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Orchard Frost Protection

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Orchardists seek to produce annual crops of high quality fruit. Often spring frosts greatly reduce the size of the crop. Much of the remaining fruit is damaged and not marketable.

There are two general types of spring freezes: advection and radiation. An advection freeze occurs when an arctic cold air mass moves into an area. Usually it is accompanied by winds. Fighting an advection freeze is very difficult. A radiation freeze occurs on cloudless nights when there is little or no wind. Heat from the ground, trees, and buds is lost as radiation to the sky. Air near the ground is cooled and is heavier than the warm air above. As the radiation loss continues the colder air drifts along the ground to the lowest places resulting in "frost pockets". On such nights, inversions are formed. An inversion occurs when warmer air is above cooler air. Within the inversion the temperature increases as height from the ground increases. The top of the inversion occurs where the temperature begins to decrease with height. Knowing the height of the inversion is essential when wind machines are used as frost protection. Radiation frosts are the type we can combat.

The best way to prevent frost damage is proper site selection. Hillsides are the desirable sites. Cold air will drain to lower areas. River bottoms and valley floors are usually undesirable orchard sites. Fencerows or woods below a hillside orchard will block the flow of air which may result in damage. Such obstructions above an orchard may divert the cold air and work to our advantage. Rows of trees themselves, particularly in dense plantings, may obstruct the flow of air. Therefore, planting with the slope may aid in prevention of frost injury.

Sometimes land which is not frosty is not available or we may want to grow fruits which are somewhat frost susceptible. Some type of frost protection may be necessary. Accurate and dependable temperature detection equipment is essential. Frost alarms which allow the grower to sleep with confidence the alarm will ring are available. A battery backup for the alarm is a wise investment. Straight tube alcohol thermometers with the temperature scale etched on the tube are essential. These are often called standard orchard thermometers. They should be placed both within and outside the orchard. They should be mounted in standard thermometer shelters five feet above the ground.

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Heaters are still used in some areas for frost protection. Usually 20 to 40 heaters per acre are used. The heaters may have individual fuel supplies or may be on a pipeline system. Oil, gas, or liquid propane are used as fuels. Lightup may be by flamethrowers or electronic ignition. Heaters are probably the least problematic of the frost protection systems. Researchers in Pennsylvania feel heaters are still feasible even with higher fuel costs, provided proper temperature sensing equipment is used and heaters are adjusted accordingly.

Wind machines are useful on radiant frost nights when temperature inversions occur. They mix warm air from above with cooler air near the ground thus warming the air around the trees. Before a wind machine is purchased, one should know about inversions in his particular orchard. If a site consistently has an inversion of at least 3^{o} F at the 30 to 50 foot zone, a wind machine could be worth trying. Each machine will have a range of 6 to 10 acres. Helicopters have been used for the same purpose. Warm air is mixed with cooler air near the ground by flying at the top of the inversion.

Overtree sprinkler irrigation is used in some areas to reduce frost injury. When water freezes, latent heat is released. With this system, water is continuously sprinkled on the trees. Ice builds up. As long as a film of water is maintained, the temperature of the plant tissue will remain about 31.5^{o} F. If the application of water stops, the ice and plant parts will become colder than the surrounding air. More injury will result than if nothing had been done. The water application is started when the temperature on shielded orchard thermometers reach 33^{o} F and is continued until the ice is melting rapidly the next morning. Application rates are usually .15 to .20 inches per hour. Sprinkler overlap should be at least 40% of the wetted diameter from each sprinkler. This assures thorough coverage. The sprinklers should rotate at least once per minute and should be constructed to prevent ice buildup. Wind is usually the limiting factor in effectiveness. A breeze will dry the ice and the temperature inside will drop rapidly. Ice buildup may be quite a problem. Limb breakage will occur if temperatures require a long run of the system. Sprinkler irrigation for frost protection should be approached with care. The method will work but improper use or a breakdown can do more harm than good.

None of the above systems is foolproof. All require constant checking. All require you to be out in the orchard constantly during operation. Constant temperature monitoring, adjusting equipment, and making repairs are essential for dependable economic operation.

Delaying bloom is another approach to reducing injury from frost. This method is still in the experimental development. Water is sprinkled on the trees any time the temperature is over 45^{o} F following the completion of the rest period. As water evaporates off the buds heat is absorbed from them thus slowing down their development. Delays of up to 17 days have been reported. More research is needed before this system is used commercially, but it does look promising.

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