Colored Plastic Mulches for High Tunnel Tomato Production

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Introduction

Weather often is one of the limiting factors for crop production in northern states. Growers in Iowa and other northern climatic regions are increasingly utilizing high tunnels to extend their growing season and increase fruit and vegetable production. In early spring and late fall, high tunnels help warm the air and soil and aid with crop growth and development. However, during summer, temperatures rise quickly in high tunnels and can detrimentally affect crop growth and development.

In 2012, a number of growers reported poor fruit set and quality in their tomatoes, mainly due to higher-than-normal temperatures inside high tunnels. Temperature management for high tunnel tomato production is critical because high temperatures can lead to blossom drop, fruit abnormalities, and overall yield reduction. One of the management aspects affecting root zone temperature is the mulch system. Depending on the type and color of mulch used, root zone temperatures can vary.

This two-year study investigated the use of colored plastic mulch and its effect on tomato root zone temperature, crop growth, yield, and fruit characteristics. A standard black plastic mulch and a bare ground treatment also was included to simulate grower practice.

Materials and Methods

On March 26, 2012 and March 27, 2013, tomato seeds (*Solanum lycopersicum* 'Mt. Spring') were seeded into a soilless greenhouse medium (Sunshine LC1 Mix) in 98-cell flats. Transplants were grown in the greenhouse for four weeks and later moved to a lath house for acclimation. In mid-April, a high tunnel was tilled and nitrogen was applied at the rate of 60 lb/acre. On May 3, 2012 and May 10, 2013, tomato plants were transplanted into raised beds. Each treatment had a single bed with a total of 10 plants. In-row spacing between plants was 18 in. (46 cm).

Experimental design was a randomized complete block design with three replications. Treatments included: 1) bare ground, 2) black plastic, 3) blue plastic 4) olive plastic, and 5) red plastic. In 2012, the primary source of fertilizer used was a 20-20-20 (N-P_2O_5-K_2O) liquid fertilizer. In 2013, in addition to the 20-20-20 fertilizer, potassium nitrate (13.5-0-46.2) and calcium nitrate (15.5-0-0-19) fertilizers also were applied through drip irrigation. Temperature sensors were installed to monitor root zone temperature.

Data were collected on marketable and non-marketable fruit number and yield, plant height, chlorophyll content, stem girth, and total plant dry weight. Chlorophyll content was measured indirectly using SPAD meter (Konica Minolta, NJ, USA). Tomatoes were harvested six times in 2012 starting July 17, and eight times in 2013 starting July 23, at weekly intervals. Both years, four fruits were randomly collected from the fourth harvests and analyzed for pH, electrical conductivity (EC), and total soluble solutes (brix).

Results and Discussion

Overall, yields were higher in 2013 than 2012. This could be due to balanced fertilizer

application using potassium and calcium nitrate fertilizer. Crops from the solanaceous family prefer nitrogen in the nitrate form. Average soil temperatures 4 in. (10 cm) below the soil surface throughout the growing season varied, but there were no significant differences between treatments (Figure 1).

Contrary to studies that have shown differences in tomato yields under different colored plastics, our study did not reveal any statistically significant difference. Both fruit numbers and marketable yields were statistically similar among treatments in both years (Table 1).

Most studies that have shown differences were conducted under field conditions and not under high tunnels. Based on our results, plastic mulch color does not affect crop yields in high tunnel production. The blue plastic mulch showed an increase in marketable fruit number and yield but it was statistically non-significant. Non-marketable fruit number and weights did not show any significant trend.

Plant height, SPAD, stem girth, and total plant dry weight did not show any statistically significant difference (Table 2). There were no statistically significant differences in fruit pH, EC, or total soluble solids in 2012 or 2013 (Table 3).

In general, the study showed no difference in crop performance based on the mulch treatment. Root zone temperatures were slightly affected, but it did not translate into any positive or negative effect on crop performance or yield.

Table 1. Effect of mulch treatments on tomato yield characteristics.[a]

Treatment	Marketable		Non-marketable	
	Number[b]	Yield[b] (kg)	Number[b]	Weight[b] (kg)
	2012			
Bare ground	176	38.5	87	16.6
Black plastic	180	41.3	105	21.4
Blue plastic	197	46.7	85	15.7
Olive plastic	186	41.8	87	16.1
Red plastic	176	38.0	94	19.7
	2013			
Bare ground	285	62.1	57	9.0
Black plastic	272	60.8	53	9.4
Blue plastic	287	63.7	49	7.3
Olive plastic	285	61.5	55	8.3
Red plastic	287	60.3	71	10.6

[a]Data collected from 10 plants harvested six and eight times in 2012 and 2013.
[b]Non-significant; Fisher's Protected LSD (P≤0.05).

Table 2. Effect of mulch treatments on tomato growth characteristics.[a]

Treatment	Plant height[b] (cm)	SPAD[b]	Stem girth[b] (mm)	Plant dry weight[b] (g)
Bare ground	83.4	55.5	12.7	380.0
Black plastic	88.6	58.0	13.3	420.0
Blue plastic	87.7	58.8	13.8	463.3
Olive plastic	82.4	58.3	14.4	606.7
Red plastic	86.1	59.5	14.1	466.7
	2013			
Bare ground	84.1	62.0	12.2	310.0
Black plastic	81.3	63.7	12.2	310.8
Blue plastic	78.7	61.2	12.7	326.9
Olive plastic	81.8	62.2	13.0	312.8
Red plastic	83.8	59.5	12.7	321.7

[a]Means for plant height, SPAD, and stem girth are average of measurements from 6 and 10 plants/treatment replication taken on June 28, 2012 and 2013. Plant dry weight is average of data collected from two whole plants collected after the final harvest on August 20, 2012 and September 3, 2013.
[b]Non-significant; Fisher's Protected LSD (P≤0.05).

Table 3. Effect of mulch treatments on tomato fruit characteristics.[a]

Treatment	pH[b]	EC[b] (dS/m)	TSS[b] (Brix)
	2012		
Bare ground	4.4	3.0	5.2
Black plastic	4.4	3.0	5.1
Blue plastic	4.5	3.0	5.5
Olive plastic	4.4	2.9	5.4
Red plastic	4.5	2.6	5.2
	2013		
Bare ground	4.6	4.3	4.4
Black plastic	4.6	4.4	4.5
Blue plastic	4.6	4.6	4.5
Olive plastic	4.6	4.4	4.4
Red plastic	4.6		4.5

[a]Data from four marketable fruits collected randomly from each treatment replication on August 7, 2012 and August 12, 2013.
[b]Non-significant; Fisher's Protected LSD (P≤0.05).

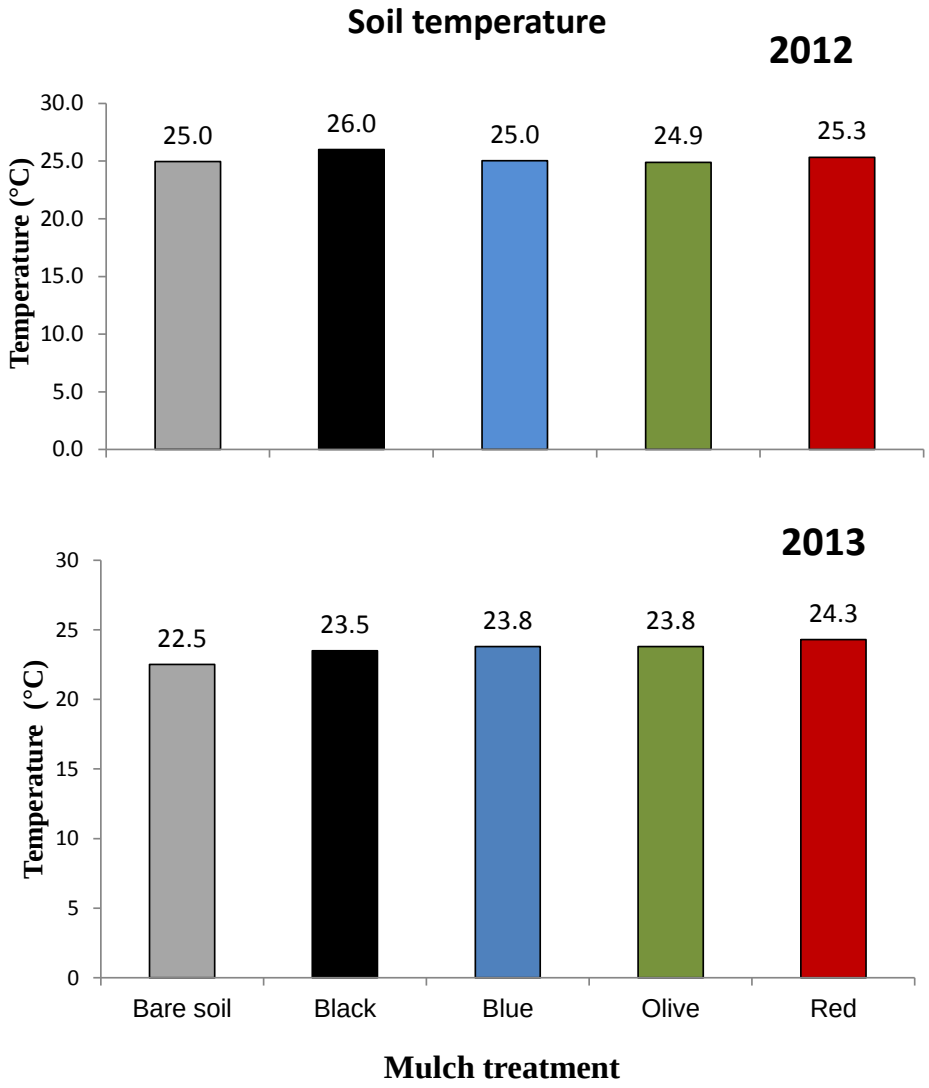

Figure 1. Average soil temperature during tomato growing season at 10-cm depth in 2012 and 2013.