

Protecting a Citrus Tree from Cold

ISSUED MARCH 2001 BY:

Glenn C. Wright
Associate Specialist

PUBLICATION AZ1222
3/2001

ag.arizona.edu/pubs/
crops/az1222.pdf

This information
has been reviewed by
university faculty.

*Warmth, warmth, more warmth! For we are
dying of cold, and not darkness. It is not the night
that kills, but the frost.*

Miguel de Unamuno

Introduction

Citrus trees are not particularly cold hardy. This fact is one of the primary reasons for the existence of the citrus industry in Southern Arizona. Nonetheless, freezing temperatures are likely, and it is prudent for homeowners to take precautions.

Citrus trees are most likely to survive cold temperatures if they are planted in the proper location. The USDA has divided the US into eleven plant hardiness zones based on 10°F average annual minimum temperature¹ ranges. Zones 2 through 10 are further subdivided (a and b) which represent 5° F differences within each 10° F zone. In Arizona, citrus may be safely grown in zone 10a, where average annual minimum temperatures range from 30 to 35°F, and in zone 9b, where average annual minimum temperatures range from 25 to 30°F. In zone 9a (20 to 25° F), citrus may be grown in areas with proper cold air drainage. These areas include the slopes surrounding Tucson, and some areas of Pinal County. Bottomland areas within zone 9a would not be acceptable, as cold air will accumulate. Citrus planted in the Rillito Creek and Gila River valleys of zone 9a, are highly susceptible to frost damage.

Differences in elevation, slope of the land, degree of urbanization (presence of concrete and asphalt), and other factors affect the number of frost-free days in any particular location. Average first frost date, average last frost date, average daily winter minimum temperature and the record low temperature for several citrus growing areas are shown in Table 1. These temperatures and dates should be taken as a general guide only. Take temperature readings in your location and compare them to the temperature reported in the news. Additional resources available on the Internet are shown on page 2. Use this information to predict the impact of forecasted freezes. Your location may be several degrees warmer or colder than the temperature reported on the news.

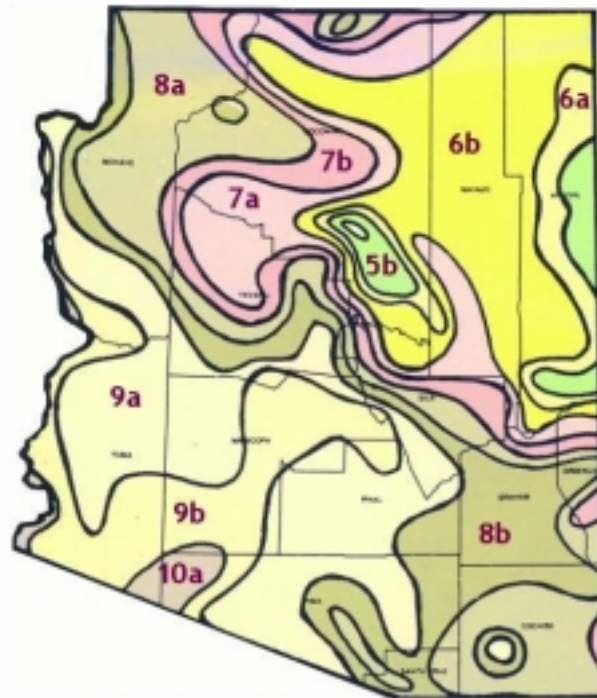


Figure 1. USDA plant hardiness zones for Arizona.¹

At a Glance

- *Frosts are more common than freezes in Arizona.*
- *Site selection, proper variety and rootstock and tree acclimation are the most important defenses against cold temperatures.*
- *Covering, supplemental heating, or irrigating may protect trees.*
- *Avoid pruning a cold-damaged tree until spring.*

Table 1. Frost-related weather data for several Arizona locations (°F).

Location and USDA zone	Avg. Date of First Frost	Avg. Date of Last Frost	Avg. Min. Temp. (Dec. – Feb.)	Record Minimum Temperature and Year
Bullhead City (10a)	Dec. 19 th	Jan. 12 th	44.0	24.0 (1990)
Deer Valley (9b)	Nov. 30 th	Feb. 10 th	38.4	8.0 (1971)
Mesa (9b)	Nov. 27 th	Feb. 26 th	37.4	15.0 (1950)
Parker (9b)	Nov. 30 th	Feb. 17 th	37.6	9.0 (1911)
Phoenix (9b)	Dec. 27 th	Jan. 21 st	42.6	17.0 (1950)
Tucson (9a)	Nov. 28 th	Mar. 3 rd	39.6	16.0 (1949)
Yuma (10a)	Dec. 23 rd	Feb 2 nd	40.0	19.0 (1937)

Heat Accumulation and Loss

Heat may be transmitted from one material to another or from one place to another by three processes: conduction, convection, and radiation. When your hand is warmed by a cup of hot coffee, heat is transferred by conduction. Convection is the transfer of heat by the movement of heated liquid or gas. Radiation is movement of heat from

one object to another without being physically connected. This is how the earth receives the sun's energy, how crops lose heat at night. The sun warms the earth by day and the solid objects, such as plants, accumulate the heat and pass it on to the air. The warmer air rises and is replaced by cooler air from above, and the atmosphere is warmed. During the night, heat is lost from plants and other solid objects to the atmosphere. When the night is clear, plants will lose heat to the air, until they are cooler than the surrounding air. Water vapor in the form of clouds and CO₂ block heat loss to the outer atmosphere. That is why cloudy winter nights are often warmer than cloudless ones.

When the layers of air closer to the ground are colder than upper layers, this is known as an **inversion** (Fig. 2). Light winds will often keep inversion layers from forming, allowing the plants to stay warmer.

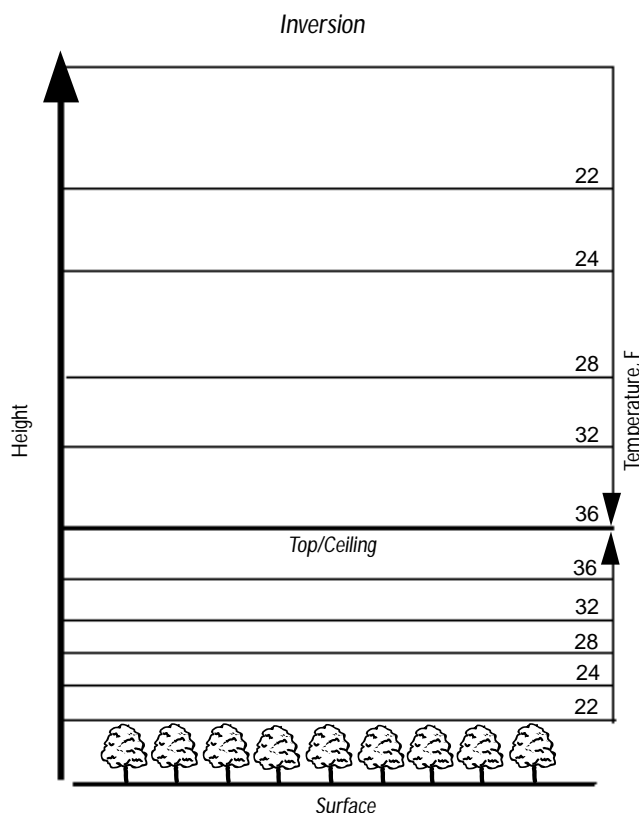


Figure 2. Inversion layer.

Frosts and Freezes

The great majority of the cold events in Arizona are frosts, which occur when conditions are calm and clear, and an inversion exists. Frosts are also more likely when the air is dry. Dry air is subject to high day to night fluctuations. During a frost, sub-freezing temperatures rarely last more than a few hours or drop below 20°F. Attempts to protect citrus from frost are often successful.

A freeze can be much more severe than a frost. An advective, or windborne, freeze occurs when an arctic cold air mass moves into an area bringing freezing temperatures. Compared to Florida and Texas, freezes are relatively uncommon in Arizona. Most arctic cold fronts stay north of Southern Arizona, or travel east of the Rocky Mountains. Wind speeds are usually above 5 mph and clouds may be present. Freezes may last for several days. Attempts to protect trees are generally not very successful under these conditions.

Temperature data resources on the Internet

National Weather Service: <http://www.wrcc.dri.edu/summary/climsmaz.html>
 Arizona Meteorological Network: <http://ag.arizona.edu/azmet/>

Long-term Cold Protection Strategies

The four most important cold protection strategies available to the homeowner should be taken prior to the frost or freeze. These include selecting the proper citrus tree variety and rootstock for the location, selecting the proper planting site, and allowing the tree to acclimate to the cold.

VARIETY SELECTION

Not all citrus varieties are equally cold hardy. Trifoliate orange, a deciduous, inedible ornamental citrus tree can survive temperatures as low as 5°F. Kumquats are also quite cold hardy, as are 'Satsuma' mandarins. Sour orange, tangerines and tangelos, sweet and navel oranges and grapefruit trees are partially cold hardy, and may survive temperatures as low as 20°F without significant damage. Lemon, lime and citron trees are the least cold tolerant and will suffer at least some damage when temperatures drop below 25°F.

Early ripening varieties can also be planted, so that the fruit may be harvested before cold weather arrives. Some examples include 'Satsuma' mandarin, 'Fallglo' mandarin, 'Hamlin' orange, 'Marrs' orange, and 'Fukumoto' navel orange.

ROOTSTOCK SELECTION

Some rootstocks impart significant cold hardiness to the tree. Unfortunately, homeowners seldom have a choice of rootstock. Most nurseries sell trees that are the best adapted for the area, but trees on sale do not always have the rootstock identified. 'Trifoliate orange' is quite tolerant, as is 'Flying dragon', 'Sour orange', and 'Cleopatra' mandarin. 'Carrizo' citrange and 'C-35' citrange are moderately tolerant, while 'Rough lemon', 'Macrophylla' and 'Volkameriana' are not as tolerant of cold temperatures².

SITE SELECTION

The ideal location to plant citrus, especially in a marginal citrus area, is in a wind-protected, sunny area. Planting against a wall that receives sun in the winter will keep the tree a few degrees warmer. Also, planting on a gentle slope will allow cold air to flow past the tree.

ACCLIMATING THE TREE

Actively growing trees are more sensitive than are dormant trees and succulent flowers and new leafy growth are the most sensitive. Fruit are slightly less sensitive to frost, followed by mature leaves, then stems and trunks.

Trees should be "hardened off" in the fall by applying fertilizers with higher levels of phosphorus (P) and potassium (K) and reduced nitrogen (N). Trees should not be pruned, as this may stimulate new, tender growth.

Short-term Cold Protection Strategies for a Frost

When frost is imminent, the following strategies are recommended.

COVER THE TREE

Small trees may be covered with blankets, quilts or burlap sacks. This strategy conserves heat accumulated during the day.

PROVIDE ADDITIONAL HEAT

A heat source, such as a string of old-style Christmas lights or a shop light with an incandescent light bulb, can be placed in the canopy of smaller or medium sized trees. This strategy works best on trees that have been covered. Be careful not to allow the light to come in contact with water.

MAINTAIN SOIL MOISTURE

When the soil around the tree is kept moist, it will not radiate as much heat to the atmosphere at night. This is much more effective if the ground is bare around the tree.

SPRAY THE TREE CANOPY WITH WATER

Trees should be sprinkled with water throughout the frost. As the water freezes around the leaves and branches, it will liberate enough heat to maintain the tissue temperature at 32°F. This strategy will only be successful if the water is flowing continuously throughout the frost, and if it remains flowing until the air temperature is above 37°F. Only the leaves that are sprinkled will not suffer freeze damage, although there could be some limb breakage due to accumulation of ice (Fig. 3).



Figure 3. Ice-draped orange tree after a recent freeze in Central California

Short-term Cold Protection Strategies for a Freeze

Short-term cold protection strategies are not as successful when there is a freeze, but they should be attempted anyway. Additionally, if a freeze is expected, some attempt should be made to protect the bud union. Soil should be mounded around the trunk to a point higher than the bud union (the point where the rootstock and scion join — often identifiable by a change in trunk bark color or texture). This strategy is based on the probability that the soil will not freeze, and if the majority of the tree freezes, the tree can be regenerated from the trunk just above the bud union.

Caring for the Frost-damaged Tree

Sometimes, despite the best efforts of the gardener, a tree will be damaged by frost (Fig. 4). Cold-damaged fruit will appear water-soaked on the inside, sometimes without exterior evidence of damage. One to two weeks later, the rind will separate from the segments and the fruit will become soft and puffy. Finally, the segments will dry and the fruit will become pithy. Damaged fruit may often be juiced if harvested quickly after the frost. Fruit in the warmer interior of the tree are likely to be less damaged than those on the outside.



Figure 4. Frost-damaged navel orange tree.

Occasionally, leaves are not killed by a freeze, but only damaged. These leaves need not be removed, and will continue to function (Fig. 5). Leaves that are killed during a freeze will fall off the tree, or may be removed.

It is best to wait to determine the extent of the damage to branches and trunks before pruning, since it is sometimes difficult to distinguish between dead wood and living wood. Prune out the dead wood after the spring growth flush shows the extent of the damage. If trees must be pruned sooner than the growth flush, because damaged trees are unsightly, go back and remove additional dead wood throughout the season.



Figure 5. Frost damaged lemon leaves.

Make pruning cuts in live wood, just below the point where the frost damaged wood begins. Simply scrape the bark with a knife; live wood will be green just under the bark, while dead wood will be brown. After pruning, paint any bark newly exposed to the sun with white water-based paint (latex) or whitewash, to prevent sunburn and eventual disease.

If the entire tree is damaged by frost or freeze, the variety may die, leaving only the rootstock. Appearance of leaves that are distinctly different than the variety, or fruit that is uncharacteristically seedy, rough or sour will often indicate that the variety has died and only the rootstock remains. In this case, it is best to remove the entire tree and replant.

References

- ¹ USDA Plant Hardiness Zone Map. 1990. USDA Miscellaneous Publication No. 1475. <http://www.ars-grin.gov/na/hardines.html>
- ² Davies, F. and L.G. Albrigo. 1994. Citrus. Crop Production Science in Horticulture Series, Volume 2. CAB International, Wallingford, UK.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, James A. Christenson, Director, Cooperative Extension, College of Agriculture and Life Sciences, The University of Arizona.

The University of Arizona College of Agriculture and Life Sciences is an equal opportunity employer authorized to provide research, educational information, and other services only to individuals and institutions that function without regard to sex, religion, color, national origin, age, Vietnam era Veteran's status, or disability

Any products, services, or organizations that are mentioned, shown, or indirectly implied in this publication do not imply endorsement by The University of Arizona.