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Freeze Injuries in Avocado Fruit[1]

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Abstract. **Differences were found in the extent of freeze injury among 'Fuerte', 'Hass' and 'Nabal' avocados *(Persea americana* Mill.). Large 'Fuerte' fruit suffered more than small ones. Relatively high rates of ethylene production and of respiration were found in heavily injured fruit as soon as 1 day after harvest. Keeping quality of freeze-damaged fruit was reduced. It is concluded that the major processes involved in ripening, such as softening, respiration, ethylene production, and the activity of pectic enzymes, are enhanced in freeze-injured fruit.**

There was a prolonged period of freezing conditions in the coastal area of Israel during December 1972 and January 1973. Minimum night temperatures in the orchards were between -3° and -6°C for about 20 consecutive nights damaging avocado trees and fruit. It has been reported that 'Lula' avocado fruit in Florida suffered damage at similar temperatures (2, 3). Observations in the orchard and experiments in the laboratory were carried out during and after the freeze period, with the aim of defining physiological changes in fruit in connection with freeze damage and of developing criteria for the separation of unmarketable fruit from marketable ones.

Ethylene evolution, respiration rate, weight losses, changes in specific gravity of the whole fruit, and changes in activity of certain enzymes were determined in 'Hass' and 'Fuerte' fruit. Ethylene and CO_2 were determined by gas chromatography and pectinmethlesterase (PME) and polygalacturonase (PG) activities as previously described (5). Peroxidase was determined according to McCune (4) and cellulase by Abeles' method (1). Five replicates with 10 fruit each were used for each determination.

Various forms of damage were observed: Severely damaged fruit which showed evident browning of the peel and pulp abscised within 10 days after the beginning of the freezing weather. Damage in some other fruit could be found only upon cutting them open when dark areas were noted around vascular tissues in the pulp. Light browning of the fruit stem was a symptom of such damage near the vascular tissues in some cases.

Extent of freeze injuries differed with cultivar, 'Fuerte' fruit suffering the most, 'Hass' intermediate, and 'Nabal' only slightly. Sensitivity of these cultivars to freezing is similar to their sensitivity to chilling injury during storage (7). There is, however, no similarity in

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symptoms between freeze injury and chilling injury. The picking season in Israel for 'Fuerte' starts in Oct., for 'Hass' in Jan., and for 'Nabal' in Feb. It is possible that sensitivity of the fruit to freeze injury relates to the order of maturation of the fruit.

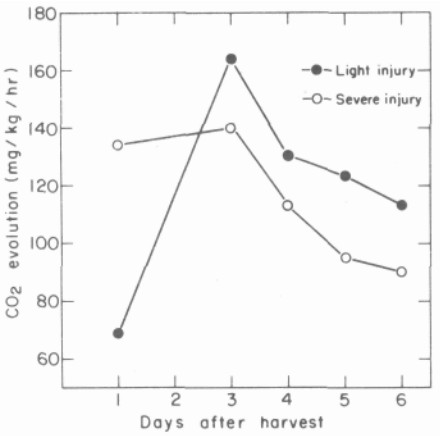

Fig. 1. Respiration rate of freeze-injured 'Hass' avocado fruit.

'Fuerte' fruit suffering severe injury had black instead of green peel, reddish brown stems, and also darkening of the vascular tissue near the blossom-end. Darkening of the vascular tissue was evident only upon cutting into fruit suffering light injury. There was darkening of the peel, browning of the stem and small cracks in the pulp and darkening of the vascular tissues near the stem-end in severely injured 'Hass' fruit.

The rate of weight loss at 14°C and 85 to 90% relative humidity of fruit with various degrees of injury was 0.3% per day, about the same as that measured in uninjured fruit in a year without freeze (6). Changes in specific gravity could not be used for the identification of injured specimens, as it ranged from 0.994 to 1.025 according to the cultivar and was not correlated with degree of damage.

A rather good correlation was found between fruit wt and the extent of freeze injuries. It was found that 5, 15, 30 and 75% of 'Fuerte' fruits weighing 200, 250, 300 and 350 g, respectively, showed freeze injury in one of the orchards. About 80% of the fruits weighing 300 g and above were injured while no injury was evident in fruit weighing 250 g or less in other orchards.

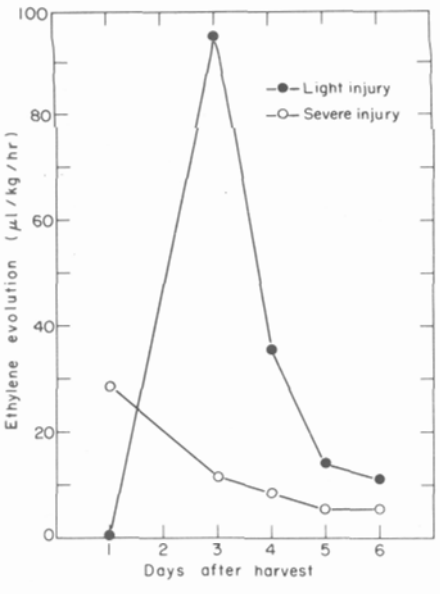

Fig. 2. Ethylene evolution of freeze-injured 'Hass' avocado fruit.

Keeping quality of freeze-damaged fruit stored at 14°C was reduced in comparison with that of fruit in a year with normal temperatures. For example, freeze-damaged 'Hass' fruit kept for 7 to 10 days instead of the usual 10 to 14 days (unpublished data). Reduction of keeping quality was also reflected in respiration patterns (Fig. 1) and ethylene production of the fruit (Fig. 2) as measured after 24 hr equilibration at 20°C. Lightly injured fruit reached respiration and ethylene peaks at the same time, that is, on the 3rd day after picking. The typical decrease in respiration after picking did not occur at all in freeze-injured fruit. Severely injured fruit had relatively high ethylene production and respiration rates as early as one day after harvest, which then decreased until the fruit was completely soft. In normal years without freezing temperatures, no significant ethylene production occurs at 20°C for at least 6 days. These findings may indicate that the climacteric peaks of respiration and ethylene production of freeze-damaged fruit already occurred on the tree. The degree of injury was verified by cutting open the fruits at the end of the experiment.

No differences in PME, PG, and peroxidase activity were observed between fruit with various degrees of injury; however, cellulase activity in fruit with severe injury was higher than that in fruit with light injury.

It can be concluded that in freeze-injured fruit, ripening processes are enhanced and also that the larger the fruit is, the more it is damaged by freeze. This knowledge has already been used for practical purposes, such as the separation of marketable from unmarketable fruit.

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