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TEMPERATURE CONDITIONS AND TOLERANCE OF AVOCADO FRUIT TISSUE

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Heat injury of fruit tissues is observed occasionally in nearly all commercial fruit species including avocado. Mild injury may result in the development of a corky or roughened fruit surface or if severe the deeper tissues may be killed, hardened and discolored. Injury of this sort may be of considerable economic loss under some circumstances. An understanding of the basic conditions under which such injury is likely to occur may suggest corrective measures to alleviate the trouble or to reduce its severity. Knowledge of fruit physiology and of the tolerance of tissues to heat exposure can be helpful in understanding the problems of fruit development in general.

The present study was made to ascertain some information concerning the higher temperature conditions which may prevail in the avocado fruit or which may be tolerated under some conditions.

MATERIALS AND METHODS

Field observations were made at the university orchard and the botanical garden in Los Angeles and at a commercial orchard near Covina. Temperatures of fruit tissues were determined under various conditions of exposure to the sun and in relation to location on the tree. Actual temperatures were observed with the Tele-Thermometer (Yellow Springs Instrument Company) Model 44TD. This instrument provides for a number of individual stainless steel probes which can be inserted into specific-fruit tissues. Temperatures of any individual probe is read on a common dial.

Tissue temperature tolerances were determined by a tissue culture technique. The avocado fruit was surface sterilized and sliced into pieces one millimeter thick from which disks 8 millimeters in diameter were punched. These disks were placed on a sterile agar nutrient media in screw cap vials. All operations were performed in a transfer chamber under sterile conditions. The vials with the plant tissue sections were then submerged in a temperature controlled water bath for various time periods. All vials were then placed at 25° C. in an incubator. Survival of tissues was determined after a period of incubation of 3 to 4 weeks. Survival was assumed if the tissue disk showed any evidence of surface proliferation when examined under the microscope.

The effect of surface or skin color on fruit temperature was determined on detached

Hass fruits of comparable size with long stems kept in water. The fruit naturally colored (black), nearly mature (green) or white (painted with a single coat of white plastic base paint) was placed in full sun for observations.

OBSERVATIONS

The temperature of the avocado fruit shows marked diurnal fluctuation related in general to the amount of sunshine which prevails. Only the higher temperatures which occur during the daytime are considered in this discussion. It is evident from Figure 1 that the temperature of exposed fruit in the field is generally higher than that of the air. Such temperature differential is especially evident in fruits exposed to the sun. Temperature differences between air and fruit wall of 10 to 20 degrees F. commonly are observed under conditions of moderate air temperatures during midday. Thus one cannot accurately estimate actual fruit temperature from air temperature data. Position of the fruit on the tree determines to a considerable extent the rate of heating and cooling of the fruit tissue. Exposed fruits on the south side may accumulate considerable heat and attain temperatures far above the air temperature even very early in the day. Comparable fruit protected or hidden within the tree on either north or south side will slowly approach air temperature but generally will not exceed the latter at midday. As the air temperature declines during the afternoon the fruit temperature may remain constant for some time and then fall slowly. Thus later in the afternoon fruit temperatures may be considerably above the air temperature as the result of heat retention in the thick fleshy fruit wall.

Fruit color is an important factor in the rate of heat accumulation in the pericarp wall as noted in Figure 2. Reflection of radiant heat from the sun by fruit which was painted white reduced the pericarp temperature almost 20 degrees below that of the naturally black fruit under conditions of exposure to full sun at an air temperature of approximately 80° F. Likewise the temperature in a fruit of similar size (approximately 6.5 x 8.5 cm.) but green in color remains considerably lower, namely 10° F., than the fully colored fruit. In this particular situation a temperature differential of 30° F. exists between air and the fully colored fruit. Likewise the effect of the painted surface reduced the temperature differential by 60 per cent. These observations were made under conditions of comparatively still air. Rate of air movement, relative humidity and other factors which affect transpiration will consequently govern actual temperature conditions within the fruit pericarp.

Temperature gradients within an individual fruit are shown in Figure 3. The fruit in this experiment was detached, but the stem was kept in water and the fruit exposed to full sun hanging in a natural vertical position. Probes placed in the north and south hemispheres of the fruit indicate that the temperature rises rapidly during the early part of the day in the south half exposed to the sun. The shaded hemisphere becomes heated more slowly, the rate following almost exactly that of the air temperature. Eventually all parts of the fruit attain the same temperature as the sun shifts to the west in the afternoon and both hemispheres are essentially equally exposed. A more detailed study of the temperature gradient within the fruit is seen in Figure 4. Here the temperature is noted to drop markedly from skin to seed at midday. A temperature

difference of more than 15 degree between skin and seed in early morning is easily demonstrated when the air temperature is 70 to 75° F. This gradient becomes less toward the middle of the afternoon.

HIGH TEMPERATURE TOLERANCE OF TISSUE

The difficulties in ascertaining information on actual high temperature tolerance of fruit tissue under field conditions has prompted the exploration of other techniques to obtain the desired data. The ability of tissue culture technique to detect tissue survival provides a new potentially important approach to this problem. While the criteria is that of life or death of the tissue segments, the possibility of severe or permanent injury is ignored in the present experiments. As the technique is improved possibly detection of degrees of injury can be made.

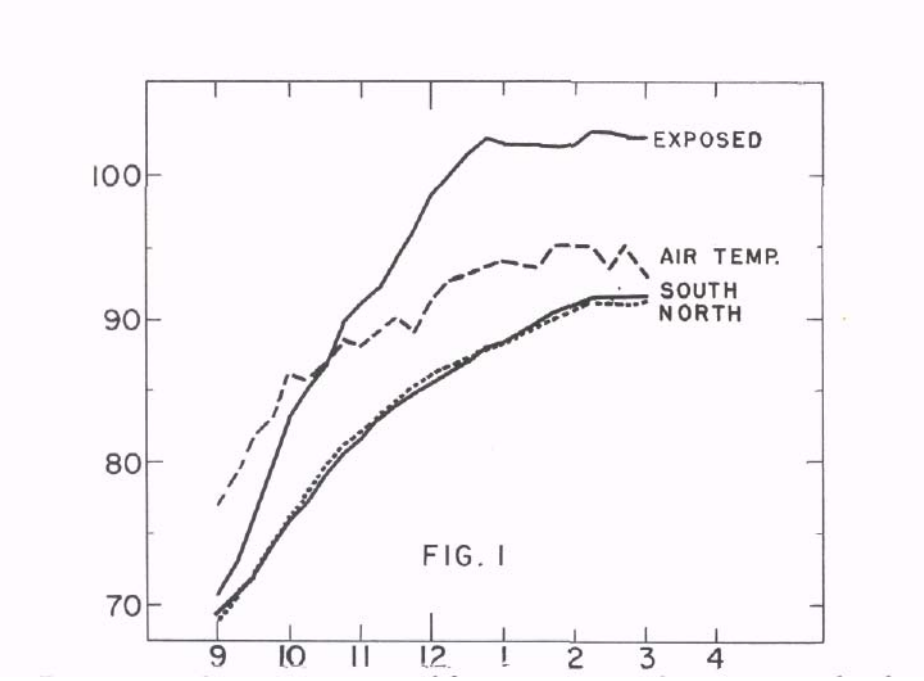

Figure 1. Avocado temperature curve of fruits on tree exposed to sun compared with fruits in shade on north and south side of tree.

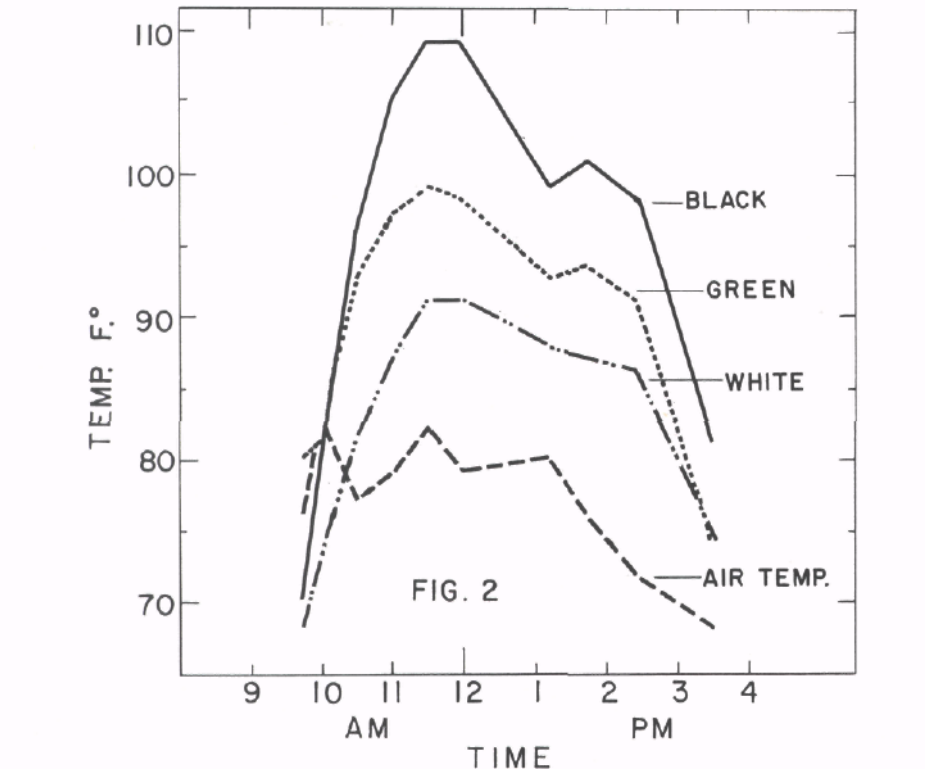

Figure 2. Temperature of detached Hass fruits with stems in water and exposed to full sun. Black fruit was natural color, white fruit was coated with plastic paint.

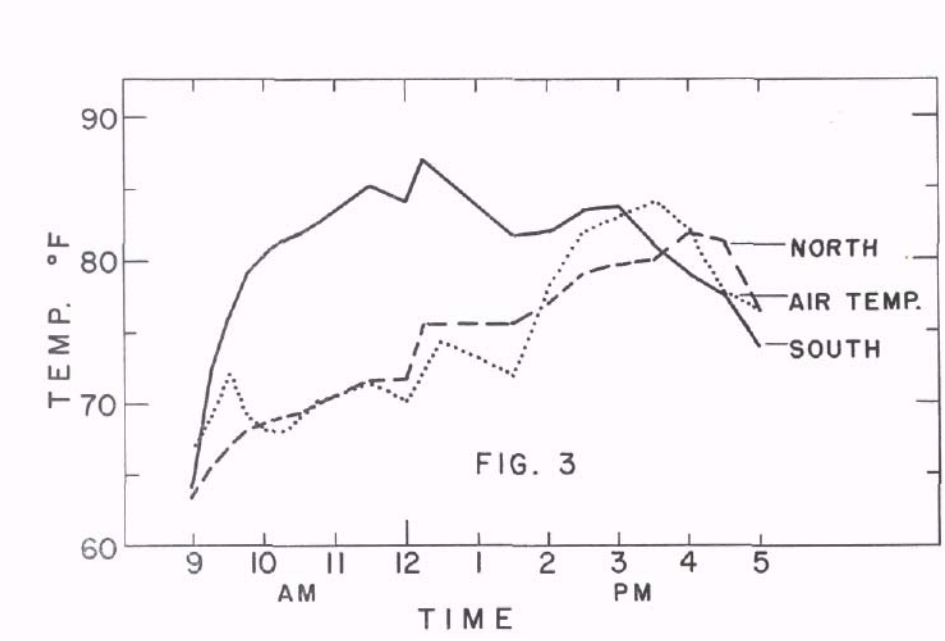

Figure 3. Temperature differential within single Lyon avocado fruit, detached with stem in water and exposed to sun.

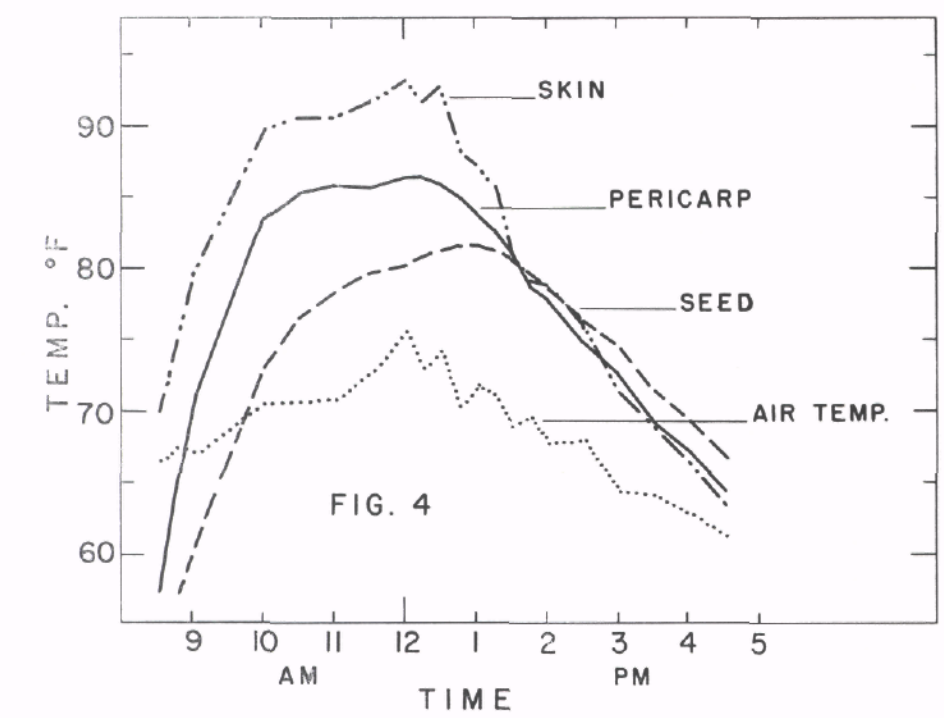

Figure 4. Temperature gradient within south half of detached Nabal fruit exposed to sun.

A summary of some preliminary experiments on temperature tolerance of the avocado pericarp tissue taken from nearly mature Hass fruit in August is given in Table 1.

Table I

Survival of Tissue Segments in Vitro Following Exposure to High Temperature.*

Temperature		Exposure
F°	C°	Time in Minutes
129.2	54	15
125.6	52	20
122.0	50	90
118.4	48	195
114.8	46	480

*60 per cent survival of all tissue disks

While a wide range of variation is observed in survival of individual fruit segments in these experiments the arbitrary criteria of 60 per cent survival was selected on which the data is summarized. It is noted that a temperature condition of approximately 130° F. can be tolerated for a period of 15 minutes with subsequent survival of more than half of the tissues. Without doubt, higher temperatures can be tolerated for shorter periods or with less survival. As techniques are improved, these critical temperatures can be ascertained. Heat tolerances in the more moderate ranges of these experiments, namely 115° F, are considerable. More than half the tissues survived this temperature when exposed for 8 hours. Several other experiments demonstrated 100 per cent survival of tissue exposed to 115° F for a period of 6 hours. Lower temperatures presumably can be tolerated for longer periods without subsequent injury.

These preliminary observations under limited conditions in the field and under controlled environment in the laboratory indicate that a wide range of temperature conditions exist in the avocado fruit at any given time during the day and that this tissue can withstand high temperatures for short periods of time. It is conceivable that under conditions where heat injury to fruit tissue may be a major problem that some modification of the environment could be developed to reduce this injury. Shading of exposed fruit or provision of a temporary fruit cover such as a fruit spray of such quality and color to reflect radiant heat could markedly reduce fruit tissue injury. Modification of other ecological factors such as soil reflection, fruit and tree shading, air movement and relative humidity conceivably could affect fruit temperatures in a favorable manner.