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Frost Management

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BEST MANAGEMENT PRACTICES GUIDE FOR MASSACHUSETTS CRANBERRY PRODUCTION

Frost Management

Cranberries, like many other temperate crops, are sensitive to below-freezing temperatures during the active growing season. This sensitivity is an important factor in cranberry management. Cranberry bogs have traditionally been placed in lowland areas such as swamps and marshes, compounding frost concerns since the temperatures on cranberry bogs tend to be lower than those in surrounding lands. In recent years bogs have also been constructed in upland areas on mineral soils. However, all bogs are constructed with the planted area at a lower level than its adjacent surroundings. This arrangement contributes to the development of 'frost pockets' on the bogs. The cold air drains from the adjacent high ground into the low areas on clear, calm nights. In addition, the enormous amount of vegetation present on a cranberry bog is extremely efficient at radiating heat under clear, calm skies, a process known as *radiational cooling*. Due to these factors, it is not unusual for bog temperatures to be 10 degrees colder than those of nearby non-bog areas. There may be as much as a 20 degree difference in some locations.

Sprinkler irrigation systems (and flooding on rare occasions) are used to protect the cranberry plants and fruit from freezing temperatures. Sprinklers are the most common method of cranberry frost protection. As the water applied to the plant cools, heat is released preventing the plant from freezing. If a film of water is maintained by continuous application of water, the temperature of the plant tissue will remain above freezing, even if a layer of ice forms.

The critical temperature or *frost tolerance* varies with plant development and color of the fruit. Protection is required to keep the plants above the critical temperature and avoid injury. Preventing frost injury to the flower buds in the spring and to the fruit in the fall is arguably the single most important cultural practice in cranberry production. Frost injury is the only hazard in cranberry production where major crop loss can occur in as little as one hour and total crop loss in one night.

Recommended Practices

General practices:

- **Conserve water. Manage irrigation for frost protection so that the objective is achieved with the minimum water necessary.**

  Protect the bog only when frost is imminent. The first rule of frost protection is to observe the bog and determine the tolerance. The system is then turned on at from 2-3º above the tolerance. This will ensure that the bog is protected even if the monitoring thermometer is not located in the coldest spot on the bog. However, all efforts should be made to locate monitoring thermometers at the coldest parts of the bog. The thermometers or sensors should be placed at the level of the vine tips, the tissue to be protected.

  Sprinkler lines may freeze at temperatures below 25ºF, so keep lines open by starting the pump and running the system at idle until the critical temperature is reached.

  Once started, run the sprinklers until the ice melts or until the bog temperature is at least 3-4ºF above the tolerance.

- **Optimize irrigation system performance.**

  Sprinklers applying a minimum of 0.1 inch per hour are required to afford adequate frost protection. Use catch-cans to determine if your system is delivering adequate water.

  Sprinklers should rotate at least one revolution per minute if they are to be effective for frost protection.

  System operating pressure should fall within the range of 45 to 60 psi with pressure requirements increasing as system spacing increases. Nozzle pressure at the last sprinkler head should be no less than 40 psi, and pressure losses across the entire system should be limited to <15% of pressure at the first sprinkler off the main water line.

  For information on how to maintain sprinklers, refer to the Irrigation Management BMP.

Specific practices:

- **Determine frost tolerance on your bog.**

  Spring. Flower buds and new leaves are susceptible to frost damage in the spring. Examine the buds to determine tolerance. By the time the foliage is showing signs of re-greening in mid-April, the tolerance of the buds has risen to 18ºF. At this stage, the buds remain tight and red (winter dormant color). As the buds begin to swell, sensitivity increases dependent on cultivar. Cultivars with large buds (and large fruit later) tend to become sensitive earlier in their development compared to small-budded cultivars. For example, 'Ben Lear' and 'Stevens' tolerate temperatures no lower than 30ºF once the terminal bud begins to elongate, while at that same developmental stage, 'Early Black' and 'Howes' will tolerate 27ºF. Frost tolerances of terminal buds during spring development are listed in the Frost Protection Guide (see references).

  Fall. In the fall, it is the berries that must be protected from frost injury. With the exception of summer-flooded bogs, there has been no report of *bud* injury in the fall in Massachusetts. As the fruit ripen and red color develops, frost tolerance increases (i. e. the critical temperature drops). Green fruit will not survive temperatures below 20ºF, while fully red fruit can survive temperatures from 24ºF to as low as 20ºF depending on cultivar. Short exposures to even lower temperatures may not cause injury to fully ripe fruit. Frost tolerances of fruit during fall development are listed in the Frost Protection Guide (see references).

  Development of frost tolerance is *site-specific* and should be monitored on all bogs.

- **An important frost warning service is provided by the Cape Cod Cranberry Growers Association to its members.**

  Dr. Henry Franklin developed formulas using temperature and dewpoint data for predicting frost events on cranberry bogs in Massachusetts. Today, CCCGA uses this information along with weather forecasts to determine a predicted low temperature for Massachusetts cranberry bogs. This information is provided *as a member benefit*.

  The formulas predict the minimum temperature that can be expected on average cranberry bogs under 'ideal' frost conditions - clear skies and no wind. This is a baseline forecast developed for the East Wareham area. ***However, where weather is concerned, there are no sure bets.*** The Frost Warning Service is just that - a warning to watch conditions on each bog for danger of critical temperatures.

- **Monitor conditions that may favor the development of frost on your bog.**

  Dewpoint. High dewpoints are favorable - the danger of frost is less.

  Wind. Cold wind during the day often dies during the night, increasing the danger of frost. The presence of wind can mitigate the effects of radiational cooling by mixing the cool surface air with warmer upper-level air. This can protect the bog from frost but should not be relied upon. If the wind drops, bog temperatures may drop as much 10 degrees in two hours. Winds of less than 10 mph associated with high pressure seldom hold through the night.

Air masses. The most dangerous location for a high pressure cell is directly over the cranberry area or slightly to the south and west. As the high approaches and the winds die, quite cold temperatures may develop.

Clouds. High clouds are of little value in preventing frost conditions. On the other hand, low clouds persisting until after midnight can be protective - temperatures often drop only one degree per hour after they dissipate.

Precipitation. Substantial rain (1-1.5 inches) within a day or so of cold conditions may prevent temperatures from reaching the critical level. However, this is not a sure thing. Drought conditions increase the danger of frost.

Timing. Critical temperature is often not reached until near dawn in the spring. In the fall, the critical temperature may be reached quite early in the evening. Late in the fall, the temperature may fall below the tolerance just after dark.

- **Monitor temperatures on your bog if there is potential for frost.**

  All efforts should be made to locate monitoring thermometers at the coldest parts of the bog - these may vary with season and direction of dying winds. The thermometers or sensors should be placed at the level of the vine tips or fruit, the tissues to be protected.

  Temperature relationships among locations do NOT remain constant. Do not rely on upland or home temperatures to predict the temperature on your bog. Monitor on-bog temperatures.

  Remember that irrigation should be started before the tolerance is reached -- set sensors and alarms accordingly.

  Alarms are available that notify you of critical temperatures using phone land lines or cellular technology. Consult local vendors for options.

- **Take safety precautions.**

  Floodlights on vehicles can aid in scouting for malfunctioning sprinkler heads and provide lighting to avoid accidents.

  Remember that ice will form on ditch edges and bridging planks, exercise caution.

  Work in teams or remain in radio or phone contact with others.

For further information:

DeMoranville, C. J. **Frost protection guide for Massachusetts cranberry production**. UMass Cranberry Experiment Station/UMass Extension Publication. April 1998. 8pp.

DeMoranville, C. J. "Frost management". in Sandler, H. A., ed. **Cranberry Production: A Guide for Massachusetts**. UMass Extension Publication SP-127. December 1997. Second printing February 1998. pp. 31-34.

Irrigation Management BMP in this series.

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