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

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Abstract
A field experiment was conducted during 2015 to assess the weed growth and root parameters of tomato crop to evaluate effects of four main treatments 60, 80, 100 and 120 per cent Evapotranspiration (ET) using drip irrigation and three mulches (white on black, silver on black and black) with bare soil (weed free) and un-weeded as controls. The use of polyethylene mulch has increased dramatically in the last 15 years, in India. Because they have many benefits: increase in soil temperature especially in early spring, reduced weed problem, moisture conservation and higher crop yields. The maximum weed count was found in 120 per cent ET and minimum in 60 per cent ET. Among the mulches minimum weed count was found in white on black plastic colour mulch. Polythene mulches were effective in suppressing the weed infestation. The maximum root length was observed under treatment 60 per cent ET without mulch (55.24). This might be due to search of water by the plant roots which probe hundreds of feet deep in search of water. The maximum root spread was found in 80 per cent ET in combination with white on black plastic colour mulch. Altogether, our results showed that plastic colour mulching is one weed control strategy in tomato crop that also provides other benefits in terms of sustainable agriculture, such as soil protection or avoiding weedicide pollution.

Keywords: Mulching, drip irrigation, polyethylene, evapotranspiration, weed

Introduction
Tomato (*Solanum lycopersicum*) is an important solanaceous vegetable and play a vital role in Indian diet by virtue of their nutrients, delicious taste and various modes of consumption and uses. Tomato is the second most important vegetable crop next to potato in the world in terms of acreage and production with 15,05,13,000 M tonnes of fresh fruit obtained from 458.24 M ha and productivity 32.8 t ha^{-1} (FAO, 2012)**.** In India tomato is cultivated in an area of 0.86 M ha.

Drip irrigation has become the standard practice for tomato production. Although it can be used with or without plastic mulch, its use is highly recommended with plastic mulch. One of the major advantages of drip irrigation is its water use efficiency. Studies in Florida indicate that drip irrigated vegetables require 40 percent less water than sprinkler irrigated vegetables. Weeds are also less of a problem, since only the rows are watered and the middles remain dry. Some studies have also shown significant yield increases with drip irrigation and plastic mulch when compared with furrow irrigation.

Weeds need to be controlled because they are efficient competitors with the crop for nutrients, moisture and sunlight. Some of them might be hosts of pests and diseases of tomatoes, or they might provide shelter for insect pests. It is very important that weeds be controlled in the early stages of crop development, because early competition can more seriously affect plant growth, and result in the lowering of crop yields. Weed growth can also hinder the correct application of pest and disease chemicals, which are usually necessary in the production of tomatoes. Though herbicides are considered excellent tools within a weed management strategy in many cropping systems; however, misuse of this technology can lead to problems such as residual carry-over, cropping restrictions, groundwater contamination and the development of genetically-based herbicide resistance (Booth *et al*., 2003) [4]. By mulching the weeds can be controlled. Loose materials such as straw, bark and composted municipal green waste can provide effective weed control as organic mulches, but the thickness of the mulch layer needed to suppress weed emergence is likely to make transport costs prohibitive unless the material is

produced on-farm (Merwin *et al.*, 1995) [5]. Black polyethylene mulches are used for weed control in a range of crops under the organic growing system (Bond and Grundy, 2001) [3].

The size and pattern of root development are particularly important for crops growing in soil that supplies only limited quantities of water and nutrient in time and space. Top growth such as lots of deep green leaves, buds, and flowers are an indication that your plant is in great condition, but it pays to take a peek at the roots, too. Hence root growth and spread is also an important factor to be considered.

Material and Methods

The study was done in College of Agricultural Engineering Research Farm located in the Raichur area of the Karnataka. The maximum temperature of 41.3°C was recorded in the month of March, 2016 and the lowest maximum temperature of 26.6°C was recorded in the month of November, 2016 during the study. The maximum evaporation of 14 mm per day was recorded in the month of March, 2016 and the minimum evaporation 2 mm per day in the month of January, 2016 according to data from the Region Agriculture Research Station-Raichur.

There were four main irrigation treatments (60, 80, 100 and 120 per centof ET in drip irrigation) and three mulches (white on black, silver on black and black) with bare soil as control, in a split plot design with three replications. Seedlings of tomato (var. US 800) was transplanted at spacing of 0.60m x 0.45m. The seedlings were transplanted in 16 beds of 5m x 1 m. One lateral of 16 mm diameter was used for each bed with an inline dripper at 40 cm distance and discharge of 4 lph. Irrigation was provided daily after calculating water requirement based on past 24 hours of pan evaporation. The weed growths in experimental plot at 30, 60, 90 and 120 DAT were recorded. The highest number of weed in one-meter square was found throughout the crop period. At the time of final harvest, the tagged five plants from each plot were carefully separated by cutting with roots. Thereafter, the roots mass of the selected plants was carefully dug out, washed gently to remove the soil, rinsed thoroughly and observations of root length and root spread were taken. Crop root length was recorded from base of the plant to root tip with the help of measuring scale. After washing, debris of weed roots, the lateral spread from center of stem was measured horizontally at various vertical intervals.

Results and Discussion

1. Weed population

The weed growths in experimental plot at 30, 60, 90 and 120 DAT were recorded in Table 1 and presented in Fig.1.

Weed growth was significantly influenced by different irrigation levels and plastic colour mulches. At different irrigation levels treatment 120 per cent ET recorded the maximum (15.94) weed count and minimum (6.37) weed count was noted in treatment 60 per cent ET and among the plastic colour mulches maximum (27.52 weed count was in the treatment without mulch) and minimum (4.30) weed count was in the treatment white on black plastic mulch. The reduction of weeds was due to plastic sheet reflects and intercepts direct solar radiation that induces the germination of weed seeds. The weeds were found in mulched plot was only through opening of planting holes. The present results obtained are in line with the findings of Anil Shrestha (2006) and Ashrafuzzaman *et al.* (2011) [1].

2. Crop root parameters

2.1 Crop Root length

The results on the root length after harvesting as influenced by irrigation levels and plastic colour mulches and their interaction are presented in Table 2 and Fig. 2. Significantly maximum root length in was noted under the treatment 60 per cent ET using drip irrigation (51.61 cm) followed by irrigation at 80 per cent ET (46.33cm). Among plastic mulches, significantly maximum root length of 47.68cm was recorded under treatments without mulch condition, During the interaction effect maximum root length was observed under treatment 60 per cent ET using drip irrigation without mulch (55.24 cm). Root length was minimum under the treatment 120 per cent ET using drip irrigation in combination with white on black plastic colour mulch (40.53 cm). The effect of plastic mulches did not show much effect on root length but were influenced by different irrigation levels only. The longest root length in 60 per cent ET drip irrigation treatment could be ascribed due to less soil moisture availability at top, therefore root grown vertically. Similar results were also obtained by Oliveira *et al.* (1996) [6] for this trait.

2.2 Crop root spread

The effect of irrigation levels, plastic colour mulches and their interactions on crop root spread are presented in the Table 3 and depicted in Fig.3. Significantly more root spread was observed under the treatment 80 per cent ET using drip irrigation (30.00 cm). Root spread was statistically par in the treatment 60 per cent ET using drip irrigation (27.65 cm) and 100 per cent ET using drip irrigation (27.24 cm) due to the effect of various irrigation levels. Significantly maximum root spread was observed under the treatment white on black plastic mulch (29.66 cm) followed by silver on black plastic mulch (29.02 cm). The maximum root spread (31.35 cm) was noted under treatment 80 per cent ET using drip irrigation with white on black plastic mulch and it was minimum (25.97 cm). in the treatment 120 per cent ET using drip irrigation without mulch condition.

Table 1: Effect of different irrigation levels and plastic colour mulches on weed count

Treatments	Weed count at DAT			
	30	60	90	120
Irrigation levels				
I_1	9.53	9.41	8.14	6.37
I_2	11.46	10.07	8.53	6.88
I_3	14.02	11.33	9.03	7.25
I_4	15.94	13.17	10.21	8.20
SEm±	0.48	0.28	0.28	0.27
CD at 5 per cent level	1.65	0.96	0.98	0.94
Mulch levels				
M_0	27.52	23.15	21.09	15.16

M_1	7.35	6.46	4.80	4.30
M_2	7.55	6.82	4.94	4.38
M_3	8.52	7.55	5.07	4.85
SEm±	0.44	0.33	0.31	0.35
CD at 5 per cent level	1.28	0.96	0.92	1.03

Main treatments
I_1: Irrigation at 60 per cent ET using drip irrigation
I_2: Irrigation at 80 per cent ET using drip irrigation
I_3: Irrigation at 100 per cent ET using drip irrigation
I_4: Irrigation at 120 per cent ET using drip irrigation

Sub treatments
M_0: Without mulch condition
M_1: White on black plastic mulch
M_2: Silver on black plastic mulch
M_3: Black plastic colour mulch

Table 2: Effect of different irrigation levels and plastic colour mulches on crop root length (cm)

Treatment	M_0	M_1	M_2	M_3	Mean
I_1	55.24	50.48	51.23	49.48	51.61
I_2	45.07	46.75	46.37	47.12	46.33
I_3	47.69	42.38	40.82	43.02	43.48
I_4	42.70	41.84	40.53	41.57	41.66
Mean	47.68	45.37	44.74	45.30	
		SEM ±		CD at 5 per cent	
Main treatment		0.58		2.01	
Sub treatment		0.58		1.69	
I at same M		1.16		3.38	
M at the same or different I		1.35		4.13	

Main treatments
I_1: Irrigation at 60 per cent ET using drip irrigation
I_2: Irrigation at 80 per cent ET using drip irrigation
I_3: Irrigation at 100 per cent ET using drip irrigation
I_4: Irrigation at 120 per cent ET using drip irrigation

Sub treatments
M_0: Without mulch condition
M_1: White on black plastic mulch
M_2: Silver on black plastic mulch
M_3: Black plastic colour mulch

Table 3: Effect of different irrigation levels and plastic colour mulches on the crop root spread (cm)

Treatments	M_0	M_1	M_2	M_3	Mean
I_1	26.53	29.03	28.42	26.63	27.65
I_2	29.17	31.35	29.83	29.64	30.00
I_3	28.20	29.95	29.60	28.97	29.18
I_4	25.97	28.30	28.23	26.47	27.24
Mean	27.93	29.66	29.02	27.47	
		SEM ±		CD at 5 per cent	
Main treatment		0.31		1.06	
Sub treatment		0.49		1.43	
I at same M		0.98		2.96	
M at the same or different I		1.21		3.82	

Main treatments
I_1: Irrigation at 60 per cent ET using drip irrigation
I_2: Irrigation at 80 per cent ET using drip irrigation
I_3: Irrigation at 100 per cent ET using drip irrigation
I_4: Irrigation at 120 per cent ET using drip irrigation

Sub treatments
M_0: Without mulch condition
M_1: White on black plastic mulch
M_2: Silver on black plastic mulch
M_3: Black plastic colour mulch

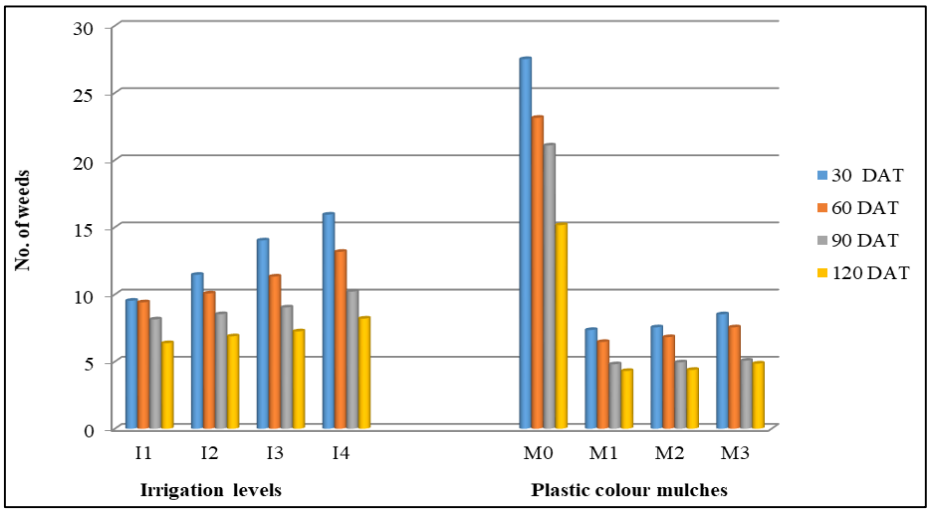

Fig 1: Effect of irrigation levels and plastic colour mulches on weed count at different DAT

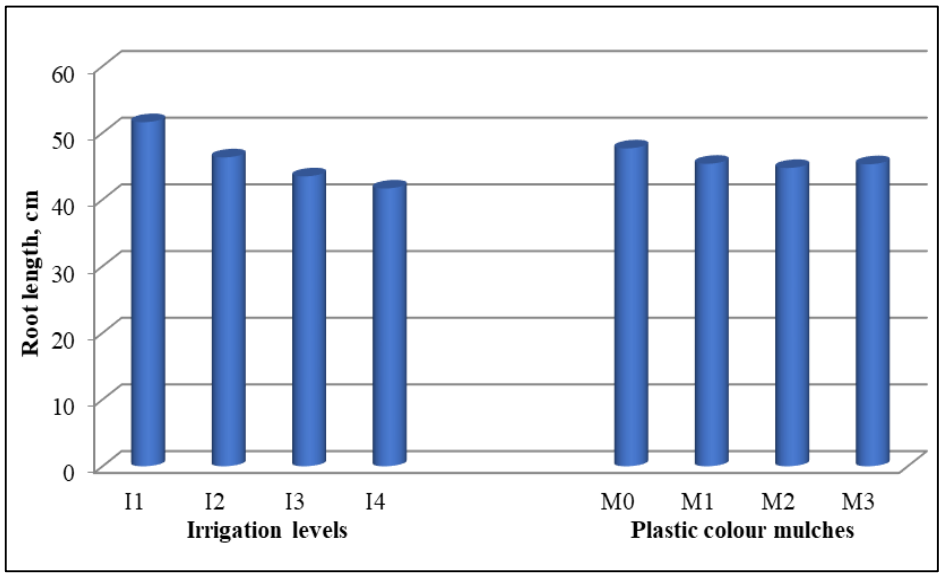

Fig 2: Effect of irrigation levels and plastic colour mulches on root length (cm)

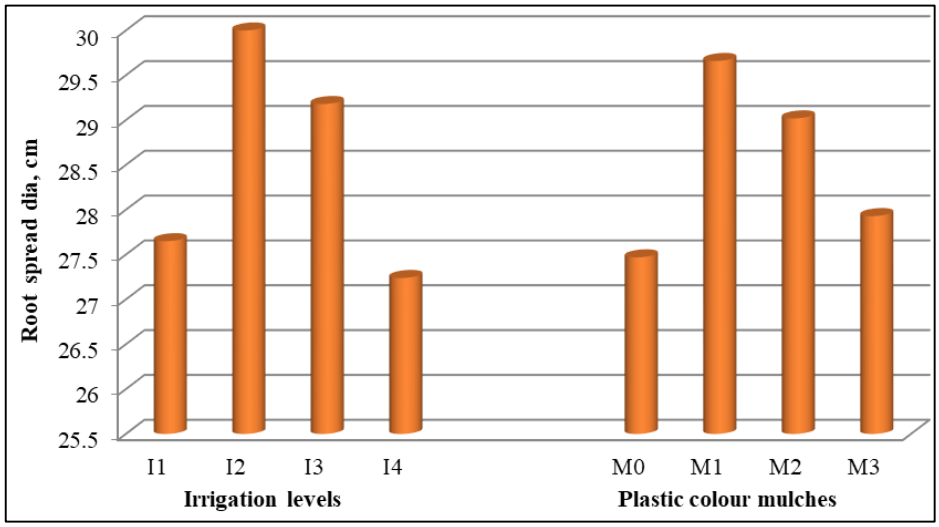

Fig 3: Effect of irrigation levels and plastic colour mulches on root spread (cm)

Conclusion

The weed population was maximum in 120 per cent ET (15.94) and minimum in 60 per cent ET (6.37) and in interaction effects maximum weed growth was recorded in treatment 120 per cent ET in combination with no mulch (31.57). The maximum root length was recorded in 60 per cent ET and minimum in 120 per cent ET. Among the mulches maximum root length was recorded in plot without mulch due to water stress at 60 per cent ET. The root spread was found maximum in 80 per cent ET and among the mulches it was maximum in white on black plastic colour mulch. Due to interaction effects maximum root spread was found in 80 per cent ET with white on black plastic colour mulch.

List of abbreviations

ET: Evapotranspiration
T: Treatment per cent: Percentage

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