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Response of Fruit Development Period to Temperature During Specific Periods After Full Bloom in Peach

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Abstract

Much research has been conducted to evaluate the relationship of temperature on growth and development. Models for predicting harvest time are generally based on temperature data for the entire period of growth and development. In peaches, fruit development period (FDP) is not associated well with temperature data for the entire period. Temperature of 30 to 45 days after full bloom serves as the best predictor for FDP in early ripening peaches under Texas conditions. The FDP of these peach cultivars is influenced by temperature differently. The reduction of FDP varies from about 2 to 6 days with one degree increase in temperature.

Introduction

Temperature's association with time required for growth and development has long been recognized and used for building models to predict harvest time for various crops (Dufault et al., 1989; Hoover, 1955; Madariaga and Knott, 1951). These models for predicting harvest time were based on the temperature throughout entire cropping cycle. However, in fruit crops, prevailing temperature throughout entire development (full bloom to harvest) may not yield an accurate prediction. Kronenberg's (1988) analysis of data from ten apple cultivars in four different locations in Europe indicated only temperature during the first month after the onset of flowering and the period immediately before harvesting influenced the length of fruit development. In apricots, the mean daily temperature during first six weeks after full bloom served as a good criteria for predicting harvest time (Baker and Brook, 1944; Brown, 1952). In peaches, the most critical time for FDP was the first two months after full bloom (Topp and Sherman, 1989; Weinberger, 1948). These studies have shown that temperatures during specific periods after full bloom have profound effects on FDP in fruit crops.

The objectives of this paper are to examine the specific time period that is the best predictor of FDP, and to interpret differences or similarities of selected peach cultivars' response to temperature during this period.

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Materials and Methods

Eight early ripening peach cultivars which had a range of mean FDP from 65 to 87 days and chilling requirement of 150 to 650 chill units from three different locations in Texas were analyzed (Table 1). The date of full bloom (50-70% flowers open) to the first harvest date (20% fruit ripe) was recorded for each cultivar in each year and location. This time represented the FDP.

Daily maximum and minimum temperatures were collected from a climatological station from each location. The data of interest is the daily temperature from full bloom to harvest. Daily mean temperature $[(T_{max}+T_{min})/2]$ has been found to linearly associate well with FDP in peaches (Munoz et al., 1986). The daily mean temperature was used for calculating the average daily mean temperature of 15, 30, 45, 60, and 75 day intervals after full bloom of the cultivars.

These average daily mean temperatures of the periods were analyzed separately for each cultivar using the Statistic Analysis System (SAS, 1988). The average daily mean temperature (T_{mean}) of selected periods that yielded the highest coefficient of determination (r^2) with FDP was the best predictor of FDP. Rate of fruit development (RATE = 100/FDP) was analyzed in an analysis of covariance using the average daily mean temprature as the covariate to study cultivars' response to temperature.

Results and Discussion

The regression indicated that using the average daily mean temperature during selected periods as independent variable yielded higher r^2 value with FDP than did the mean temperature of entire FDP (Table 2). The selected periods ranged from 0-30 days in 'Early Amber,' 'Flordaking,' 'Flordaprince,' 'San Pedro,' 'Springcrest,' and 'Texstar' to 0-45 days in 'EarliGrande' and 'Junegold.'

These selected periods were associated with time during the 1st stage of the double-sigmoid growth pattern in peach development, which lasts about 4 to 6 weeks (Zucconi, 1986). The less significant effect of temperature beyond 30 to 45 days of FDP might be due to: 1) the greater year by year temperature variation of the first 30 to 45 days of FDP as compared to the latter stage of FDP, or 2) fruit development rate was optimized at the temperature experienced during the latter stage whereas in the early stage they were not. In addition, DeJong and Goudriaan (1989) found that peach fruits' relative growth rate remained relatively constant after fruit development reached the 2nd stage. Consequently, temperature after 30-45 days of full bloom yields less correlation with FDP.

Table 1. Peach cultivars used in study.

Cultivar	Chilling units[z]	Location[y]	Years
EarliGrande	250	CS	6
		YM	5
		WS	5
Early Amber	350	CS	6
		YM	6
Flordaking	450	CS	3
		YM	6
Flordaprince	150	CS	2
		YM	3
		WS	5
Junegold	650	CS	7
		YM	5
San Pedro	250	CS	4
		YM	4
		WS	5
Springcrest	650	CS	3
		YM	6
Texstar	550	CS	7
		YM	3

[z]According to relative time of bloom.
[y]CS = College Station, 31° N latitude.
YM = Yoakum, 29° N latitude.
WS = Weslaco, 26° N latitude

An analysis of covariance using the average daily mean temperature during selected periods as the covariate indicated cultivar, temperature, and cultivar × temperature interaction effects were highly significant. The interaction effect meant that if RATE (100/FDP) of each cultivar were regressed on temperature, all regression lines were not parallel (Figure 1). This result was comparable to Blake's (1930) observation indicating that fruits of peaches responded to spring temperature dissimilarly.

'Springcrest' had the highest slope indicating that it had the largest response to temperature change among the cultivars. With one degree increase in temperature, 'Springcrest' had its FDP decrease more than 5 days (Table 3). The FDP of 'Springcrest' was over 90 days in France where spring temperature was cooler (Lambertin A., per. com.).

For 'Early Amber' and 'Flordaking,' the change of their FDP to temperature change was similar; about 4 to 5 days decrease in FDP with a 1 °C increase in mean temperature (Table 3). Howevr, RATE (100/FDP) of 'Flordaking' is normally higher than of 'Early Amber' (Figure 1). As a result, the FDP of 'Flordaking' is shorter than that of 'Early Amber' when blooming at the same time with no other environmental stresses.

Table 2. Temperature as a predictor of fruit development period.

Cultivar	Mean FDP (days)	Selected period (days)	Selected period r^2	Entire FDP r^2
EarliGrande	83	0-45	0.84	0.57
Early Amber	82	0-30	0.81	0.20
Flordaking	78	0-30	0.79	0.39
Flordaprince	86	0-30	0.66	0.40
Junegold	77	0-45	0.57	0.43
San Pedro	87	0-30	0.60	0.25
Springcrest	65	0-30	0.83	0.70
Texstar	82	0-30	0.56	0.25

'EarliGrande,' 'Junegold,' and 'San Pedro' responded to temperature similarly (equal slopes and intercepts), so the change in their FDP was comparable. With one degree reduction in temperature, their FDP increased about 3 to 4 days (Table 3). If these cultivars were exposed to similar temperature after full bloom, their FDP would be approximately equal. The difference in their observed FDP is caused by their different full bloom dates which results in their fruits experiencing different temperature regimes.

'Flordaprince' and 'Texstar' had the least response of FDP to temperature change. The FDP was altered 2 to 3 days with a temperature change of one degree (Table 3). Thus, altering temperature after full bloom would change their FDP about one-half of that seen with 'Springcrest.'

Table 3. Estimated regression coefficients of rate of peach development with temperature.

Cultivar	Intercept (SD)	Slope (SD)	r^2	FDP/1°C[z]
EarliGrande	0.40 (0.10)	0.052 (0.006)	0.83	3.4
Early Amber	-0.01 (0.19)	0.080 (0.012)	0.81	5.0
Flordaking	0.12 (0.25)	0.078 (0.016)	0.77	4.2
Flordaprince	0.56 (0.17)	0.039 (0.011)	0.63	2.8
Junegold	0.37 (0.26)	0.053 (0.015)	0.56	3.6
San Pedro	0.40 (0.21)	0.049 (0.013)	0.56	3.5
Springcrest	-0.33 (0.31)	0.108 (0.018)	0.84	5.7
Texstar	0.78 (0.14)	0.026 (0.008)	0.53	1.8

[z]Average change FDP (days) in 1 °C change within 14-18 °C range.

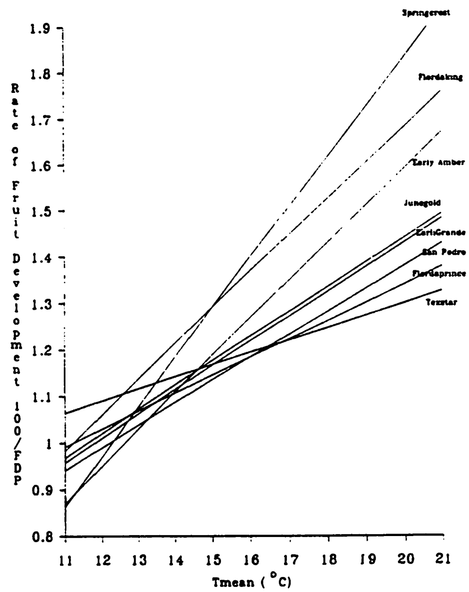

Figure 1. Estimated regression lines of RATE on T_{mean}.

Conclusions

The average daily mean temperature during the first 30 to 45 days of fruit development yielded a better predictor of FDP than did the mean daily temperature for entire FDP. Fruit development response to temperature was not similar among the medium to low chill early ripening peach cultivars examined. 'Springcrest' responded twice as much to temperature change as 'Flordaprince' and 'Texstar.' The other cultivars fell between these extremes. Fruit development period of peaches is genetically controlled (Vileila-Morales et al., 1981) and is influenced by temperature. The result indicated that the influence of temperature on FDP was different among peach cultivars.

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