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Freeze damage symptoms and recovery for citrus

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The extent of cold injury to citrus depends on a number of factors, and its expression may occur over an extended period of time. Factors responsible for freeze damage include minimum temperature, duration of freezing temperatures and stage of tree acclimation. Susceptibility of trees to freezing temperatures can also be related to tree vigor, scion and rootstock, crop load, and grove and soil conditions.

Figure 1. Dark, water-soaked areas indicate ice formation in leaves.

SYMPTOMS OF FREEZE DAMAGE

Leaf and Wood Injury

Citrus freeze injury is due to ice formation in the intercellular spaces. Ice formation is usually accompanied by disruption of cell membranes, which produces damage to cell walls. Ice formation in the leaves is indicated by dark, water-soaked areas on the surface (see Figure 1).

Such areas may or may not turn brown after thawing. Completely frozen, killed leaves appear bleached or tan to brown in color (see Figure 2). New succulent growth, when frozen, will often turn blackish (instead of brown) in color upon thawing. Leaf drop within a few days indicates that the wood is likely not damaged or killed (see Figure 3, page 19), while leaf retention on the twigs usually indicates wood kill.

Figure 2. Tan to brown curled leaves are symptoms of freeze damage.

Wood damage can be checked by scraping the outer layer of bark. Green tissue in most (but not all) cases indicates live wood, while brown tissue implies freeze-damaged dead wood. Ice formation may also occur in wood and result in bark splits, particularly in young trees (see Figure 4, page 20). Such splits may be extensive in larger trees, resulting in serious injury. Extensive bark splits may cause the

Figure 3. Leaf drop within a few days after a freeze indicates that the wood is likely not dead.

limbs to die and later break off many years after freezing temperatures.

New growth developing on freeze-damaged trees following freezes will often collapse as the wood behind the growth dies from freeze injury. It is recommended not to initiate pruning operations until the extent of the damage is determined. Varieties such as Pineapple oranges and Murcotts, when heavily loaded with fruit, will often sustain severe freeze damage. However, similar trees, when lightly cropped or without fruit following harvest, will tolerate freezes well.

Fruit Injury

Fruit severely injured during a freeze may drop quickly or over time, but usually its external appearance is not significantly changed (see Figure 5, page 20). Temples and grapefruit are particularly susceptible to fruit drop, while oranges are often retained on the tree for longer periods.

Freeze damage on certain cultivars such as Murcotts and grapefruit may show dark or reddish-brown depressions, pockets or pitting on the peel surface. Blemishes in the form of pitting may occur on the peel of grapefruit as a result of low, but nonfreezing temperatures, known as "chilling" injury. Following severe freezes, fruit will show extensive internal injury

Figure 4. Bark split can result from freeze injury.

Figure 5. Fruit drop caused by freeze may occur quickly or over time.

Figure 6. This freeze-damaged fruit has extensive internal injury.

(see Figure 6) that progresses with time. Thin-skinned fruit usually show greater internal injury than thick-skinned cultivars such as grapefruit.

The first evidence of freeze injury is the presence of water-soaked areas on the segment membranes with the juice sacs or vesicles in injured areas subsequently becoming dry and collapsed (see Figure 6). Shortly after the freeze, cutting the fruit progressively from the outside to the inside (starting at the stem end) will show the amount of ice formed and its location. The deeper the ice is formed, the greater is the severity of injury. The frozen area will eventually dry out, leaving the injured fruit partially hollow and lighter in weight than sound fruit of comparable size. Juice loss occurs over a period of several weeks with the extent of loss being dependent on damage severity and weather conditions following the freeze.

RECOVERING FROM FREEZE DAMAGE

Care of citrus trees that have been freeze-injured must be dependent on factors such as time of year at which the freeze occurs, condition of the trees at time of injury and weather conditions immediately following injury. These factors will influence the type of approach to use for recovery of freeze-damaged trees. The natural reaction after a freeze is to do something right away, although there is very little that can be done at that time, as it is impossible to determine the full extent of injury. Twigs and branches may continue to die for a period of several months to a couple of years following a severe freeze.

Pruning

No attempt should be made to prune or even assess freeze damage until the new spring flush gets fully expanded and mature. Therefore, no pruning should be done until late in the spring or the summer after a freeze. This delay is desirable since it is difficult to determine the actual extent of freeze injury until new growth commences and fully develops. In early spring, freeze-damaged trees often produce new growth that soon dies back. Sufficient time should be given for the dying back to cease and for the new healthy growth to take place and fully expand.

Experience has shown that early pruning does not promote recovery and that delaying pruning to the proper time will save money. Pruning cuts should be made into living wood and, where possible, at crotches, leaving no stubs or uneven surfaces. It is advisable to remove heavy brush from the grove immediately following the pruning operation.

Fertilization

Fertilization of freeze-damaged trees should be reduced until the trees are back to their original canopy size and foliage density. Fertilizer should be applied more frequently, but rates should be reduced in proportion to the amount of tree damage and to the expected crop load. Growers and production managers should make wise decisions based upon their local situation.

For example, trees suffering 10 to 15 percent wood loss should receive a regular nutritional program as fruit will be produced that year. Trees suffering 50 to 60 percent wood loss most likely will not produce fruit that year, and the nutritional program should be reduced according to the damage.

Nutrient deficiency symptoms may be intensified in freeze-damaged trees due to the drain entailed by the large amount of growth necessary to replace lost foliage. Thus, foliar sprays of micronutrients (copper, zinc, manganese and boron) will be beneficial to new growth. Nitrogen, phosphorus, potassium, magnesium and calcium should also be applied to satisfy the needs of the trees and to increase leaf size because trees tend to produce small leaves for a few years after suffering severe leaf loss.

Irrigation

When leaves are lost, transpiration from the tree canopy is greatly reduced. Therefore, the amount of

water required should be reduced. Excessive irrigation does not result in rapid recovery, but may result in root damage and nutrient movement below the root zone.

Normal irrigation should be practiced when trees regain their normal foliage development and canopy density. Irrigation in the winter following cold injury should be reduced because it may induce new vegetative growth, which might be damaged by subsequent freezes. If freeze damage occurs early in the winter, cutting back on irrigation will delay tree growth until the danger of additional freezes has passed. However, trees that put forth new growth should not be allowed to get water-stressed.

Weed and Disease Control

Weed control will be essential to rapid recovery from freeze damage, as weeds will compete heavily with the trees for available water, nutrients and light. Foliage loss can result in additional weed pressure due to the increase in sunlight within the tree canopy. With loss of foliage, growers cannot afford to lose any of the new flush.

Fungicide applications for greasy spot control in May and July will be needed. Melanose control after a freeze is a difficult decision for growers and production managers to make. If fruit is expected that year and the fruit is destined for the fresh fruit market, fungicide applications will be needed to increase pack-out. Even on non-fruiting trees, one or two fungicide applications should be made to help prevent infection of new flushes and next year's crop. Be sure to include copper or another fungicide with nutritional sprays to enhance disease management.

CONCLUSION

In summary, one of the most devastating environmental stresses to citrus trees is a freeze event. However, citrus trees are vigorous and can recover quickly from cold damage, if given proper care. The extent of freeze damage and the level of care provided to citrus trees dictate the recovery rate.

With proper care, trees suffering defoliation and minor twig damage can be expected to return to pre-freeze condition in one year. Trees with extensive damage to small branches, but no damage to scaffold branches and the trunk should recover by the second year. Growers should properly evaluate the extent of cold damage to trees. Then, follow the appropriate recommended citrus cultural practices to allow for trees to recover satisfactorily.

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