Effect of Shade on Quality of Greenhouse Tomato

Martin P.N. Gent, Dept of Forestry & Horticulture
The Connecticut Agricultural Experiment Station
PO Box 1106, New Haven, CT 06504
Phone: 203-974-8489   E-mail: Martin.Gent@po.state.ct.us

What amount of shade is optimal for the production of high quality tomatoes in a greenhouse? Horticultural science and plant physiology suggest that when grown in a greenhouse, the quality of tomato fruit may benefit from some shade. High light and temperature can induce the skin of the tomato fruit to crack, and alter metabolism leading to uneven ripening. On the other hand, the rate of production or total yield typically increases with the amount of available sunlight. Is there a level of shade that increase fruit quality more than it decreases the rate of production? This critical amount of shade likely will depend on more than ambient sunlight. In terms of greenhouse microclimate, it is likely to depend on air temperature, humidity, and day length, as these all influence aspects of plant physiology related to fruit development and composition.

In previous years, I noted that the quality of greenhouse tomato fruit depended on whether the greenhouses were shaded during the summer months. Tomatoes were grown in a similar way in the years from 1999 through 2002, except that in some years the greenhouses were covered with reflective aluminized cloth that provided 30% shade, and in other years the greenhouses were unshaded. In years when the greenhouses were covered with shade cloth, the fraction of a fruit that was marketable was 10 to 20% greater than in years when the greenhouses were not shaded (Table 1).

The planting in 1999 was late, summer was hot and sunny, and there was no shade cloth on the greenhouses. This combination resulted in the poorest fruit quality of any year of these trials. The incidences of fruit with cracked skin, green shoulder, or blossom end rot were higher in 1999 than in any other year. Seedlings were not set at the final spacing until 20 May and plants did not start to produce until mid-July. This trial also had the lowest yields, in part because the rate of production was slowed by decreasing light intensity in September.

In 2000 and 2001, shade cloth was applied to the greenhouses in mid June. The spring of 2000 was warm and sunny, but summer was cool and wet. Plants were set at the final spacing on 23 Feb and fruit production commenced on 12 May, earlier than in other years. The final harvest was 15 Aug 2000. The summer of 2001was warm. Plants were set at the final spacing on 7 March and fruit production commenced on 1 May. The yield characteristics were similar in these two years, except fruit size was one ounce larger in 2001 than in 2000. Because of the difference in fruit size, the incidence of fruit with cracked skin was slightly greater in 2001 than 2000. Nevertheless, this was a much lower incidence of fruit with cracked skin, green shoulder or blossom end rot than in 1999.

Shade cloth was not applied in 2002, and summer temperatures were average. Plants were set at the final spacing on 20 March, fruit production began on 4 June, and picking continued to 26 August. Although the highest yields were achieved in 2002, only 44% of the total yield was marketable, compared to 56 to 58% in 2000 and 2001. Thus marketable yield in 2002 was reduced due to a lack of shade, primarily due to a greater incidence of cracked skin and green shoulder or uneven ripening.

This last summer, I attempted to determine the effects of shade more precisely through simultaneous comparisons among greenhouses covered with different amounts of shade, varying from none to 50 percent shade. The houses were either uncovered, or covered with reflective aluminized shade cloth that provided 0, 15%, 30% or 50% shade. The shade was applied at the start of the first warm weather in early June corresponding to the start of fruit production. The houses remained shaded for the rest of the summer, and fruit was picked until late August. Plants were set at the final spacing on 24 March, fruit production began on 9 June, and picking continued to 29 August 2003.

This comparison demonstrated some interesting points. First, the rate of fruit production did not respond immediately to the amount of shade applied. There was essentially no difference in the production in June, and yield in July was reduced in only two of three shaded conditions. However in August, the reduction in yield due to shade became obvious. Thus the effect of shade on the yield of fruiting tomato plants developed gradually. It took more than one month to have an obvious effect.

Second, shade affected fruit size immediately following the application of shade to the greenhouses. The size of fruit decreased with the amount of shade, for the tomatoes picked within two or three weeks of application of shade. However, this effect was not so clear in the following month, and the 30% shade treatment produced the largest fruit. In August, there was a trend towards larger fruit in the unshaded house, although this trend was smaller than in June. The rapid effect of shade on fruit size probably resulted from the fact that the number of ripening fruit was fixed. These had to compete for a reduced supply of carbohydrates. Later on the plants probably adapted to a change in carbohydrate supply by altering the number of fruit set.

A Farmer is more interested in marketable production rather than total production. Shade tended to increase the fraction of fruit that was marketable, so although total yield was reduced by shade, marketable yield was affected less. In the comparison of different levels of shade in 2003, the 15% shade treatment had the highest marketable yield in June. The treatments with more shade yielded less marketable fruit that the unshaded treatment. In August, there was a more obvious trend towards lower marketable yields in houses with more shade. Over the entire 2003 season, the unshaded greenhouse produced the highest total and marketable yield.

Cracked skin was the defect most affected by shade. About 35% of the fruit produced in unshaded greenhouses had cracked skin, whereas only 25% of tomatoes in greenhouses with

50% shade had cracked skin (Table 2). Some 6 to 8% of fruit had blossom end rot. The fraction with this defect declined slightly as more shade was applied. Very few fruit had uneven ripening or green shoulder, as all the cultivars used in 2003 had the even ripening gene.

The summer of 2003 was relatively cloudy. It is likely that there were more deleterious effects of shade, and less of beneficial effects than would be seen in a summer with more normal weather. Averaged over the entire season in 2003, there was no benefit of any degree of shade compared to no shade, because total yield was decreased more than fruit quality was increased. In previous summers it seemed that the increase in fruit quality due to shade outweighed the decreasing yield or fruit size. I am planning to continue these experiments in future seasons, to look more closely at cultivars that tend to have poor quality in unshaded greenhouses.

Table 1. Yield characteristics of tomato that varied from year to year depending on whether shade cloth was applied to the greenhouses in the years 1999 through 2002.

		Total	Market	Market	Fruit	Percent of total		
		pounds/	pounds/	fraction	size	Cracks	Green	Blossom
Year	Shade	plant	plant	weight%	ounce	in skin	shoulder	end rot
1999	None	8.7	2.7	32	4.2	40	13	9
2000	30%	14.1	8.1	58	4.5	15	5	1
2001	30%	13.7	7.6	56	5.8	21	5	1
2002	None	15.7	7.1	44	6.2	30	14	4

Table 2. Yield characteristics of tomato in 2003 as a function of different amounts of shade provided by reflective aluminized cloth applied to the greenhouses.

	Total	Market	Market	Fruit	Percent of total		
	pounds/	pounds/	fraction	size	Cracks	Green	Blossom
Shade	plant	plant	weight%	ounce	in skin	shoulder	end rot
None	14.5	7.8	54	7.4	34	1.5	7.6
15%	13.4	7.6	57	7.2	29	1.5	6.2
30%	13.0	7.1	54	7.3	30	1.0	7.2
50%	11.2	7.0	63	6.8	25	1.1	5.9