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Impact of Plastic Mulching on Biometric Parameters of Tomato Crop (*Solanum lycopersicum*): A Meta-analysis

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ABSTRACT: Plastic mulching helps for moisture retention, maintenance of soil temperatures and weed control. However, comparative research on how mulched drip irrigation impacts tomato crop growth and regulates the link between plant biometric data have been restricted. Hence trials were carried out on an experimental farm at UAS-Raichur to evaluate the precision of irrigation water for tomato production using different coloured plastic mulches and various irrigation levels: without mulch (control), white on black plastic mulch, silver on black plastic mulch and black plastic mulch on plant height, the number of branches per plant and leaf area index (LAI) under varied drip watering levels in combination with irrigation levels. The experiment was laid out in a split-plot design with sixteen treatments and three replications. Observations were recorded on various parameters related to growth and yield. Drip irrigation levels and plastic colour mulches substantially influenced tomato growth components such as plant height, number of branches per plant and leaf area index. When drip irrigation at 80 per cent ET with white on black plastic colour mulch was used, the maximum plant height (94.15 cm), number of branches per plant (19.17) and highest leaf area index (2.85) were observed when compared to other treatments in the experiment. From the above-mentioned investigations, it can be concluded that white on black plastic colour mulch with 80 per cent of ET irrigation water requirement is best in areas of high-temperature regions.

Keywords: Plastic mulching, moisture retention, precision irrigation, drip, growth.

INTRODUCTION

Agriculture is the world's greatest water user, accounting for 70per cent of total use (Qin *et al.*, 2016). Rain-fed (non-irrigated) agriculture covers 8 per cent of global cropland, producing 60–70 per cent of the world's food (Chen *et al.*, 2014). Rain-fed agriculture is becoming increasingly important in the global food supply as a result of the growing water deficit (Li *et al.*, 2017). Global warming and erratic rainfall patterns, on the other hand, are to blame for the scarcity of water resources that limit agricultural production in arid and semi-arid countries (Qin *et al.*, 2015). With its capacity to offer little and frequent water applications directly in plant root zone areas, drip irrigation has piqued researchers' interest here to reduce water consumption and a potential increase in production (Darwish *et al.*, 2003; Janat, 2003). Drip irrigation has been shown to save 30 to 50 per cent of irrigation water while increasing crop output by 15 to 20per cent (Pramod *et al.*, 2022). As the world relies on irrigated land production, irrigated agriculture faces major difficulties that jeopardize its viability. It is important to use water efficiently and bring more land under irrigation using available water resources. As a result, conserving soil moisture through mulching could be an effective way to save water while increasing dryland farming production.

In recent years, notably in vegetable cultivation, plastic film has been the primary material used for soil mulching (Steinmetz *et al.*, 2016). Mulching is a water-saving practice that conserves soil moisture, regulates temperature, and reduces soil evaporation in dryland environments (Yang *et al.*, 2015). In rain-fed farming systems, surface mulching is commonly used as a water conservation measure (Zribi *et al.*, 2015). Plastic sheet mulch is more effective than wheat straw mulch at conserving soil water (Li *et al.*, 2013). Mulching's key advantage is that it conserves soil moisture by minimizing surface evaporation and preventing soil erosion (Qin *et al.*, 2016). Mulched drip irrigation is a common water-saving irrigation technology that can improve water resource utilization efficiency in arid

areas. The change in irrigation method affects the growth of the crop root system and then regulates the growth of aboveground organs (Wang *et al.,* 2020). Mulching conserves soil water by minimizing evaporation and controlling soil temperature, lowering irrigation demand during crop cultivation periods (Kader *et al.,* 2017). Plastic mulching has become a widely used agricultural practice due to the immediate economic benefits it provides, such as increased yields, earlier harvests, improved fruit quality, and reduced water use. Different types and colours viz. black, green, yellow, blue, grey and red plastic mulch have characteristics optical properties that change the levels of light radiation reaching the soil, causing increases or decreases in the soil temperature and moisture (Zahed *et al.,* 2021). However, both from an environmental and agronomic standpoint, understanding of the long-term viability of plastic mulching is lacking. Mulching has a critical impact as a water-saving practice in rain-fed crop production to minimize water stress in agriculture. It is primarily crucial for retaining soil moisture, regulating soil temperature and minimizing soil evaporation, all of which have an impact on crop productivity. Mulching has several strategic implications for the soil ecosystem, crop growth and climate. Even mulch insulates the soil, assisting in the creation of beautiful and protected landscapes by providing a barrier from cold and hot temperatures. This research has gathered a wealth of knowledge about plastic mulch materials as well as their use in crop cultivation.

We investigate the impact of plastic mulching and irrigation levels on tomato biometric parameters as a function of environmental circumstances. We chose tomato as a test crop because of its worldwide importance and varied reactions to climatic variables. Tomato (*Solanum lycopersicum* L.) is a globally important vegetable that is commercially grown on all continents (Sun *et al.,* 2014).Tomatoes are an important part of the world's diet because they contain high levels of lycopene and minerals, which are beneficial to human health (Perveen *et al.,* 2015). A thorough and quantitative study of the effects of mulching may help to close yield gaps between feasible and actual crop yields and better guide practitioners.

MATERIAL AND METHODS

During Rabi, the experiment was carried out at the College of Agricultural Engineering in Raichur (October 2015 to September 2016). Raichur lies in Karnataka's Region 1's Zone II, which is in the north-eastern dry zone. This location is located at 16 15' N latitude and 77 20' E longitude, at an elevation of 389 meters above mean sea level (MSL). The split-plot field experiment included three replications with four main treatments and four sub treatments. There are 16 beds in each experimental plot, I_1- Water application at 60 per cent ET using drip irrigation, I_2- Water application at 80 per cent ET using drip irrigation, and I_3-Water application at 100 per cent ET using drip irrigation I_4-Water application at 120 per cent ET using drip irrigation and sub treatments were M_0- Without mulch (control), M_1- White on black plastic mulch, M_2– Silver on black plastic mulch and M_3– Black plastic mulch were the major treatments.

The experimental field has clay textured soil and a pH of 7.9 and good electrical conductivity of 0.98 dS m^{-1}. Sowing was done on a bed of 5 m long and 1.0 m width rows. Surface drip irrigation was used for the experiment. Laying was done manually with on and off valves fixed for each bed. Healthy seedlings were transplanted onto the well-prepared experimental plots after approximately three weeks. The treatment combinations were used to sow a single seedling. Plant protection measures were implemented following the tomato crop's recommended package of actions. For evaluating several characteristics such as growth, blooming, quality characters, root parameter, and yield, the following observations were made at intervals of 30, 60, 90, and 120 days after transplanting on five randomly tagged competitive plants from each plot of each replication.

With the use of a meter scale, the height of the plant was measured from the bottom to the top at 30, 60, 90, and 120 days after transplanting, height of the plants was measured (DAT). Five plants were randomly tagged in each treatment to track the number of branches after transplantation. The leaf area index was calculated by dividing the leaf area per plant by the plant's land area.

$$\text{LAI} = \frac{\text{Leaf area per plant}}{\text{Area of particular plant}}$$

RESULTS AND DISCUSSIONS

In terms of the interaction impact (Table 1), the maximum plant height of 94.15 cm was reported under drip irrigation at 80per cent ET with white on black plastic colour mulch during the growing period, when compared to other treatments. Many studies have reported that plastic mulch increases the yield of many vegetables, such as eggplant (Adamczewska-Sowinska *et al.,* 2016), potatoes (Li *et al.,* 2018), and tomatoes (Rahman *et al.,* 2016; Kundu *et al.,* 2019).In the interaction effect (Table 2), most 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 (19.18). The enhanced plant height and a maximum number of branches under this treatment could be attributed to a combination of better moisture content (Zhong-kui Xie *et al.,* 2005), higher biosynthesis, and optimal nutrient uptake at the right soil temperature. Similar results have been reported for maize (Haque *et al.,* 2018; Yin *et al.,* 2019 and by Paul *et al.* (2013) crops. Table 3 shows the LAI interaction impact for 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 (3.01 at 90 DAT) (2.83 at 90 DAT). This could owe to adequate soil moisture and a favourable microclimate around the plant, as well as increased photosynthetic radiation and better light dispersion, all of which aided photosynthetic activity. Second, greater

plant metabolism and auxin production appear to contribute to overall plant growth and development. For a long time, vegetative growth keeps pace with reproductive growth (Wang and Yin 2015). The results are also in good agreement with the findings of Stephen *et al.* (2015).

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

Treatment	120 DAT				
	M_0	M_1	M_2	M_3	
I_1	82.31	87.14	84.69	82.17	84.08
I_2	86.13	94.15	91.26	86.76	89.57
I_3	84.41	89.37	86.54	79.58	84.98
I_4	82.63	85.13	84.75	81.87	83.60
Mean	83.87	88.95	86.81	82.60	
		SEM ±		CD at 5 per cent	
Main treatment		0.69		2.38	
Sub treatment		0.61		1.79	
I at same M		1.23		3.74	
M at the same or different I		1.34		4.02	

Table 2: Effect of different irrigation levels and plastic colour mulches on the number of branches per plant.

Treatment	120 DAT				
	M_0	M_1	M_2	M_3	**Mean**
I_1	15.14	17.05	16.07	14.82	15.77
I_2	16.39	19.17	17.34	16.24	17.29
I_3	15.69	17.27	16.67	16.32	16.49
I_4	15.79	16.16	16.07	14.93	15.74
Mean	15.75	17.41	16.54	15.58	
		SEM ±		CD at 5 per cent	
Main treatment		0.27		0.92	
Sub treatment		0.26		0.78	
I at same M		0.54		1.59	
M at the same or different I		1.06		3.22	

Table 3: Effect of different irrigation levels and plastic colour mulches on LAI.

Treatment	90 DAT				
	M_0	M_1	M_2	M_3	**Mean**
I_1	2.01	2.40	2.35	2.10	2.21
I_2	2.50	2.85	2.60	2.42	2.59
I_3	2.25	2.51	2.33	2.14	2.31
I_4	1.84	1.98	2.13	1.88	1.96
Mean	2.15	2.44	2.35	2.14	
		SEM ±		CD at 5 per cent	
Main treatment		0.07		0.24	
Sub treatment		0.06		0.19	
I at same M		0.11		0.38	
M at the same or different I		0.17		0.58	

CONCLUSIONS

With increased water demand and fears of water scarcity, increasing production per unit of water used is more vital than ever. The use of plastic mulch, a rise in soil temperature and a reduction in moisture loss were all factors in the tomato crop's increased benefits. Mulching was more expensive, but the increased yield more than offset the increased cost. Drip irrigation has been a more successful irrigation approach in enhancing tomato crop output, especially when combined with white on black plastic mulch. Different soil mulches have different effects on plant development, depending on the growing season.

FUTURE SCOPE

Future research should look at a variety of crop species and types with the goal of evaluating the viability of organic and inorganic mulches under drip irrigation that can endure environmental impact are easy to apply.

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Conflict of Interest. None.

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