WINTER MANAGEMENT 2018 - 2020

Prepared by Carolyn J. DeMoranville and Peter Jeranyama

Cranberry vines may be injured or killed by severe winter weather. The most common injury is classified as a ‘physiological drought’ when moisture lost from the vines due to wind and evaporation cannot be replaced due to freezing in the root zone. That injury is known as 'winterkill'. The symptoms are leaf discoloration and eventual drop. Such injury can occur within 3 days if the root zone is frozen to a depth of 4 inches, air temperature is below freezing, and strong winds (10 mph or greater) occur. Injury is prevented by a winter flood that should be in place when winterkill conditions exist. It is likely that 2-3 days with temperatures below 20°F will be enough to freeze the soil. New plantings (first year) are less susceptible to winterkill but should still be protected in severe conditions.

If crop elimination by mowing or flooding is planned for the following season, the winter flood may be eliminated.

General winter flood management:

The winter flood may be applied as early as December 1 and should remain on the bog as long as winterkill conditions are present or forecast. The flood may be delayed as long as winterkill conditions are not forecast if the plants are fully dormant. Exposure to moderately cold temperatures will encourage deeper dormancy leading to lower oxygen and carbohydrate demand and greater cold tolerance. However, an early cold snap following a warm fall could lead to actual cold injury in the plants (similar to frost injury). Under such conditions, the winter flood should be in place even before winterkill conditions are reached. Generally, the flood should not need to be held any later than March 15. However, holding the flood for a few days past that date will not harm the bog.

To be effective, the flood should cover the plants entirely (no vine tips sticking out). It is particularly important to maintain a sufficiently deep flood on new plantings to prevent heaving of the plants during freeze/thaw cycles during the winter.

For bogs that cannot maintain a winter flood:

On bogs that cannot maintain a winter flood, additional winter protection may be gained by the application of an antitranspirant. These waxy or resin-based materials reduce the amount of water loss from the leaves by providing an additional physical layer on the leaf surface. Research with Vapor Gard has shown that one application, made prior to the onset of winterkill conditions, may offer some protection against winter injury. Vapor Gard should be applied at the rate of 1 gal/A. Since the material becomes quite thick at low temperatures, application is best when done at temperatures above 45°F (above 50°F is much preferable). It may be combined with hot water to facilitate mixing. It can be applied through the irrigation system, by boom sprayer or tank spray apparatus. Vapor Gard needs at least 1 hour of sunny conditions after application to ensure proper set of the material on the leaf surface. Vapor Gard will persist on the plant for several months, so application should be planned for the fall (November typically has favorable conditions). Other products such as Wilt-Pruf or Moisturin are available, but we do not have much experience with these.

Oxygen deficiency injury:

Historic research by Bergman indicated that a lack of dissolved oxygen in the winter flood water was the cause of injury to cranberry plants, resulting in leaf drop and reduced yield potential. Plants, like animals, use oxygen in respiration so lack of oxygen could lead to plant injury. Bergman stated that oxygen deficiency injury may occur when oxygen levels in the winter flood water drop below 4 mg/l (full oxygenation = 10^{+} mg/l). Bergman further stated that lack of light penetration led to poor photosynthesis, and it was the lack of photosynthesis that led to poor oxygenation in the water. The recommended remedy was to remove water from under the iced-over flood if light penetration was poor.

Removal of water from beneath the ice is standard practice in WI and in cold conditions in MA. In WI, the removal of remaining water is done as soon as a thick ice layer forms on the surface. Air then penetrates along edges and through cracks in the ice so that the vines are exposed to atmospheric oxygen. If the flood remains unfrozen as is often the case in MA and NJ, oxygen readily mixes into the water from the surrounding air with the possible exception of very deep (3^+ feet) areas in out-of-grade bogs. If plants are encased in ice for a prolonged period, they may be smothered by metabolic byproducts [e.g., CO_2, ethanol (C2 H5 OH), and methanol (CH3 OH)] or injured when exposed to cold air due to the relatively low insulation value of ice (Durling et al., 1995). In contrast, snow can be highly beneficial to overwintering crops such as cranberry, providing effective insulation from extreme cold conditions and fluctuating temperatures (Leep, et al., 2001). The insulating properties of snow are generally the result of trapped air (low thermal matrix and the high reflectance of incident radiation on a snow-covered surface; these two factors in turn depend on the depth of the snow, its age, and its density (McComb, et al. 1992).

Research in both MA and WI has caused us to re-examine Bergman's theories and recommendations. Research by Justine Vanden Heuvel and Teryl Roper showed that cranberries require very little light for photosynthesis and the light that penetrates snow or sand may be sufficient for this purpose. Further, in a bog with a full layer of water beneath ice, even with 9 inches of snow on the ice, oxygen in the water beneath remained at 8 mg/l or greater. In WI, covering ice with black cloth, sand, or snow did not lead to leaf drop or crop reduction in the plants below the treatments. In MA, plants held flooded in darkness and low oxygen did not show reduced carbohydrate (the product of photosynthesis) or leaf drop.

So what is the cause of the leaf drop that is observed after the winter at certain bogs? Definitely, loss of leaves is a sign of some sort of stress on the plants. It is unlikely that lack of light is the cause. Lack of oxygen remains a possibility if the levels actually become severely depleted. A likely scenario for this would be pulling the water from beneath the ice and leaving a shallow layer of water in low spots. The smaller volume of water could become oxygen depleted where a large volume had not.

As wetland plants, cranberries can survive periods of poor oxygenation during flooded conditions. In particular, the plants can tolerate low oxygen levels in saturated soil. However, survival under these conditions requires using up carbohydrate (food) reserves. Plants with poor carbohydrate reserves due to large crops, poor sunshine the previous fall, or other stresses may have less ability to tolerate low oxygen stress and may show injury the next spring. In those cases, failure to prevent oxygen deficiency can result in leaf drop, inability of blossoms to set fruit, and crop reduction.

Certainly, any risk associated with using a winter flood is far outweighed by the benefit of protection from winterkill injury.

To assure that leaf drop potential is minimized:

- Remove the water from beneath a frozen flood as soon as is practical – this also minimizes mobilization of soil phosphorus into the flood water due to soil anoxia.
- If water is being held beneath ice, monitor oxygen levels in the underlying flood. Do not allow water with <3 mg/l oxygen to remain beneath the ice. Consider pulling water at a reading of 5 (mg/l) on a standard color kit.
- Try to avoid shallow layers of water beneath ice, they may lose oxygen more readily than deeper layers of water.
- If you pull the water from beneath the ice -- make sure that you leave no puddles behind. Vines trapped in these puddles under the ice are particularly susceptible to leaf drop in the spring.
- Manage plantings during the season so that stress is minimized -- in particular, irrigate properly.

Management after a mid-winter thaw:

Once the water has been removed from beneath the ice, the remaining ice may melt during a mid-winter thaw, leaving the vines exposed. Bogs may be left exposed as long as winterkill conditions are not present (see above). However, long exposures to abnormally warm temperatures (>55°F) may lead to loss of chilling. The result could be a reduction in hardiness and greater susceptibility to spring frost. Depending on the conditions prior to the winter flood, loss of chilling during a mid-winter thaw could also lead to reduction in bud break and flowering the following season. This is especially true if the previous fall was warmer than usual, leading to lack of chilling accumulation. To guard against these possibilities, reflood the bog if a long warm spell is forecast during mid-winter. The water will cool at night and re-warm slowly during the day, buffering against the warm daytime temperatures. Environmental factors may have a profound effect on the susceptibility of buds to winter injury. Cranberry buds can be injured due to repeated freezing and thawing.

Management after the winter flood:

Once the flood has been removed, the cranberry buds will break dormancy in response to exposure to warm temperatures. The earlier the flood is removed, the sooner the plants will experience enough heat units to break dormancy. To avoid the need for frost protection during the first half of April, hold the winter flood until March 10-15. In the early spring, cranberry buds will survive exposure to at least 18ºF. As the buds lose their dormant color and begin to expand, they must be protected from frost damage. The tolerance varies by variety and growth stage. Refer to the "Frost protection guide for Massachusetts cranberry production", the Frost Management BMP, and Frost Tolerance Reports on the Station’s website for further information: http://ag.umass.edu/cranberry [look under Quick Links].

References

Durling, J.C., O.B. Hesterman, and C.A. Rotz. 1995. Predicting first-cut alfalfa yields from preceeding winter weather. J. Prod. Agric.8:254–259.

Leep, R H., J.A. Andresen, and P. Jeranyama. 2001. Fall dormancy and snow depth effects on winterkill of alfalfa. Agronomy J. 93:1142-1148.

McComb, T.J.L., A.B. Rimmer, M.L.B. Rogers, K.E. Turver, and A.F. Vickers. 1992. A mathematical model for the prediction of temperature in a dry snow layer. Cold Reg. Sci. Technol. 20:247–259.