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Diurnal Fluctuation in Size in Various Parts of the Avocado Tree and Fruit[1]

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The relative rapid growth in diameter of trunk, branches and fruit of the avocado at various times during the year is vividly depicted by growth curves. There are certain periods in the winter months when the daily or weekly growth increase is absent or very small, in contrast to those periods in the spring and summer, when daily increase in girth is of considerable magnitude. The apparently smooth growth curve of daily or weekly measurements is found comprised of a series of fluctuations.

Daily diameter measurements were made on the trunk, branch, fruit, and root of a mature Fuerte tree at Los Angeles during various periods in 1954. By means of a C-clamp arrangement, a machinist's dial gauge, which registers changes of 0.001 inch, was attached to the plant parts to indicate the changes in diameter. Readings were made at appropriate periods simultaneously with observation of the temperature obtained from a thermometer suspended in the tree near the fruit at a height approximately five feet from the ground. Temperature effects on the instruments proved insignificant in the present study.

Fluctuations in fruit size:—The normal seasonal fruit growth curve of avocado fruit has been shown to follow the sigmoid or S-shape (4, 5). Daily fluctuations in diameter of the avocado fruit were observed in the present study. Maximum fruit size was attained early in the day—about 8:00 or 9:00 o'clock in the morning in August, depending upon the weather conditions. When the transpiration became active because of increase in light and temperature, internal competition for water developed. Under these conditions of moisture stress water moved from the fruit to the leaves with the resultant reduction in fruit size. As the transpiration increased toward noon, moisture loss from the fruit continued and the fruit diameter decreased until about 2 or 3 o'clock in the afternoon, when, at Los Angeles, the prevailing westerly wind from the ocean became effective to raise the humidity and lower the temperature, with the resultant decrease in leaf transpiration and increase in fruit diameter.

The very regular diurnal fluctuation in diameter in two nearly mature and firm fruits 7.3 and 6.8 cm in diameter, respectively, is shown in Fig. 1. These fruits were on different trees about 48 feet apart in the orchard. The consistent increase in diameter at night and shrinkage during the daylight period is evident in both fruits. The days were bright and warm during the observations and diurnal temperature fluctuations were great. The consistent daily increase in fruit size over a period of time is demonstrated by plot-ling the daily maxima and minima for several days (Fig. 2).

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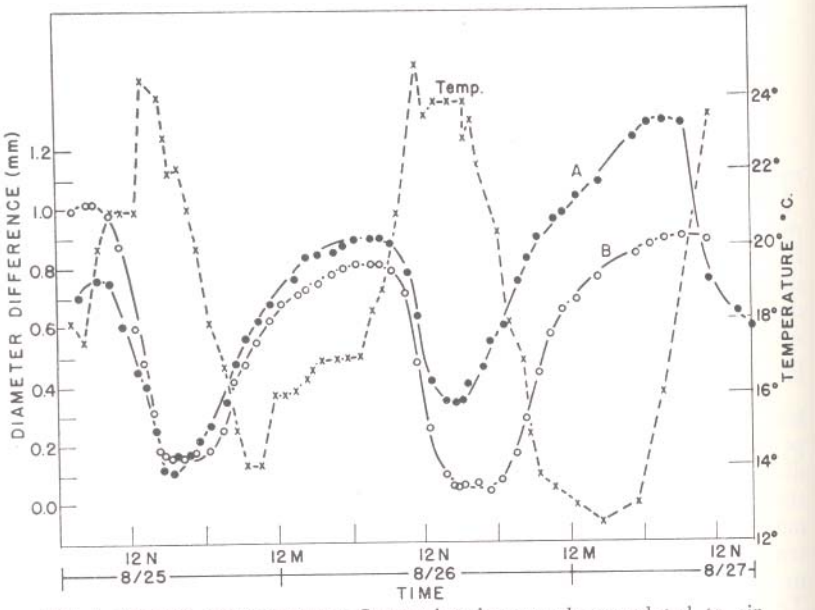

Fig. 1. Diurnal fruit diameter fluctuation in avocado as related to air temperature. A, B—individual fruits on separate trees.

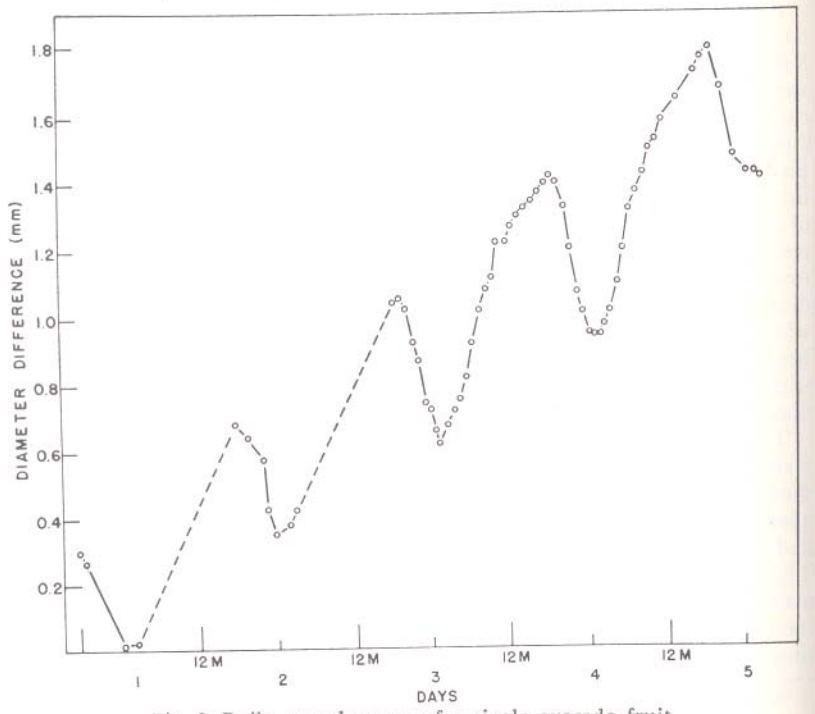

Fig. 2. Daily growth curve of a single avocado fruit.

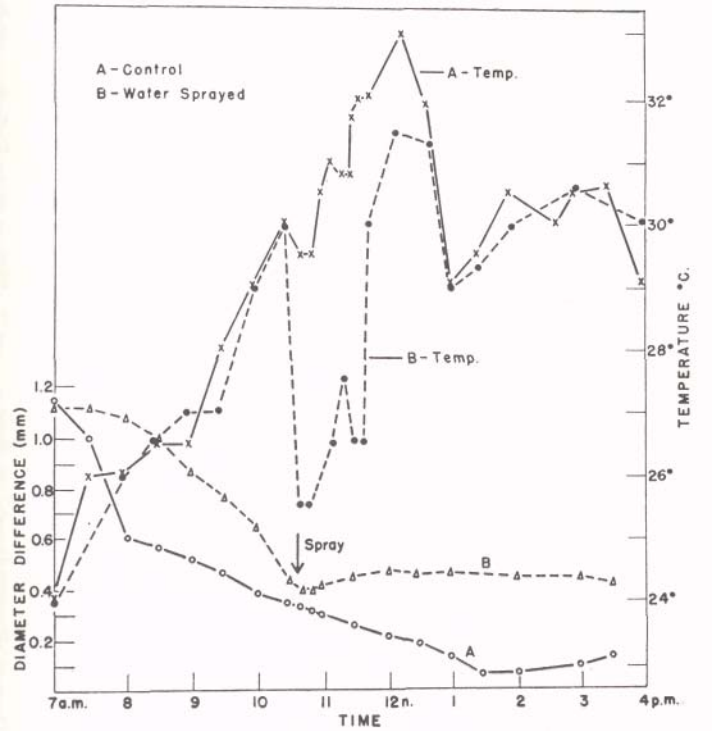

Fig. 3. Avocado fruit diameter as affected by water spray on tree.

The degree of fluctuation in fruit size is closely related to the transpiration and moisture relations within the plant. Measurements were made on the two fruits on separate trees mentioned previously on a warm, clear day in August (Fig. 3). The normal and abrupt shrinkage of both fruits had begun in the morning at about 8:00 o'clock. At 10:30 a.m. and at ten-minute intervals thereafter until 11:30 a.m., one of the trees was entirely covered with a fine spray of water to wet all the leaf surface. Each spraying operation required about one minute. The fruits and instruments were protected from the water spray by a vinyl film shelter. Temperatures and fruit diameters were read simultaneously under the wetted and the control tree. The effect of tree wetting was reflected in a drop in air temperature from 30 degrees C to 26 degrees C within about three to five minutes and a distinct cessation of fruit shrinkage, which could be detected about five minutes after wetting of the leaves. Fifteen minutes following the spray an actual increase in fruit diameter was detected. Only a very slight decrease in fruit diameter I was observed during the remainder of the day in the wetted tree, although the air temperature followed that of the control. The fruit on the control tree indicated a diameter change of 0.8 mm. on this particular day. It is evident that the major factor affecting fruit shrinkage is transpiration. That die fruit is a reservoir of moisture for the leaves when the tree is under internal water stress is evident from simple experiments in which detached leafy branches with and without fruit are kept in a warm dry atmosphere. Detached branches with fruits maintained high leaf turgor for a much longer period than those branches without fruit. The fruit shrinks markedly as its moisture is transferred to the leaves.

The relationship between diameter change and moisture loss in fruit was observed in a detached, mature fruit which had an initial weight of 224.1 grams. After 24 hours in the laboratory the fruit lost about 13 grams in weight and decreased 0.584 mm in diameter. This is approximately 5.8 per cent loss in weight. Diurnal diameter fluctuations of 0.5 mm were commonly observed in attached fruits. Similar fruits, if harvested in the latter part of the day, contain significantly less moisture compared with those harvested in early morning before the moisture stress is evident, a condition which has practical significance in regard to total weight of fruit produced in an orchard.

Diurnal fluctuations in partially developed, immature fruit arc proportionally greater than those observed in mature fruits. Daily shrinkages of 0.5 mm are frequently detected and daily diameter increases of 1.0 mm during the night period can be demonstrated in fruits 4.5 cm in diameter. While moisture balances within the plant probably are responsible for the major part of the daily fluctuation in diameter, the day-to-day increase in fruit size is a function of cell division and cell expansion in the immature, developing fruit (6). In the mature fruit the rate of cell division is relatively low, hence contraction and expansion probably are controlled almost entirely by internal moisture balances at this stage.

Fluctuations in trunk and branch diameters:—Similar daily fluctuations in diameter of other plant parts were also observed (Fig. 4). The tree under study in August, 1954, had a trunk diameter of approximately 27 cm, where a dendrometer was attached at a height of about 1 meter from the ground. It will be noted that the maximum trunk diameter readings were reached about 7 or 8 o'clock in the morning and thereafter a continuous and abrupt decrease occurred until late afternoon. Again this daytime trunk shrinkage is related inversely to the temperature and undoubtedly reflects the internal moisture stress in the tree.

Measurements made on a medium-size branch about 14 cm. in diameter indicated diurnal fluctuations in size similar to those of the fruit and trunk. Size changes in the branch, however, appear to lag somewhat behind those of the trunk and size increase begins somewhat ahead of the trunk in the afternoon.

While daily fluctuations are easily demonstrated in diameter of the above-ground parts of the avocado, similar diurnal changes in size of roots also occur. Fluctuations of 0.2 mm have been observed in a root approximately 24 cm in diameter.

Daily variations in fruit diameter have been observed in the hesperidum (1), but have not been reported for the typical botanical berry of the evergreen fruit tree such as avocado. The application of information on rate of citrus fruit growth (2, 3) has been considered as a possible criterion on which to formulate a schedule of irrigation in the orchard management program. The significance of diurnal size fluctuation of the various plant parts of avocado has not been determined except as it reflects internal water relationships. The phenomenon may have some practical applications. Among these the effects of wide diurnal fluctuations in diameter may be related to certain growth problems in the fruit and tree which are manifest by cracking of the bark of limbs or skin of fruits under some environmental conditions.

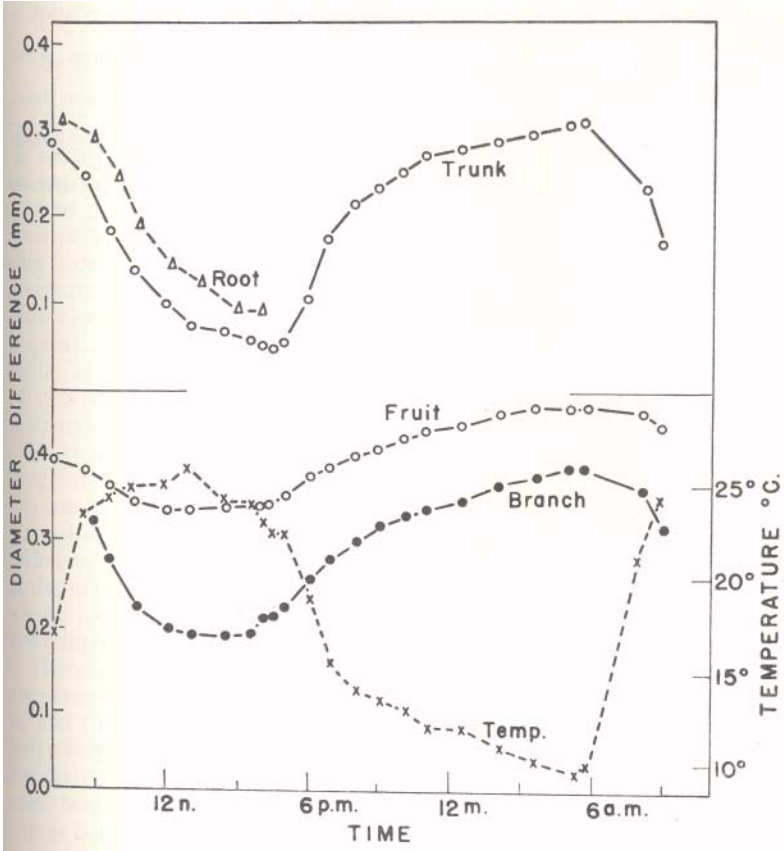

Fig. 4. Diurnal fluctuations in diameter of various plant parts of a single avocado tree.

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