FROST / FREEZE PROTECTION

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Consistency in cropping and maintenance of fruit quality are keys to profitable peach production. Frosts and freezes can account for crop losses ranging from minor to complete. Cold-induced scarring of fruit can also produce major losses. In many cases, crops can be protected from cold damage by one or more methods. This chapter acquaints you with the various types of cold events, identifies situations in which protection is feasible, and outlines strengths and weaknesses of various control options.

As peach fruit buds progress from a fully dormant condition to bloom, they lose their ability to tolerate cold temperatures without being injured or killed. The **critical temperature** is defined as the temperature that buds, flowers, or fruits will tolerate for 30 minutes or less. Critical temperatures for various deciduous fruits have been published, and those for peaches are shown in Table 1.

Table 1. Critical temperatures for fruit buds of peach.

	Bud Development Stage						
	First Swelling	Calyx Green	Calyx Red	First Pink	First Bloom	Full Bloom	Post Bloom
Avg. Temp. (°F) for 10% Kill	18	21	23	25	26	27	28
Avg. Temp. (°F) for 90% Kill	1	5	9	15	21	24	25

Ballard, J. K. and E. L. Proebsting. 1978. Frost and Frost Control in Washington Orchards. Wash. State Univ. Coop. Ext. Bull. No. 634.

Several factors can influence the actual temperature at which injury occurs. The numbers in Table 1 are only a guide. Buds on weak trees cannot tolerate the same temperatures as those from healthy trees. Conditions leading up to the cold event influence hardiness.

Thermometers used to monitor orchard temperatures must be reliable. Use straight-tube, alcohol, minimum-registering thermometers with the scale etched on the tube. They should be placed in standard thermometer shelters, as evaporative cooling can cause lower readings on exposed thermometers. Check thermometers annually by submerging them in a slurry of ice and water to assure accuracy; water in the mix should stabilize after stirring. After frost season, store thermometers upright (bulb down) in a cool place. Watch for separations in the alcohol column.

Use a minimum of two thermometers, one in the coldest part of the orchard to help determine when to institute active frost control measures and the other outside the orchard (preferably upwind) and away from the area affected by the frost control techniques to help determine when to discontinue frost protecting. Additional thermometers placed in other parts of the orchard further aid in deciding when to frost protect. Be sure thermometers are not directly affected by heaters. *The temperature of the buds, twigs, and leaves can be 2° to 4°F lower than the air temperature registered by a shielded thermometer; take this into account when using frost protection.*

Check thermometers frequently. Record time, location, minimum temperature, and the temperature at the time of reading. Keep these records over time, they can help detect temperature trends and determine the effectiveness of frost protection measures.

Frost alarms can be effective in informing you of an approaching problem if they are correctly installed and maintained. The sensor for the alarm should be placed in a standard thermometer shelter to prevent evaporative cooling from producing a false alarm. The circuitry and the accuracy of the unit should be inspected each season to assure proper operation. Immerse the sensor in an icewater slush with at least two check thermometers to confirm reliability.

Dewpoint is the temperature at which moisture will begin to condense out of the air, forming dew. The higher the relative humidity at a given air temperature, the higher the dewpoint. When the relative humidity is 100%, the air temperature equals the dewpoint. Frostpoint is similar to dewpoint — it is the temperature at which frost just begins to form. The difference between dewpoint and frostpoint is less than 2.5°F at temperatures between 14° and 32°F, so for practical purposes these terms can be used interchangeably.

On calm nights, the dewpoint represents the lowest temperature to which the air can cool, which is due to the liberation of latent heat during the formation of dew or frost. In essence, the heat released as water condenses offsets the tendency for the air to cool, so the temperature stabilizes at the dewpoint. Dewpoint also affects the rate of air temperature decrease. *With a low dewpoint, the potential exists for a very rapid drop in temperature, sometimes several °F per hour.* Knowing the dewpoint is valuable in deciding whether or not frost protection may be needed and when to initiate active frost protection measures such as sprinkling, wind machines, or heating.

A sling psychrometer (also called a wet-bulb dry-bulb thermometer) is used to determine dewpoint readings. This instrument is made up of a pair of thermometers mounted on a frame. A swivel handle attached to the frame allows the thermometers to be whirled. The bulb on the lower thermometer is covered with a thin muslin sock, which is wet at the time of measurement. Twirling the psychrometer affects both thermometers. The dry bulb measures air temperature. The wet bulb registers lower due to the cooling effects of evaporation on the wet sock. The difference in readings is referred to as the "wet bulb depression," and is indicative of the relative humidity and dewpoint. Wet bulb temperatures should not be relied on to determine when to begin frost protecting, as the readings may be too low. Refer to Table 2 to determine relative humidity and to Table 3 to determine dewpoint by the use of a sling psychrometer. Conversion charts and slide rulers for conversion are available from many of the same sources that sell the sling psychrometers.

To obtain reliable readings from a sling psychrometer, the instrument must be kept in good condition. The sock on the wet bulb thermometer should be replaced periodically because impurities left on it by evaporation can cause inaccurate readings.

Table 2. Determining the relative humidity from wet-bulb and dry-bulb thermometers.

Dry Bulb Temp. (°F)	**Difference Between Readings of the Wet-Bulb and the Dry-Bulb Thermometers (Degrees Fahrenheit)**																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	70	40	10																	
5	75	50	26	4																
10	80	60	40	22	4															
15	84	68	52	34	20	5														
20	6	72	59	46	33	20	7													
21	86	73	60	48	34	22	11													
22	87	74	61	50	36	25	13	2												
23	87	75	62	51	38	27	16	4												
24	88	76	64	53	41	30	19	8												
25	88	77	65	54	42	32	22	11												
26	88	77	66	55	44	34	24	14	4											
27	88	78	67	56	46	36	26	16	6											
28	89	78	68	57	48	37	28	18	9											
29	89	78	69	58	49	39	30	20												
30	89	80	70	60	51	41	32	23	14	6										
31	90	80	71	61	52	43	34	26	17	8										
32	90	81	72	62	53	44	36	27	19	10										

33	**90**	82	73	63	55	46	38	29	21	13	5									
34	**90**	**82**	74	65	56	48	40	32	24	16	8									
35	**90**	**82**	**73**	66	58	50	42	34	26	18	10	4								
36	**91**	**82**	**74**	**65**	59	51	44	36	28	20	13	6								
37	**91**	**83**	**75**	**66**	**58**	53	45	38	30	22	16	8								
38	**91**	**83**	**75**	**67**	**59**	**51**	47	39	32	24	17	10	4							
39	**91**	**83**	**76**	**68**	**60**	**53**	**46**	41	34	27	20	13	6							
40	**92**	**84**	**77**	**68**	**61**	**53**	**47**	**39**	36	28	22	15	8							
41	**92**	**84**	**77**	**69**	**62**	**54**	**47**	**40**	**31**	31	24	17	11	5						
42	**92**	**84**	**77**	**70**	**62**	**55**	**48**	**41**	**34**	**28**	26	19	13	6						
43	**93**	**84**	**78**	**70**	**63**	**56**	**49**	**43**	**36**	**29**	**23**	22	15	9	3					
44	**93**	**85**	**78**	**71**	**64**	**57**	**50**	**44**	**37**	**31**	**24**	**18**	17	12	5					
45	**93**	**86**	**78**	**72**	**65**	**58**	**57**	**45**	**39**	**32**	**26**	**20**	**14**	13	8	3				
46	**93**	**86**	**79**	**72**	**65**	**58**	**53**	**46**	**40**	**33**	**27**	**22**	**16**	**11**	11	5				
47	**93**	**86**	**79**	**72**	**66**	**59**	**54**	**47**	**41**	**35**	**29**	**23**	**17**	**12**	**7**	2				
48	**93**	**86**	**80**	**73**	**67**	**60**	**54**	**48**	**42**	**36**	**30**	**24**	**19**	**14**	**8**	**4**	4			
49	**93**	**86**	**80**	**74**	**67**	**61**	**55**	**49**	**43**	**38**	**32**	**26**	**20**	**16**	**10**	**5**	**2**			
50	**93**	**87**	**81**	**75**	**68**	**62**	**56**	**50**	**45**	**39**	**33**	**28**	**23**	**18**	**13**	**7**	**3**			

Table 3. Determining dewpoint using air temperature (dry-bulb reading) and relative humidity.

Dry-bulb Temp. °F	Percent Relative Humidity																		
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
5	-35	–30	–25	–21	-17	–14	–12	–10	-8	-6	-5	-4	-2	-1	1	2	3	4	5
10	-31	-25	-20	–16	-13	–10	-7	-5	-3	-2	0	2	3	4	5	7	8	9	10
15	-28	-21	-16	-12	-8	-5	-3	-1	1	3	5	6	8	9	10	12	13	14	15
20	-24	-16	-11	-8	-4	-2	2	4	6	8	10	11	13	14	15	16	18	19	20
25	-20	-15	-8	-4	0	3	6	8	10	12	15	16	18	19	20	21	23	24	25
30	-15	-9	-3	2	5	8	11	13	15	17	20	22	23	24	25	27	28	29	30
35	-12	-5	1	5	9	12	15	18	20	22	24	26	27	28	30	32	33	34	35
40	-7	0	5	9	14	16	19	22	24	26	28	29	31	33	35	36	38	39	40
45	-4	3	9	13	17	20	23	25	28	30	32	34	36	38	39	41	43	44	45
50	-1	7	13	17	21	24	27	30	32	34	37	39	41	42	44	45	47	49	50

Advective freezes and radiation frosts are the two types of cold events that threaten fruit crops. Many nights will have characteristics of both types.

An advective freeze occurs when an arctic cold mass moves into a region. During the day, an advective freeze is cold, with temperatures seldom getting above 50°F; air is often dry and windy. These conditions persist into the night, with temperatures getting much colder. Temperature inversions are usually weak. These conditions generally affect a fairly large area and may persist for several days. The wind and temperatures, which may be quite low, combine to make most frost protection practices ineffective. Advective freezes are normal in winter but may also occur in spring.

A **radiation frost** is generally fairly localized and of a shorter duration than an advective freeze. Days preceding radiation frosts are clear, calm, and fairly warm. At night, skies remain clear, the winds stay calm, and temperatures drop drastically. At night, heat absorbed by the ground during the day is radiated into the atmosphere. Air in contact with the ground is cooled, causing it to be heavier than the warm air above. This cold air drifts along the ground to the lowest areas. Usually, it is coldest just prior to sunrise. Active frost control techniques can be successfully employed during a radiation frost. Radiation frosts often have strong inversions.

An **inversion** is a layer of warm air floating over a layer of colder air next to the surface of the ground. During daylight hours, the earth absorbs heat from the sun. Air in contact with the ground is heated; therefore, the warmest air is at ground level. Air temperatures get progressively cooler with increasing elevation above-ground. On a calm, clear night, the ground is cooled by radiant heat loss into the sky. The air near the ground is colder than the air higher off the ground (exactly the opposite of what may be observed during the day). At some height, this increasing temperature trend reverses itself and temperatures decrease with increasing elevation. This point is called the height of the inversion.

The strength of the inversion (weak vs. strong) refers to the temperature differential at 50 to 60 feet above-ground versus the temperature three to five feet above-ground. The temperature differential at this height has a pronounced effect on the performance of ground heaters and wind machines.

As heated air rises, it gets cooler. The height at which the airstream temperature reaches the same temperature as its surroundings is referred to as the **ceiling**. At this point, the upward motion of the airsteam stops. The **ceiling corresponds to the height of the inversion**. Smoke from a small fire rises until it reaches the ceiling, at which point it stops rising and spreads out. The ceiling is generally low on nights following warm days. The volume of the air to be heated and the amount of fuel needed to heat it are relatively small. Heating and/or the use of wind machines may be quite successful in such conditions. A high ceiling (following cold days) means that there is a lot of air to be heated and that the amount of fuel needed to heat it will be high.

Winds mix colder air at ground levelwith warmer air above it. As long as the wind stirs the air, the temperature drop will be slowed. Often winds decrease at night, which predisposes more rapid temperature drops. When a wind is strong enough to thoroughly mix all the air in and above trees, the temperature in an orchard can actually rise. Wind machines are employed to mix the air and hopefully keep it above the critical temperature.

Clouds — Yes, Smoke — No

Heat lost from the orchard is radiated in long wavelengths that cannot entirely pass through the water vapor of clouds. Clouds, if low enough and of great enough density, absorb radiant heat from the ground and re-radiate it back into the orchard. Clouds passing over an orchard on a frosty night may stop the drop in temperature and may even cause a temperature increase. Small, isolated clouds and cirrus clouds do not impede radiation of heat from the orchard floor.

Although cloud cover helps retain heat, smoke does not effectively maintain warmth. Heat radiated from the orchard in long wavelengths will pass through smoke, but short wavelength radiation from the sun does not. Therefore, the use of smudge pots or burning tires to produce smoke as well as heat does not work. Radiated ground heat escapes through the smoke at night and the smoke prevents heat from the sun from reaching the ground during the day, which delays the warming of the orchard in the morning and necessitates longer frost protection times.

Passive and active frost controls are the two basic categories of frost protection.

Passive control involves elements that cannot be changed or are difficult to change once they are in place. Site selection and development, variety, pruning and training, tree health, and orchard floor management are all factors that have a passive impact on frost susceptibility. Employing passive frost control concepts may lessen the need for active controls, reduce the frequency of using the active controls, or at least increase the effectiveness of active controls.

Passive controls do not constitute an extra expense in orchard development and maintenance, plus they are sound horticultural practices from other standpoints.

Elevation in regard to the immediate surroundings may offer protection during a radiation frost event. As a rule of thumb, for each 100 feet increase in elevation during a radiation frost event, expect an increase of 5° to 10°F. Thus, an orchard located in an elevated site may not experience frost damage, whereas serious injury may occur in an orchard situated at a lower site. Locating the orchard on a slope instead of a hilltop may be preferred, as winds and freeze damage may be more likely to occur on a hilltop. An elevated site may experience decreased disease pressure, as fogs may settle below the orchard, which creates a less favorable environment for disease development.

How far down a slope to plant depends on how much air drainage occurs. If air readily drains from a site, it is feasible to crop at lower elevations.

An important part of orchard site preparation includes the removal of any blockages to air drainage out of the orchard. Even if the orchard is planted on an elevated site, the presence of woodlands, hedgerows, or overgrown fencerows on the slope below the orchard can slow air drainage out of the site and create a frost pocket above the basal part of the slope.

Direction of slope can have some effect on frost problems. Trees on a north-facing slope may be somewhat delayed in their development in spring, thus reducing their vulnerability to frost. Trees on a south to southwestern slope will be most advanced.

Cultivars showing less hardiness in regard to frost should be planted further up the slope than more hardy cultivars, to give the tender cultivars the extra protection afforded by increased elevation.

Orchard floor management practices can impact on frost problems encountered in the orchard. The ideal orchard floor from a frost protection standpoint is firm, bare, moist soil, without any vegetation. This type of orchard floor absorbs more heat during the day than other floor management plans. And bare, compacted soil will re-radiate heat back into the air over a longer period at night, which offers an extra couple of degrees protection in early morning just before sunrise when temperatures are often at their lowest point. Dry, freshly tilled soil or tall grass and weeds offer the poorest floor management plan from a frost control standpoint.

Because many orchards are on uneven land, cultivating the entire orchard floor soil to control vegetation is unacceptable because of associated problems with soil erosion, reduced tree health, and poor orchard trafficability. The ideal orchard floor management plan for most sites is a continuous strip of bare soil under the trees with closely mowed sod between rows and around the orchard. The wider the vegetation-free strip the better. Close mowing in and around the orchard is an integral part of a frost protection plan. Tall grasses and/or weeds in and around the orchard will interfere with good air drainage out of the site, which increases the potential for frost in the orchard.

Although air drainage out of the orchard may be better where rows run up and down the slope, this is seldom practical. Increased problems with soil erosion in the vegetation-free site, the inherent difficulty of maintaining constant tractor speed on slopes and resultant lack of precision in making pesticide applications up and down hills, and the difficulty of designing and installing an irrigation system, all combine to make orienting tree rows across slopes a far better way to set an orchard.

Fruit buds on healthy trees are more capable of tolerating cold stresses than those on weak trees.

Active frost control. More assertive frost control techniques are said to be active. They should be used to supplement the protection offered by passive controls. They include heat, wind, heat plus wind, and irrigation. When selecting an active frost control system, choose one that is reliable and easily implemented. Keep in mind that these systems will be employed under adverse conditions. It will be cold, dark, and late at night when frost protection is needed. In the case of irrigation for frost protection, the price in crop damage, if the system should break down, is high, often worse than if nothing is done. Therefore, always test systems in advance. Anticipate potential problem areas and have spare parts and equipment on hand. These systems are not inexpensive; however, they can be an excellent investment. Proper operation of your frost control system is imperative; consult with knowledgeable individuals for design, installation, and operation.

Heaters may be used to warm the air under the inversion layer. They should be capable of raising the temperature 7°F. The success of this practice depends on the height and strength of the inversion and whether or not there is any wind. Many small heat sources are more effective than a few large heat sources. In fact, a big fire can readily puncture the inversion, resulting in a cooling of the air below the inversion. The number of heaters needed per acre may vary from about 20 to 40. The actual number depends on the energy output per heater and the orchard design. High-density orchards need more heaters than conventional plantings.

Several different types of heating systems have been used, and there are advantages and disadvantages to each.

Burning wood and tires has been used with varying degrees of success. Although they are inexpensive, these materials are very labor intensive. They are hard to light and to keep going, they are messy, and they can spread to dry grass and weeds on the orchard floor if not closely monitored.

Oil-fired heaters range from self-contained units such as return stack, large cone, and short stack heaters to pressurized oil systems where the burners are all connected by plastic fuel delivery lines. The self-contained units offer a low initial cost. They are easily moved and the number of them used per acre can be increased or decreased quickly. Lighting them can require substantial labor and time — a disadvantage when temperatures are falling rapidly.

Pressurized oil systems use fuel (generally #2 diesel fuel) delivered to the burners through plastic lines from a central distribution point. The burners feature automatic electric ignition at each unit. The advantages of this system include efficiency of the burners and the reduction of labor needed to light and operate the burners. Disadvantages include lack of flexibility in the number of burners per acre, more places for problems to occur (lines, filters, pumps, igniters), the need for a check valve on each heater for quick shutdown, and the increased cost of the system.

Gas heaters use propane or natural gas where available. Propane is the most expensive fuel on a heat unit basis, and propane may present additional problems in delivery to the orchard and in handling. An on-farm propane storage tank should be big enough to allow for two consecutive nights of use.

Natural gas is easiest to use. However, it is unlikely that it will be available at many orchards. With it, no storage tanks, pumps, or filters are needed. Heaters generally require a minimum of maintenance.

The objective of heating is to distribute heat to keep all areas of the orchard above the critical temperature. When firing up the system, light the border heaters first, starting with those on the windward or lower parts of the orchard. For individual heater systems, light every other heater. For piped pressure systems, light every other row. Light additional heaters as needed.

The appropriate index to indicate when to light heaters is air temperature. Light heaters when the air temperature is 2° to 4°F above the critical temperature for crop damage. Keep in mind that a low dewpoint means temperatures drop rapidly, so do not wait as long to start the heaters as when the dewpoint is high. Base the time to turn off heaters on a thermometer located outside of the heated area.

Overtree wind machines work by mixing warm air in the inversion with cold air in the orchard. On nights when inversions are weak or above the height of the wind machines, no benefit will be derived from running them.

Heat-generating wind machines are less efficient than wind machines alone. The added heat makes the air more buoyant and causes it to rise above treetops sooner. Wind machines supplemented with heat among trees in the outer perimeter of the machine range will help some when inversions are weak.

If an orchard site consistently shows an inversion with temperatures at least 3°F warmer at the 30 to 50 feet height as compared to the temperature among the trees, wind machines may be worthwhile.

The effective range of wind machines varies from 6 to 10 acres. The coverage area depends on the site, size of the machine, and the proximity of other overtree machines. Two or more machines tend to reinforce the effectiveness of each other.

Helicopters may be effective when inversions are strong. The helicopter should be flown in a slow pattern over the orchard in the inversion. It will mix warm air in the inversion with cold air in the orchard. Depending on the site and the strength of the inversion, a single helicopter may be used to protect upwards of 40 acres. Arrangements to secure the helicopter should be made well in advance. On nights where use is highly likely, the helicopter should be on standby at the orchard site. Fuel for the helicopter should be available so the pilot will not have to leave the orchard site to refuel. Be sure pilots are aware of hazards such as power lines, rock ledges, tall trees, and so on prior to flying at night.

Overtree sprinklers are practical to use for frost protection. However, their use is very exacting. This frost control method has more risk associated with it than other methods, but it also offers some advantages that other frost control methods do not possess; for example, their operating costs, convenience, and cleanliness as compared to other types of active frost protection.

As water cools, it gives up heat. One British Thermal Unit (BTU) of heat will be removed from each pound of water for each degree Fahrenheit of temperature reduction. Heat will be given up at this rate until the temperature of the water reaches 32°F. Water turning to ice (called the “latent heat of fusion”) liberates 144 BTUs per pound. This heat energy is available to prevent plant tissue from dropping below 31.5°F. As long as a film of water is maintained by continuous application, the temperature of the plant tissue will remain at or above 31.5°F even though a layer of ice is being steadily formed.

If water application stops, evaporative cooling often cools both the ice and the plant even lower than the surrounding air. Ice is a very poor insulator. **It is imperative that a continuously maintained film of water is sustained as long as the temperature is low enough to freeze ice or until the ice begins to melt rapidly after dawn.** Over time, the layer of ice can build up to the point that the excess weight can damage trees. Training trees to hold a lot of weight throughout their life and having the trees pruned prior to the time that the irrigation system will be used is important in minimizing the potential for tree damage.

For protection down to 20°F, an application rate of between 0.15 and 0.20 inches of water an hour is needed, depending on the dewpoint and wind speed. Although an application rate of 0.15 inches should provide protection down to 20°F, a 0.20 inch per hour application rate is better on the upwind side of the orchard where evaporative cooling rates are highest. Large volumes of water are required, for example:

- 0.15 inches/hour = 67.3 gallons per minute or 4,038 gallons per hour. This volume is the equivalent of an accumulation of 1-1/2 inches of water in a 10-hour run.
- 0.20 inches/hour = 90 gallons per minute or 5,400 gallons per hour.

The water supply should be adequate to run continuously 10 hours a night for at least three consecutive nights. If pumping from a pond, the size and the recharge capacity of the pond are important. If pumping from a stream, the reliability of the stream and the flow rate are similarly important.

To give good frost protection, the water must be distributed all over the orchard. A system designed for drought control is generally inadequate for frost protection. When the system is started, the pumps and the mains must be large enough to allow the entire system to be run at one time.

Sprinkler heads should rotate at least once every minute to maintain a water film over the plant tissue and ice at all times. Two revolutions per minute provide more control than one. Sprinkler heads should be constructed to prevent ice buildup around the activator spring.

The site often dictates the spacing of sprinkler heads. Wind velocity and direction, tree spacing and arrangement, and the direction of traffic pattern should all be considered. The maximum distance between sprinklers is governed by the diameter of the sprinkler discharge pattern and wind velocity. In general, the maximum spacing between sprinklers should not exceed 50 percent of the wetted diameter.

Overhead irrigation frost control systems should be started before the temperature of a shielded thermometer drops to 33°F in the coldest part of the orchard. Starting at a lower temperature is risky because the temperature in the sprinkled area will drop during the first few minutes of operation due to evaporative cooling and may hasten the drop below the critical temperature. If the dewpoint is low, start the frost control sooner, as temperatures will drop rapidly, making it difficult to get the system running before the critical temperature is reached.

End sprinkling after sunup when the rising temperature reaches 33°F outside the treated area and the ice is beginning to melt. If the wind is blowing, do not shut down until 35°F. It is not necessary to wait until the ice is all gone before shutting the system down.

Bloom delay has been studied for many years. A fall application of ethephon can delay bud break in spring. Research has demonstrated numerous problems with bloom delay. If the rates are too high, fruit buds may be killed. In extreme cases, limbs and even entire trees could be killed. The number of days delay has not been constant from year to year. Ethephon is not labeled for bloom delay.

Using higher rates and multiple applications of dormant oil during winter can slow respiration rates in trees and delay bud break. The number of days delay has been inconsistent. Additional research is being conducted to improve the reliability of the treatments. Dormant oils are not labeled for bloom delay at this time.

Overtree sprinkling during the winter months can delay bud break. Once the chilling requirement of the tree has been met and when air temperatures get above 50°F, evaporative cooling from the sprinkling will slow bud development. Problems with tree health and in working the orchard can occur as a result of the application of large amounts of water.