

Wide Range of Damage

eight preliminary reports indicate tree and

SUBTROPICAL FRUITS

K. M. Smoyer

The recent major freeze caused severe injury to both crop and trees of many subtropical evergreen fruit trees of the State.

Avocado trees suffered extreme damage in most avocado growing districts, and many young trees were killed outright. Very little damage has been found on mature citrus trees, but in most areas young trees were badly damaged or killed. In many cases even well wrapped trees were frozen.

Specimen trees and small plantings of other subtropicals such as sapotes, mangoes, cherimoyas, etc., were damaged also, but these are not grown commercially to any extent. Frost damaged trees of these varieties should be handled in the same manner as citrus and avocado trees.

Where trees have been damaged severely, it will be necessary to make certain adjustments in normal cultural programs to help bring the trees back to maximum fruit production as soon as possible.

Frost damaged trees should not be pruned until the spring flush of growth is well advanced. This may require four or five months of waiting.

It is impossible to determine accurately from field observations which wood is dead and which is alive. Pruning before the new growth develops usually results in removing more wood than was actually

killed and reduces the size of the trees more than necessary. The more heavily a tree is pruned the longer it will take to regain its original size and bearing capacity.

Other than being unsightly, dead wood in a tree is of no consequence. The one possible exception is in areas where dothiorella rot of avocados is prevalent. This disease lives on deadwood which serves as a source of infection for the fruit. In these instances, it is best to remove the dead wood as soon as possible after the blooming season.

An old tree should not be pruned until the new buds or the suckers back of dead wood have grown out six to ten inches. Many times small strips of bark may start buds growing, but the development of shoots will be slow and weak because of insufficient live wood underneath to support them.

Small limbs should be cut back far enough to remove all of the completely dead branches and most of the limbs that have been only partly damaged. If three-quarters or more of the cross section of a limb is undamaged it may be left. It will, however, be weak and might break more quickly under a heavy load of fruit. Cuts should be made to strong lateral suckers or to old limbs.

Main scaffold limbs should be cut so that no dead wood is left. Partially dead limbs are weak, and with avocados, may present a hazard in harvesting or may later break under heavy crops or winds.

All avocado pruning wounds over two inches in diameter should be covered with some kind of pruning compound such as a water soluble asphaltum. No treatment is necessary on citrus.

Pruning too early may result in not removing all of the large dead wood and may necessitate going over the trees again. This only increases the costs in orchards which must now be operated at maximum efficiency if they are to return a profit.

Young trees should not be pruned until the new shoots which may develop from either above or below the bud union are at least ten to twelve inches long. From those above the bud union select the best and strongest sucker for training into the new tree. Then remove the old damaged top by cutting just above the sucker to be saved. After this remove the

balance of the suckers below the one to be saved. All dead wood in the old trunk should be cut out. If such young trees are killed down to the bud they will often send out suckers from the rootstock. These are never commercial varieties so they must be rebudded when large enough. Select one of the heaviest and most vigorous of these and treat the tree as described above for suckers from above the bud union.

Pruning wounds on all varieties of one- and two-year-old trees should immediately be covered with a pruning compound.

In districts where strong winds occur, it is best to select a new shoot on the upwind side for the new tree. Avoid selecting a sucker arising from a spot where less than two-thirds of the cross section of the trunk is still alive.

A stake should be placed as close as possible and the new shoot tied to it. Suckers to be used for budding on a new top need not be staked.

Young trees which were subnormal in size and vigor before the freeze should be removed and the best nursery trees available set in their places.

Protection from sunburn on old trees is debatable, but it is a good precaution to whitewash all exposed main limbs. If considerable whitewashing is necessary, it may be sprayed on with power rigs using 50 pounds of hydrated lime and 4 pounds of zinc sulfate to 100 gallons of water. Only the south side and top of the limbs need to be protected.

For small areas, the above proportion of materials should be used with enough water to make a thin paint and then applied with a paint brush.

Whitewashing will delay bud and sucker development in the spring, but by fall there should be little difference in new growth between treated and untreated trees.

The freeze provides an opportunity for the removal of diseased citrus trees and the topworking of poor bearing or undesirable avocado varieties. Growers are reluctant to remove trees that still bear a small amount of fruit, always hoping the tree may do better next year. The loss of crop this year and even for two years, in the case of avocados, should help overcome this reluctance in removing bearing and unprofitable trees.

New growth on badly damaged trees often shows extreme symptoms of zinc



Fruit drop of frozen Valencias as result of severe weather in early January.

Result of Early '49 Cold

crop losses varied from slight to severe

deficiency. This is particularly true in orchards where the deficiency has been prevalent. It also may occur where no deficiency has ever been found. Small mottled leaves on new growth are signs of zinc deficiency. Small trees can be sprayed with hand sprayer, but power rigs should be used for large trees. A spray of five pounds of zinc sulfate, two and a half pounds hydrated lime to 100 gallons of water should be applied whenever the symptoms show. If all the old leaves are off the tree, spraying should be delayed until the new growth is well along. Without the presence of leaves little of the zinc can be absorbed.

Fertilization practices should be carried on in the normal manner in orchards only slightly damaged. In the interest of economy, badly damaged orchards could have the fertilizer program drastically reduced or even eliminated, especially where an adequate program has been used in the past.

The wilting of trees during the cold spell was from dehydration of the leaves caused by the cold and not because of insufficient water in the soil.

Irrigation practices and schedules will require some revision in badly damaged orchards. Loss of leaves and reduced size of trees from frost killing will cause trees to use less water until they regain full foliage and their original size. In well drained soils the use of more water than necessary will increase water and labor costs, waste water, and cause unnecessary leaching of fertilizers. Excessive water in heavy and poorly drained soils will rot roots and slow tree growth. In the latter type of soils, the disease known as avocado rot may get a start in the orchard and old infections spread to new trees.

Irrigation water should not be applied until the soil dries in the spring. This should be much later than usual in badly damaged orchards. Water usage is determined by the extent of leaf area and the weather. Until the hot dry summer comes, weather need not be considered except for unseasonable long dry spells this winter. With the amount of rain received so far this winter, irrigation should not be necessary for 90 to 120 days, even if no more rain falls. Trees not damaged will require water sooner. Soil examination among the roots of the tree is the only method of determining when to irrigate.

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CITRUS IN RIVERSIDE

C. P. Teague

The full extent of the January freeze damage to the citrus trees in Riverside County may not be apparent for several months. Most of the early estimates were exaggerated and in some cases they were underestimated.

The damage in Riverside County was quite variable, depending upon the districts.

Coachella Valley—The temperatures in the Coachella Valley the night of January 4-5, ranged from 14° F to 20° F, and for at least nine hours was at 20° F and below with little difference between high and low ground.

There was some tree damage to grapefruit, and a heavy loss of fruit. There seemed to be less damage to the trees under the date palms.

Hemet area—In this area, the temperatures during the nights of January 3d and 4th recorded lows of 15° F to 19° F, with durations below 20° F as long as 10 and 11 hours.

Even young one- and two-year-old trees did not seem to be very severely damaged other than leaves and small twigs but there was almost a 100% loss of fruit. A few groves in the area were heated, but even they showed considerable leaf damage and fruit loss.

Several wind machines in the area were of no value—at such low temperatures—as the fruit was completely frozen and considerable leaf damage was evident. One grove which burned heaters—one heater to two trees—and also used a wind machine, had severe loss of fruit and leaf damage. Even fruit near the heaters was lost.

Little or no tree damage resulted from the snow of the week of January 9th as the fruit was lost the week previous.

Moreno Valley—Lows were recorded of 18° F and 19° F and durations of 23° F and below for as long as 10 and 11 hours. There was some leaf damage and a large loss of fruit in unheated groves. Little twig damage seems to be evident.

Elsinore-Sedco area—Temperature lows of 16° F to 22° F were recorded in this area. Durations below 20° F were not so long as in the Moreno and Hemet area.

There was some fruit damage in the unheated groves, perhaps as high as 35% to 40%. Groves next to the lake, particularly along the south side, did not show severe frost damage. The snow which came during the week of January 9th gave severe ice damage to exposed fruit, and caused considerable tree breakage. Loss of fruit due to ice and snow damage ran up to 30% in many groves that otherwise escaped the frost.

Highgrove area—Temperatures in the Highgrove district on the night of January 3d dropped to 22° F to 25° F, but the wind came up and by midnight the temperatures were above the danger point in all cases. This wind continued the following night, and due to this the loss was held to a minimum in that area. There was slight tree breakage in the higher groves due to snow, and very slight ice injury.

Riverside area—Temperature lows in the Riverside area were recorded 22° F to 25° F. As in the Highgrove area, the wind came up the first night, January 3d about midnight and prevented severe damage, and prevented damage by blowing the following night. There was a small amount of tree breakage and some ice injury due to the snow which fell in this area during the first part of the week of January 9th.

Wind machines were not of much help during the very rapid drops in temperature, but in later nights they helped out some growers by enabling them to delay the lighting of their heaters.

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Showing degree of injury on young frozen orange tree and stage of sucker growth at which frozen top may be removed.

Arlington Heights area—Temperatures lows in the Arlington Heights area the night of January 3d fell as low as 22° F by about 8:00 p.m., but after the wind increased the temperature rose to 31° F by 1:00 a.m. During the following week of the heavy snowfall, the morning of January 9th temperatures dropped to 25° F to 26° F, and some ice damage was caused during that period. Fortunately, durations of these temperatures were very short. There was slight tree damage in this area from the weight of the snow.

Corona area—Temperatures in the Corona area were affected by the wind. The lowest temperature recorded was 21° F on the highest ground the night of January 3d, but the temperature rose to 31° F by midnight. Very little damage was suffered in this area, although in the coldest places there was some frozen fruit and some loss of small lemons.

The snows of the week of January 9th caused severe tree breakage in the groves next to the foothills, particularly, the lemons. There was a little ice damage in the area due to the snow.

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SLIGHT OLIVE DAMAGE

H. T. Hartmann

No damage of any importance is believed to have occurred to olives in California from the recent freezing temperatures.

The entire crop of pickling fruit had already been harvested. Most of the fruit which was on the trees during the cold weather will be used for oil extraction. While freezing temperatures cause such fruits to shrivel severely it generally does not affect their use for oil. However, it has been reported that the freezing damage to the fruit in some Mission orchards in the Corning area was severe enough to reduce the oil yield.

In a few orchards the fruit still on the trees will be used for the salt-cure, Greek style process. Temperatures much below 25° F will cause some damage to the fruit for this process.

At least one orchard—in Glenn County—whose fruits are used for the Greek style process, was protected by orchard heaters which are not generally used in olive orchards, and escaped serious injury.

No injury has been noted to the trees themselves. Olive trees are believed to withstand temperatures as low as 10° F to 12° F. Below this they will be killed to the ground, but new shoots will arise from the roots. This happened in many olive orchards, particularly in the Fair Oaks and Corning sections, in December, 1932.

Contrary to most deciduous fruits, olives have a very light, if any, winter chilling requirement and are not particularly benefited by prolonged low temperatures.

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WIND MACHINES USED

F. A. Brooks

The January freeze is the first major cold spell since 1937 in the southern citrus areas.

In the meantime several hundred wind-machines have been installed which on the whole have provided economical frost protection for the ordinary light radiation frost. So the recent freeze with cold air overhead focussed attention on these machines which most owners knew only could raise air temperatures a few degrees when and if there was warmer air overhead.

Practically all the wind machines in the Pomona and Santa Paula areas were run whether or not any temperature rise resulted, and were kept running 15 or more hours the second and third nights of the freeze.

Operators who could do so, brought in orchard heaters to support the wind machines. They believed that with the wind machines the spare heaters were extra effective, so they achieved better protection than would have been possible with the limited number of available heaters.

As a specific example in LaVerne just north of Pomona, the temperature went down to 21° F and was below 24° F for 12 hours January 4 in spite of widespread orchard heating. There was no wind and little ceiling, but with heaters plus wind machines it was possible to keep orchard temperatures to about 28° F. On the third and fourth nights the wind machines were adequate without heaters.

One unexpected experience worth noting was that the engines drew in so much soot that the carburetors had to be cleaned every day. In general, that indicates some use of air which had been warmed by heaters and ordinarily lost above the tree tops.

A rough estimate is that without a strong inversion much more than half of the artificial heat promptly arises above the trees. Then at best only half of this overhead heat can work back into the orchard by diffusion and radiation. The wind machines would raise this percentage by forced recirculation. How much local advantage is possible in this way depends on how much heat is wasted above nearby orchards.

The use of heaters with machines is not new this year. It has been regular practice in the Santa Paula area for two or three years. The usual practice is to fire up corner and border heaters as soon as the machine by itself proves inadequate. One manager with machines in a cold spot lights up heaters five rows deep all around the edge of the tract.

Regarding the big heaters used in truck crops for frost protection, a brief visit in the Coachella Valley in December revealed that the unusual coldness reduced the area of protection below what was anticipated. These heaters were not designed for severe frost, but a test in tomatoes shows that for a group of nine heaters a spacing of about 180 feet would give a 6° protection for more than four acres.

The fuel rate for this figures out a little better than 25 gallons per acre hour which is the usual burning rate for citrus orchards using 50 small heaters per acre. There is an important difference, however, as protection by the big heaters requires direct exposure to beam radiation and shaded areas may freeze.

Tentative conclusions are that even though present oil and operating costs may make the regular heaters too expensive to use often on light frosts, they should nevertheless be kept ready to support the wind machines during a severe frost or freeze. Other than providing enclosures, heat remains the essential mode of protection against severe frosts. The wind machines seem to have helped the heaters.

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TRUCK CROPS

Division Staff

Warm season vegetables, even when protected by brush or paper caps, could not survive the continued exposure to temperatures below their freezing point experienced during the cold nights in January.

In some cases the roots and basal stems have survived sufficiently to be able to send out new growth. An application of nitrogen fertilizer will help stimulate new growth.

Some of the cool season crops such as broccoli and peas which were hit by the freeze during the harvest period will in time produce new growth and yield a later harvest. The cool season crops in general have not been irretrievably damaged. While the supply of produce for immediate harvesting is reduced and rendered of lower quality, some of these cool crops will recover if temperatures return

to normal. Many young and newly seeded fields of cool season crops have been killed and will have to be replanted, as naturally is the case of warm season crops which were just started.

Should the cold period be protracted it is likely to cause premature seedstalk development in biennial crops such as cabbage, carrot, beet, onion and celery. A short freeze by itself is not conducive to the initiation of seedstalks in these crops but a long, cool spell would do this.

The above report was made by the staff members in the Division of Truck Crops at the Experiment Station, Davis.

CAPRIFIG CROP REDUCED

Julian C. Crane

It has been estimated that only 10% of the 1949 caprifig crop remained after the January cold weather.

As a result of unfavorable growing conditions for figs last season, the overwintering crop of mamme caprifigs this winter was considerably smaller than in years past. Some injury to mamme figs was brought about by low temperatures the latter part of November. Temperatures as low as 17° F during the first two weeks of January seriously reduced the crop further.

Cold temperatures that dormant fig trees will withstand depend upon such factors as degree of dormancy, variety, and condition of the trees. The cold spell of December 1932 afforded the opportunity of obtaining evidence regarding the association between these factors and cold injury. It was reported that at 10° F to 12° F well cared for mature trees were only slightly injured but severe injury occurred to old trees and young bearing trees. Temperatures of 15° F to 18° F were accompanied by no injury other than a reduction in the first crop of fruit the following year, evidently from injury to the young fruit buds. The apparent resistance in descending order of the four main varieties was Kadota, Calimyrna, Adriatic, and Mission.

The mamme crop of caprifigs that remains on the tree during the winter season is subject to injury or total destruction by cold weather. It is not known exactly what temperature limit may be set as indicating freedom from cold injury of caprifigs since variety resistance and stages of development of the Blastophaga enter into the problem. Observations indicate that Reeding No. 3 caprifigs are more susceptible to low temperatures than are mamme caprifigs of the Stanford and Milco varieties. From past experience it would seem that temperatures of 18° F and below would result in injury to mamme caprifigs, the extent of the injury

depending upon variety, stage of development, and age of the tree.

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FLOWER INDUSTRY

V. T. Stoutemyer

Unusually low temperatures during early January brought heavy financial losses to the outdoor flower growing industry of California. The low temperatures were often accompanied by high winds which minimized the usual advantage of elevated locations. Only a few isolated areas have remained in uninterrupted production. Temperatures approaching 20° F were frequently recorded in coastal areas and those in the interior valleys and transitional zones were often lower.

Few cut flower growers and nurserymen were prepared to use heaters. Those who tried the new type oil-burning infrared heaters found that they were inadequate under the conditions of this period. The same was true of those using electric infrared lamps except in instances where cloth coverings could be placed over lath houses. In Southern California some greenhouses with crops such as gardenias did not have adequate heating facilities for the emergency and production suffered correspondingly. Destruction of cloth and lath houses by snow was serious in some areas.

Many annual cut flower crops were injured. The foliage of gladiolus and amaryllis was often frozen to the ground with probably serious damage to underground parts. The loss of foliage as well as flowers on well-established plantings of strelitzias will be reflected in decreased production in the next few years. Cymbidium orchids grown under lath often suffered loss of foliage as well as of blooming spikes.

Damage to woody ornamental plants was large both in landscape plantings and in nurseries. Container grown nursery stock is particularly susceptible to freezing and many California nurseries specialize in this type of material. Losses will be greatest on smaller sizes of plants and on newly planted nursery stock which did not have time to become well established.

The popularity of tropical plants in recent years has added to the seriousness of this freeze. Losses of such plants as Eugénias, Fuchsias, *Coprosma*, *Reinwardtia*, *Tibouchina*, *Rondeletia*, *Ochna*, and *Musa* were frequent. The extent to which some of these will sprout from the ground later remains to be seen. Many other shrubs lost the tips of young new growth. California native plants escaped

injury with the exception of *Rhus laurina*, which has long been recognized as tender. Among the vines, *Bougainvillea*, *Solantra*, *Thunbergia grandiflora*, and *Phaederanthus buccinatorius* were especially tender, yet were uninjured in a few protected locations.

Losses of the commonly used street trees have been much less serious than those of ornamental shrubs or vines. The Cajeput Tree—*Melaleuca leucadendra*—much used in Los Angeles in recent years has shown severe trunk injuries in some locations. The foliage of some of the more tender species of *Eucalyptus* has been browned. The evergreen species of *Ficus* showed, in general, much tenderness. A number of other popular ornamental trees have shown themselves to be on the borderline of hardiness and suitable only for the warmest locations.

Plants against walls were often not favored, except when this contributed directly to wind protection, which was shown to be an important factor in freedom of the plants from foliage injury. Poinsettias were often observed to survive when against masonry house walls and to be lost when planted near wooden walls. Heat radiation from the earth was apparently important since the amount of protection given by an overhanging roof or the low branches of a tree was truly remarkable. Those interested in the landscape use of tender plants may doubtless escape much trouble in the future by providing both these types of protection.

Woody plants which have suffered freezing have the best chance for recovery if left alone. In spite of the unsightly appearance of the plants, it is best to delay pruning until new growth has started and the true extent of the damage can be observed. Premature pruning increases the risk of additional damage. Fertilizer should be withheld and great care should be taken to avoid an excess of water at the roots. Plants on well drained soils will have the best chance of recovery.

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DECIDUOUS FRUIT AND NUTS

Warren P. Tufts

Deciduous fruit and nut trees were fully dormant during California's abnormally cold weather the first part of January. Up to January 28, 1949 there were no reports of temperatures so low as those experienced in the December 1932 freeze which greatly damaged many citrus orchards in northern California, but did no harm to deciduous fruit trees which produced normally in 1933.

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