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Using Colored Plastic Mulches in Tomato (*Lycopersicon esculentum* L.) Production

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Abstract. The use of polyethylene mulch has increased dramatically in the last 10 years, in Iran. Because they have many benefits: increase in soil temperature especially in early spring, reduced weed problem, moisture conservation and higher crop yields. A field experiment was conducted on tomato (*Lycopersicon esculentum* L.) at during growing season (April-July) in 2010, in a randomized complete block design with three replicates. Treatments consisted five colored polyethylene mulch (clear, black, blue, red and silver on black) with bare soil (weed free) and un-weeded as controls. Results showed that soil temperature under the various colored mulches was 3 to 6 ˚C warmer compared to bare soil. The highest soil temperature was recorded under blue plastic. The plants grown on silver/black mulch produced Maximum marketable yield and fruit weight. The silver/black and black plastic mulches resulted in a 95-98% reduction in weed biomass. In an attempt to reducing chemical input for weed control and increase to yield of tomato black and silver/black plastic mulch may be a good alternative for conventional clear plastic mulches.

Keywords: Marketable yield, Weed control, Silver/black plastic, Soil temperature

1. Introduction

Tomato (*Lycopersicon esculentum* L.) is one of the important vegetable crops extensively grown during the spring and summer seasons in many regions of Iran. Iran ranks seventh in tomato production in the world (FAO, 2010). However, in early spring, low temperature and in summer, water deficit often limit growth and development of vegetable crops. In the other hand, Heavy infestation summer weed is a great problem, since chemical control in fresh market fruits faced with limitations. Plastic mulch application is effective in increasing soil temperature, conserving soil moisture and weed control (Lamont, 2005; Zhang et al., 2007; Brault et al., 2002).

Plastic mulches are used extensively in commercial vegetable production (Lamont, 1993). The most popular plastic mulch worldwide is black, though white-on-black and clear mulches are also used (Schales, 1990). While most of Iranian growers use only conventional clear plastics. Other colors that have been evaluated include; blue, green, red, yellow, brown, white, and silver (Brault et al., 2002; Gough, 2001; Hanna, 2000; Ngouajio and Ernest, 2004). Different colored mulches have multiple effects on the crops being grown. Higher yields have been reported for crops such as strawberries (*Fragaria* sp.) when using clear plastic in combination with soil fumigation with methyl bromide and chloropicrin (Johnson and Fennimore, 2005). Ham et al. (1993) reported that White-on black and silver mulches reflect 48 and 39% of shortwave radiation, respectively. Black plastic mulch increased number of fruit in tomato by 5-fruit per plant compared to bare ground (Diaz-Perez and Batal, 2002). The soil surface beneath red polyethylene mulch had the highest mean temperature, followed by surface soil on bare plots and beneath the black and

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silver mulches respectively (Gough, 2001). Ashrafuzzaman et al. (2011) recorded the highest number of weed in clear plastic mulch and the lowest in black plastic.

2. Materials and Methods

The experiment was conducted during the period of April to July 2010 at the research field of Varamin-Pishva Branch, Islamic Azad University (latitude 35 °19 Ń, 51 °39 Ė; elevation 918 m), Varamin, Iran. The soil was a silty clay with pH = 7.6. The experimental design was a randomized complete block with three replications. Five mulching treatments (clear, black, red, blue and silver on black) along with a control (bare soil weed free) and weedy check were imposed on tomato (*Lycopersicon esculentum* L. var. Super Chief). The site was fertilized according to soil test recommendations. Plots were 6 × 6 m on 15 cm high raised beds. Mulches were laid in the field by hand, one day before transplanting date. Drip irrigation tubing was placed under mulches during the same process. In control plots, no herbicides were applied and any weed escapes were controlled by bi-weekly hand weeding. Seeds of tomato were sown at nursery (low tunnel covered with clear plastic) on 11 February 2010. On 9 April, Fifty eight-day old seedlings were transplanted by making holes of 5 cm diameter on the film at 40 000 plants ha^{-1} with double rows of tomato on raised bed and 150 cm apart with 33 cm intra-row spacing. Soil temperatures were measured at 10 cm depth for all treatments using soil thermometer at tow time (8:30 am and 2:30 pm) on second day after each irrigation. At 75 days after transplanting (DAT), weeds were collected from the plots and their number, fresh and oven dried weights were recorded. Fruit were harvested at weekly and Yield and yield contributing characters were recorded at each harvest. Data were analyzed using Proc GLM procedure in the Statistical Analysis System (SAS Institute, Inc. 2002).

3. Results and Discussion

3.1. Mulch and Soil Temperature

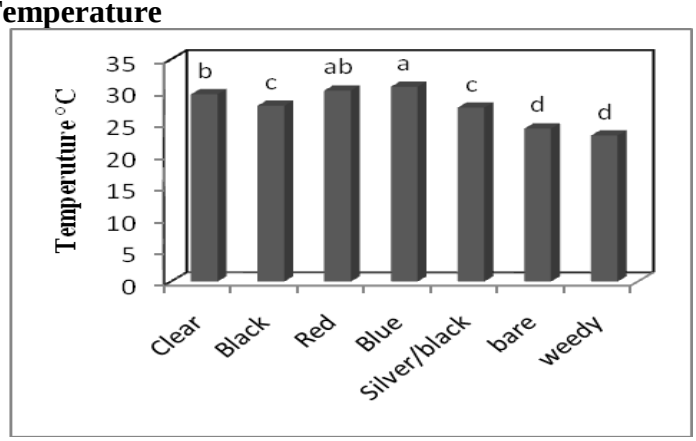

Fig. 1: Soil temperature at 10 cm depth in mulched and unmulched treatments

Soil temperature at 10 cm depth was different due to the presence of mulch and mulch color (Fig. 1). Temperature under mulch was 3.3 to 6.6˚C higher than that of the bare soil. Due to using plastic mulch soil temperature increased 2 to below 6 ℃ compared to without plastic (Easson and Fearnehough, 2000). The highest soil Temperature was recorded under blue mulch (30.7˚C), fallowed by red (30.1˚C) and clear (29.5˚C) plastic. Among plastic mulches, silver/black had the lowest soil temperature. This is consistent with findings of Gough (2001). Soil warming at early spring provided suitable conditions for growth of tomato seedlings, but also weeds germinated and grew under plastic. Reduce temperature in the silver/black mulch at the end of growing season increased plants survival.

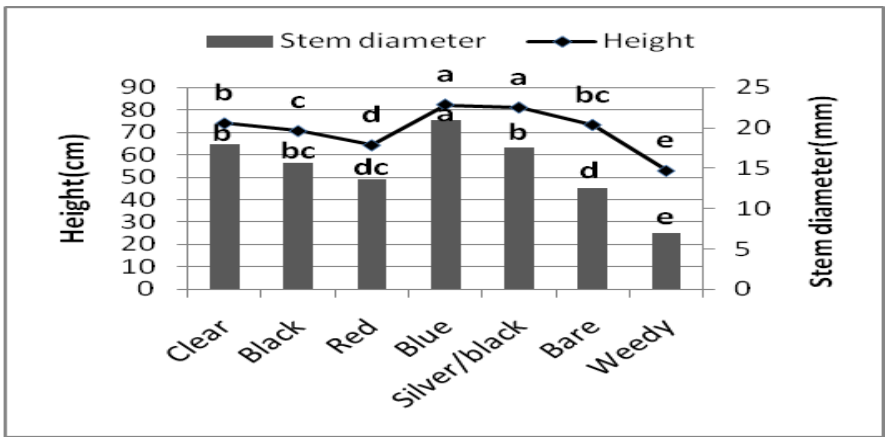

Fig. 2: Effect of experimental treatment on tomato height and stem base diameter. (Figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.)

3.2. Height and Stem Base Diameter

Figure 2 shows significant variations in tomato height and stem diameter due to different colored mulches. The plants grown with plastic mulch had maximum height (82.3cm) and diameter (21mm). The smallest plant (53cm) was observed in weedy plots. The increased plant height in mulched plants was possibly due to better availability of soil moisture and optimum soil temperature provided by the mulches. According to Decoteau (1990) in red bell pepper, plants grown in red mulch were taller than the other colored mulch treatments.

3.3. Effect of Colored Mulches on Weeds

The heavy weed infestation was observed in weedy plots (Table 1). Significantly, the highest weed number and biomass was recorded in weedy plots (277 plant/m^2 and 803.4 g/ m^2, respectively). The major weeds were redroot pigweed (*Amaranthus retroflexus* L.), rice grass (*Echinochloa colonum* L.), common purslane (*Portulaca oleracea* L.), green foxtail (*Setaria viridis* L.) and Johnson grass (*Sorghum halepense* L.). Among mulch treatments, highest weed number and biomass recorded in clear plastic. Ashrafuzzaman et al. (2011) the highest number of weeds per m^2 recorded in transparent plastic mulch (186.5) and the lowest was in black plastic mulch (54.25). The high light transmission increased soil temperature and created a microclimate conducive to weed germination (Ngouajio and Ernest, 2005). The silver/black mulch provide by 98% weed control, fallowed black (95%), blue (89%), clear (85%) and red (84%) plastic. There was complete elimination of weeds under silver/black polyethylene mulch, whereas in non-mulched plots (control) weeding was done manually five times during of experimentation. Ngouajio et al. (2008) also reported complete elimination of weeds with the use of black polyethylene. The red plastic also discolored within 30 days after transplanting and allowed easy entrance of solar radiation through it, hence, produced moderate weed density and biomass. Silver/black and black plastic mulch produced weeds only through the punch and no weed was found under the plastic, which might be due to lack of percentage of light through black plastic. Black plastic mulch blocked the weeds, except a few, which emerged through the planting holes (Schonbeck, 1999).

Table 1. Effect of different treatments on weed number and biomass(75 days after transplanting)

Treatment	No. of weed (no./m^2)	Weed biomass (g/m^2)	Control (%)
Clear	14.8b	124.3b	85bc
Black	5.9b	38.9bc	95abc
Red	12b	130.0b	84c
Blue	11b	87.4bc	89abc
Silver/black	1.6b	13.9bc	98ab
Bare soil	00.0b	00.0c	100a
Weedy	277a	803.4a	00.0d
$LSD_{(0.05)}$	74.9	77.9	8.7
CV (%)	26.3	19.8	6.2

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.

3.4. Plant dry Matter, Yield and Fruit Weight

All colored plastic mulch produced significantly higher DM compared to bare soil (Table 2). The highest DM (11191 kg/ha) was observed in blue plastic mulch, possibly due to light reflectance from the mulch surface. However,There was no significant difference between this mulch, silver/black and black plastic. In contrast, bare soil showed the lowest DM, fallowed by weedy treatment. Results of Decoteau et al. (1986) indicated that Plants grown with black or white mulch produced more leaves and petioles, and had larger stems than plants with silver or red mulch.

There was no significant difference in the average fruit weight among mulch treatments (Table 2). However, the largest fruit produced on the silver/black mulch, which was significantly larger than fruit from bare ground. Decoteau et al. (1986) obtained the greatest number of fruits on plants in the silver treatments, while the largest fruits were measured in the black mulch treatments.

Application of plastic mulches increased the yields compared to non-mulched plots (Table 2). Higher yields in mulch treatments might be due to its effects on soil temperature, soil moisture and weed suppression. The highest total and marketable yield although produced on silver/black mulch, there was no significant different statistically among plastic mulches. Black and silver/black plastics resulted in 50 and 65% elevation in tomato marketable yield relative to bare ground, respectively. Sing and Kamal (2012) obtained higher tomato yield with black plastic mulch than with bare soil. Decoteau et al. (1989) recorded highest total yield in red mulch (45.9 t/ha) compared to black (44.3t/ha) and silver (43.1t/ha).

The percentage of cull fruits was also least on the silver/black plastic mulch and highest on the weedy plots, fallowed by bare soil (Table 2).

Table 2. Tomato yield, plant dry matter (DM) and fruit weight as affected by different treatments

Treatment	Plant DM (kg/ha)	Total yield (kg/ha)	Marketable yield (kg/ha)	Cull (%)	Max. fruit weight (g)	Avg. fruit weight (g)
Clear	6133c	34761b	31576c	9.2b	137.4a	94.0a
Black	10355a	40782ab	38241ab	6.3b	127.6a	91.2a
Red	7762b	34863b	32165bc	7.8b	138.1a	93.9a
Blue	11191a	38942ab	35673abc	8.3b	135.8a	94.4a
Silver/black	10498a	44219a	41931a	5.2b	145.1a	99.0a
Bare soil	3788d	28001c	25418d	9.2b	120.9a	84.9a
Weedy	800e	4452d	2369e	46.8a	62.4b	43.9b
$LSD_{(0.05)}$	1148	4338	4334	2.88	17.39	11.12
CV (%)	8.93	10.20	8.22	12.29	7.8	7.3

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT.

4. Conclusion

These studies have demonstrated the benefits of silver/black and black plastic mulching on tomato yield. Mulching resulted in 24 to 65% increase in marketable yield as compared to bare soil. It also increases the soil temperature, which helps in establishing the early planting of tomato plants in cold areas. Black and silver/black plastic mulch dramatically controlled weeds. Thus, we recommend use of black or silver/black mulch rather than clear conventional plastic mulch, in similar conditions.

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