Shading of Tomato Plants Inconsistently Affects Fruit Yield

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High day and/or night temperatures interfere with tomato fruit set (Berry and Uddin, 1988). Incorporating genetic resistance to detrimental effects of high temperature on tomato fruit set has not had uniform success. Thus, cultural methods are needed to supply tomato fruit for existing market windows. In the southern Plains, planting tomato by mid-April will produce marketable yields of $\approx 25 \text{ t} \cdot \text{ha}^{-1}$ (Oklahoma State Univ., 1989, 1990). Day and night temperatures increase and yields tend to decrease as the season progresses. This experiment was designed to determine if shading could be used to increase yields and extend tomato fruit production season.

The experiment was conducted on a Bernow fine-loamy, siliceous, thermic Glossic Paleudalf soil at Lane, Okla. Fertilizer was applied at recommended rates when rough beds, lying east to west, were formed. Final beds, on 1.8-m centers, were 20 cm high and 0.8 m wide. Plots were 6.1 m long with 2.4-m alleys between them. Black plastic mulch (0.032 mm thick) and drip irrigation (23 cm between emitters) were applied after beds were formed. Six-week-old greenhouse-grown tomato (*Lycopersicon esculentum* Mill. cvs. Flash and Sunny) seedlings were transplanted 0.45 m apart on 15 May, 15 June, and 15 July in 1991 and 1992, with 12 plants per treatment. These cultivars are considered poor fruit setters under high temperatures.

In one-half of the plots, 1-m-wide, black, polypropylene 63% shade fabric was attached to cross members of T-shaped supports (1.6-cm-diameter reinforcing bar, 1.25 m above the bed surface) and to wire strung between cross member tips extending the length of the plots. The shade cloth, put in place 3 weeks after transplanting, was draped over the bed ends and secured to exclude direct solar radiation. Only reinforcing bar was placed in control beds. Plants were supported using the stake and weave method (Rhoads et al., 1988). Maximum-minimum temperature thermometers, suspended near centers of shaded and nonshaded plots 0.75 m above the bed surface, were monitored daily. Air temperatures and precipitation were recorded at a nearby weather station.

The factorial experiments (two cultivars $\times$ three planting dates $\times$ two shade treatments) were replicated four times in a randomized complete block. Fruit were harvested twice weekly. The last harvest was determined by the size of remaining fruit and the possibility that they would be harvestable. Total and marketable (≥ 58 to 64 mm in diameter) fruit yields were recorded. In 1992, dry weight of the above-ground vegetative tissues from each planting date was recorded after the last harvest. Data were analyzed using general linear models in SAS (SAS, Inc., Cary, N.C.).

Average maximum and minimum air temperatures and total precipitation for cropping periods differed. In 1991, the average air minimum and maximum were 19.4 and 31.7°C, respectively. In 1992, they were 16.8 and 28.7°C, ranging to $\approx 37^\circ\text{C}$ or above. Shade reduced the average air minimum and maximum by 1.0 and 2.5°C, respectively, in both years.

Planting month interacted with shade to affect total and marketable fruit yields (Table 1). Shade improved total fruit yield of plants established in June 1991, but failed to affect fruit yield for plants established in any month in 1992. Shading increased shoot dry weight and interacted with planting date and cultivar to influence shoot dry weights in 1992 (Table 1). Shoots of shaded 'Sunny' plants were heavier than those of nonshaded plants only when planted in May. Shade and planting

month had no effect on shoot dry weights (average 89 g) for 'Flash' plants. Plants established in May and June, but not July, had dry weights positively correlated ($P \leq 0.01$) with total and marketable fruit yield (data not shown). The relationship between shoot dry weight and fruit yield may not have developed for plants established in July due to the shorter production period.

For glasshouse tomatoes planted in November, shading up to 23% reduced estimated total above-ground biomass (Cockshull et al., 1992). The temperatures recorded in Oklahoma were similar to those reported by Dane et al. (1991) as being detrimental to fruit set and pollen fertility of several tomato cultivars. Although shade-lowered air temperatures can favor fruit set, shading may have reduced net photosynthesis, or interfered with light-controlled plant morphogenesis, favoring vegetative development (Logendra et al., 1990).

Shading did not increase tomato fruit yield consistently, and its use is not justified.

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Table 1. Effect of planting month (P), cultivar (CV), and shading (S) on tomato total and marketable fruit yield, and shoot dry weight.

Treatment		Year					
		1991		1992		Shoot dry wt	
		Fruit yield ($\text{t} \cdot \text{ha}^{-1}$)		Fruit yield ($\text{t} \cdot \text{ha}^{-1}$)		(g/shoot)	
Planting month	Shade	Total	Marketable	Total	Marketable	Sunny	Flash
May	Yes	28.1	21.5	19.5 ^a	12.0 ^a	134	99
	No	36.7**	26.9**	18.4	6.5	57*	119 ^{ns}
June	Yes	12.5	6.9	16.0	7.9	107	106
	No	6.9*	3.7 ^{ns}	10.6	3.8	78 ^{ns}	66 ^{ns}
July	Yes	1.5	1.0	2.2	1.5	89	81
	No	0.3 ^{ns}	0.2 ^{ns}	2.9	1.4	87 ^{ns}	61 ^{ns}
F test significances ^y							
P		**	**	**	**		NS
S		NS	NS	NS	NS		*
CV		NS	NS	NS	NS		NS
P $\times$ S		**	**	NS	NS		NS
P $\times$ CV		NS	NS	NS	NS		NS
CV $\times$ S		NS	NS	NS	NS		NS
P $\times$ S $\times$ CV		NS	NS	NS	NS		*

^aValues in these columns were not compared since the interaction was determined to be nonsignificant.

^yNonsignificant (NS) or significant at $P \leq 0.05$ (*) or 0.01 (**).

^{ns,*,**}Values of compared shade pairs were nonsignificant or significantly different at $P \leq 0.05$ or 0.01, respectively, by least squares means.

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