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Frost Protection for the Home Gardener

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Avoiding damaging low temperatures in spring and fall is a challenge that the home gardener faces each year. An entire garden can be destroyed in one night with an unwelcome visit by "Jack Frost." Understanding what causes frost will help gardeners decide on the best course of action to overcome or reduce its harmful effects.

Frost — Two Varieties

Frost occurs when the temperature of a plant and the air around the plant falls below 32°F or 0°C. Depending on the air temperature, dew point and the temperature of the plants, one of two types of frost results:

White frost, also called hoarfrost, is white and feathery in appearance. It is not always harmful. For short periods, white frost formed just below the freezing mark may help to insulate plants.

Black frost has a few aliases including hard frost, dry freeze and killing frost. The term black is derived from the appearance of the affected vegetation. Air near the plant is very dry with this type of frost; little or no ice is visible.

Dew point temperatures are the key in determining the variety of frost. Dew point is the air temperature at which dew forms. If dew point temperature is below freezing and the surface temperature drops to the dew point, then white frost forms. So white frost is really frozen dew. Black frost occurs when the air is much drier: the frost occurs before air temperature drops to the dew point.

During the growing season, dew point temperatures are routinely included in agricultural weather forecasts. National Weather Service offices that release these forecasts are located in Boise, Lewiston, Pocatello and Twin Falls, Idaho, and Spokane, Washington. Telephone numbers for these offices can be found in the U.S. Government offices section of the phone book under the Department of Commerce.

Different weather patterns cause frosts. A cold front is on the way when barometric pressure falls, clouds thicken and southerly winds increase. Winds will switch to the west to northwest after the front passes. If the cold front is strong enough to support subfreezing temperatures, the winds will cause a phenomenon known as an advective-type freeze. On the other hand, when high atmospheric pressure dominates, the air is still and the sky clear, a radiation-type freeze can occur.

Cold Fronts — Advective-type Freezes

Not every cold front will be severe enough to cause frost damage. Wind is the chief factor. Cold fronts preceded and followed by strong winds usually have large differences in temperatures across the frontal boundary. When this occurs in the spring, an advective freeze is on the way. If the advection of subfreezing air did not get your garden on the first night after frontal passage, do not celebrate yet. Very often the second night after the front passes is the worst night for damaging temperatures. By then, dew points have lowered (the air has dried-out), and protective cloud cover has usually disappeared.

High Pressure, Fair Weather — Radiation-type Freezes

A strong high-pressure system may give us fair weather. It also makes ideal conditions for radiation-type heat loss at night. When enough heat is lost to drop temperatures below freezing, a radiation-type freeze occurs.

Radiation from the sun during the day is absorbed by plants and the adjacent soil. Much of it will be returned to the sky as radiant energy at nighttime. The amount of heat lost (radiated) at night is determined by *cloud cover, winds, humidity* and by the *maximum temperature* that occurred during the preceding afternoon.

Clouds at night are a gardener's friend. They act as a blanket inhibiting heat loss from the surface (Fig. 1). Winds can be beneficial when there is warm air aloft as in a typical nighttime inversion. The wind will help mix warmer air from above with the colder air below, the way the large wind machines do in commercial orchards (Fig. 2). Relatively high humidities, or dew points above 35°F in Idaho, help to hold heat near the surface as the clouds do (Fig. 3). The higher the afternoon maximum temperature, the less likelihood of a frost (Fig. 4).

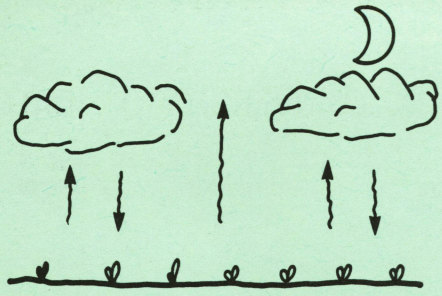

Fig. 1. Heat lost at night returns to the surface.

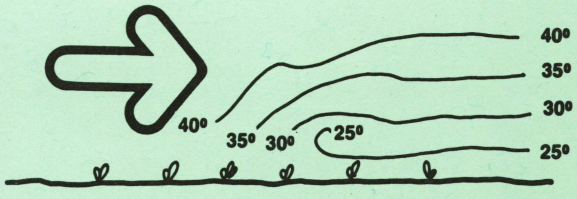

Fig. 2. Wind mixes warmer temperatures aloft with colder temperatures below.

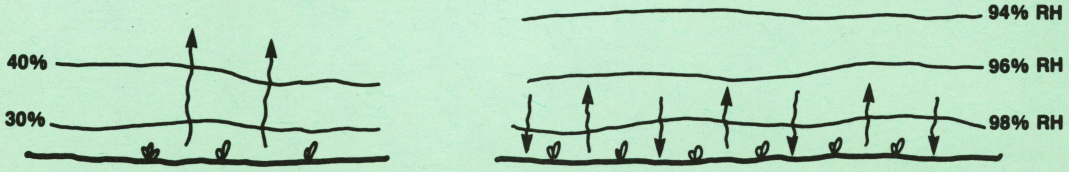

Fig. 3. (left) Low humidities do not hold down the heat, and (right) high humidity holds heat down.

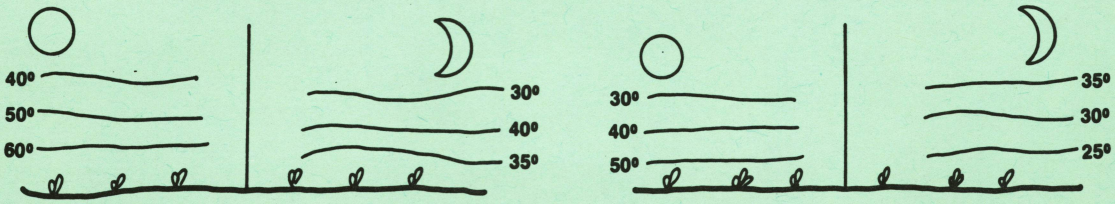

Fig. 4. (left) Warmer daytime temperatures mean warmer nighttime lows, and (right) cooler daytime temperatures mean cooler nighttime lows.

When none of these favorable ingredients is present, the warm temperatures of the day are lost by radiational cooling at night. The temperature falls and keeps on falling until a certain level is reached. That level or minimum temperature can sometimes be determined by using an old forecasting trick. It only works under clear skies, calm winds and a stable weather pattern. Dew point again is the clue. The dew point at 3 to 4 p.m. will usually be close to the actual minimum temperature for the coming night. For example, a midafternoon dew point of 26°F will tell weather-sensitive gardeners to expect a minimum nighttime temperature of near 26°F. And those gardeners will be prepared to protect their plants.

If you prefer to do your own forecasting of minimum temperatures based on dew points, you might want to use a sling psychrometer. A sling psychrometer is two standard thermometers that are attached to a brace with a handle for spinning. The mercury bulb on one of the thermometers is covered with a cloth sock that is moistened before spinning. The rotating action causes the moistened sock to cool with evaporation. When the wet bulb thermometer indicates the lowest reading, note the two temperatures. Then determine the dew point from a table using the wet and dry air readings.

This technique is not reliable during every weather pattern. If the air mass changes over night, the results won't even be close.

How To Protect Gardens from Frost

The home garden represents a substantial investment in care, time, energy and money that can be destroyed in an hour by frost. How can you avoid frost damage? A variety of protection strategies might be considered.

Passive Protection

When To Plant — The "smartest" strategy is to plant your garden at the right time of year. Each spring there are those that try to get a jump on the growing season by planting warm season vegetables during an early April warm spell. Perhaps these growers will be lucky one year, but the odds are against them. If you are going to "play the odds," know what they are before you begin. Contact your local University of Idaho extension agricultural agent and ask for the average dates of the last frost in the spring and the first frost in the fall. When you obtain these dates, you will then know when the "odds" are in your favor. Table 1 lists these dates for several locations in Idaho.

A more complete list is available in University of Idaho Bulletin 494, *Spring and Fall Freezing Temperatures and Growing Seasons in Idaho.* Your county Extension agricultural agent offers a wide variety of publications on plant care. Check the government offices section of your phone book for the nearest University of Idaho Cooperative Extension office.

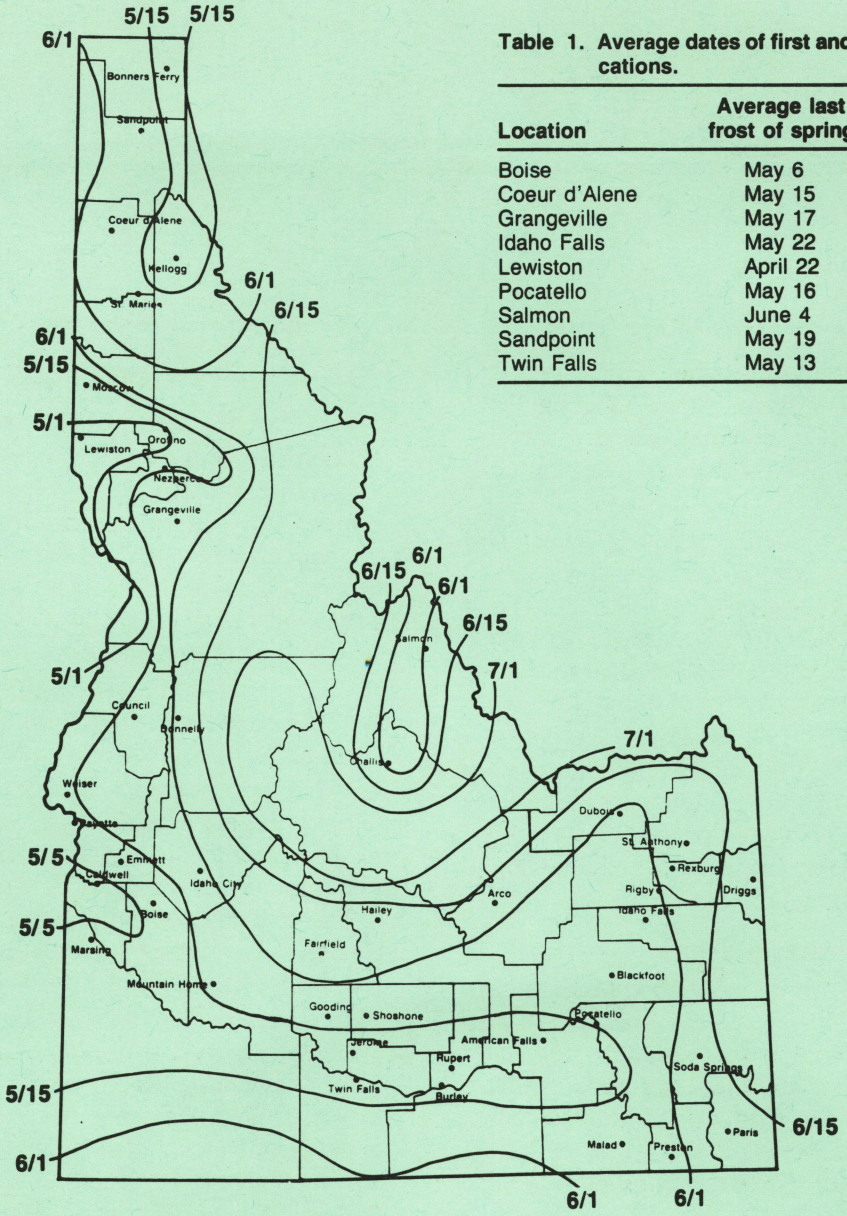

Fig. 5. Average last spring frost date.

Table 1. Average dates of first and last frosts at selected Idaho locations.

Location	Average last frost of spring	Average first frost of fall	Days
Boise	May 6	Oct. 8	155
Coeur d'Alene	May 15	Sept. 25	133
Grangeville	May 17	Sept. 21	127
Idaho Falls	May 22	Sept. 20	121
Lewiston	April 22	Oct. 14	174
Pocatello	May 16	Sept. 20	127
Salmon	June 4	Sept. 9	97
Sandpoint	May 19	Sept. 13	117
Twin Falls	May 13	Sept. 22	131

The differences in frost dates are great and depend mostly on latitude and elevation. Even within a given area, microclimates exist that can be significantly different from the area a few miles away. If you are new to your area, check with your gardening neighbors. The statistically favored approach would be to schedule your planting and harvesting between the two average frost dates for your area. If what you plan to plant requires a longer growing season than the average for your area, then you may want to consider planting a different variety or a different crop.

Where To Plant — Strong spring breezes can intensify the chilling effects of the wind on young plants. The wind increases evaporation, thereby depleting the plant and soil of needed moisture. Wet soil has a greater heat capacity than dry soil and can sometimes keep a plant from freezing. Pick a spot that is sheltered from the wind. Be careful not to create too good a shelter, however. No air movement at all will encourage disease.

Choosing the correct "when and where to plant" strategies are not always enough. Mother Nature and Jack Frost don't follow rules made by man. If you listen to the weather reports, you usually have at least 12 hours to prepare for the damaging effects of a frost. So when passive protection is not enough, more immediate methods can be taken to *add* or to *contain* heat.

Protection by Adding Heat

Gardeners' imaginations sometimes run wild to come up with new ways to keep crops warm. Some help and some do not. Unlike the commercial fruit grower, the home gardener cannot rely on bringing warm air down to the surface from 30 to 40 feet above the ground with giant wind machines. Smudge pots and heaters are equally impractical, especially on young row crops that are close to the surface. Sprinkler systems have proven effective commercially, but sprinkler use by the home gardener, without the aid of specially built sprinkler heads and knowledge of flow rates, may cause more damage than it prevents.

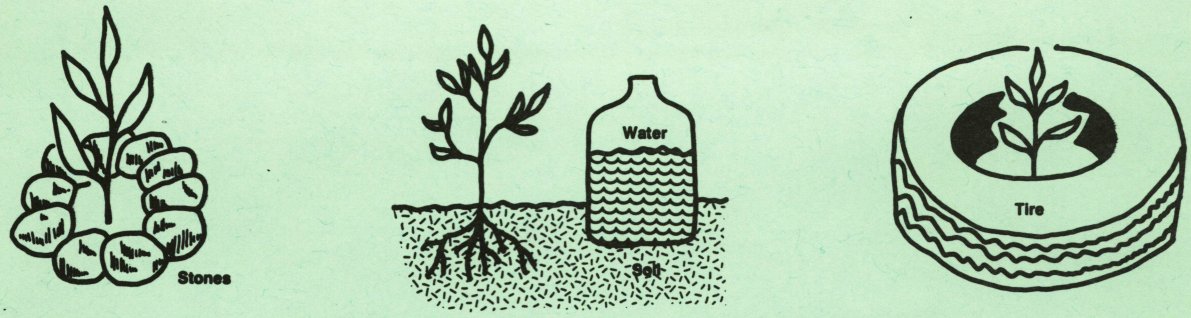

Fig. 6. Methods to protect garden crops by adding heat: (a) stones, (b) containers with water and (c) tires.

Among the alternatives to sprinklers and heaters are methods with a more natural flavor. Stones (Fig. 6a), containers filled with water (Fig. 6b) and tires (Fig. 6c) are good absorbers of heat during the day and excellent radiators at night.

Soil temperatures that are increased during the day will also radiate more heat at night. Soil temperatures can be increased in a number of ways. Among them are (1) add a little coal dust to the surface to darken the soil; (2) make use of solar reflectors; for example, plant next to a white fence; (3) increase the heat capacity of the soil by keeping the soil damp.

Remember, however, that the same techniques used to protect against the cold in spring might cause an overly hot environment in the summer that could stress your crops. Whatever you do, try to make it flexible enough to "undo" during the summer.

Protection by Containing Heat

Covering your garden crops with a good insulator will contain the heat gained during the day and help to prevent frost at night. Be sure to use an insulator, not a conductor. To decide whether an object is a good insulator or conductor, touch it. If it is warm or neutral to the touch, it is usually a good insulator. If it is cold to the touch, like metal, it is a conductor. Some good insulators include hot caps, newspapers, grocery bags, paper cups, most plastic sheeting, plastic garbage cans, rubber, wooden boxes and glass (Fig. 7). Do not use conductors like metal cans. Temperatures could actually be colder inside a metal container than outside.

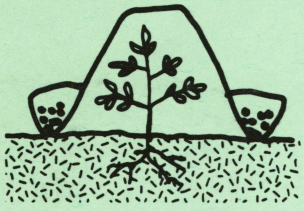

Fig. 7. Commercial hot cap (cut-away view).

Coverings offer the home gardener an advantage that the commercial grower does not have. Where it can be practical at home, covering crops is not practical on the farm. You can cover a small garden easily. The farmer cannot easily cover a field.

Tips for the Home Gardener For Preventing Frost Damage

1. **Cultural Practices:** (a) Make sure the variety you are planting is hardy enough for your area; (b) Do not plant too early in the season. Check on the average last frost date and the length of the growing season for your area; (c) Planting near a wind break may protect from frosty winds, but stagnant air will promote radiation frosts and also disease later in the season.

2. **Soil Conditions:** (a) Keep the soil moist and compact; (b) If weeds are thick, remove them on a sunny day before noon, then gently pack the soil.

3. **Fire and Water:** (a) Do not use space heaters. They are risky and not very effective on row crops; (b) Do not use sprinklers. Delicate young plants will collapse under the weight of ice; (c) Flood irrigation is not recommended. The mud and nutrient leaching is too expensive a trade off. Besides, saturated soil the night after the flood could promote frost instead of prevent it.

4. **Contain or Add Natural Heat:** (a) Contain heat by covering your crops with a sheet of plastic. Brown paper grocery bags make excellent covers too; (b) Put a natural heat source near your plants. Large stones, tires or a plastic container of water will store heat during the day and release it at night.

Tips for the Home Fruit Grower

Fruit trees offer a special challenge to the home grower. Commercial practices are expensive and impractical. The safest practice for you and your trees is to cover as much as you can. On small trees, drape a piece of plastic over the tree, making a canopy or umbrella effect. With large trees, umbrella as many limbs as you can. Do not enclose the limbs. Your goal is to trap the heat that is rising up from the ground. It may not seem like much, but very often you only need an increase in temperature of 2 or 3 degrees to save your buds.

Some home fruit trees have been protected with the addition of Christmas tree lights, but success depends on the number of lights and the degree of protection needed.

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