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# FLOWER BUD DEVELOPMENT IN THE AVOCADO

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Knowledge concerning the time when flower or fruit buds are formed in the avocado can be helpful to an understanding of the growth and bearing behavior of the tree and may be useful in connection with or relation to certain orchard management practices.

The avocado, like many evergreen subtropical fruits, may exhibit two or more growth flushes during the year in contrast to the single annual growth period observed in most deciduous trees. The normal period of bloom for the avocado in California is during the fall months, November and December, for some varieties and seedlings of the Mexican race, and extends well into the spring and early summer, May and June, for varieties of the Guatemalan race. The bloom period for any given variety may be from one to six months or more, depending upon the favoranleness of conditions for fruit setting during the bloom.

The fruit-bud system in the avocado is derived from terminal and sub-terminal buds on growth of the previous season. Ordinarily the buds are mixed and contain both floral and vegetative primordia. Concurrent with shoot elongation the lateral branches or secondary shoots again become simply or highly branched structures upon which the individual flowers are borne. The terminal portion of the main axis from which subsequent length growth continues, remains vegetative. Fruit bud systems of this type, which is characteristic of the avocado, are called indeterminate. Occasionally shoot tips are found which terminate in a flower bud from which no further length growth cm occur (3). Such inflorescence types are called determinate. Avocado flowers thus are borne in inflorescences which develop as clusters of short branched panicles near the shoot terminals.

Some avocado flowers set fruit if conditions of climate, especially temperature, are favorable, but by far the greater part of the flower crop fails to set fruit and will drop. The bloom period usually is terminated and vegetative length growth begins in the shoot concurrent with the set and development of young fruit Where climatic conditions are not favorable for fruit set and all the flowers of a given inflorescence have fallen, there frequently is developed on the same shoot an entirely new series of inflorescence branches with many new flowers. This second series of flower buds apparently is initiated and develops within the period of a few weeks prior to bloom.

The evidence that flower buds may be formed a relatively short time before the developing buds can be discerned with the naked eye is obtained by tracing the development of shoot tips by means of microscopic examination in the laboratory. This is accomplished by collecting at intervals representative samples of shoot tips on which

inflorescences and flowers will be borne. The present investigation involved collections of ten shoot tips from each of four trees at monthly intervals from July through February. Each collection represented an average stage of shoot tip development for the given trees at the time. The shoot tips, each about ⅜ of an inch in length, were prepared for microscopic examination.

The materials selected for this investigation were one tree of the Mexicola variety (Mexican race), two of Fuerte (Mexican-Guatemalan hybrid), and one tree of Dickinson (Guatemalan race), all growing in the subtropical horticulture orchard on the Los Angeles campus of the University of California. One of the Fuerte trees, 27 (43), was in the "off-crop" phase, the other, 27 (34), in the "on-crop" phase. Notes were made on tree condition and stage of shoot and inflorescence growth and development at each collection.

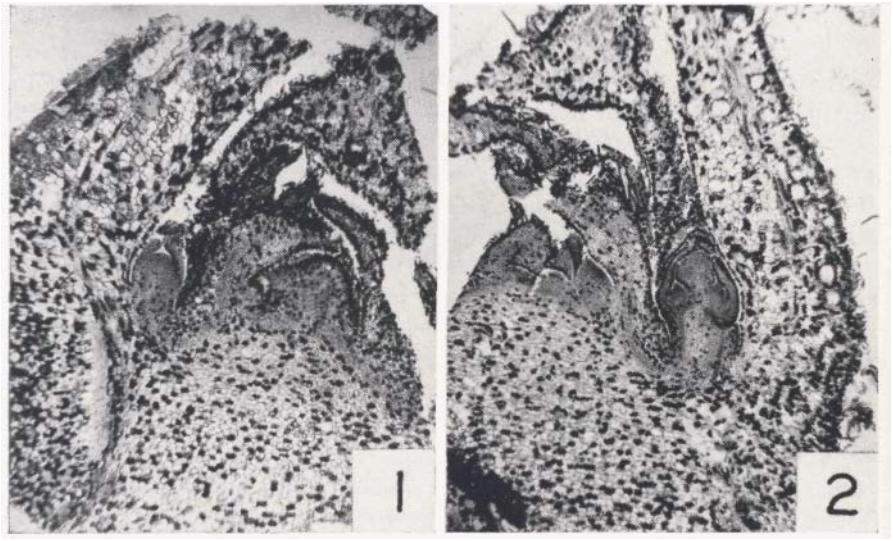


Figure 1—*Early morphological indication of inflorescence is lateral bud in avocado shoot tip.*

Figure 2—*Later stage in avocado inflorescence showing development of secondary branches.*

The study of these tip sections showed that most of the buds near the shoot apex were similar and without indications of flowers at all dates except in those collections made four or five weeks preceding full bloom. Potential flower bud development was first indicated by the rounded apex of the axillary buds and by the elongation of the inflorescence axis (Fig. 1A). In the four tree specimens studied the earliest morphological evidence of floral development was observed between six weeks and two months prior to bloom.

The Fuerte tree, 27(43), which was in full bloom in December, already showed microscopic evidence of flower buds the preceding October 10, whereas the other Fuerte, 27(34), which bloomed in early February, contained evidence of well developed flower buds the preceding November 7. The Mexicola tree, which had flower bud primordia present in December, was in full bloom the following February 7. Dickinson, on the other extreme, contained evidence of flower buds for the first time on February 7,

and appeared to bloom the following March. The trees from which the collections were made and other trees in the orchard exhibited a wide degree of fluctuation in the rate and extent of development of inflorescences between trees and even between panicles on the same tree. Thus the rate or time of floral development for any given tree in such studies is merely relative and not absolute.

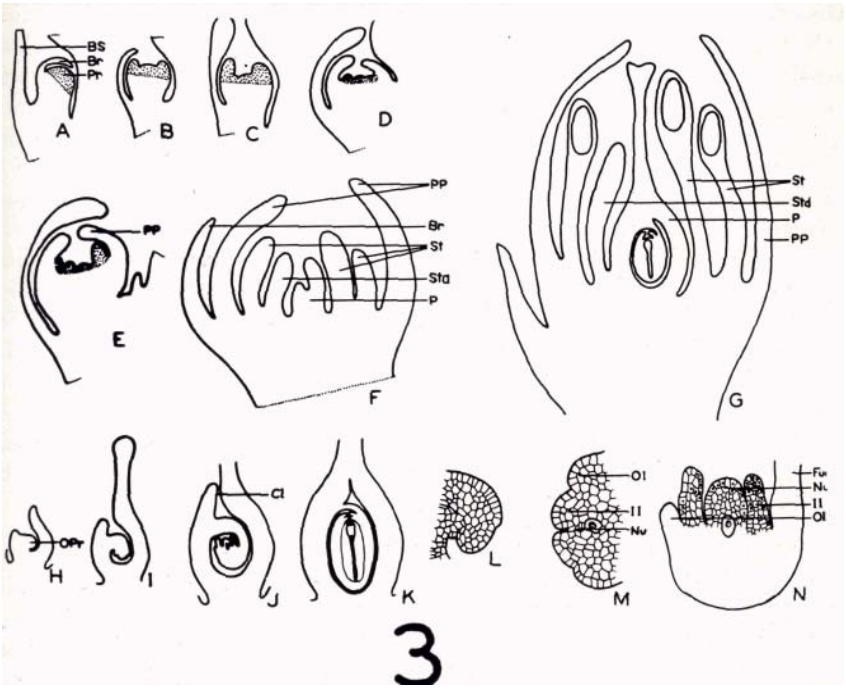


Figure 3—*Progressive development of individual avocado flowers (A-G) and pistil (H-K). Detail development of ovule showing origin of two seed coats. BS-bud scale, Br-bract, Pr-primordial dome, PP-petal primordia, St-stamen, Sta-staminode, P-pistil, O Pr-ovule primordia, Cl-cleft in pistil, Ol-outer integument, II-inner integument, Nu-nucellus, Fun-funiculus.*

The time of flower bud formation in the avocado, which occurs only a few weeks prior to blossoming, is entirely different from the situation observed in most deciduous fruits. In such plants as the apple, flower buds are formed six months to a year or more prior to the spring bloom, but remain undeveloped until shortly before the tree is in full flower. On the other hand, the relatively short interval between flower bud initiation and full bloom, as found in citrus (1) and in the avocado in Florida (2) appears to be characteristic of the evergreen subtropical plants, which are in active growth during much of the year. Checking of vegetative growth in such subtropical plants by drought or excessively high temperature often may be sufficient stimulus to cause flower bud formation any time during the year. The exact nature of the causes of and the factors associated with flower bud formation in subtropical trees is, however, not well known.

Concurrent with the formation of the inflorescence as a whole, the individual flower develops in a definite pattern. The sequence of development among the several floral parts of a single flower begins sometime after the inflorescence axis has been initiated. The growing apex of the individual floral primordium, when viewed in longitudinal section, is first evident as a conical mass of cells in the axil of a bract (Fig. 3A). This

mass of dividing cells becomes slightly flattened, and on the periphery of the disk the perianth or sepal and petal parts appear (Fig. 3B-E). These rudimentary perianth segments elongate and curve inward, arching over the apex of the axis. Stamen primordia arise at the same level, but inside the perianth parts and opposite to them. Inside the second whorl appears a third set of primordia, which is the inner stamens or staminodia (Fig. 3F). The pistil is the last floral organ to develop. It first appears as a small, conical mass which by differential growth produces a cup-like structure, one side of which becomes higher than the other. The higher side gives rise to the style and stigma and the lower, which develops more slowly, bears the ovule primordium on its inner surface (Fig. 3F-I). In the growth process the ovule stalk gradually bends downward toward the base of the flower. The seed coats and nucellar tissue are formed at this time. The inner integument or seed coat appears first and is followed by the outer (Fig. 3L-N). The ovule stalk continues to grow such that the ovule is completely rotated and the micropyle becomes located immediately beneath the stalk attachment.

After the formation of the several floral parts and the rotation of the ovule within the young pistil, which occurs while the floral bud is quite small, there follows a period during which all the flower parts increase in size. Pollen is developed in the upper portions of the stamens at this time, and an egg cell forms near the micropyle in the ovule. The flower is now mature and is ready to bloom and for pollination.

The conclusions derived from the study of floral bud initiation in the avocado in California are 1) that floral structures may be evident two months prior to the appearance of flowers of the avocado in California, and 2) individual flower buds are formed from six weeks to two months before full bloom, in any given variety. Within a given flower the floral envelope or perianth parts are first to develop followed by the stamens, and lastly, the pistil with the single ovule is formed.

LITERATURE CITED

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