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BLUEBERRY FREEZE DAMAGE AND PROTECTION MEASURES

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Freeze-Prone Sites

Commercial blueberries are generally planted in low areas with high organic-matter content. These sites satisfy the cultural requirements of blueberries for a constant and uniform moisture supply. However, on cold, still nights when radiation frosts occur, heavy cold air from higher surrounding areas "drains" into the low areas causing lower temperatures. Also, the high organic content, especially if the soil is dry, acts as an insulator to restrict heat in the soil from moving up around the plants. The cultural requirement for a uniform soil moisture makes selecting higher sites that are less subject to radiation frosts much less practical than with other fruit crops. Although there is almost no wind during a radiation frost an occasional gentle breeze will occur. Removal of trees and brush from around the field to improve air circulation will allow these breezes to penetrate the field at bush level. The cold air will be displaced or mixed with the warmer air from higher locations and less temperature drop will occur.

Cold Susceptibility

Blueberry blossoms and small berries are considered hardier than the blossoms of most fruits. Temperatures must drop below 28 °F for economic losses to occur on highbush blueberry (*Vaccinium corymbosum* L.). The temperature at which freeze injury begins to occur depends on the stage of development from dormant flower buds through young fruit. During the winter, dormant flower buds of highbush blueberries will survive temperatures as low as -20 to -30 °F while the less hardy rabbiteye (*V. ashei* Reade) have survived -10 oF but are often damaged below 0 oF. As flowerbud swell progresses, cold tolerance decreases. By the time individual flowers begin to protrude from the bud, temperatures below 20 °F will begin damaging the most exposed flowers. When corollas have reached half of their full length, temperatures below 25 to 26 oF will kill the complete flowers. However, at this stage, blossoms on rabbiteye blueberries may receive corolla damage at temperatures as high as 30 °F. The corolla withers, but usually remains attached. The withered, unopened corolla prevents bee pollination and otherwise undamaged flowers drop rather than developing into fruit. Corolla damage to unopened highbush flowers that prevents pollination is seldom a problem with highbush blueberries. When the blossoms are open, a temperature of 27 °F for more than a few minutes causes damage. Immediately after corolla drop and before the berry begins to swell is the most sensitive stage. A few minutes below 28 oF will result in damage. As the berry begins to enlarge, susceptibility is similar to the critical temperature of 28 °F for open blossoms.

Injury Symptoms

Cold damage is not always obvious. Following temperatures well below the critical level, the complete flower or small fruit will develop a water-soaked appearance, shrivel and drop. However, a very brief time at the critical temperature may damage only the pistil. All or a portion of the damaged pistil will develop a brown appearance and prevent pollination and fruit set. Ovules, which develop into the seeds within the berry, can also be damaged without any exterior symptoms. Healthy ovules are plump and white, but become black with cold injury. If a large number of ovules or young seeds are black, the flower or fruit will probably drop. If only a few are damaged, fruit development usually continues, but the fruit will be later ripening and of smaller size than berries with a larger number of healthy seeds.

Monitoring Temperature

Reliable and accurate thermometers that register current and minimum temperatures are essential if frost control measures will be used and also to help predict the extent of damage if no protection is provided. Most fields should have at least 3 thermometers placed at bush height in high (warm), low (cold) and average locations in the field. Hygrothermographs that constantly measure temperature and relative humidity placed in a weather shelter at bush height are also very helpful if frost protection measures are available. The plot of temperature and humidity as the night progresses on the hygrothermograph chart aids in making the best possible management decisions. It is much easier to determine the rate of temperature drop and predict the minimum temperature before sunrise from the hygrothermograph chart than from watching the thermometers and plotting temperature change. Thermometers in warm, cold and average locations in the field should be checked in addition to the hygrothermograph to determine differences across the farm. Relative humidity is usually 100% on radiation frost nights, however, occasionally lower humidity occurs. With sprinkler irrigation for frost control, the system must be started at a higher temperature when humidity is low to compensate for the evaporative cooling that will occur as the first water strikes the bushes. A sling psychrometer that measures wet bulb and dry bulb temperatures is a less expensive method for determining relative humidity than the hygrothermograph, however, unlike the hygrothermograph, there is no constant measurement or permanent record.

Sources of temperature monitoring equipment are listed in Table 1. Commercially manufactured temperature alarms are available or they can be assembled from a refrigeration thermostat and transformer. The thermostat should be set at a temperature high enough to awaken the irrigation manager in time to check field thermometers before the temperature drops below 35°F. Thermometers shielded from the open sky and placed at the height of the upper $^{1}/_{3}$ of the bush give air temperature readings that can be related to the temperatures described in this leaflet.

Listening to weather reports is not a reliable method of monitoring current temperatures or determining what the low temperature will be in a blueberry field. Many of the official temperatures reported on radio or television are taken at airport locations. The large paved areas that hold heat and the aircraft mixing of air at airports makes them much warmer than surrounding areas on radiation frost nights. However, you may be able to develop a reasonably reliable adjustment factor for how much colder the blueberry field is than the local reporting station. Blueberry fields will often be as much as 10 to 12 °F colder on a radiation frost night than warmer locations such as airports.

Practices for Reducing Freeze Damage

Pruning — Flower buds on short, small-diameter shoots will open and become susceptible to freeze damage sooner than flower buds on larger diameter shoots. Pruning to a balance of early blooming and later blooming shoots will help insure a crop. If no frost or freeze occurs, the early blossoms will develop into the early ripening, high priced fruit. If a frost or freeze occurs, there will still be some later fruit for a partial crop.

Avoid Cultivation — Cultivation in late winter and early spring tends to increase freeze damage. Soil temperature on a radiation-frost night will be much warmer than air temperature. If the soil has been cultivated, the surface layer will contain more air and less water. With less water, the surface layer will hold less heat. Also, the increased soil air will cause the surface layer to be a better insulator which will decrease the amount of heat released from deeper in the soil. Bushes will probably stay 1 to 2 °F warmer on uncultivated soil than on cultivated soil. To avoid spring cultivation, adequate drainage should be established the previous fall, followed by herbicide application in late winter.

Maintain Soil Moisture — Growers who have hose reel, hose pull, or small portable irrigation systems can benefit from maintaining a moist soil during the period when frosts are possible. By increasing the amount of water in the soil, the soil will absorb more heat during the day and conduct more heat to the surface for plant protection. Maintaining a moist surface on peat and muck soils is especially important. When these soils are dry, they hold very little heat and a dry surface acts as an excellent insulator to prevent beneficial heat release. Excess water for extended periods must be avoided to prevent flooding or phytophthora root rot damage.

Sprinkler Irrigation —Permanent or solid set irrigation has been the most dependable frost control method. Depending on the design of the system, damage can be prevented when temperatures drop as low as 20 to 23 °F. The system commonly used in blueberries is a sprinkler spacing of 60 ft. x 60 ft with nozzles that supply about 5 to 6 gpm at 55 to 60 psi. This design requires 12 sprinklers/acre. The system is started when the temperature has dropped into a range of 33 to 38 °F and the grower expects the temperature to reach a minimum below 28 °F before warming begins after sunrise. The temperature to begin sprinkling depends on humidity. If the humidity is near 100% as it usually is on radiation-frost nights in southeastern NC, 33 to 34 °F is satisfactory. However, at 40% relative humidity the system should be started at about 37 °F to avoid evaporative cooling below 30 °F. A psychrometer or hygrometer as previously mentioned is needed to determine relative humidity.

Company and Contact Information	Minimum Thermometers	Hygrothermo-graphs	Temperature Alarms	Psychro-meters
Cole-Parmer 7425 N. Oak Park Ave. Chicago, IL 60648	X	X		
Forestry Supplies, Inc. 205 W. Rankin St. P.O. Box 8397 Jackson, MS 39204 1-800-647-5368	X	X	X	X
Hummert International 4500 Earth City Expressway Earth City, MO 63045 1-800-325-3055	X	X	X	X