Environmental Effects on Fruit Ripening and Average Fruit Weight for Three Peach Cultivars

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Abstract

Three peach cultivars, 'Crimson Lady' (early), 'Redhaven' (mid-season) and 'Cresthaven' (late), were planted at twelve locations within the USA in 2009. All trees were grafted on 'Lovell' rootstock and came from the same nursery. Five trees of each cultivar were planted at a spacing of 6 m by 5 m at each location. In 2012, eight locations were able to participate in the study. In order to obtain maximum fruit growth, trees were thinned to about 40-50 fruit within 30-40 days of bloom, were irrigated when needed and kept free of diseases and pests. When fruit started to soften (tree ripe), a first harvest was initiated. The second, and last, harvest occurred about one week later. Individual fruit were weighed and a composite sample per tree was used to measure percent soluble solids content (SSC) with a refractometer. Daily weather parameters of maximum and minimum temperatures, solar radiation, precipitation and average humidity were measured in close proximity to the orchard. Full bloom dates ranged from early March to early May for the different locations. Time from full bloom to harvest varied by about 30 days among locations for all three cultivars. This parameter correlated very well with average temperature (average of daily maximum and minimum) for 60 days after bloom. Correlation coefficients were -0.94, -0.96 and -0.98 for the three cultivars, respectively. Average fruit weight varied among sites from 141 g to 216 g for 'Crimson Lady', 159 g to 313 g for 'Redhaven' and 152 g to 413 g for 'Cresthaven'. This parameter correlated well with average solar radiation from bloom to harvest for 'Redhaven' ($r = 0.87$) and 'Cresthaven' ($r = 0.73$), but not 'Crimson Lady'. The relationship with 'Cresthaven' was significantly improved by adding in the factor of average temperature for 20 days after bloom ($r^2 = 0.91$). Cooler temperatures were

associated with larger fruit. No weather parameters correlated well with 'Crimson Lady' fruit weight or with SSC for any of the three cultivars. The study will continue for at least 2 more years to obtain more robust relationships.

INTRODUCTION

Weather conditions are well known to affect harvest date, fruit growth and fruit quality (Boonprakob et al., 1992; Lopez and DeJong, 2007; Lopez et al., 2007; Marra et al., 2002; Topp and Sherman, 1989; Weinberger, 1948). From previous work (Johnson et al., 2011), it was established that 'Cresthaven' peach fruit weight varies substantially from one location to another. Weather factors contributing to this variability included early spring temperatures and solar radiation. To expand on these results and verify the relationships, it was decided to add additional cultivars and locations.

MATERIALS AND METHODS

In 2009, 12 locations that were participating in a NC-140 peach rootstock trial planted 8 to 10 additional trees of 'Crimson Lady', 'Redhaven' and 'Cresthaven' peach cultivars on 'Lovell' rootstock. All trees were propagated by the same nursery and planted in the following locations: Clanton, Alabama; Fayetteville, Arkansas; Parlier, California; Grand Junction, Colorado; Byron, Georgia; Parma, Idaho; Brownstown, Illinois; Princeton, Kentucky; Wye Mills, Maryland; Geneva, New York; Seneca, South Carolina; and Kaysville, Utah. Trees were planted at a 5 m x 6 m spacing and trained to an open vase. In 2012, 5 healthy trees of each cultivar were selected for the study. Within 30 to 40 days of bloom, they were thinned to a single fruit per shoot, usually no more than 40 to 50 fruit per tree. Trees were irrigated and kept free of insect and disease problems so that maximum fruit growth could be achieved. First harvest was initiated when some fruit were full color and starting to soften (tree ripe). The second and final harvest was approximately one week later. All defective and unripe fruit were discarded. Measurements were taken of individual fruit weights and percent soluble solids content (SSC) of a composite sample from each tree. Harvest date was an estimate of when 50% of the fruit reached tree ripe maturity. Full bloom was set on the date when 90% of the flowers were open. Between these two dates, the following daily parameters were recorded from a weather station near each orchard: maximum and minimum air temperature, average relative humidity, precipitation and solar radiation. Averages for each of these parameters were calculated for the whole period and for 20, 40, 60, and 80 days after bloom and for 20, 40 and 60 days before harvest. Standard regression analysis was carried out between fruit weight, SSC, days from bloom to harvest and each of these weather variables.

RESULTS AND DISCUSSION

Bloom dates and harvest dates differed considerably among the 8 sites in this experiment (Table 1). Both varied by about 2 months for each of the 3 cultivars. Days from bloom to harvest ranged from 64 to 94 days, 82 to 120 days and 114 to 141 days for 'Crimson Lady', 'Redhaven' and 'Cresthaven', respectively. The weather variables were also quite different among the sites (data not shown) and often did not correlate with each other. For example, there was no correlation between average temperature and solar radiation for 20 days after bloom among the 8 locations. Thus, this dataset should allow for increased ability to separate out the weather conditions that have the greatest effect on fruit growth and quality.

As has been well established, there is a strong relationship between days from bloom to harvest and early spring temperatures (Boonprakob et al., 1992; Lopez and DeJong, 2007; Marra et al., 2002; Topp and Sherman, 1989; Weinberger, 1948). Other studies have used average temperatures anywhere from 25 to 52 days after bloom (Boonprakob et al., 1992; Marra et al., 2002; Weinberger, 1948). In our experiment, we found significant correlations by using the time period for just 20 days after bloom, but the best relationship was with 60 days after bloom. Correlation coefficients were -0.84, -0.84, and -0.88 at 20 days and -0.94, -0.96 and -0.98 at 60 days for 'Crimson Lady', 'Redhaven'

and ‘Cresthaven’, respectively (Fig. 1). A couple of studies have suggested the slope of this relationship varies from one cultivar to another (Boonprakob et al., 1992; Marra et al., 2002). The three cultivars in our study were very similar, having slopes of 4.5, 5.4 and 4.9 days/°C for ‘Crimson Lady’, ‘Redhaven’ and ‘Cresthaven’, respectively. This agrees well with the slope of 5.0 days/°C reported by Topp and Sherman (1989) for 22 low-chill cultivars in Australia. Boonprakob et al. (1992), reported slopes ranging from 1.8 to 5.7 days/°C for 8 cultivars.

Average fruit weight varied among sites from 141 g to 216 g for ‘Crimson Lady’, 159 g to 313 g for ‘Redhaven’ and 152 g to 413 g for ‘Cresthaven’ (Table 1). ‘Crimson Lady’ showed the least variability and only had 6 data points. No weather parameters correlated with fruit weight for this cultivar. Fruit weight for the other 2 cultivars correlated well with average solar radiation for the whole period from bloom to harvest (Figs. 2 and 3). Correlation coefficients were 0.87 and 0.73 for ‘Redhaven’ and ‘Cresthaven’, respectively. It makes physiological sense that increased solar radiation should lead to increased carbohydrate production by photosynthesis and thus increase the potential for fruit growth. Plans are underway to test this idea using a photosynthesis/fruit growth computer model. The ‘Cresthaven’ relationship was significantly improved by adding in the factor of average temperature for 20 days after bloom ($R^2 = 0.91$). This relationship is similar to the harvest delay correlation discussed above. Thus, cooler spring temperatures not only delayed harvest, but also led to larger fruit, at least for ‘Cresthaven’. The same relationship did not hold true for the other 2 cultivars.

With this limited dataset, no significant correlations were found between SSC and the different weather parameters. This experiment will continue for at least 2 more seasons so more data points can be generated and stronger relationships can be determined.

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Tables

Table 1. Bloom date, harvest date, fruit weight, % soluble solids content and select weather variables for three cultivars at eight locations of the peach physiology study in 2012.

Cultivar	State	Bloom date (m/d)	Harvest date (m/d)	Days bloom to harvest	Average fruit weight (g)	Soluble solids content (%)	Average temp. 60 days after bloom (°C)	Average solar radiation bloom to harvest (MJ/m^2)	Average temp. 20 days after bloom (°C)
'Crimson Lady'	CA	3/2	6/4	94	203	11.0	14.2	22.0	11.7
	GA	3/9	5/18	70	154	11.3	19.9	21.4	19.5
	ID	4/15	7/13	89	160	11.3	14.7	23.6	12.8
	MD	3/21	6/21	92	141	8.4	14.2	19.4	11.6
	NY	5/2	7/5	64	145	11.4	18.6	19.8	15.7
	SC	3/8	5/21	74	216	6.8	18.8	21.3	18.4
'Redhaven'	AL	3/7	6/8	93	159	11.8	19.4	20.1	18.9
	CA	3/9	6/26	109	313	11.8	15.1	23.6	12.5
	GA	3/24	6/14	82	183	12.8	20.4	22.9	19.0
	ID	4/15	8/8	115	283	10.9	14.7	24.0	12.8
	KY	3/16	6/19	95	193	12.6	17.4	21.4	19.4
	MD	3/23	7/21	120	161	13.0	14.3	20.0	11.0
	NY	5/1	7/29	89	159	10.4	18.4	19.2	15.3
	SC	3/15	6/16	93	263	10.4	19.4	23.0	20.3
'Cresthaven'	AL	3/10	7/2	114	152	14.3	19.9	21.3	19.6
	CA	3/13	7/26	135	413	13.3	15.7	24.6	12.8
	ID	4/16	9/1	138	386	14.1	14.8	23.4	12.6
	KY	3/20	7/22	124	173	14.8	17.4	21.4	17.7
	MD	3/24	8/12	141	267	13.2	14.3	19.9	10.5
	NY	5/2	8/25	115	193	15.3	18.6	18.8	15.7
	SC	3/15	7/12	119	290	14.0	19.4	23.6	20.3

Figures

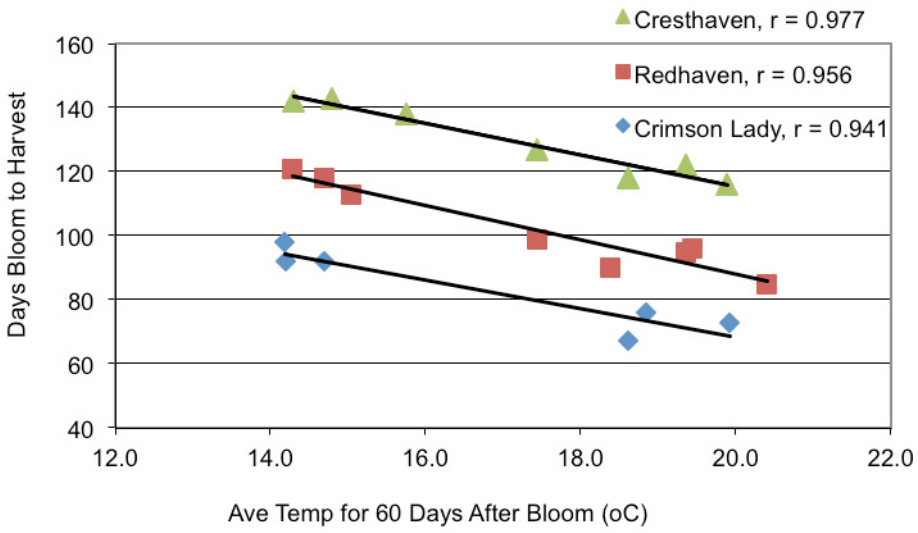

Fig. 1. The relationship between days from bloom to harvest and average temperature (°C) for 60 days after bloom for 'Crimson Lady', 'Redhaven' and 'Cresthaven' cultivars in the peach physiology study.

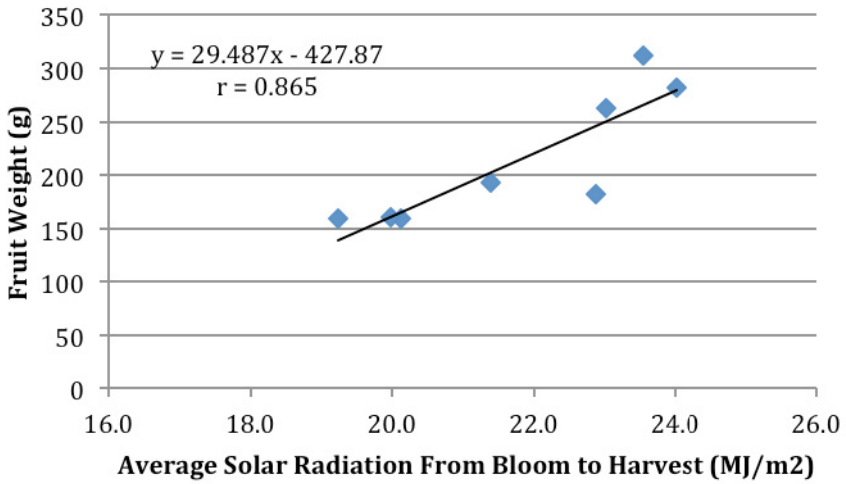

Fig. 2. The relationship between fruit weight and average solar radiation from bloom to harvest among 8 sites in 2012 for 'Redhaven' in the peach physiology study.

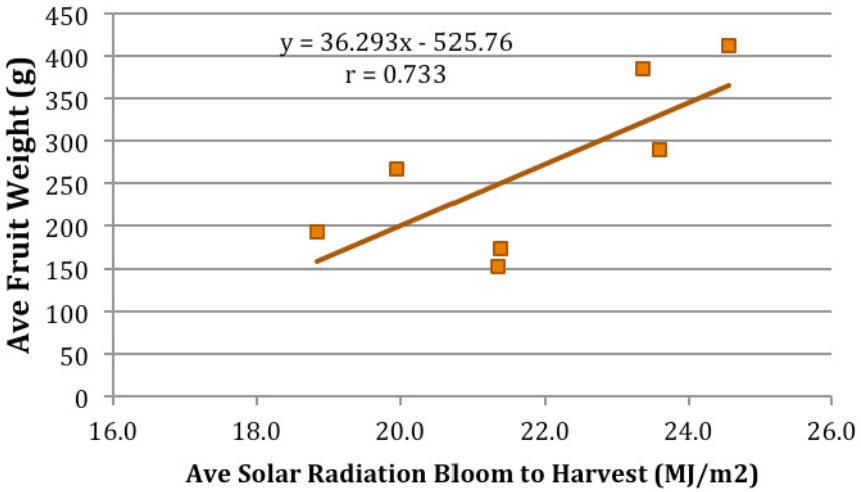

Fig. 3. The relationship between average fruit weight and average solar radiation from bloom to harvest among 7 sites in 2012 for 'Cresthaven' in the peach physiology study.