Fresh Market Tomato Yield Not Affected by Plastic Mulch Color

By H. G. Taber and Vince Lawson
Departments of Horticulture and Outlying Farms, Iowa State University, Ames, Iowa 50011
taber@iastate.edu

Iowa early spring weather conditions are harsh and the soils cold. Thus, a plasticulture system consisting of ground mulch, row covers, and a winter cover crop for wind protection is employed. Black plastic is the common mulch for Iowa tomato production with some acreage of the wavelength selective plastics. Clear mulch elevates the 4-inch soil temperature the most but is only used where weed control has been excellent with previous cropping practices. Almost all growers use a staked or caged training system. Although highest early yield is achieved with the plasticulture system there is some grower concern with high soil temperature in mid-summer on continued tomato plant vigor and fruit yield and fruit size.

As root temperature increases beyond the optimum, 79 ^{o}F, root length, mass, and the extent of branching decreases. Further, the amount of carbohydrates accumulated by the fruit decreases significantly. Recent fieldwork by the University of Georgia showed that optimal tomato fruit number per plant, individual fruit weight, total fruit yield per plant, and plant fresh weight occurred when the 4-inch soil temperature for the season did not exceed 77.7 to 79.3 ^{o}F. Soil temperature > 2 ^{o}F above the optimum significantly decreased fruit number and individual fruit weight. But, unlike northern latitudes, the southeast sets transplants in warm soils; and high soil temperature during seedling vegetative growth can have a very deleterious effect on subsequent fruit yield. High soil temperature with clear plastic may be especially acute when tomatoes are grown on coarse, sand soils where temperature moves progressively deeper in the soil profile and at a faster rate than in the finer textured soils with higher water holding capacity.

Our objective was to evaluate an early fresh market tomato variety, Mtn. Spring, for total yield and fruit quality when exposed to high mid-summer soil temperatures at the Muscatine Island Research Farm.

Materials and Methods

Planting: Transplants of Mtn. Spring set May 19, 2003.
Soil Type: Alluvial coarse, sand; organic matter content ≤ 1.5%; CEC of 2.5 to 5 meq/100 g.
Plot Design: RCB with 4 replications. Plot = one row 24 feet long with plant spacing of 17 inches in-row. The center 10 plants were used for data collection. All rows were staked, pruned to the 1st cluster, and tied. All plots trickle irrigated with Chapin cane, turbulent flow tubing.
Fertilizer, weed control, pest management: According to the standard practice of the area.
Treatments (ground mulches – laid May 14):

1. Clear (infrared, polyethylene, 0.6 mil)
2. Clear/White (the infrared painted white on June 13th)
3. Black (HD polyethylene, 0.7 mil)
4. Red (SRM embossed, 1.0 mil)
5. Silver (SRM, HD polyethylene, printed, 0.75 mil)

Data Collection:
Soil: soil temperature at the 4-inch depth continuously monitored by thermocouples attached to a Campbell Scientific CR10 data logger. The scan rate was every 2 minutes and values averaged hourly and daily.
Fruit: Ripe fruit (at least 30% color) harvested from the center 10 plants of each plot once per week. Fruit were sorted into unmarketable and marketable and the number and weight of each category determined. Unmarketable fruit consisted of external defects of blotchy ripening (more than 5%), cracks, BER, and rots.

Results

Soil temperature effects
The 4-inch soil temperature data for each plastic treatment was averaged across 4 reps and presented as weekly means (Table 1, Fig. 1). There were significant differences among the mulches in soil warming characteristics up to June 13 at which time the weekly average air temperature dramatically rose 11 ^{o}F and remained near 77 ^{o}F until August 14th. The soil temperature effects were infrared > red = black > silver. On June 13th (after the appearance of anthesis on the first flower cluster) the infrared plastic was painted white (trt. #2) to lower the soil temperature, and this significant cooling effect was noted the rest of the season to the first harvest on August 5 (Table 2). From June 24 to the end of the season there was little difference in the soil temperature. We noted during this period that the staked crop provided some shading to the area of thermocouple measurement which was on the outside edge of the wetted pattern. The trickle system was run 2X daily to keep up with ET demand, and on this coarse sand soil very little root development occurred outside the wetted zone.

Fruit Performance
Plastic mulch type did not affect total fruit yield or individual fruit size (Table 3). This effect was the same when considering early yield, the August 5 harvest. At final harvest, August 21, all green fruit remaining on the plant were harvested to determine the effect of plastic mulch on the progression of fruit development and maturation. As with total red fruit, there was no effect of plastic type on green fruit development (Table 4). Green fruit remaining on August 21 represented 4.8 % of total fruit produced.

The growing season air temperature was below normal until August averaging –1.8, -2.5, -1.0, and +2.7 ^{o}F for May, June, July and August, respectively. The August heat spell started August 14 with maximum temperature > 90 ^{o}F daily through the end of the month. However, the high temperatures did not affect the trial as harvest was complete by August 21.

Table 1. The weekly average 4-inch soil temperature for plastic mulch types. Tomato row direction was north-south and thermocouples were placed on the east side of the row approximately 4 inches from the center line. This position was on the outside edge of the trickle irrigation wetting pattern. Temperature in ^{o}F.

Week	Infrared	InfraWhite	Black	Silver	Red	Air
27-May	76.3	76.7	69.2	67.5	69.2	17.6
3-Jun	78.6	79.0	73.0	71.4	73.9	19.7
10-Jun	72.3	72.6	69.6	68.7	70.3	19.9
17-Jun	79.9	78.5	77.3	75.9	78.6	24.8
24-Jun	80.6	76.9	78.7	78.3	79.1	24.1
1-Jul	80.8	78.1	79.9	78.3	79.3	25.6
8-Jul	82.8	80.3	82.7	82.7	81.8	29.4
15-Jul	78.8	76.9	78.2	77.3	77.7	25.7
22-Jul	81.0	79.2	81.0	79.8	80.1	26.6
29-Jul	78.6	76.8	78.4	77.4	77.6	25.3
5-Aug	79.2	77.7	79.5	77.9	79.5	26.9
12-Aug	78.6	77.6	78.9	77.6	77.7	24.9
19-Aug	78.6	77.5	79.6	77.5	77.6	26.9
26-Aug	79.7	79.6	81.7	80.5	79.8	27.3
2-Sep	79.3	78.8	79.5	78.6	78.8	25.2

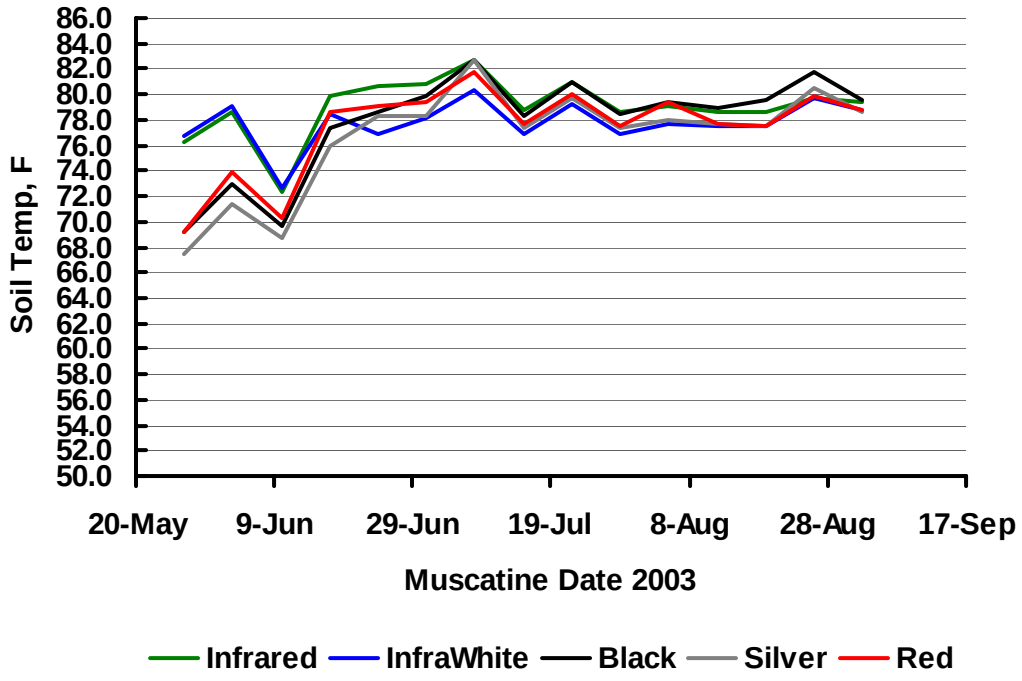

Fig. 1. A graphic representation of the data in table 1, except for air temperature.

Table 2. The average weekly 4-inch depth soil temperature from June 24 to Aug. 5, 2003. This time period represents the infrared painted white treatment.

Plastic Mulch	^{o}F
Infrared	80.2 A
InfraWhite	77.9 B
Black	79.7 A
Red	79.3 A
Silver	78.8 A

Mean separation by DMRT, 5% level.

Table 3. Plastic color mulch effect on total fruit produced and fruit size from Aug 1 to Aug 21, 2003.

	----------Cwt/acre ----------				Fruit Size, lbs ea.	
Mulch Type	Large	Small	Total Mkt	Total Yield	Large	Small
Black	164	51	215	389	0.53	0.25
Infrared	203	53	256	434	0.55	0.27
Infra/White	211	42	252	443	0.58	0.29
Red	205	65	270	396	0.53	0.27
Silver	198	62	260	429	0.56	0.28
Sign., P>.05	NS	NS	NS	NS	NS	NS

Table 4. Influence of plastic mulch type on maturation of green fruit remaining after final harvest, August 21, 2003.

Mulch Type	Green Fruit	Green Fruit Size
	---- cwt/acre ----	---- lbs ea ---
Black	21	0.22
Infrared	15	0.24
Infra/White	23	0.25
Red	20	0.21
Silver	20	0.23
Significance, P > 0.05	NS	NS