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Freeze Damage to Plants in Lower Elevations of Southern Nevada

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Climates and Microclimates

The climate of the lower elevations in southern Nevada is generally considered semi-tropical desert, with freezing temperatures occurring between December and March. At higher elevations the chance of freezing temperatures is earlier in the fall and often occurs into early summer months. Tremendous variations in freezing temperatures occur in the same valley due to changes in topography, microclimate, orientation to the sun and urbanization.

Because cold air is denser than warm air (during calm weather with little wind), cold air will layer beneath warmer air, forcing the warmer air to rise above it (inversion). These air layers may remain undisturbed if there is little to no wind. Areas where cold air frequently settles have been loosely termed "frost pockets," even though they may or may not be associated with frost.

Frost pockets tend to occur in the lowest elevations of a valley or in landscape depressions against the north or east sides of walls that impede the flow of cold air to lower elevations. In valleys surrounded by mountains, the west-facing side of the valley tends to be warmer than the east-facing side of the valley.

Freeze or cold damage to plants and late or early frosts are less likely on sloping land facing south or west. However, because these solar orientations are warmer, they tend to encourage earlier growth and flowering in the spring. This new growth is more susceptible to freeze damage than old growth, increasing the chance of cold damage to plants during late spring frost. The climate on slopes oriented north and east delays early growth and flowering and may decrease cold damage to plants in a late spring frost.

Fig. 1 Freeze damage on immature growth. Damaged stems were cut back to healthy growth. The plant was fertilized and watered.

Urban landscapes provide many chances for developing microclimates which in turn

diminish the chances of winter freezes. Urban microclimates oriented west and south and protected from winds provide conditions for winter-tender plants to survive otherwise freezing temperatures.

Causes of Frost or Freeze Damage

Even though many people call freeze damage to plants "frost damage," there may be no evidence of frost at all when freeze damage occurs. Frost occurs on surfaces when the temperature of a surface drops below freezing and there is sufficient moisture in the surrounding warmer air to form ice crystals or frost on these colder surfaces. In desert climates, the relative humidity is often too low to form frost.

Fig. 2 Three days after early morning freeze damage. The leaf dropped from the plant and was replaced.

Freeze damage can occur without frost. If temperatures are low enough to cause plant freeze damage but the relative humidity or moisture content of the air is very low, plant damage due to freezing temperatures may occur without the development of frost.

Frost can sometimes form even if air temperatures are above freezing. This type of freezing is common during nights with cloudless skies. In the case of *radiation frost* or *hoar frost*, ice crystals may form on plants and other objects when their surface temperature drops below freezing and sufficient moisture is in the air, but air temperatures linger above freezing. Water puddling on surfaces may also freeze, even when air temperatures are above freezing, due to a loss of heat via radiation to the open skies.

Freeze damage is more extensive when low temperatures are combined with winds. Plants are not subject to a wind chill factor the same as warm-blooded animals. However, wind can compound damage produced by freezing temperatures to woody plants growing in warmer climates. This is due to a more rapid loss of heat stored by the thermal mass of larger plants. It is best to protect tender plants from strong winds during the winter months.

Plant Damage Due to Freezing Temperatures

Many plants can be injured or killed due to freezing temperatures. The extent of damage to plants depends on several factors including:

- Type of plant
- Where it was grown or its origin
- Plant maturity and health
- Fertilizer practices
- Presence of later summer growth
- The lowest air temperature achieved
- The month of the year freezing temperatures occur
- Plant parts exposed to freezing temperatures
- Overall duration of the freeze

Plants are generally categorized according to the freezing temperatures they can tolerate, usually due to where they were grown or their

"genetic" home. Tropical plants, as the name implies, originated in climates where freezing temperatures rarely or never occurred. Plants like tomatoes and other summer vegetables, winter-tender shrubs like bougainvillea, some citrus such as limes and some oranges all originated in tropical climates. Exposed to temperatures at or below freezing, these plants can die or will suffer considerable damage. Tropical plants have few internal protection mechanisms against freezing temperatures. Semi-tropical plants, such as Meyer's lemon and winter vegetables like radishes, broccoli and spinach, can handle temperatures slightly below freezing.

Perennial plants (plants which survive most winters and enlarge year after year) can withstand much lower temperatures once established than they can when first planted. This can be seen in the field with fruit trees, landscape plants and even turfgrass. Whether this is due to plant maturity or their degree of establishment has not been determined; but older, more mature plants can typically tolerate freezing temperatures better than their more juvenile or less-established counterparts.

Plants which are considered "borderline" in their tolerance of freezing temperatures will survive low temperatures better if they are not pruned or fertilized with a nitrogen-containing fertilizer after about August 1. Pruning or fertilizing late in the season may stimulate new growth and reduce the tolerance of some plants to freezing temperatures. New growth must "harden off" to prepare for upcoming winter freezes.

Usually air temperature decreases as the night progresses, with the coldest temperature generally occurring just before sunrise. If temperatures drop below freezing for a very short period of time, damage to tender plants is typically minimal or lessened. If the same temperature is reached but maintained for several hours, freeze damage to tender plants is more severe.

Freezing temperatures occurring early in the fall and late in spring are usually more damaging to plants than if those same temperatures occur in mid winter. Hardy perennial plants become more tolerant of progressively dropping temperatures if temperatures move gradually toward freezing in the fall and gradually warm up in the spring.

Fig.3. Notice that the leaves of this plant were damaged heavily while the lower and more mature parts were not. This plant will recover early next season.

Some plant parts are more susceptible to freezing temperatures than others. The most tender plant parts are buds and flowers. Flowers of fruit and nut trees that bloom early in the season can be very susceptible to late frosts even if the tree itself is very cold hardy. The tender ovary inside the flower that forms the fruit is highly susceptible to light frosts in the bud stage and once the flower is open. A light frost just before or at the time of bloom can eliminate most and sometimes all of the fruit for that season.

The roots of plants are less cold hardy than stems and branches of the same plant. Stems and branches of some plants may tolerate temperatures to 20°F, while roots of the same plant may tolerate little to no freezing temperatures at all. Soil, particularly wet soil, serves as an insulator and provides protection for plant roots. Container plants, where there is not enough soil volume to insulate the roots from freezing temperatures, can suffer more damage than the same plant growing in the ground.

Plant Response to Cold Temperatures

Two types of plant injury can occur due to cold air temperatures. Tropical plants can be injured by air temperatures below 50°F. This is the same type of damage that can be seen when a fresh banana is placed in a refrigerator set at 40°F and turns brown. Because the damaging temperature was above freezing, this type of damage is called *chilling injury* and occurs to some tropical plants and plant parts.

Fig. 4. Even though palm leaves were damaged by freezing, the bud, protected by the base of the fronds, was not. This palm will recover nicely.

The second type of plant injury is *freeze damage* and only occurs when air temperatures are at or below freezing. Semi-tropical and temperate plants gradually develop increased tolerance to freezing temperatures as winter approaches. Increasing a plant's tolerance to freezing temperatures relies on two external factors: increasing hours of nighttime and a gradual seasonal decrease in air temperatures. Mechanisms within the plant respond to shorter day lengths, initiating acclimatization to winter cold. If this were the only signal the plant received, it would not achieve its minimum threshold freezing temperature. The gradual drop in nighttime air temperatures is the second signal that helps determine the plant's minimum cold tolerance.

Although the air temperature may drop below freezing, the plant will not necessarily freeze. Plants have several mechanisms by which they resist or tolerate freezing temperatures. These mechanisms include super cooling and tolerance to the formation of ice crystals inside the cells of the plant.

Freeze damage in woody plants is usually first seen as leaf wilt (if it is a broad-leaf evergreen), followed by browning and leaf drop. If freezing temperatures are severe or if the plant is deciduous, stem or branch dieback may occur. Freeze damage to cacti and other succulents usually results in tissue that softens and turns white. Eventually these damaged areas turn black as decaying organisms take over. These injured plant parts eventually fall off.

Fig.5. Freeze damage to nopal (Opuntia spp.*) cactus*

Freeze damage to plants might not become evident for several months or even years after the damage has occurred. In the case of certain palms, the trunk and central bud may be

damaged, weakening the plant. Plants damaged in this way might not succumb quickly but may over time.

Protecting Plants from Freezing Temperatures

Little can be done if freezing temperatures greatly exceed the minimum threshold temperature of a plant. However, some things can be done to give plants an "edge" during freezing conditions. Small fruit trees, shrubs and vegetables can be covered, but covers should be removed during the day and replaced again when danger of freezing temperatures threatens.

Woody landscape plants and fruit trees.

- Apply fertilizers at half rates if applying them during summer months; eliminate nitrogen fertilizers after August 1. If fertilizers are to be applied after August 1, apply those high in potassium but low in nitrogen.
- Plants should enter the fall months as healthy as possible, but growth should be reduced.
- Irrigate plants adequately all season long, but gradually reduce irrigation frequency as colder temperatures approach.
- Reserve heavy pruning for December or January. Light pruning can be done any month.
- Woody plants that are likely to freeze should be mulched to protect the roots and crown. See *Mulches for Nevada Landscapes*, UNCE SP 06-10 http://www.unce.unr.edu/publications/files/ho/2006/sp0610.pdf
- Use windbreaks to protect tender plants from damaging winds. See *Living Windbreaks for Desert Dwellers*, UNCE Fact Sheet 06-88 http://www.unce.unr.edu/publications/files/ho/2006/fs0688.pdf
- Damage to cacti usually occurs on the growing tips first so protect these locations with a frost blanket, Styrofoam® cups or other devices whenever possible.

Vegetables and smaller winter-tender plants.

- Use cold frames, hoop houses and tunnels for larger garden spots. These devices will add at least a month of production to both the spring and fall.
- Move container plants into protected areas during freezing temperatures and back again when temperatures rise above freezing.
- Water container plants (except succulents and cacti) just prior to freezing temperatures.
- Place row crop covers (frost blankets) over the tops of plants to provide 4° to 5°F of protection. Since these usually transmit light, they can be left in place for extended periods and do not need to be removed.
- Use hot-caps or water storage devices, (Wall-o-Water®) e.g., for individual plants.

What to Do after a Freeze

In most cases, if the plant was healthy last season and growing strong, there is little that you have to do to encourage recovery other than irrigate normally. If the plant was doing poorly and not in good health, chances for recovery will be less than for its healthy counterpart.

If possible, delay all pruning until after the danger of freezing weather has passed. Older damaged plant material will provide some protection during continued freezing temperatures. When pruning, cut back to healthy tissue using a sharp and sterilized pruning shears or saw. When all the damaged parts of the plant have been removed, examine it carefully. Many woody plants require additional pruning at this point for shaping.

Some plants may be killed all the way to the ground. If this is the case and you want to see if it will come back, make clean sharp cuts

leaving about 6 inches of growth above the ground for regenerating the plant. Be patient; it may take three to four months for some plants to produce new growth. If you use mulch around plants like bougainvillea or cape honeysuckle and they appear to have died back to ground level, rake back the mulch from around the crowns of the plants after the danger of freezing weather has passed. Prune them back to about 2 inches above the soil surface. This will help speed regrowth from the crown if it has survived. Light and warmth will hasten growth and recovery.

Fig. 6. Freeze damage on oleander at early morning temperatures of 14°F. Notice a difference in freezing tolerance (one undamaged plant in the center) due to a difference in freeze tolerance among varieties. The damaged oleanders were cut back to near the ground and they recovered by mid-summer.

In the case of succulents and cacti with freeze damage, if bacterial rot symptoms are evident, prune the affected parts back to healthy tissue. Use sterilized tools to prevent the infection spreading through the plant. A pruning cut in cold weather is susceptible to infection also, so treat these with an appropriate fungicide. Delay pruning until the weather is warm and all danger of frost is past if there are not rot symptoms.

Average Frost or Freeze Dates for Southern Nevada

The last frost/freeze date for an area is the last day in spring that historical records indicate there was a frost. The average last frost day is used in many recommendations as a date after which it is considered safe to plant tender plants. However, the chance of an early or late frost is always a possibility. Most generic planting directions are based on the average last frost dates from the respective USDA Plant Hardiness Zones.

The Western Region Climate Center located at Desert Research Institute (DRI) in Reno keeps historical weather data. The DRI website has highs and lows and heating and cooling degree days, as well as spring and fall freeze probability dates and length of freeze-free season at: http://www.wrcc.dri.edu/summary/climsmnv.html. See Table 1 for information on selected locations in southern Nevada. Additional weather information is also available from the National Climatic Data Center (NCDC) (http://www.ncdc.noaa.gov/oa/ncdc.html).

If you are an avid gardener who would like more accurate information for your location, keep a garden journal and record your own weather data. There are internet sites like Weather Underground www.wunderground.com that store and share individually reported local weather information. You may find a location on their site that is closer to your home than the official weather sites listed by the climate centers.

Table 1. Southern Nevada Freeze Probabilities

Location, Station #, Elevation in feet above sea level, Dates Included in Report	Spring 'Freeze' Probabilities			Fall 'Freeze' Probabilities			Length of 'Freeze-Free Days'		
	Earliest Month/Day	50% Month/Day	Latest Month/Day	Earliest Month/Day	50% Month/Day	Latest Month/Day	Shortest	50%	Longest
Alamo #260099 E 3464' 7/2/1948 – 9/30/1962	04/05	05/13	06/11	09/12	09/26	10/11	102	117	187
Amargosa Farms Garey #260150 E 2450' 12/1/1965 – 4/30/2007	02/11	03/22	04/28	10/13	11/07	12/09	177	236	269
Beatty #260714 E 3307' 7/1/1948 – 11/30/1972	03/22	04/12	05/07	10/10	10/30	11/13	170	207	232
Beatty 8 miles North #260718 E 3550' 12/1/1972 – 12/31/2005	02/18	04/15	05/22	09/26	10/30	11/19	158	198	260
Bunkerville #261327 E 1550' 12/1/1979 – 4/30/2007	03/07	03/21	03/31	09/11	11/16	11/24	227	312	***
Boulder City #261071 E 2550' 9/3/1931 – 12/31/2005	**/**	02/10	04/27	10/29	12/16	**/**	227	312	***
Echo Bay #262497 E 1250' 8/1/1989 – 4/30/2007	**/**	02/02	03/16	11/20	12/09	**/**	261	306	***
Indian Springs #263980 E (App) 950' 7/11/1948 – 6/30/1964	03/09	04/03	04/25	09/26	10/24	11/16	166	212	228
Las Vegas WSO Airport #264436 E 2131' 2/1/1937 – 4/30/2007	**/**	02/28	04/12	10/21	11/24	12/19	203	269	***
Lathrop Wells #264473 E 2182' 11/1/1970 – 8/31/1977	03/11	04/01	04/18	10/19	10/25	11/09	203	269	***

/ , ***See chart notes after chart

Location, Station #, Elevation in feet above sea level, Dates Included in Report	Spring 'Freeze' Probabilities			Fall 'Freeze' Probabilities			Length of 'Freeze-Free Days'		
	Earliest Month/Day	50% Month/Day	Latest Month/Day	Earliest Month/Day	50% Month/Day	Latest Month/Day	Shortest	50%	Longest
Mesquite #265085 E 1570' 3/1/1956 – 11/26/2006	02/24	03/16	04/02	11/05	11/10	11/29	231	239	272
Callville Bay #261371 E 1270' 7/1/1989 – 4/30/2007	**/**	01/19	07/30	11/21	12/11	12/27	281	325	***
Laughlin #264480 E 605' 2/1/1988 – 4/30/2007	**/**	**/**	02/27	11/20	12/30	**/**	297	***	***
Logandale #264651 E 1410' 2/1/1968 – 1/31/1992	02/12	03/16	04/28	10/28	11/17	12/02	228	248	273
N. Las Vegas #265705 E 1898' 2/1/1951 – 9/30/2005	01/08	03/28	05/03	10/07	11/04	12/20	157	211	332
Pahranagat W. L. Refuge #265880 E 3400' 3/1/1964 – 12/31/2005	02/26	04/17	05/20	09/19	10/28	11/21	134	192	252
Overton #265846 E 1250' 7/1/1948 – 4/30/2007	01/30	03/15	04/24	10/24	11/16	12/09	205	243	288
Pahrump #265890 E 2674' 10/1/1948 – 12/31/2005	02/09	03/31	05/07	10/02	10/30	11/26	163	212	283
Red Rock Canyon St Park #266691 E 3780' 5/1/1977 – 4/30/2007	02/24	03/30	05/08	10/16	11/06	11/21	171	220	254
Searchlight #267369 E 3540' 1/1/1914 – 4/30/2007	01/09	03/22	05/21	10/24	11/21	**/**	156	248	***

/ , ***See chart notes after chart

Notes to Chart

Spring 'Freeze' Probabilities

Earliest	Earliest date when a minimum temperature below the threshold occurred.
/	There has been a year when the minimum temperature didn't go below the threshold temperature during the Jan. 1 to July 31 period or that there was insufficient data to determine a date.
50%	Percent probability that a minimum temperature below the threshold will occur on or after the given date.
/	Non-occurrence of the threshold or insufficient data to determine a threshold.
Latest	Latest date when a minimum temperature below the threshold occurred.
/	There has never been a year when the minimum temperature went below the threshold temperature during the Jan. 1 to July 31 period or insufficient data to determine a date.
07/30	Would mean the minimum temperature can go below the threshold temperature any day during the Jan. 1 to July 31 period.

Fall 'Freeze' Probabilities

Earliest	Earliest date when a minimum temperature below the threshold occurred.
/	There has never been a year when the minimum temperature went below the threshold temperature during the July 31 to Dec. 31 period or insufficient data to determine a date.
50%	Percent probability that a minimum temperature below the threshold will occur on or before the given date.
/	Non-occurrence of the threshold or insufficient data to determine a threshold.
Latest	Latest date when a minimum temperature below the threshold occurred.
/	There has been a year when the minimum temperature didn't go below the threshold temperature during the July 31 to Dec. 31 period or insufficient data to determine a date.

'Freeze-Free Days' Season Probabilities

Shortest	Least number of consecutive days recorded with minimum temperature above threshold.
***	Would mean minimum temperature below threshold has not occurred.
50%	Percent probability that a consecutive number of days will occur with the minimum temperature not below the threshold.
***	Would mean non-occurrence of the threshold
Longest	Greatest number of consecutive days recorded with minimum temperature above threshold.
***	Would mean that at least one year occurred when minimum temperature below threshold was not recorded.

Note: All periods include August 1.

References

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