

Protecting Avocados from Frost

Frost damage reduces tree growth and fruit yields. Thus, it presents a problem to the avocado grower who must develop and maintain high production to have a profitable business.

Before choosing frost protection equipment, however, the individual grower should ask himself this question: "Will the fruit and foliage saved pay for the trouble and expense of protection?" In some places, a small amount of damage may not fully justify the installation and operation of frost protection equipment. In other places, avocados can be grown only if expensive heating is done. Nearly all locations have sufficient cold to cause the grower to take into account probable frost damage, possible methods of protection, and the long-range economic effect of his frost situation.

How Frosts and Freezes Occur

Before considering the methods of frost protection, one should understand the conditions under which low temperatures occur. To differentiate between the two major sources of the cold, the terms local radiation frost and freeze are used.

Local Radiation Frost

Frosts are caused by a cooling of the objects on the earth's surface during the night. This loss of heat from the foliage and soil is called radiation. Heat accumulated from sunshine during the day is radiated to the sky during the night. The cooled objects chill the surrounding air and usually the coldest zone is near the ground surface. Air temperatures are warmer as one goes higher until a height is reached where they are at a maximum for that location. This is called the ceiling. The temperature and height of the ceiling is different for each plane and situation.

When the ceiling is low, warm air is nearer the ground than when the ceiling is high. This phenomenon, occurring frequently in Southern California, is called *temperature inversion* and accounts for this area's ability to protect its orchards.

Colder air settles near the ground and then moves (flows) down the slope to still lower ground resulting in what is called the *drift*.

Terrain features and winds influence its direction and velocity. A strong drift maintains air temperatures higher than those existing when little or no drift is present

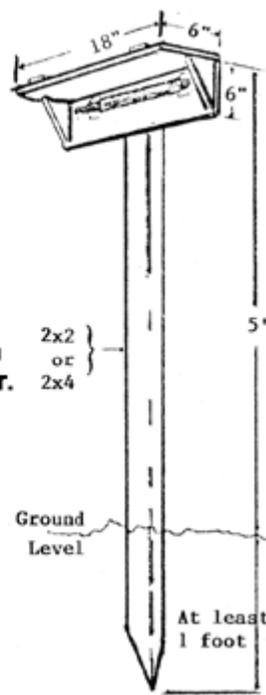
Freeze

The other type of freezing weather occurs when a large mass of cold air moves in from the north. Fortunately, these freezes have not occurred frequently. The major ones were in 1913, 1922, 1937, 1949, and 1950. Under freeze conditions, temperatures usually go below those experienced during local radiation frosts. When this cold air moves in, high ground is no warmer than lower ground and there is little or no ceiling. Orchard protection at such times are difficult and methods employing the addition of heat are most effective.

Measuring Temperatures

Orchard temperatures are usually measured with a specially designed self-registering minimum thermometer mounted in a standardized shelter.

Standardized shelter for self-registering minimum temperature thermometer.



In this way, readings are comparable and experience allows the grower to use these air temperature readings in judging his hazard and operating his equipment. The height of the thermometer above ground should be five feet in mature orchards and two feet in nurseries and recently planted orchards. Most orchards have areas that are colder than other areas. You should have enough thermometers to measure temperatures in each of these areas. In establishing thermometer locations in a new orchard, set up one thermometer in a permanent reference location. Move the other thermometers around every few nights until you find the cold spots. With this experience, you can locate and determine the number of thermometers needed. The range in numbers will be from a minimum of two or three for small groves to one for each three to five acres in larger orchards.

TYPES OF INJURY

Fruit Damage

Fruit damage consists of frozen stems, frozen fibers inside the fruit, or frozen flesh and skin, depending on the temperatures and their duration. This damage appears slowly and is difficult to appraise accurately.

For some varieties, principally in the case of the Fuerte, the first evidence of damage will show up as a browning on the stem a few days after a frost. Mature fruit with only the stems frosted can be picked and marketed. Nearly every year some of the crop from frosted Fuerte groves is salvaged by picking all the fruit showing frosted stems as soon after the frost as possible. Unless this fruit is harvested, it will fall from the tree. Frozen fruit of other varieties, particularly the Guatemalan types, may never show the browning, but will drop anyway.

Frozen fruit fibers (vascular bundles) turn black and California law prohibits the marketing of all seriously damaged fruits. Before you pick mature frosted fruit, you should call in your marketing organization representative and local agricultural inspector to help you determine how much of the fruit should be harvested. By cutting representative fruit, they can tell whether it is within the legal tolerance or not, and guide you in marketing your fruit.

Severely frozen fruit may show brown water-soaked spots in the skin, gray areas in the flesh, and may even crack or split. It is unmarketable and will drop from the tree in time.

Tree Damage

Frozen blossoms, leaves, and twigs turn black within a few days. But larger wood, although frozen, may never turn black. Great variation occurs in the location of tree damage. In some cases, only the lower part of the tree will be frosted, while in other cases only the top part is affected. Sometimes, only a limb on one side will be frosted. Thus, it is impossible to evaluate accurately the extent of wood damage until new growth comes out the following spring and summer.

Trees suffering moderate wood damage usually will not bloom properly and will produce a reduced crop the following season. Occasionally, trees have been killed all the way to the ground by severe freezes.

Tree Resistance

When tender growth should be delayed until early spring

The resistance of the fruit and trees to freezing temperatures helps determine whether a grove must be protected or not. Then too, both the minimum temperature and the duration of damaging temperatures affect the amount of injury. For example, three or four hours of 29 degrees may injure an orchard more than a brief drop to 25 degrees. Frost susceptibility varies greatly from situation to situation. Adequate appraisal of each situation should include consideration of the following variables.

Age and Crowding

Young trees (up to 3 years of age) and recently top-worked trees of all varieties may be killed by temperatures which would only cause minor damage to nearby mature trees. Protection for such trees is a wise practice, even in warm locations.

In general, older trees of a given variety are more resistant, except in orchards where they are crowded. Where the soil is shaded during the day, it cannot absorb the sun's heat and thus has little heat to give off during the night. Crowding also restricts the drift through the grove and increases the difficulties of orchard heating. For these reasons, thinning groves is often advisable to reduce their frost hazard.

Health

Weak trees are more subject to frost damage than healthy ones. Be sure your trees go through the whole year with an adequate supply of moisture; withholding irrigation water in the fall to "harden them up" can actually weaken trees and make them more susceptible.

Growth Flush

Occasionally avocado trees are in a growth flush (a period of rapid new growth) when freezing temperatures occur. This is not usual, but unseasonably warm weather may stimulate a tree into abnormal growth in the winter. To avoid stimulation, pruning should be delayed until early spring. When tender growth occurs in the winter, growers may have to provide additional protection or sustain damage.

Size of Crop

Trees with large crops are more susceptible to frost. To save this fruit, temperatures would have to be maintained one or two degrees higher than would otherwise be necessary.

Varieties of Avocado

A wide range of susceptibility occurs among avocado varieties. To classify them according to their resistance is difficult because of the variations already mentioned. But the races of avocados do exhibit differences and can be used as frost resistance indicators.

The *Mexican race* is the most resistant, and is able to withstand temperatures about as well as orange trees.

The *Guatemalan race* is the most susceptible grown in California. Some varieties are slightly more resistant than others, so the race can be divided into tender and very tender classifications. Because the fruit is immature during the winter, the crop may be lost while the trees will suffer only minor damage. Lower temperatures will seriously damage trees and affect their future productivity.

The *hybrids*, as typified by the Fuerte, are intermediate in their frost resistance, and are in about the same class as lemon trees. Because of the Fuerte's importance, it has become the standard measure of frost resistance. Protection is usually provided to save the Fuerte crop since the fruit is mature in the winter months.

As a guide to inexperienced growers, Table I gives a basis for establishing frost protection practices. The critical temperatures listed are for mature healthy trees. Other tree conditions might move these figures one or two degrees higher. Also, the duration of the damaging temperatures would affect the degree of injury.

Variety Frost Resistance		
Race	Typical varieties	Critical temperature below which fruit and/or trees are subject to damage
Mexican	Duke, Topa topa, Mexicola, Zutano, Bacon	25 Degrees F
Hybrids	Fuerte, Puebla	28 Degrees F
Guatemalan (Tender)	Ryan, Hass, MacArthur, Nabal, Endranol, Rincon	29 Degrees F
Guatemalan (Very Tender)	Anaheim, Dickinson, Carlsbad, Challenge, Hellen	30 Degrees F

Need for Protection

Frost protection is an expensive and disagreeable job which requires careful consideration by all growers. Each grower must determine his own needs. No one can predict accurately the frost hazard for a given location. Information can be obtained by installing the proper thermometers on the property. Observing adjoining orchards and talking with neighbors will give good background information.

The topography of the orchard and the surrounding land enters into the evaluation. Land on hillsides with steeper slopes is usually warmer than lower valley land. Locations with strong prevailing drifts, or exposed to winds, usually are warmer than sheltered areas having little air movement. Tall dense windbreaks can make a grove one or two degrees colder, but the lower branches of the windbreak can be trimmed to overcome this. Coastal areas usually have less frost hazard because the relative humidity is higher, and ceilings are lower than in interior areas.

As mentioned in the beginning, your final evaluation should answer this question: "Will the fruit and foliage I save pay for the trouble and expense of protection?" Often it is possible to take some damage every few years and still have a more profitable orchard than if equipment were purchased and operated. On the other hand, an investment in equipment, if properly operated, will save your trees and crops. The decision should be based on a long range economic estimate, balancing the money lost by damage against the costs of protection. This same evaluation will determine the type of protection to provide, if needed.

In some counties and communities, smoke ordinances regulate the type of equipment and methods of operation to reduce smoke output. When you purchase new orchard heater equipment, it should be the most

smokeless available in order to comply with possible future expansion or tightening of these ordinances. The trend toward eliminating smoky orchard heaters in most areas will affect the grower's choice of equipment.