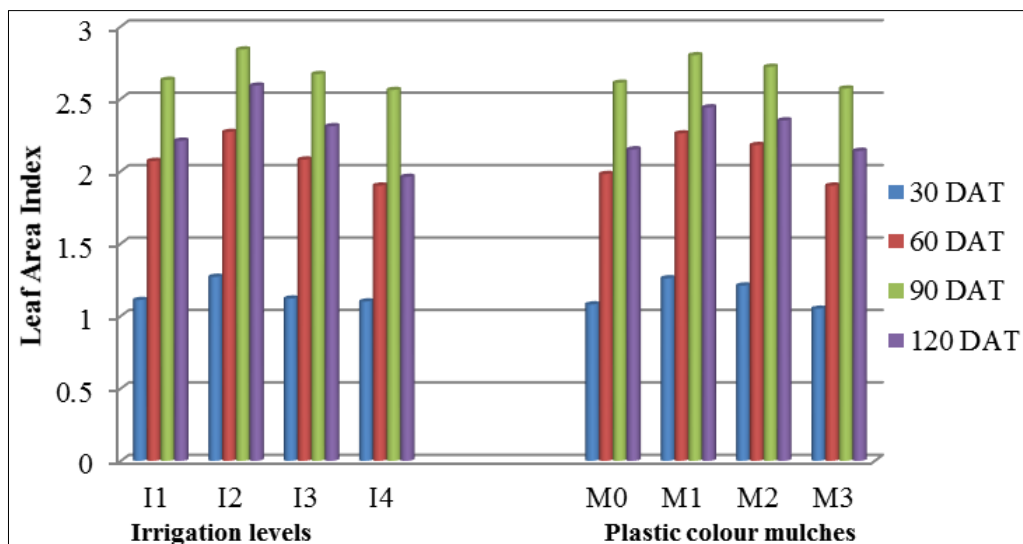


Fig 4: Effect of irrigation levels and plastic colour mulches on LAI at different DAT

Conclusion

Based on the experimental results, it could be concluded that plastic mulches along with calculated and perfect irrigation levels had shown tremendous effects on the plant height, number of branches per plant, Leaf Area Index (LAI) and

Days to 50% flowering of tomato crop. Among the plastic colour mulches and irrigation levels, white on black plastic mulch showed superior performance in combination with drip irrigation of at 80% ET.

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