California Avocado Society 1951 Yearbook 36: 164-168

INFLUENCE OF GLASSHOUSE CONDITIONS ON FLOWER BEHAVIOR OF HASS AND ANAHEIM AVOCADOS

R. S. Bringhurst
Assistant Geneticist, University of California, Los Angeles

Summary

The first opening of flowers of tip-grafted trees of the Hass and Anaheim varieties in the glasshouse began in early forenoon and the second opening in early afternoon. The situation was reversed with comparable trees and large bearing trees continuously outside. In the latter, first opening flowers appeared initially from noon until late afternoon, apparently fluctuating with the temperature. Night temperatures may be very important, since trees placed in the glasshouse for the night only behaved essentially as the trees under continuous glasshouse conditions, and trees placed in the glasshouse for the day only behaved essentially as trees continuously outside.

The double opening of individual avocado flowers has been described by Stout (1923, 1933), Robinson and Savage (1926), and others. The flowers are dichogamous. At first opening, termed stage I when complete, the petals and stamens art extremely reflexed and the pistil prominently exposed. The flowers are then female in function and no pollen is shed. On the same day the flowers close and remain closed until the following day when they reopen into stage II. The petals are then parted but not reflexed, three of the stamens are erect against the pistil, functional pollen is shed but the stigma is usually withered and no longer receptive to pollen. The rhythmic nature of the double opening also has been investigated and many varieties have been classified into A and B groups on the following basis.

A. Varieties such as Dickinson, supposed to have stage I flowers in the morning and stage II flowers in the afternoon, and

B. Varieties such as Fuerte, supposed to have stage II flowers in the morning and stage I flowers in the afternoon.

Variations in flower opening of given varieties has been discussed to some extent by the above cited and Nirody (1922), Stout and Savage (1925), and Robinson (1931). They reported that inclement weather and in particular low temperatures tended to change the blooming cycle. Strict synchronism of the blooming stages may not occur so that stage I and stage II flowers may open in a single variety at a given time. Time of opening may fluctuate considerably and stage I flowers may not appear at all on some days. In many California locations "irregular" behavior appears to be quite normal. Lyon was reported by Lammerts (1942) as having flowers which opened only once. Pollen was shed on individual flowers while their pistils appeared receptive, after the manner

described for six varieties in the San Diego Coastal Zone by Robinson (1931). Observations on marked buds of Lyon revealed that the flowers opened only once during the 1951 season at U.C.L.A. Concurrently, stage I flowers appeared regularly in the afternoon on the Dickinson variety, which has been described as an "A" variety.

Precise knowledge of the flower cycles of different varieties and their relationship to temperature and other influencing factors is desirable. The information may be valuable in critically evaluating bearing behavior of specific varieties in different localities. Breeding work may also benefit directly from such information. It is of interest to attempt to catalogue the flower opening behavior of avocado varieties under controlled conditions. This paper is a report of preliminary studies on the effect of glasshouse conditions on the flowering behavior of the Hass and Anaheim varieties.

Materials and Methods

Plant materials were selected from several dozen tip-grafted Hass and Anaheim trees in three gallon containers made available by Dr. F. F. Halma. The trees in containers flowered at the same time as bearing trees of both varieties growing nearby.

Trees of each variety were handled as follows:

1. Two trees in the glasshouse continuously beginning April 22, 1951.
2. Two trees outside continuously beginning April 22, 1951.
3. Two trees placed in the glasshouse from 7:30 A.M. to 5:30 P.M. and moved outside again from 5:30 P.M. to 7:30 A.M. each day beginning May 16, 1951.
4. Two trees outside from 7:30 A.M. to 5:30 P.M. and moved in the glasshouse from 5:30 P.M. to 7:30 A.M. each day beginning May 16, 1951.

Regular observations were made on flowers of these trees and also large bearing trees of both varieties. Observations continued through June 5 thus including the principal 1951 fruit-set period for both varieties at U.C.L.A. Continuous temperature-humidity records were available for outside conditions through the entire season. Similar records were also obtained in the glasshouse and in a large Hass tree at a height of approximately 15 feet. Temperature readings on the two outside instruments were essentially the same. Minimum glasshouse temperatures were maintained at 60° to 65°F from the start of the experiment until May 19, when the heat was cut off. All references to time have been converted to standard time.

Results

The effect of glasshouse environment on the flowering behavior was marked and immediate. Table 1 gives the flowering notes for Hass obtained April 23, the day after the plants were placed in the glasshouse. The flowering cycle of the glasshouse trees was inverted in relation to the outside trees. Stage I flowers only appeared on the glasshouse trees from early forenoon until about noon, when stage II flowers began to open as the stage I flowers were closing. Outside trees, including bearing trees, exhibited stage II flowers exclusively, on this same day until noon or shortly thereafter when stage I flowers began to appear. Overlap of stage I and stage II flowers with pollen shedding on individual trees was evident on plants in the glasshouse, comparable plants outside and bearing trees. Data for the Anaheim variety were similar.

Table 1. Effect of glasshouse conditions on flower opening of the Hass variety April 23, 1951, during a relatively warm period.

Location	Temperature		Condition of flowers*			
	Max.	Min.	7:30 A.M.	9:00	11:00	1:00 P.M.
Glasshouse	92	65	I	I	I & II D	II D
Outside	67	54	II	II	II D	I & II D
Large tree	67	54	II	II	II	I & II D

* I indicates first opening flowers, II second opening flowers, and D shedding pollen.

April 23 was a clear day following a warm night. Minimum temperature the night before was 54° F, as compared with an average minimum temperature of 50°F for a 37 day period beginning April 21. The maximum temperature was 67 °F, only 1 degree cooler than the average for the same period. This was a favorable day for pollination as evidenced by the fact that three fruits were set that day from early-afternoon pollinations of flowers on a bearing Hass tree.

Observations on flower opening on trees under continuous glasshouse conditions were essentially the same for the duration of the experiment. Stage I flowers always opened in the morning, although the opening often started one to two hours later than shown in table 1. The appearance of stage I flowers on the glasshouse trees also preceded their appearance on the outside trees in containers and the bearing trees by at least two and one-half hours. Minimum and maximum temperatures averaged 15° and 20° respectively higher in the glasshouse than outside during the period of these observations (65° and 92°F). Fluctuations were generally of small magnitude. Time of flower opening on the trees outside fluctuated considerably. Stage 1 flowers sometimes did not appear until as late as 6:00 P.M. The fluctuations could in most instances be associated with low night temperatures.

Table 2 illustrates flowering during a period of cold nights extending from April 29 through May 4. The minimum temperature this day was 45°F, five degrees below the before-mentioned average, while the maximum was 70°F, two degrees above the average. The minimum in the glasshouse was the lowest observed for reasons unknown. Stage I flowers in the glasshouse appeared relatively late in the morning but by 1:30 only stage II flowers were evident. In contrast, stage II flowers did not appear on the trees outside until late afternoon. This was not a favorable day for pollination as evidenced by the fact that hand pollinations made from 5: to 6: P.M. on a large Hass tree were unsuccessful.

Table 2. Effect of glasshouse conditions on flower opening of the Hass variety May 4, 1951, during a relatively cool period.

Location	Temperature		Condition of flowers*					
	Max.	Min.	8:30 A.M.	10:45	11:50	1:30 P.M.	4:00	6:00
Glasshouse	95	57	closed	I	I	II	II D	II D
Outside	70	45	closed	II	IID	II D	closed	I
Large tree	70	45	few II	II	IID	II D	few II	I&II

* I indicates first opening flowers, II second opening flowers, and D shedding pollen.

Flower opening of trees of both varieties placed in the glasshouse at night and outside during the day was about the same as that of trees continuously in the glasshouse. Stage I flowers always appeared in the morning. When differences were noted, trees continuously in the glasshouse had stage I flowers earlier. The difference never exceeded an hour. Similarly, flower opening of trees placed outside at night and in the glasshouse during the day was coordinated with trees continuously outside. When differences were noted the trees placed in the glass house during the day exhibited first opening flowers earlier than trees continuously outside. Stage I flowers always appeared on the trees placed in the glasshouse for one night only before they appeared on trees that were placed in the glasshouse for the day only.

Discussion

Information obtained in this preliminary study of flowering of avocado trees in a controlled environment indicates that flower opening cycles under such conditions will be systematic from day to day. Hass and Anaheim trees under fairly uniform glasshouse conditions, where the minimum temperatures fluctuate around 65°F, can evidently be classified as "A" type, having the stage I flowers in the morning. If, however, either variety were to be classified on the basis of orchard tree observations at U.C.L.A. during the same period, with minimum temperatures fluctuating around 50°F, it would be classified as type "B," having stage I flowers during the afternoon. The same would also be true of the Dickinson variety. Whether the 1951 fruit-set season at U.C.L.A. was "abnormal" is a matter of conjecture. The three above varieties each set a good crop of fruit.

Examination of the data assembled here suggests that temperature was the principal factor influencing the flowering cycle in the two varieties considered. High temperatures during the previous night greatly advanced the stage I opening. In support of this it may be pointed out that trees placed in the glasshouse during the night only behaved much like trees that remained in the glasshouse day and night, and trees placed in the glasshouse during the day only behaved much like those remaining outside day and night. Furthermore, following warm nights stage I flowers appeared earlier in the afternoon than they did following cold nights on the trees outside. Advancement of the opening stage I flowers may be an important factor in fruit set with the Hass variety. The hour of the day of each hand pollination was recorded. Evaluation of these data indicates that pollinations made by mid-afternoon are more effective than those made

late in the afternoon.

Literature Cited

Lammerts, W. E. Progress report on avocado breeding. Yearbook Calif. Avo. Soc. 1942:36-41. 1942.

Nirody, B. A. Investigations in avocado breeding. Ann. Rpt. Calif. Avo. Assn. 1921-22: 65-78. 1922.

Stout, A. B. A study in cross-pollination of avocados in southern California. Ann. Rpt. Calif. Avo. Assn. 1922-23:29-45. 1923.

_____. The pollination of avocados. Fla. Agric. Exp. Sta. Bull. 257. 1933.

_____, and Savage, E. M. The flower behavior of avocados with special reference to inter planting. Proc. Fla. Hort. Soc. 1925:80-89. 1925.

Robinson, T. R. Some aberrant forms of flower mechanism in the avocado. Yearbook Calif. Avo. Soc. 1931:107-111. 1931.

_____, and Savage, E. Pollination of the avocado. U.S.D.A. Circ. 387. 1926.