Pheno-climatography of Spring Peach Bud Development[1]

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Abstract. **A model has been developed that relates the stages of spring bud development of 'Redhaven' and 'Elberta' peaches (*Prunus persica* (L.) Batsch) to an accumulation of growing degree hours following rest completion. The accumulation of growing degree hours is based on a lower limit of 4.5°C and an upper limit of 25°.**

The susceptibility of peach trees to cold damage becomes greater as the buds develop in the spring. Peach buds may survive -27°C during midwinter, but as warmer weather occurs after completion of rest, growth begins and cold hardiness rapidly dissipates (5).

In a previous paper (6) an equation was presented for modeling rest using orchard temperature data. This chill unit model developed by Richardson et al. has been used to determine the time when the accumulation of growth units should begin. In this paper a model is presented that allows a forecast of the approximate timing of stages of bud growth and development after a tree has completed its interval of rest.

After rest completion temperature above some base level will result in growth and bud development. In general, the amount of development that occurs in a given day increases with temp above the base level.

We assume no growth in buds held below their base temp.

Many citations can be found which relate the phenological development of different plants to some form of heat unit or growing day accumulation (e.g. 2, 3, 7). Two limitations occur in early models developed for fruit trees. First, the accumulation of energy is begun on a fixed calendar date for each given location and second, it is assumed, that within the range of temp normally found in the free air, the rate of growth continues to increase with temp.

Studies at Utah State University have shown that: 1) The time a tree completes winter rest may vary by as much as 8 weeks between seasons. 2) Peach trees, which had completed rest fail to show signs of growth after being held for several months in chambers controlled at 4.5°C (40°F). 3) Peach twigs that had completed rest show the maximum rate of bud development between 26° and 27°C in growth chambers.

The fact that the linear increase in growth rate with increasing temp holds only over a limited range and varies for different plants was recognized by researchers several years ago. For these reasons a new growing degree day model for corn was developed which used a 50°F lower limit and an 86°F upper limit (1). This model has been accepted by the industry. Another model for cool-temperature crops uses a base of 40°F and an upper limit of 77°F (8). The studies at Utah State University indicate that 'Elberta' and 'Redhaven' peaches respond quite closely to the model proposed for cool-temp plants and these limits have therefore been used in the model proposed in this paper.

As the phenological development of peach trees was observed in greenhouse and growth chamber studies, we recognized the need for a smaller scale energy unit than the growing degree day (GDD) and developed the growing degree hour (GDH) model. This model uses the same limits as the growing degree day model. One growing degree hour Celsius (GDH°C) is defined as 1 hour at a temp 1°C above the base temp of 4.5°C. GDH's are calculated by subtracting 4.5° from each hourly temp between 4.5° and 25°. All temp above 25° are assumed equal to 25°; thus the greatest accumulation for any 1 hour is 20.5 GDH's.

The use of the GDH in place of the GDD model becomes even more significant when the accumulation of energy units obtained by using the two models early in the growing season is compared. A comparison of the accumulations obtained using normal temp at the Salt Lake City Airport between March 1 and April 18, indicates 1/3 more energy units accumulated using the GDH than the GDD model. Since the tree responds to energy minute by minute and not just day by day this difference is quite important.

In this present study 6 'Redhaven' peach trees (5 years old) were transplanted into 27-gallon containers early in the fall. After leaf drop, the trees were placed in a cold storage room at 4.5°C until their chilling requirements were satisfied. The trees were maintained at this temp until needed, and then allowed to develop in a fiberglass greenhouse maintained at 15.5 ± 4°C.

Temp were recorded with standard Weather Service thermographs. Phenological stages published by Washington State University were used (4).

In the first test, 2 trees placed in the greenhouse at 2 PM on Dec. 26, 1972 reached full bloom Jan. 13, 17 days later (Table 1). Comparable trees in a second test initiated Jan. 10, 1973 at 4:30 PM reached full bloom on Jan. 28, 1973. The averages of the growing degree hours obtained in these 2 tests (Table 1) were used to develop our model.

To evalute the model in the field, dates of full bloom of 'Redhaven' peach trees in Logan and Salt Lake City, Utah during the 1971-72 season were related to their GDH accumulations after rest

Table 1. Pheno-climatography of 'Redhaven' peaches grown in the greenhouse.

Stage description	Test 1 accumulation (GDH°C)	Date	Test 2 accumulation (GDH°C)	Date	Avg accumulation (GDH°C)
Development begins	0	Dec. 26, '72	0	Jan. 10, '73	0
Bud swell	1981	Jan. 1, '73	–	–	–
Green calyx	2580	Jan. 3, '73	2705	Jan. 19, '73	2643
Pink tip	3710	Jan. 8, '73	3623	Jan. 22, '73	3667
First bloom	4174	Jan. 10, '73	4234	Jan. 24, '73	4204
Full bloom	4926	Jan. 13, '73	4918	Jan. 28, '73	4922

Table 2. Calculated and observed phenological dates for 'Redhaven' peaches 1971 and 1972.

Location	Rest completion date[z]	Calculated full bloom date[y]	Observed full bloom date
Salt Lake City, Utah	Jan. 10, 1972	March 23, 1972	March 25, 1972
Logan, Utah	Jan. 24, 1972	April 25, 1972	April 27, 1972

[z]Determined by the chill unit model (6).
[y]Determined by greenhouse studies, see Table 1.

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Table 3. Pheno-climatology for 'Elberta' peaches.[z]

Stage of development	Growing degree hr °C accumulation[y]	SD
First swell	2167	650
Calyx green	2617	533
Calyx red	3056	509
First pink	3717	674
First bloom	4239	658
Full bloom	5110	447
Post bloom	5972	559

[z]Based on climatological and phenological data for 'Elberta' peaches from Prosser, Washington for the years 1962-1964, 1965-1967; data supplied by E. L. Proebsting.
[y]Growing degree hour accumulation after completion of rest as determined from time of 790 chill unit accumulation (4).

completion. The difference in each case between the observed and calculated dates of full bloom was 2 days (Table 2).

Hourly temp for this and other field studies were estimated from the daily maximum and minimum values (6); GDH were calculated from these hourly estimates.

'Elberta' peach phenology. Nine years of phenological data for 'Elberta' peaches at the Prosser, Washington Experiment Station were obtained from E. L. Proebsting. Using climatological data from this station the accumulations of GDH's for each developmental stage were computed. Average values of these accumulations and their standard deviations are shown in Table 3.

A comparison of the data for 'Redhaven' peaches in Table 1 with those for 'Elberta' in Table 3, indicates that their recognizable stages of flower development correspond closely for any given energy accumulation.

1973-74 field tests. To further evaluate the model for both peach cultivars relative to field conditions in Utah, weekly phenological observations were taken during the Springs of 1973 and 1974 in 13 peach orchards along the Wasatch Front (Payson to Brigham City, Utah). Due to the severe cold weather in Dec. 1972 many trees were killed and those that survived had very few viable blossoms. Fortunately, seven orchards, that were fairly close to climatological stations in the U.S. Weather Service, contained sufficient blossoms to permit determination of most of the phenological dates. The same orchards were used in 1974. In almost every case the more recognizable stages of development occurred within a few days of the dates predicted by the model. The standard deviation of the difference between observed and calculated full bloom dates for these 2 years of data at the seven orchards was 3.3 days.

Conclusions. Field tests of the combined chill unit-growing degree hour model have proved its usefulness in predicting stages of phenological development.

The model permits an evaluation of the probable effects of various cultural practices in an orchard on tree development. It is also possible to predict the delay in bloom development that can be obtained by cooling the buds with overhead sprinklers. The model was used during the past 2 years in this manner and the predicted delay of the full bloom date was within 1 day of the observed date during both years.

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A Method for Selecting the Optimum Maturity Distribution for Mechanical Harvesting of Clingstone Peaches for Processing[1]

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Abstract. **High speed reflected light spectrophotometry was used to determine an optimum maturity distribution of mechanically harvested clingstone peaches (*Prunus persica* (L.) Batsch) for processing. Succinic acid-2,2-dimethylhydrazide (SADH) applied at pit-hardening, advanced the optimum harvest date from 3 to 5 days and increased the yield of processable fruit from 62% for the control trees to 80% for the treated trees.**

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Mechanical harvesting of clingstone peaches is a once-over operation which results in the harvest of a wide and continuously changing range of maturities. This often is the most serious problem in harvest mechanization (2). Sims et al. (7) reported on effects of SADH on color development (at a given firmness) for freestone fruit but did not consider its effect on the maturity distribution of clingstones.

The relationship between maturity distribution and optimum processing recovery can be critical: if too much fruit is immature, total recovery of processable fruit and processed quality will be reduced; if immature fruit are allowed to ripen, the quantity of over-ripe and tree-dropped fruit increases and total recovery decreases. The objective of this study was to develop a method for selecting the most advantageous time for once-over harvest by determining: 1) the maturity distribution of fruit on individual trees during the harvest period by use of a rapid sorting technique and 2) the effects of SADH on maturity distribution.

A block of 26 mature trees of 'Baby Gold 7' clingstone peaches, located in Greer, South Carolina, was used for this work. At the pit-hardening stage, half the trees were sprayed with 2000 ppm SADH at 15 liters/tree. The remainder served as border trees and controls. Two SADH treated and 2 control trees were harvested with the Clemson peach