Texas A&M University – Kingsville Citrus Center Fact Sheet TAMUK-CC-Path 3

SUMMARY OF HISTORICALLY IMPORTANT FREEZES IN THE RIO GRANDE VALLEY, THE EFFECTS OF DIFFERENT FACTORS ON FREEZE PROTECTION, AND BEST PRACTICES

David Laughlin, Veronica Ancona, and Mamoudou Sétamou

Texas A&M University – Kingsville Citrus Center, 312 N. International Blvd., Weslaco, TX 78599

Historically important freezes

January 29-31 1949

December 7, 1950 and January 29, 1951

January 9-12, 1962

December 24-26, 1983

December 22-24, 1989

February 14-16, 2021

1949-Freeze arrived Friday night and temperatures remained freezing for about 60 hours until Sunday January 31. Minimum temperatures reached were about 20°F in the Mission area. Trees that were actively growing were severely damaged, dormant trees were defoliated but suffered minimal death.

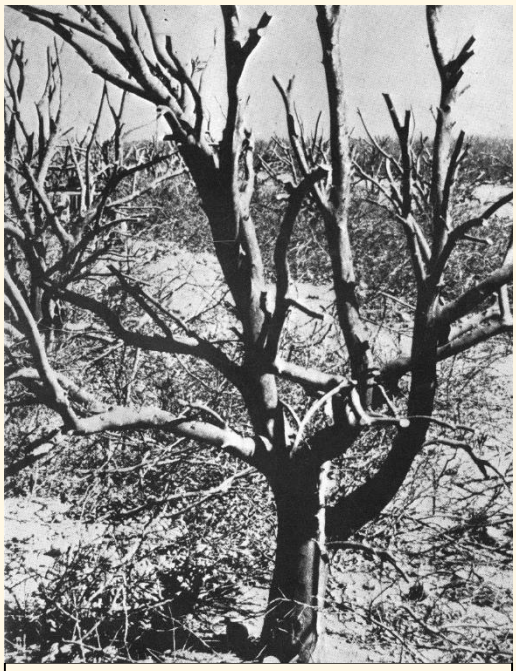
1950/1951-The December freeze was of short duration. Temperatures were below freezing for about 14 hours and reached a low of 25°F. The January freeze lasted for 5 days. The first 3 days the temperatures ranged between 25°F and 32°F. Lows of 18 F to 20 °F were reached during the last two days of the freeze. It is estimated that five million trees were killed.

1962 -Temperatures remained below freezing for as long as 70 hours and below 20 F from 3 to 11 hours. Minimum temperatures reached 19 °F.

1983- 55 hours below freezing with a minimum temperature of 20 °F. This freeze event reduced the RGV citrus acreage from an estimated 70,000 to 30,000 acres.

1989- Freezing conditions lasted for about 55 hours with one of the lowest temperatures ever recorded in Brownsville at 16 °F. This freeze destroyed 24,000 acres of citrus, thus reducing the citrus acreage from an estimated 35,700 acres to 11,700 acres. Taken together with the damage of the 1983 freeze this means a total reduction of 84% since 1983.

2021- Temperatures reached below freezing for 40 hours with lows reaching 22 °F in Weslaco. Trees in an active state of growth were more severely than dormant trees. Orange trees in general fared better than grapefruit trees. Very few trees died outright, although the freeze caused an estimated 70% reduction in yield for the 2021/22 season through the cumulative effect both tree damage and external quality issues resulting from melanose.



Above: Severely pruned tree following 1983 freeze. Source: Journal of the Rio Grande Valley Horticultural Society, Volume 38, 1985
Below: Damage immediately following 2021 freeze.

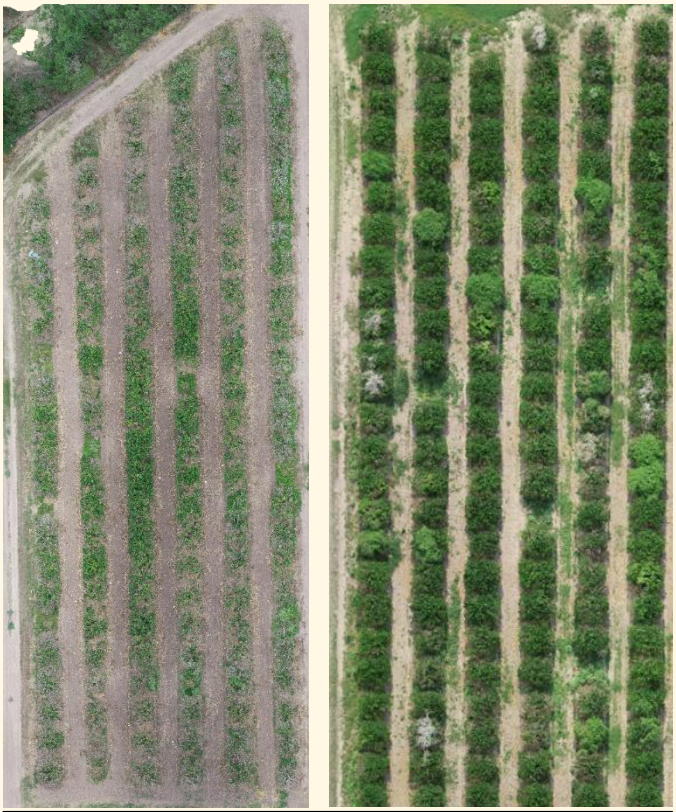
Freeze response related to phenology

Trees are more cold hardy during the winter dormancy period than in the fall or spring, i.e. actively growing trees are more susceptible than dormant ones. Preconditioning through cool temp exposure may be one of the factors that leads to the cold tolerance of certain varieties such as trifoliate orange, citranges, citrumelos, and mandarins compared to limes and lemons which continue to grow actively during the winter. A field-based cold chamber study performed on mature grapefruit trees showed that freeze tolerance due to dormancy improves until February or March. Cambial activity, i.e. sap flow, which is related to freeze tolerance can be related to bud growth, however knowing the cambial activity of a tree prior to a freeze only allows one to predict if the tree is more likely to suffer freeze damage. Post-freeze response of citrus trees was observed to be related to pre-freeze phenology in 2021. Trees that were flushing and blooming were more damaged afterwards than those that were dormant during the freeze.

A demonstration of the cambium removal technique which can be used to test tree dormancy. If the cambium is easily removed then the tree is not dormant, if the cambium is not easily removed this indicates a state of dormancy.

Freeze response related to variety

Although all citrus are considered cold tender there are varying degrees of tolerance, mainly related to dormancy. **Citron**, **lemons**, and **limes** are considered the most cold sensitive as they typically grow actively throughout the year although **Meyer** lemons are considered more cold tolerance than other lemons. Generally sweet orange varieties are more cold tolerant than grapefruit. During the freeze of 2021, there was a noticeable difference in the degree of freeze injury in grapefruit versus sweet orange with most orange tree exhibiting minimal damage. Mandarins are a highly diverse group and thus some varieties are able to tolerate freezing temperature to a high degree while others are quite cold tender. In general **satsumas**, **Dancy**, and **Murcott** mandarins exhibit freeze tolerance.



Aerial images taken in April 2021 following the freeze in February of a Rio Red grapefruit orchard (left) and Valencia orange (right). Note the border effect in the grapefruit block/ Images courtesy of J. Solorzano and J. Enciso.

Freeze response related to rootstock

Multiple studies have shown that rootstocks can contribute to cold tolerance through multiple mechanisms including salt tolerance (Na uptake), and the ability to undergo cold-induced dormancy. Sour orange continues to be one of the better options due to graft compatibility, good fruit quality, and tolerance to Texas soil conditions. In recent years, C22 citrange resulted in less vigorous trees that are more susceptible to micronutrient deficiencies related to soil pH. In general, citranges appear to reduce the cold tolerance of the scion variety, an exception being **Rusk**. Despite some conflicting information, rootstocks that may improve the cold tolerance of citrus trees are **sour orange, Cleopatra mandarin, Rangpur lime, *Severina buxifolia*, and rough lemon, Clementine mandarin, and Sunki mandarin and satsumas.** Rootstocks that did not induce bud dormancy and have demonstrated a high degree of freeze injury are **grapefruit, sweet orange, Thong Dee pomelo, Siam pomelo, and Thornton tangelo, citranges** and **alemow (*Citrus macrophylla*).** This effect was shown to correlate strongly with **chloride sensitivity** meaning that cold tolerance may be linked to salt tolerance.

The effect of nutrition on freeze response

Little is known about the role of tree nutrition on freeze response. A single experiment that studied the application of N and micronutrients prior to the freeze did not have any effect on freeze damage during the 1962 freeze in Texas compared to studies done in California and Florida. Appropriate nutrition following a freeze is important however. Foliar applications of **Fe, Zn,** and **Mn** may increase canopy growth following freeze damage and can help in tree recovery. This is linked to the root dieback that occurs following freeze defoliation which leads to a decreased uptake of nutrients with which to maintain the new flush. Thus some trees that flush following a freeze may experience a second dieback if the root system cannot support the new growth. Therefore application of foliar nutrients is recommended.

The effect of irrigation on freeze response

Water can be an important tool to mitigate freeze damage. Sprinklers may effectively reduce damage if water is continually applied through heat released during freezing. However if water is halted then the resulting damage may be worse than if water had never been applied, therefore the grower must be committed to this strategy. Observation made in irrigated orchards versus non-irrigated orchards have shown that the application of irrigation water may buffer the trees from freezing temperatures. Withholding water during the winter period help tree achieve and prolong dormancy which can protect them from freeze injury. It should also be noted that trees that are properly cared for throughout the year prior to a freeze may enter dormancy more readily that trees that are uncared for, especially if winter rains occur, less healthy trees are more likely to break dormancy.

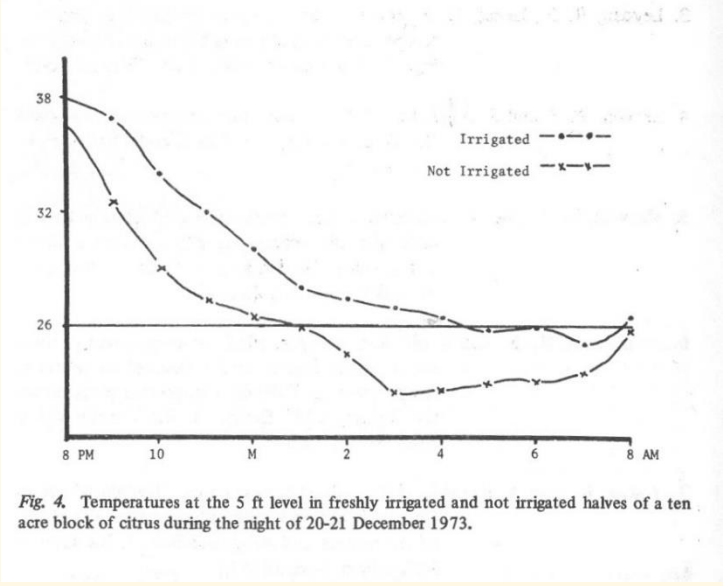


Fig. 4. Temperatures at the 5 ft level in freshly irrigated and not irrigated halves of a ten acre block of citrus during the night of 20-21 December 1973.

Graph demonstrating the potential buffering effect that irrigation applied before a freeze can have on air temperatures during a freeze. Source: Leyden and Hensz. 1974. Journal of the Rio Grande Valley Horticultural Society.

The effect of cultural practices

There are a number of cultural practices that can affect the level of freeze damage in citrus trees. Maintaining the grove floor free of weeds and cover crops can offer some level of protection since the presence of vegetation can reduce ambient temperatures by a few degrees and lead to greater tree injury. There is some evidence that disking before a freeze may offer some protection by disrupting sap flow. Oil sprays should be avoided during the winter since they can reduce the cold-hardiness of tree. Installing thermal wraps on young plantings is important to protect the young trees, especially around the bud union. Following a freeze, pruning to removed dead wood and promote good canopy structure is important. Each orchard needs to be evaluated on a case-by-case basis around 6 weeks following a freeze so that and honest assessment can be done. Trees with minimal damage can be hedged and topped while trees with severe damage may require more aggressive pruning. Young trees may need to be rebudded if they are killed back to the bud union.

Immature grapefruit with severe melanose infection in May 2021 as a result of numerous dead twigs and branches and wet conditions. Protecting the fruit during the first 10 weeks after fruit set is critical.

Rio Red grapefruit tree exhibiting vigorous growth in the fall of 2021 following hedging and selective pruning after the February 2021 freeze.

Freeze effects on pests and diseases of citrus

There is little evidence on the effect that diseases have on trees prior to and during a freeze although a study conducted in 1952 indicated that trees infected with psorosis and other trunk diseases were more susceptible to freeze injury. Following a freeze however, significant levels of melanose may affect both the new leaves and the fruit. This is due to the millions of spores that are produced on the dead twigs and branches following a freeze. Up to 36 million spores per inch-length of dead twigs were observed post 2021 freeze. Therefore, pruning to removed dead twigs and branches as well as timely application of fungicides targeting young fruit after fruit set are highly recommended. Anthracnose can also affect leaves and fruit following a freeze but damage is minimal. Following the 2021 freeze, most insect pests were scare in citrus groves for up to three months post freeze, but aphids and chilli thrips became abundant afterwards. In contrast, one month following the freeze, a dramatic increase of red mite and citrus rust mite populations was observed. Barnacle scales became also more prevalent in some localized grapefruit groves.

Predicting freezes

Freezes are difficult to predict and may occur twice during one season or once every few years. Sporleder calculated some probabilities of low temperatures occurring from November through March based on 50 years of data from 1920 through 1970 and determined that freezes in the Rio Grande Valley are essentially unpredictable. It is necessary to perform an analysis using recent data from 1970 until the present to take into account recent trends and the effects of climate change on these probabilities.

Table 1. Probability and return period for selected minimum temperatures, Weslaco, Texas, November through March.

Temperature	*Probability of temperature occurring*	*Return period T(x)*
35	.993	1.0
34	.971	1.0
33	.921	1.1
32	.837	1.2
31	.728	1.4
30	.606	1.6
29	.487	2.1
28	.380	2.6
27	.290	3.4
26	.218	4.6
25	.161	6.2
24	.118	8.5
23	.086	11.6
22	.063	16.0
21	.045	22.1
20	.033	30.7
19	.023	42.6
18	.017	59.3
17	.012	82.6
16	.009	115.1

Source: Computed from minimum extreme monthly temperatures for the 50-year period 1920-21 to 1969-70, Texas Agricultural Experiment Station, Weslaco, Texas.

Source: Sporleder T.L. 1970. Journal of the Rio Grande Valley Horticultural Society. Volume 24.

Best practices to mitigate freeze damage

Pre-freeze:

- Make sure that young trees are wrapped with the appropriate trunk wrap.
- Try to ensure that trees become dormant by withholding irrigation. You can test for dormancy through the use of the cambium removal technique. If the cambium peels easily then the tree is not dormant, if the cambium is difficult to peel then the tree is dormant.
- If a freeze in imminent, apply irrigation, if possible. However for groves equipped with sprinkler or microjet do not apply water unless you are prepared to spray for the duration of the freeze.
- Ensure that orchards are kept free of weeds whether through mechanical or chemical means.
- Disking before a freeze may help protect trees from freeze damage by disrupting the sap flow through root damage.

Post-freeze:

- Perform an evaluation several weeks following the freeze to determine true damage. Remove dead branches through hedging, topping, and pruning, preferably before fruit set to avoid infection of the fruit with melanose.
- Apply an effective fungicide such as copper or pyraclostrobin (Headline) following fruit set to control post-bloom fruit drop and melanose.
- Apply foliar nutrients to aid in tree recovery since following leaf drop there will be a reduction in the root system.