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Effect of Plastic Mulch Color on Tomato Production in High Tunnels

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Abstract
High tunnel production is increasing in Iowa as they provide protection from wind and frost and help extend the growing season. Although production aspects inside high tunnels are similar to field production, high tunnel environment is challenging especially when it comes to temperature management. During summer, temperatures rise fairly quickly in high tunnels and can detrimentally affect crop growth and development. It is not uncommon to see temperatures above 100o F inside high tunnels.

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Introduction

High tunnel production is increasing in Iowa as they provide protection from wind and frost and help extend the growing season. Although production aspects inside high tunnels are similar to field production, high tunnel environment is challenging especially when it comes to temperature management. During summer, temperatures rise fairly quickly in high tunnels and can detrimentally affect crop growth and development. It is not uncommon to see temperatures above 100^{o}F inside high tunnels.

One of the most commonly grown vegetables in high tunnel is tomato. In a recent survey of growers in Iowa, Kansas, Missouri, and Nebraska who used high tunnels, 90 percent had grown tomatoes in the last four years. Temperature management for high tunnel tomato production is critical since 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 study investigated the use of colored plastic mulch and its effect on tomato root zone temperature, crop growth, yield, and fruit characteristics.

Materials and Methods

On March 27, 2012, tomato seeds (*Solanum lycopersicum* ‘Mt. Spring’) were seeded into a soil-less greenhouse medium (Sunshine LC1 Mix) in 98-celled flats. Transplants were grown in the greenhouse for four weeks and later moved to a lath-house for acclimation. On May 3, 2012, tomato crop was transplanted on raised beds. Each treatment had a single bed with a total of 10 plants. In-row spacing between plants was 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. 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 at weekly intervals starting July 17, 2012. Four fruits were randomly collected from the fourth harvest and analyzed for pH, electrical conductivity (EC), and total soluble solutes (brix).

Results and Discussion

Irrespective of the 2012 growing season (high temperatures), the tomato crop performed well in high tunnels (Figure 1). Overall yields were satisfactory except the first harvest where most tomatoes were non marketable due to poor quality (internal whitening). Excessive heat during fruit set and formation leading up to the first harvest would have contributed to this. Average soil temperatures throughout the growing season under plastics varied but there were no significant differences between treatments (Figure 2). Surprisingly, bare ground treatment maintained root zone temperatures similar to the colored plastic mulches. The highest temperature was under the black plastic mulch (26°C or 78.8°F).

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 (Table 1). 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 also 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 (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. The study will be repeated in 2013 to account for year-to-year variability due to climatic conditions.

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

Treatment	Marketable		Non-marketable	
	Number[NS]	Yield[NS] (kg)	Number[NS]	Weight[NS] (kg)
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

[x]Data collected from 10 plants harvested six times during the growing season.
[NS]Non-significant; Fisher's Protected LSD ($P \leq 0.05$).

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

Treatment	Plant height[NS] (cm)	SPAD[NS]	Stem girth[NS] (mm)	Plant dry weight[NS] (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

[x]Means for plant height, SPAD, and stem girth are average of measurements from six plants per treatment replication taken on June 28, 2012. Plant dry weight is average of data collected from two whole plants collected after the final harvest on August 20, 2012.
[NS]Non-significant; Fisher's Protected LSD ($P \leq 0.05$).

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

Treatment	pH[NS]	EC[NS] (dS/m)	TSS[NS] (Brix)
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

[x]Data from four marketable fruits collected randomly from each treatment replication on August 7, 2012. EC = electrical conductivity; TSS = total soluble solutes or brix.
[NS]Non-significant; Fisher's Protected LSD ($P \leq 0.05$).

Figure 1. Tomato plants on June 28, 2012 inside the high tunnel at the ISU Armstrong Research Farm, Lewis, IA.

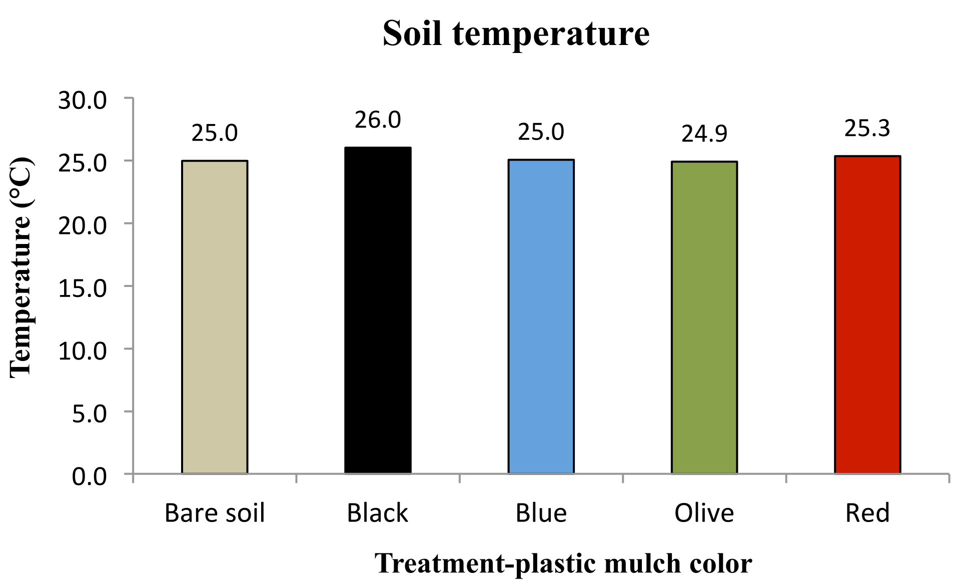

Figure 2. Average soil temperature collected during tomato growing season at 10 cm depth.