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DAILY SIZE CHANGES IN AVOCADO RELATED TO TEMPERATURE

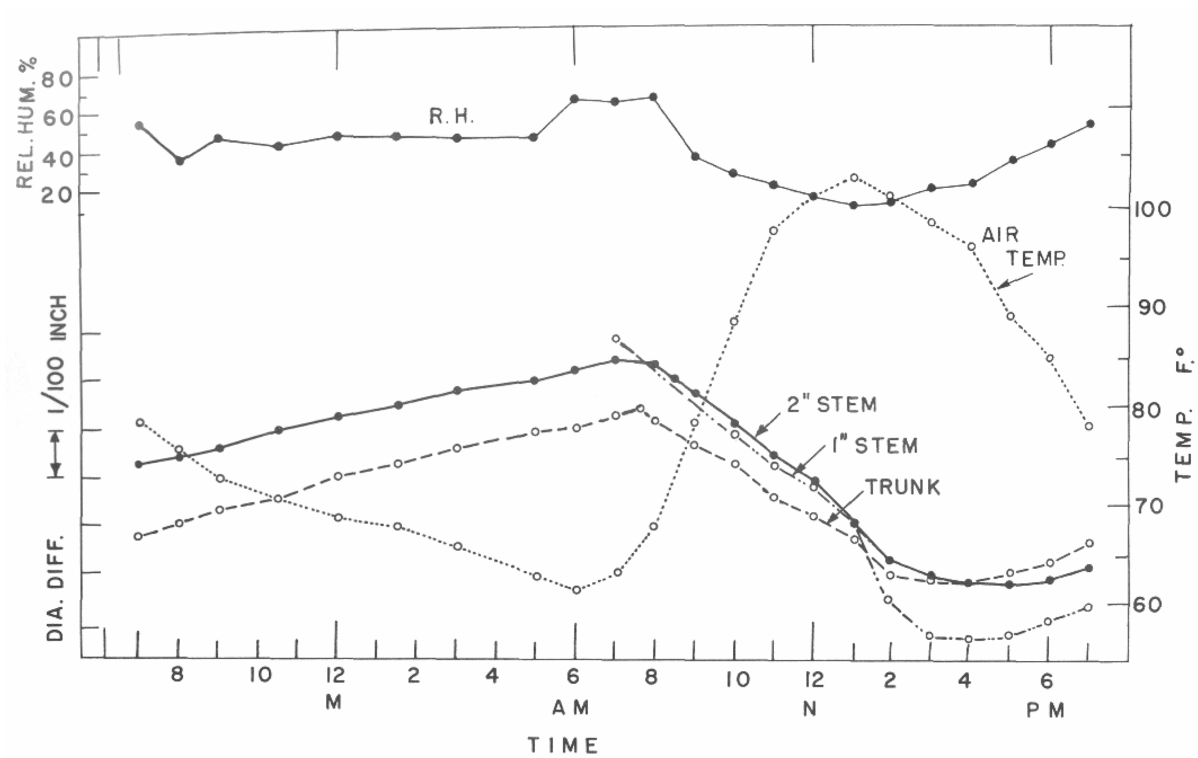
C. A. Schroeder
Department of Biology, University of California, Los Angeles.

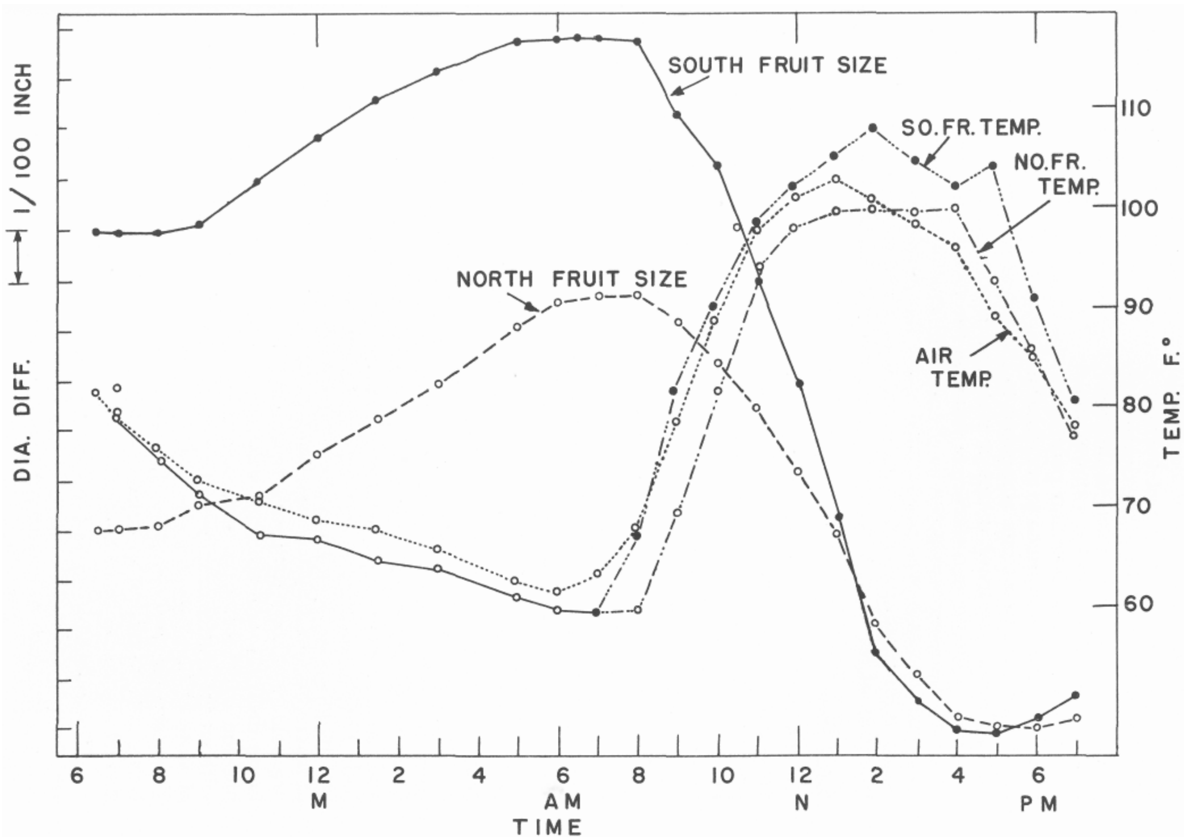
Water loss and stress as the result of transpiration from plant tissues ultimately is reflected in the wilting of leaves, the development of a flaccid condition in the stem tissue, and if fruit is present there is a marked shrinkage of the fruit (1). Extreme water stress associated with increases in temperature can result in shedding of the leaves and fruit. The avocado is a plant which is sensitive to water stress, hence must be grown under irrigation in an arid climate such as found in the subtropical areas to which the species is adapted, where appropriate temperature conditions are found. Where the avocado is grown under marginal desert conditions it sometimes suffers from sunburn to the plant parts, especially the younger exposed stems and fruits, when high temperatures and exposure to the sun prevail. Moreover under moisture stress there may be excessive shedding of fruit under some conditions. The relationship of moisture content to fruit harvest also can be of economic consideration.

Methods and Materials

An attempt was made to ascertain some of the gross changes in plant dimensions which result from high temperature and the resulting moisture stress in avocado grown under a semi-coastal and inland climatic conditions such as are found at Rancho Sespe near Fillmore, California. The observations were made during a period of heat stress, September 23-25, 1975, in an orchard of Hass trees 17 years old with a southeast exposure at an elevation of approximately 1,500 feet above sea level. The rocky, alluvial soil had been sprinkle irrigated several days prior to the "heat wave." Though the trees did not show incipient wilting there probably was a considerable moisture stress during the time of observations.

Measurements were made on a single tree in respect to gross changes in diameter of the trunk, approximately 12 inches in diameter, a limb 2 inches in diameter, a limb 1 inch in diameter, young fruits (ca. 2 inches in diameter), one in an exposed position on the south side of the tree and the other of similar size on the north and shaded side of the tree. Temperature probes were inserted into fruits of comparable size nearby and at other locations in the tree. A Tele-Thermometer (Model 44TD) was used to determine the temperatures. Relative humidity was measured with a Psychro-Dyne Model PP1.00 psychometer. Diameter dimension changes were ascertained by machinist's dial gauges held in place by aluminum fittings (4). Manual readings were made at hourly or other intervals over a 24 hour period of "hot weather conditions." The avocado variety Hass had a "good crop" of young fruit approximately 3 inches long and 2 inches in diameter. The weather conditions were characterized by warm clear days with weak to moderate winds up to 7-10 miles per hour on occasion and clear, relatively still nights with an unmeasurable air current perceptible.





Observations:

The measurements of changes in diameter of the several plant parts are approximate and indicate only comparable differences in size of an organ which developed between two consecutive time intervals. The trunk diameter of approximately 12 inches measured at sundown (6:30 p.m. POST) is noted to increase progressively during the nighttime period until sunrise (approximately 7:00 a.m. PDST). Increase in diameter at the detection point over the night period was 27/1000 inch. The trunk continued to increase in diameter until 7:30 a.m. when it attained maximum size compared to the previous evening measurement. Decrease in trunk diameter was first detected approximately one half hour after the sun started to shine on the tree. Continued decrease in trunk diameter was noted as the air temperature continued to rise. This size decrease was accentuated upon the development of a "dry wind" with a velocity of 3-10 miles per hour and a relative atmospheric humidity of less than 10% shortly after midday (Figure 1).

Small Stems

Diurnal fluctuation in size of the small avocado stems follows the ' same general pattern as exhibited by the main trunk. Branches of approximately 2 inches in diameter attain minimum size at sunset. Immediately upon development of favorable conditions for moisture retention at sunset as the marked reduction in transpiration occurs, the larger stems begin to increase in diameter. The 2 inch stems observed increased 23/1000 inch during the sunset to sunrise period (Figure 1). Following sunrise, diameter decrease was initiated and continued throughout the daylight period again with increase in temperature and under relatively low atmospheric humidity accentuated by the desiccating wind, until a negative change of 75/1000 inch was attained.

The smaller stem of 1 inch diameter decreased a total of 52/1000 inch in diameter during the daylight period and followed the same pattern as the larger limb and trunk.

The diurnal fluctuation in size of avocado fruit is of major concern in the consideration of water stress problems within the plant as a whole. When a condition of competition develops between the leaf and fruit for available moisture, the advantage is more favorable for the leaf. This is easily demonstrated by the classical experiment in which two twigs are severed from the tree, each twig with the same number of leaves but one twig has attached a developing fruit. The severed twigs are held in the air without access to water. After a period of 24 to 48 hours the twig with the fruit will retain its leaves in a turgid condition but the fruit will have shrunk considerably. The leaves on the twig without the fruit will show wilting during the period. Following a period of 36 to 48 hours these leaves may be completely desiccated (Figure 3). This response demonstrates that under conditions of moisture stress, leaves can withdraw moisture from nearby fruit, causing the fruit to shrivel if the stress is of adequate magnitude.

The effect of competition for moisture between the attached leaf and fruit of avocado is demonstrated by the marked shrinking of developing intact fruit during any daytime period and particularly when the entire plant is under moisture stress. In the present investigation it should be noted that differences in magnitude of shrinkage between fruits of comparable size will depend upon the relative exposure of the fruit to the sun and possibly in respect to other factors such as number oí leaves along the fruiting limb. The present observations show the fruit partially exposed to the sun, located on the south side of the tree decreased in size 95/1000 during the daytime, whereas the fruit on the north side, protected considerably by a canopy of leaves, decreased 80/1000 inch during the same period (Figure 2).

Discussion

Considering the physical structure of the fruit, which is formed mostly of soft, thin walled parenchyma tissue, one would expect changes n moisture relations within this tissue to be rapidly manifest by shrinking or swelling of the fleshy pericarp wall. The greater magnitude of shrinkage among the several plant parts is indeed noted in the fruit structure. This daily change in fruit size in avocado has been noted previously in California (3). The general observation can lead to an interpretation of considerable importance in the harvest operations If moisture loss is greatest during midday and if the maximum weight of fruit is the major object of the harvest, then fruit should not be harvested except for a very short period very early in the morning prior to the development of the major transpiration phenomenon in the plant. Some preliminary observation of fruit shrinkage indicates a potential loss of 5% by weight if the fruit is picked after the sun has shone on the tree for about an hour or two. Many factors such as the relative atmospheric humidity, the temperature, and the soil moisture conditions prior to and during the harvest period will affect the degree of weight loss by the fruit.

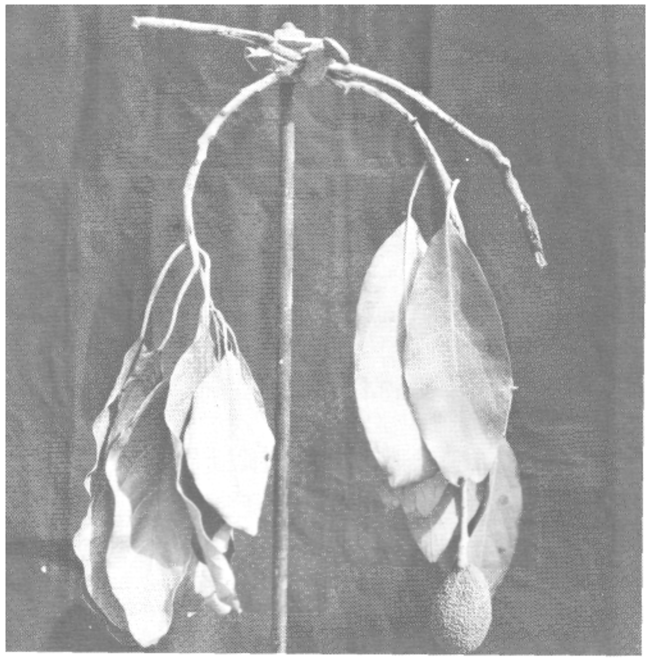


Figure 3

The relationship of temperatures within the fruit and the ambient air is of interest. The fleshy fruit provides a massive source of heat which is absorbed by the fruit wall by radiation and by increase in temperature of the surrounding air. Thus the temperature of fruit located within the leafy canopy gradually increases during the daylight and morning period and can actually exceed that of the air temperature in those fruit exposed directly to the sunlight. Similarly in late afternoon and early evening the fruit can retain a temperature level much above that of the air and it may actually be warm to the touch. Eventually the fruit will lose its heat by radiation and will attain the temperature of the ambient air. This phenomenon is demonstrated in the temperature curves of exposed and shaded fruit compared with the ambient air temperature on a warm day (Figure 2). The temperature of "exposed" fruit which the sun strikes directly can become exceedingly high sufficient to result in killing of the tissue as "sunburn."

Previous studies (2, 3, 4) have indicated that the fleshy fruit wall tissue can attain a temperature 20° to 30°F above that of the ambient air. The color of the fruit surface is a factor in this instance as black fruit will develop a higher temperature than green fruit of the same size and same exposure. Fruits artificially colored by "white wash" reflect incoming heat hence are lower in temperature than normal green fruit under *any* given condition.

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