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EVALUATION OF AVOCADO COLD HARDINESS

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Abstract

Cold hardiness of 'Gainesville' cuttings, 'Itzamna' grafted on 'Topa Topa' rootstock and seedlings of 'Mexicola' and 'Topa Topa' as determined by freeze-chamber testing corroborate the work of previous investigators. Cold tolerance of 'Waldin' was higher than previously reported and indicates a need for further study of this cultivar (cv).

Exposure to low, non-damaging temp prior to exposure to freezing temp resulted in greater cold tolerance, suggesting that avocado plants may acquire greater cold tolerance, under such temp regimes. Thus, low non-damaging temp prior to the time of a freeze may have beneficial effects by increasing the resistance of avocado plants to freezing temp.

Measurements of growth during low but not freezing temperature indicated that cold-hardy cvs grew less than non-hardy cvs, suggesting a relationship between minimum temp for vegetative growth and cold tolerance.

The avocado is an important commercial crop in South Florida. In 1973 this area produced a total of 755,000 bushels of fruit worth approximately $6 million to growers (8,9). Data are limited on the cold hardiness of various cultivars now being grown in Florida. Further, little is known of the processes of cold hardening in avocados, or if they in fact do harden at all.

Data on avocado cold hardiness have generally been collected from field observations after cold temp periods (3,4,5) although artificial freezing has been used by some researchers (6). Harris and Popenoe (2) attempted to evaluate cold hardiness by measuring the freezing point of expressed leaf sap but later work by Halma (1) did not support the validity of this method. Recent work has used the damage to excised avocado leaves as a measure of cold hardiness (6). Limited tests with the leaf freezing point (LFP) technique did not prove successful for avocado (7).

Investigations were conducted to determine the cold tolerance of 5 avocado cultivars using freeze chamber evaluations of container-grown plants and to evaluate the ability of avocado plants to acquire cold tolerance during exposure to low but not damaging temps. An attempt was also made to determine if there is a relationship between cold tolerance and the min temp for vegetative growth.

Materials and Methods

Test plants, grown in 20-cm-diam containers, included 36 19-month-old seedlings of 'Topa Topa', 18 19-month-old seedlings of 'Mexicola', 6 9-monthold 'Waldin' scions and

12 9-month-old 'Itzamna' scions on 'Topa Topa' seedling rootstocks and 12 24-month-old 'Gainesville' cuttings. They were separated at random into 2 groups for hardening treatments.

Plants undergoing a hardening treatment were] conditioned in a chamber described by Young (10). Plants were exposed to day/night temps of 21.1°C/ 10.0°C for the first 2 weeks, to 15.6°C/4.4°C the following 2 weeks and to 10.0°C/1.1°C during the fifth week. Chamber temps were accurate to within ± 0.56°C. Unhardened plants were kept in an unheated section of a greenhouse where day/night temps averaged 23.0°C/16°C for the 5-week period.

Hardened and unhardened plants were separated at random into 3 groups. Each group was then exposed to a selected, pre-set temp. Three temps were selected based on the predicted low-temp tolerance of the plants being tested. The 3 selected temp were calculated to be either lethal to the plant, low enough to cause intermediate damage or high enough to cause little or no damage and were -3.3°C, -4.4°C, and -5.6°C for 'Itzamna' -4.4°C, -5.6°C and -6.7°C for 'Topa Topa', 'Mexicola' and 'Waldin' and -5.6°C, -6.7°C and -7.8°C for 'Gainesville'.

Test plants were exposed to low temp in a walk-in freeze chamber with forced-air circulation. Temp in this chamber could be controlled within ± 1.0°C. Roots of the container-grown plants were insulated with a layer of vermiculite or perlite. Temp was monitored with 3 22-gauge copper-constan thermocouples connected to a 20-point Honeywell recorder.

Damage was evaluated in terms of % defoliation, % stem damage (damage occurring to tissue along twigs and *stems in* which bark became discolored but did not die and subsequently supported new growth), and of % dead wood. A damage rating index was formulated as DI = Rating of defoliation + rating of stem damage + $(\text{rating of wood kill})^2$ based upon the relative severity of the different damage categories. A DI rating of 4 or above indicated at least 51-100% leaf drop, 51-75% stem damage and 26-50% wood kill. The temp at which damage of this nature was sustained was considered the plant's freezing point (FP).

All growth in the previous 5-week conditioning period was removed and dry weights were recorded immediately prior to placing unhardened and hardened plants in the freeze chamber. After evaluation of freeze damage to whole plants, dry weight determinations were made on a sample of 3 plants per cultivar. Growth increment per cv for the 5-week conditioning period was calculated as the quotient of the average dry weight of the new growth divided by the average dry weight of the whole plant.

Results and Discussion

The DI rating system used in conjunction with the freeze chamber proved to be quite accurate. Freezing point (FP) temp in these tests were within the FP range as has been previously reported (Table 1) except for 'Waldin'. 'Waldin' showed a FP at -6.1°C, whereas its freezing point is reported to be from -3.9°C to -1.7°C.

Table 1. Freezing point (FP)[z] temps and previously reported ranges in cold tolerance for 5 avocados.

Cultivar	FP (°C) Hardened	FP (°C) Unhardened	Previously reported (°C)
Gainesville	-7.8	-7.2	-9.4 to -6.7 (5)[y]
Mexicola	-6.7	-6.1	-9.4 to -6.7 (5)
Topa Topa	-6.7	-6.1	-7.8 to -5.6 (5)
Itzamna	-5.0	-4.4	-4.4 to -1.7 (2,3,4)
Waldin	-6.1	-6.1	-3.9 to -1.7 (2,3,4)

[y]Numbers refer to literature cited.
[z]Based on 36 'Topa Topa' and 18 'Mexicola' seedlings, 12 'Gainesville' cuttings, 12 'Itzamna' and 6 'Waldin' budlings.

Comparisons of hardened and unhardened avocado plants showed hardened plants to tolerate 0.6°C lower temp than unhardened plants (Fig. 1) except in the case of 'Waldin' where both hardened and unhardened groups proved to be equally cold hardy. It must be pointed out that differences between FPs of hardened and unhardened plants were consistent, except in the case of 'Waldin', but slight and would be inconsequential in the field. The persistence of low but not freezing temp is rare in the avocado growing areas of the U.S., and Florida in particular. Thus, the question of cold hardiness acquisition for these areas is academic pending a northward expansion. The effect of hardiness-inducing temp may be an important factor in plant survival, however, in the high altitude, low latitude avocado producing areas.

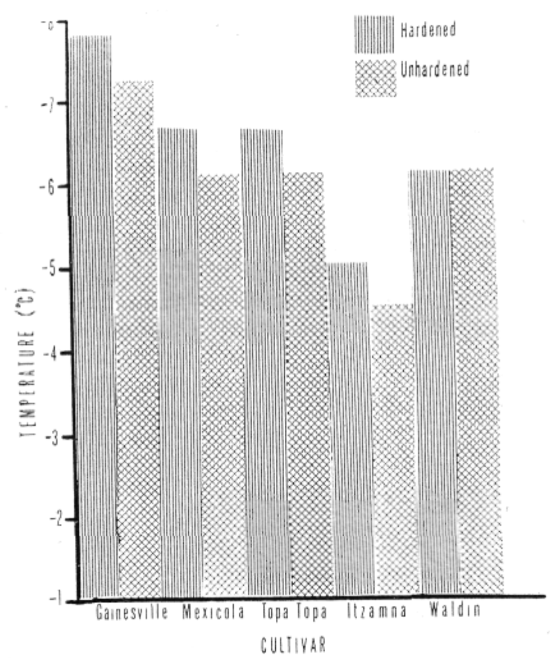

Fig. 1. Cold tolerance of hardened and unhardened avocado plants.

The hardening temp used in this work should not be regarded as ideal and in future work, a different set of parameters may prove to stimulate a greater degree of hardening. 'Waldin' did not harden as expected. The fact that hardened 'Waiden' plants were not more cold tolerant than unhardened plants under this temp regime may have been due to the fact that temp experienced by the unhardened plants were themselves sufficient to cause a degree of hardening.

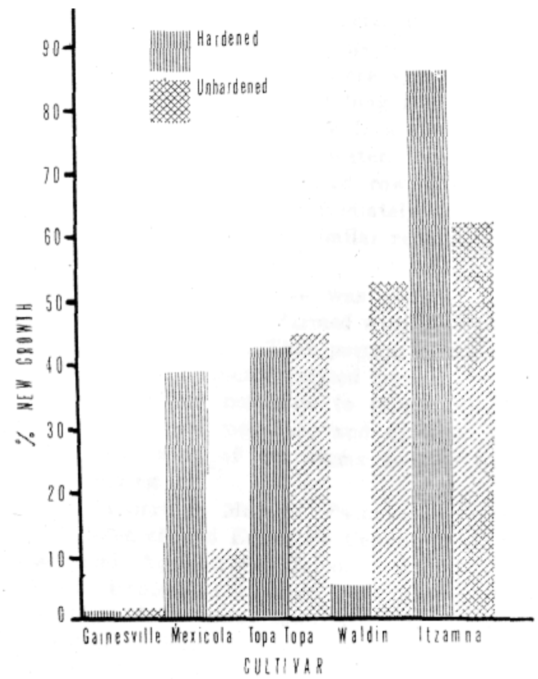

Fig. 2. Average total growth of avocado plants during a 5-week conditioning period.

Some cvs. or seedling groups continued to grow at lower temps than others during the 5-week preconditioning period (Fig. 2) indicating a difference in min growth temp. A comparison of % new growth and FP ratings for the container-grown plants is shown in Fig. 3. Plants with the greatest amount of growth during the 5-week period were also the least hardy in freeze-chamber tests.

The small amount of growth of the hardened 'Waldin' and the greater growth increments of 'Mexicola' seedlings and 'Itzamna' as compared to unhardened 'Mexicola' seedlings and 'Itzamna' were unexpected. The reason for this may be due to faulty technique rather than actual physiological effects. These discrepancies notwithstanding, the data suggest a relationship between temp at which dormancy begins and additional resistance to low temp is developed, a relationship that exists in various Citrus species and relatives (10,11,12). It must here be noted that trees of the cold-hardy Mexican race bloom during the winter months in the field when one would expect an almost complete absence of new growth and yet, they are considerably more hardy than trees of the less hardy Guatemalan and West Indian races which remain in a dormant state until the spring months, a contradiction to the data in Fig. 3. Only vegetative growth was used hence the effect of flowering on cold hardiness could not be studied. This may be the cause of the discrepancies between experimental and field data.

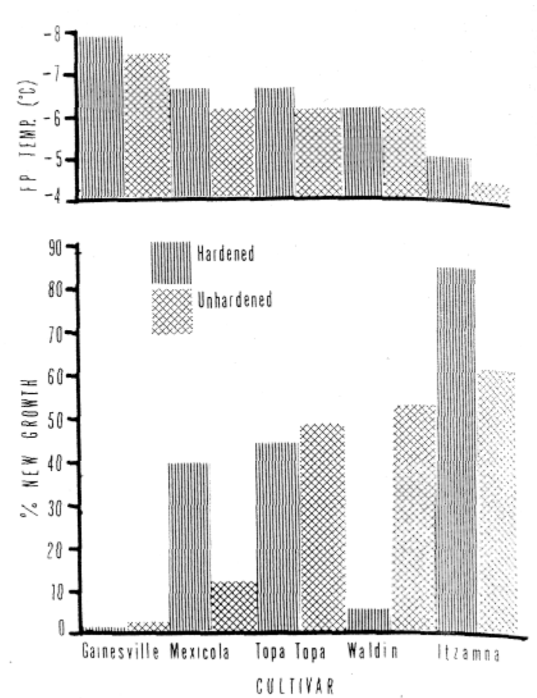

Fig. 3. Comparison of % new growth and FP temperatures for avocado plants.

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