

Soil Temperature and Citrus

low soil temperature contributes to low number of roots under citrus trees in some areas of southern California

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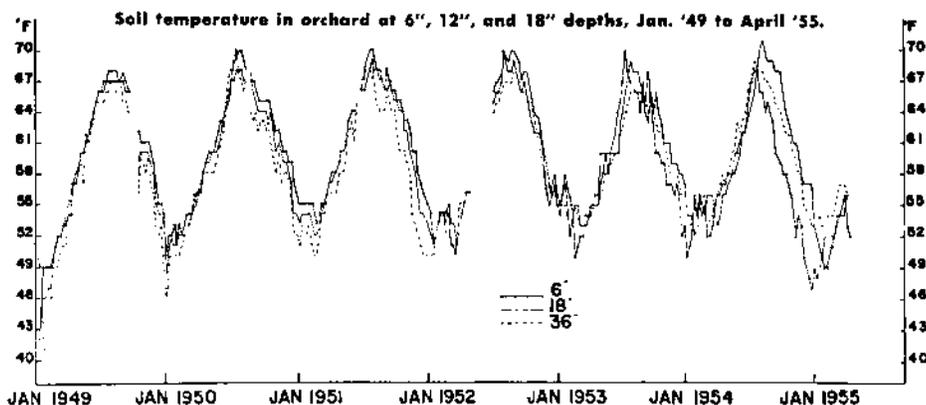
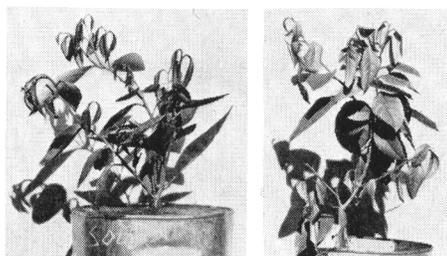
Low soil temperatures—causing low root temperatures—induced foliage wilt in glasshouse experiments with several citrus species on various rootstocks. At soil temperatures ranging from 48F to 62F and with plenty of moisture available, the foliage—especially succulent new growth—wilted, but plants having heat supplied to the roots did not wilt.

This observation brings citrus more in line with data reported for other plant species. The environmental conditions associated with this wilting included relative humidity of 20% to 55%, light intensity of from 400 to over 1,300 foot-candles—full sunlight approximates 6,000-foot candles—air temperatures of from 59F to 75F, and root media of soil and sand with each containing an optimum moisture level. The plants fully recovered within one to three hours. Although all of these plants were in the glasshouse, it does indicate that there is a real possibility that water deficit in citrus leaves in the winter months—when soil temperature is low in some California orchards—may be greater than has been thought.

The optimum temperature for citrus root growth is about 79F and the minimum temperature at which citrus roots will elongate is about 54F. The soil temperature in the Los Angeles area in the root zone is never sufficiently high for optimum growth, and there are about four months of each year when the temperature is believed too low for root elongation. Little is known concerning the practical importance of this in citrus production.

During the winter, daytime air temperatures are sufficiently high for photosynthesis of citrus in southern California,

Left: Washington Navel orange on sour orange rootstock in sand culture; root temperature was 56F, air temperature 70F. **Right:** young clone Eureka lemon on grapefruit rootstock; root temperature was 55F, air temperature 63F. Both plants recovered about three hours later and without additional irrigation.



even though the soil temperature is low. Exactly how the occurrence of photosynthetic activity of leaves—simultaneous with greatly diminished root activity—influences tree behavior has never been determined. The suggestion has been made that starch accumulates in leaves during this period and that this accumulation is important in the initiation of new growth in the spring.

In a recent study, root elongation was observed at 48F on Valencia orange cuttings grown in solution culture. The average elongation was about one-half centimeter for each rootlet in a twelve-day period. The temperature was accurately checked with a standard thermometer. Although the extent of the observations on this phenomenon is meager and evidence of root elongation in orchards of comparable temperature has not been obtained, it is likely that there are certain conditions and varieties under which length growth of roots will occur at temperatures below 54F.

Studies were made with five-year-old Valencia orange trees on sweet orange rootstock planted in boxes in which the root temperature could be controlled. The boxes were equipped with glass sides so root elongation could be observed. These studies indicated maximum root elongation was at temperatures between 80F and 90F. Considerable elongation was noted at 100F, and roots died at 105F. Previous studies had indicated that the maximum temperature for root elongation was about 99F.

Other and earlier studies have indicated that—although top and root growth may alternate, as previously ob-

served—root growth is more or less continuous until inhibited by low or high soil temperature or by low soil moisture, according to the present investigations with glass-walled boxes. Soil temperature influences top and root growth.

A study made in solution involving 16 plants on four different rootstocks at each temperature indicated an increasing root growth from 65F to 90F, but a progressive decrease in the ratio of tops to roots as the temperature was increased. In studies with bearing trees in glass-sided boxes in the glasshouse, root elongation did slow down when there was a vigorous leaf flush, but it did not stop.

Study of the whole problem of the influence of soil and air temperatures on citrus is being continued.

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Left: glass front of unheated soil box—soil temperatures vary from 60F to 70F—containing a bearing Valencia orange tree on sweet orange rootstock. **Right:** a similar tree in heated box—temperature 75F to 85F. Only newly elongated roots are visible. Temperature in box at left is typical of the summer soil temperature in the coastal area of southern California.

