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LOW TEMPERATURE KILLING POINTS OF CITRUS LEAVES FROM SPRING 1983 TO SUMMER 1984

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Abstract. **Detached leaves of 'Marsh' grapefruit** (Citrus paradisi **Macf.), 'Valencia' orange** [C. sinensis **(L.) Osb.**] **and 'Dancy' tangerine** (C. reticulata **Blanco) from Gainesville and 'Marsh' grapefruit, 'Valencia' orange and 'Temple' orange** (C. temple **Hort. ex Y. Tan.) from Highland City were collected from April 1983 to July 1984. Low temperature tolerance was determined using the electrolyte leakage killing point (KP) test. During spring and summer in 1983 and 1984, KP were determined for both more-than-1-yr-old, overwintered leaves and for less-than-1-yr-old, new-flush leaves developed in 1983 and 1984. KP of mature leaves varied from 27.5°F to 18.1°F during the time period studied. KP of expanding, new-flush leaves in Gainesville were 32°F to 31.1°F in 1983 but were equal to those of overwintering old leaves by May 1983. Overwintered and new-flush leaves acclimated, deacclimated and reacclimated in similar fashion. KP in Gainesville decreased in late December 1983 but not in Highland City due to the 5° to 6°F lower mean air temperatures in Gainesville. Acclimation in Highland City followed a period of low mean air temperatures later in the season.**

Citrus trees have the capability for developing considerable cold hardiness. Citrus trees become quiescent with cool weather in the fall and physiological changes occur which bring about development of winter cold hardiness (1, 2, 3, 4, 5, 6, 7, 8). This process is frequently called acclimation. The acclimation process is reversible with deacclimation occurring following periods of warm weather (1, 2, 7). Because cold hardiness changes during the winter period, periodic determinations of killing point temperatures (KP) have been made and reported for several years (1). This information has been valuable in understanding tree response to freezing temperatures.

Citrus leaves remain on the tree for 1 to 2 yr and pass through 1 or more winters. Questions have been raised regarding the ability of citrus leaves to deacclimate in the spring and summer and then reacclimate to cold again during their second winter on the tree.

The purpose of this research was to continue the determination of KP through the spring, summer, fall and winter for both more-than-1-yr-old (overwintered) and less-than-1-yr-old, new (spring-flush) leaves on the same trees and determine patterns of cold acclimation and deacclimation for both old and new leaves.

Materials and Methods

Citrus trees and seasons. KP were determined on the same trees used previously (1). Single trees each of 'Dancy' tangerine and 'Marsh' grapefruit on trifoliate orange (*Poncirus trifoliata* (L.) Raf.) and 'Valencia' orange on sour orange (*Citrus aurantium* L.) in Gainesville and 'Temple' orange, 'Marsh' grapefruit and 'Valencia' orange on rough lemon (*C. jambhiri* Lush.) in Highland City were used. KP were determined weekly during the winter and monthly during the spring, summer and fall.

Sampling. Sampling was the same used in earlier testing (1) and varied only in respect to age of leaves sampled. Two samples were taken from each test tree: one sample of old leaves which had passed through the previous winter and one of new, spring-flush leaves.

Killing point determinations. The electrolytic conductivity test was used as previously described (1).

Temperature effects. To compare the effect of ambient temperature on KP, weekly mean temperatures for the week prior to the KP determination were calculated.

Results and Discussion

Deacclimation and reacclimation. From February through May 1983, KP of old leaves increased to 24°F to 25°F (Fig. 1). KP remained in this temperature range through the summer and into the fall. New leaves in Gainesville had KP from 31°F to 32°F when initially formed in April but KP decreased rapidly and by mid-May were equal to those of old leaves at that time. In Highland

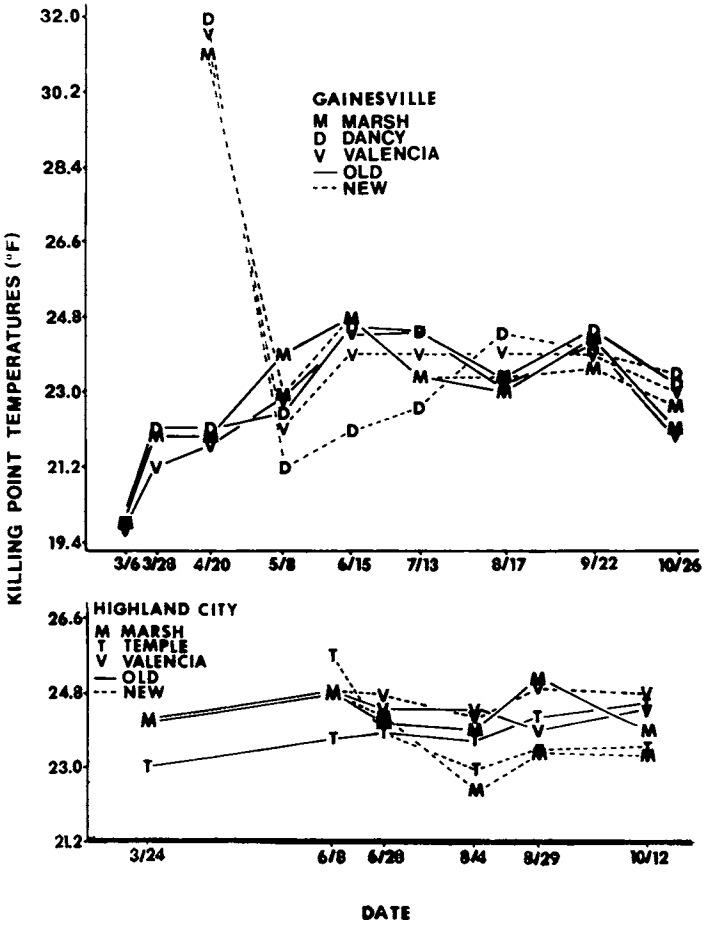

Fig. 1. Killing point temperatures of old, overwintered leaves and new, spring-flush leaves in spring, summer and fall 1983.

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City, the first samples of new and old leaves were tested on June 8, 1983. KP of new and old leaves were equal. KP of new and old leaves fluctuated in approximately the same way throughout the summer at both locations. In October 1983, leaf KP in Gainesville decreased, indicating that fall acclimation was beginning. After October it was impossible to secure enough old leaves for testing and determinations for this type of leaf were ended.

In spring 1984 (Fig. 2) the KP of old leaves in Highland City increased in the same way as in 1983 and reached 22.1°F to 24.8°F in April 1984. Due to the December 1983 freeze, no leaves were available for testing in Gainesville. KP of new leaves were 24.8°F on March 1, 1984 and were equal to the KP of old leaves by mid-April. KP remained in the 22° to 24°F range through summer 1984, and fluctuated in similar patterns for both types of leaves.

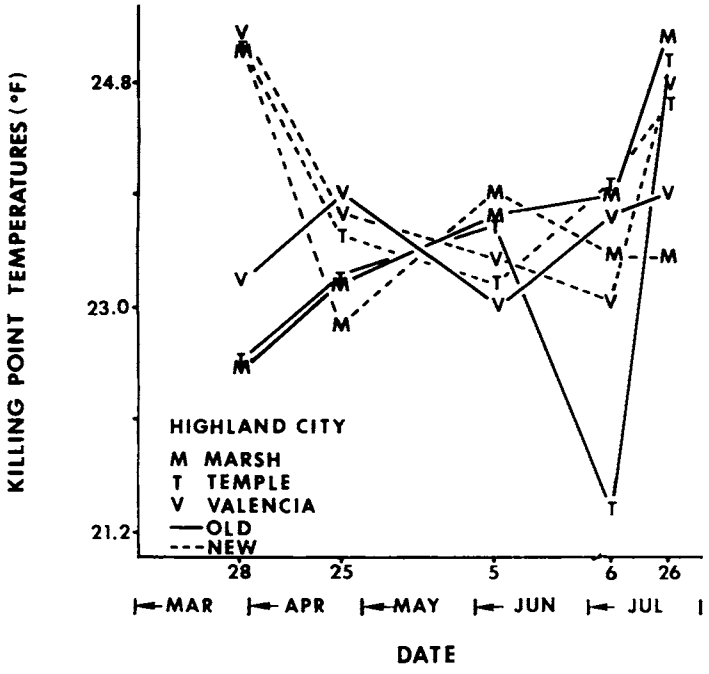

Fig. 2. Killing point temperatures of old, overwintered and new, spring-flush leaves in spring and summer 1984.

The data show that citrus leaves have the ability to acclimate in their first winter on the tree, deacclimate during the following spring and summer, and then reacclimate in their second fall and winter on the tree.

KP temperatures during fall, winter and spring 1984. KP of citrus leaves began decreasing at both Gainesville and Highland City in October 1983 (Fig. 3). By late November KP were in the 20.3°F to 22.1°F range. In early December, KP increased to the 22°F to 24°F range at both locations. In late December, KP in Gainesville decreased again to the 20° to 21°F range but remained in the 22° to 23°F range in Highland City. This difference in KP was probably due to 5° to 6°F lower mean air temperatures in Gainesville than in Highland City (Fig. 4). Temperatures are shown (Fig. 4) for Winter Haven due to lack of data for Highland City. Rootstock might have contributed to this difference, also, since the Gainesville trees were on trifoliate orange and sour orange rootstock and the Highland City trees were on rough lemon.

Following the December 24-25, 1983 freeze, no leaves were available for testing in Gainesville. Leaves on the test trees in Highland City survived the December 24-25, 1983 freeze and KP determinations continued on these trees. KP for all cultivars in Highland City decreased to 18° to 19°F in January 1984 in response to the lowest mean air tempera-

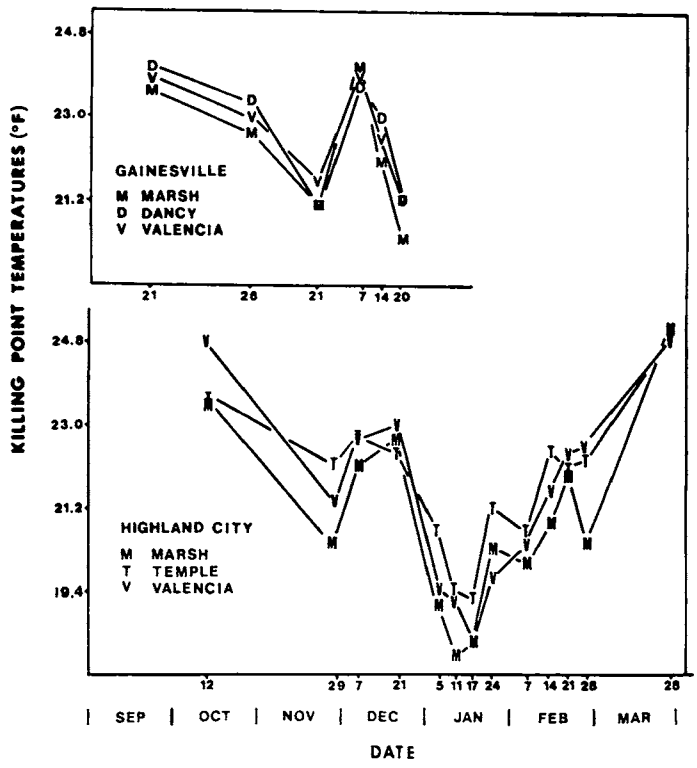

Fig. 3. Killing point temperatures in Gainesville and Highland City fall, winter and spring 1983-84.

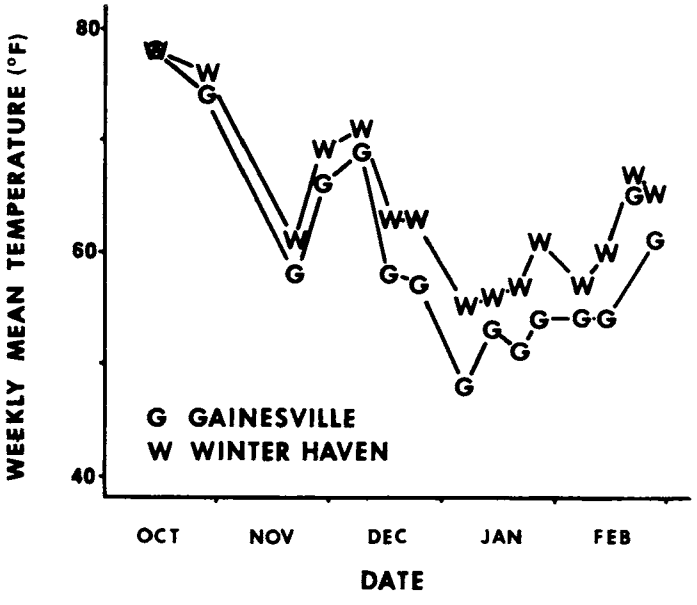

Fig. 4. Mean weekly temperatures in Gainesville and Winter Haven fall, winter, spring 1983-84.

tures of the winter (Fig. 4). During the same period in 1983 (1), KP in Highland City were 20° to 22°F, values which were 2° to 3°F higher than in the same time period in 1984. Although KP in Gainesville had decreased to the 20° to 23°F range before the December 24-25 freeze, they were still high in both locations at the time of the freeze. In late January, February and March 1984, KP increased as expected for deacclimating leaves.

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NONHARDENING TEMPERATURES—MAJOR FACTOR IN FREEZE DAMAGE TO CITRUS TREES IN DECEMBER 1983[1]

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Abstract. **Citrus plantings that survived the 1977, 1981, and 1982 freezes in Florida did not survive the December 24, 25, 26, 1983 freeze. Plantings that were lost included 8-yr-old 'Valencia' orange** [Citrus sinensis **(L.) Osb.**] **and 'Marsh' grapefruit** (C. paradisi **Macf. on 12 different rootstocks as well as 6-yr-old 'Star Ruby' grapefruit on 8 different rootstocks. Citrus selections that were noted for exceptional freeze tolerance after the 8°F minimum temperatures in 1981 were injured during 19°F in 1983. Cultural practices, tree health, age of trees, minimum temperatures, and freeze duration could not account for the extensive damage. It was concluded that noncold-hardening conditions that led into the Christmas freeze were largely responsible for excessive freeze damage to the trees. Cold-hardening temperatures were 6 times greater in 1977 and 1981, and 4 times greater in 1982 than in 1983 based on total number of hr of 50°F or less that occurred during the 11 weeks immediately preceding the freeze. During the last 4 weeks, cold hardening in 1977, 1981, and 1982 exceeded that in 1983 by 9, 12, and 3 times, respectively.**

The Christmas freeze of 1983 in Florida was one of the most unexpected and totally damaging freezes of the century in major citrus-growing areas in the upper interior and west coast counties. Conditions were highly favorable for devastating losses. Trees were in a freeze-vulnerable, active-growing stage, and many had been injured and weakened during the freezes in 1977, 1981, and 1982. Most of the fruit was still on the trees and a shipping holiday was in effect. Freeze forecasts were delayed because of unusual atmospheric conditions and hurried freeze protection efforts were hindered by holiday activities. All of these factors reinforced concerns of devastating losses after 2 nights of freezing temperatures as low as 19°F for 1 or more hr. Citrus plantings were virtually destroyed, fruit processing plants were closed, thousands of people lost jobs, financial drains were placed on local and state assistance programs, citrus imports increased, total crop yield was reduced by one-third or more, and consumers paid higher prices. Grove rehabilitation may take as long as 6 yr in new replant situations and 3 to 4 yr where trees were buckhorned (pruned to major scaffold limbs). In some instances, citrus plantings will be abandoned and targeted for nonagriculture uses.

This report summarizes comparative observations of prefreeze weather conditions, freeze profiles, tree injury, and cold-hardy citrus types during the 1983 freeze with that of 1977, 1981, and 1982. Data are part of the USDA research program on freeze problems in Florida.

Materials and Methods

Freeze injury observations in this report were limited to research plantings on the USDA A. H. Whitmore Foundation Farm near Leesburg, Florida. Plantings surveyed were equal-aged plantings of 'Valencia' orange and 'Marsh' grapefruit, on 12 different rootstocks, 'Star Ruby' grapefruit trees on 8 different rootstocks, trees that expressed exceptional cold hardiness in the 1981 freeze (5), and a new planting of cold-hardy citrus hybrids. Except for the new planting, all of the trees surveyed were survivors of the 1977, 1981, and 1982 freezes.

Ratings of freeze injury were started 5 months after the 1983 Christmas freeze and were completed in 4 weeks. Wood dieback had stopped and new growth indexed the extent of tree damage. Trees were visually rated and coded numerically on severity of leaf and wood kill. Categories of injury ratings remained the same as in 1977 (4) and 1981 (5).

Temperatures and rainfall were measured on site as in previous freeze situations. Air temperatures were recorded on hygrothermographs calibrated to the nearest 1°F and located in standard weather shelters 4½ ft above ground level. Rainfall was obtained in a standard rain gauge. Temperatures and rainfall data were used to comparatively index prefreeze conditions 11 weeks before freezes and freeze profiles were obtained from hygrothermograph charts.

Results and Discussion

The 1983 Christmas freeze was devastating in citrus plantings on the USDA A. H. Whitmore Foundation Farm. Many of the trees that survived the 1977, 1981, and 1982 freezes did not survive the 1983 freeze. Trees which were not totally lost (killed to the rootstock) were severely injured to the extent that the plantings were abandoned in favor of new plantings in 1985.

Devastating effects were especially evident in 8-yr-old sister plantings of 'Valencia' orange and 'Marsh' grapefruit on 12 different rootstocks. Forty-five of 165 'Valencia' trees which survived past freezes were killed (Table 1). This was a 27% tree loss in 1983 and represented 60% of the total trees lost prior to the 1983 freeze. The combined loss (including 1983) of 120 trees or 50% of the original planting,

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