Black Polyethylene Mulch Does Not Reduce Yield of Cucumbers Double-cropped with Tomatoes under Heat Stress

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Abstract. Black polyethylene mulch is preferred for producing early spring tomatoes (Lycopersicon esculentum Mill.) because of its warming effect on the soil around the roots. However, the use of the mulch for double-cropping cucumbers (Cucumis sativus L.) with tomatoes is considered by some growers to be undesirable because of the belief that heat accumulation under the mulch in midsummer or early fall is detrimental to cucumber yield. Eight studies were conducted from July to September in 1994, 1995, and 1996 to determine the effects of mulching spring tomatoes with black vs. white polyethylene mulch on the growth and yield of subsequent cucumber crops. Soil temperature recorded after planting cucumbers at 4:00 PM for 3 weeks was higher under black mulch than under white mulch. Color of the mulch did not affect leaf length, leaf width, and plant dry weight of cucumbers in six of the eight studies. Cucumbers grown on black mulch produced longer leaves in one study and wider leaves in two studies, and plant dry weight was lower in two studies. Mulch color had no significant effect on the premium or total yields of cucumbers in two studies. Cucumbers grown on black mulch produced lower percentages of culls in two studies.

Table 1. Planting dates, harvesting period of cucumbers, and soil temperature under black and white polyethylene mulch.

| Planting date in field | Harvesting period | Avg temp (°C) |
|------------------------|-------------------|---------------|
|                        | 1994              | Black mulch   | White mulch  |
| 12 July 19 Aug.–7 Oct. | 34.0              | 32.7          |
| 19 Aug. 30 Sept.–26 Oct.| 31.9              | 30.2          |
|                        | 1995              |               |              |
| 1 July 14 Aug.–8 Sept. | 35.8              | 33.4          |
| 1 Aug. 11 Sept.–13 Oct.| 36.2              | 34.9          |
| 1 Sept. 18 Oct.–7 Nov. | 30.9              | 29.7          |
|                        | 1996              |               |              |
| 1 July 21 Aug.–18 Sept.| 33.8              | 32.0          |
| 1 Aug. 12 Sept.–10 Oct.| 33.5              | 31.7          |
| 2 Sept. 18 Oct.–30 Oct.| 31.2              | 29.9          |

Materials and Methods

Cucumbers were double-cropped with tomatoes twice in 1994 and three times in 1995 and 1996. Planting dates, harvest periods of cucumber crops, and soil temperature under both black and white polyethylene mulch were recorded (Table 1). Cucumbers were transplanted on equal number of black and white polyethylene mulched and drip-irrigated plots (raised beds) in early April of each year. Fertilizer rates and other cultural practices consisted of standard recommendations for growing staked tomatoes for fresh market production in Louisiana (Boudreaux, 1998). On their removal after the last harvest in early July, the plots were sprayed with N-(phosphonomethyl) glycine (glyphosate) at 3.4 kg ha−1 to kill existing vegetation and expose the mulched plots to sun light. ‘Dasher II’ blend cucumber hybrid (12% Poinsett 76 pollinizer) was transplanted at July planting and direct-seeded at all other planting dates into 1.5 x 10-m tomato plots, with 30 cm between plants within a row. Transplants were raised in the greenhouse for 2 weeks prior to the July planting to allow for extra time to remove tomato plants from the field and clean the test plots. The black and white mulch treatments were replicated four times in a randomized complete-block design. Following transplanting or germination of direct seeded cucumbers, soil temperature was recorded at 10-cm depth = 4:00 PM at the center of each plot for 3 weeks using a handheld soil thermometer, and average temperature was calculated. Cucumber plants were trained vertically using existing tomato stakes for support (Hanna, 1993) and fertilized by injecting Nat 14 kg ha−1 from ammonium nitrate through the drip-irrigation system when the plants reached the third-leaf stage. Two more applications of equal amounts were made at 3-week intervals following the first application.

The length and width of 25 randomly selected mature leaves were measured during the 2nd week of harvest of each cucumber crop. All plants in each plot were removed without root or fruit after the last harvest and oven-dried at 71 °C for 5 d, and dry weight per plant was determined. Cucumbers were harvested three times each week and fruit were graded according to U.S. Dept. of Agriculture (1958) for U.S. Fancy, No. 1, No. 2, and culls.

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Results and Discussion

Soil temperatures was higher under black than under white mulch in all tests (P ≤ 0.05, t test; Table 1). Graham et al. (1995) and Hanna et al. (1997) obtained similar results in double and single-cropped mulched beds respectively. Leaf length, leaf width, and plant dry weight of cucumbers planted on black mulch did not differ significantly from those of cucumbers planted on white mulch with few exceptions (Table 2). These exceptions included longer leaves on black mulch in Sept. 1996, wider leaves on black mulch in July and Aug. 1994, and lower plant dry weight on black mulch in July and Aug. 1995 (Table 2).

Premium and total yields of cucumbers planted in July and Aug., 1994, 1995, and 1996 were not affected significantly by color of the mulch (Table 3). Mulch color had no significant effect on the yield of cucumbers planted in Sept. 1995, but black mulch significantly increased the premium and total yields of cucumbers planted in Sept. 1996 (Table 3). Cucumbers planted in Aug., 1995 and Sept. 1996 had significantly lower percentages of culls on black than on white mulch (Table 3). Producing early spring fresh-market tomatoes on black polyethylene mulch is a well established cultural practice (Sweeney et al., 1987). However, planting a second crop in the summer following spring tomatoes on the same black mulch is considered by some growers to be undesirable, apparently because of the belief that heat accumulation under the black mulch in July and August would be detrimental to the second crop (Graham et al., 1995). Results of these studies indicate that these concerns are unfounded. Growth and yield of cucumbers were similar when planted on black or white polyethylene mulch. Regardless of mulch color, cucumber yield declined noticeably when planting was delayed until August and declined further by delaying planting until September.

Cucumber growers should make every effort to plant cucumbers following tomatoes as early as possible in July to maximize cucumber yields. Seeding cucumbers in the greenhouse in early July and transplanting in the field a few weeks later is a good practice and should allow the grower plenty of time to clean tomato fields before planting cucumbers.

Results of these studies should encourage tomato growers to consider the numerous benefits of double-cropping tomatoes with cucumbers. Benefits include reducing overhead costs by using the polyethylene mulch, drip irrigation, and trellising system for both crops. Residual fertilizer remaining in the soil after the termination of tomato harvest can be utilized by the cucumber crop and reduces the need for additional application.

Limiting fertilizer use, eliminating the need for new polyethylene mulch and drip irrigation materials, and possible reduction in herbicide use could contribute positively to environmentally sound multiple use of land.

| Table 2. Effect of mulch color on leaf length, leaf width, and plant dry weight of cucumbers double-cropped with tomatoes. |
|---------------------------------------------------------------|
| **Mulch color** | **Leaf length (cm)** | **Leaf width (cm)** | **Plant dry wt (g)** |
| **1994** | **1995** | **1996** | **1994** | **1995** | **1996** | **1994** | **1995** | **1996** |
| **July planting** | | | | | | | | | |
| White | 13.4 | 13.3 | 13.0 | 17.0 | 16.7 | 16.8 | 75.9 | 70.0 | 64.4 |
| Black | 13.7 | 13.4 | 12.9 | 17.5 | 17.0 | 16.6 | 68.4 | 64.2 | 63.4 |
| Significance | NS | NS | NS | * | NS | NS | NS | * | NS |
| **August planting** | | | | | | | | | |
| White | 11.2 | 14.5 | 11.8 | 15.0 | 18.2 | 15.8 | 28.5 | 60.9 | 67.5 |
| Black | 11.4 | 14.3 | 12.5 | 15.3 | 18.2 | 16.4 | 26.0 | 52.9 | 67.1 |
| Significance | NS | NS | NS | * | NS | NS | ** | NS | NS |
| **September planting** | | | | | | | | | |
| White | 11.8 | 11.3 | 15.4 | 15.6 | 53.7 | 55.7 |
| Black | 11.7 | 12.4 | 15.1 | 16.7 | 50.7 | 59.7 |
| Significance | NS | NS | NS | NS | NS | NS |

| Table 3. Effect of mulch color on yield of cucumbers double-cropped with tomatoes. |
|---------------------------------------------------------------|
| **Mulch color** | **Premium yield (Mg·ha⁻¹)** | **Total yield (Mg·ha⁻¹)** | **Culls (%)** |
| **1994** | **1995** | **1996** | **1994** | **1995** | **1996** | **1994** | **1995** | **1996** |
| **July planting** | | | | | | | | | |
| White | 37.3 | 37.2 | 37.6 | 44.9 | 43.0 | 48.6 | 16.1 | 11.9 | 13.2 |
| Black | 36.1 | 34.4 | 35.2 | 42.8 | 40.7 | 45.6 | 14.5 | 12.4 | 12.4 |
| Significance | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **August planting** | | | | | | | | | |
| White | 12.3 | 29.6 | 21.2 | 14.8 | 35.4 | 30.3 | 11.8 | 12.6 | 15.8 |
| Black | 12.3 | 28.3 | 24.8 | 14.9 | 35.5 | 33.1 | 12.0 | 10.0 | 12.3 |
| Significance | NS | NS | NS | NS | NS | NS | ** | NS | NS |
| **September planting** | | | | | | | | | |
| White | 9.4 | 6.7 | 12.3 | 10.6 | 12.5 | 17.1 |
| Black | 10.4 | 10.5 | 13.3 | 15.5 | 9.4 | 8.4 |
| Significance | NS | NS | NS | NS | NS | NS |

*NS, **Nonsignificant or significant at P ≤ 0.05 or 0.01, respectively.

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