

# 6. Frost Prevention in Wild Blueberry Fields

## INTRODUCTION

Frost is a common problem in developed blueberry fields. In fact, freezing temperatures are known as one of the primary causes of disappointing yields in blueberry production. Frost damage reduces yield by interfering with the growth and development of plant tissues essential to fruit production.

## SENSITIVITY TO FROST

When the temperature falls below -2.2°C, the tissues of blueberry plants become susceptible to frost. Internal tissues can be damaged to various degrees depending on the time of year and which stage of development the plant is in. The most sensitive tissues are the flowers and floral buds. Buds must survive the winter in order to open the following spring and (after being pollinated) produce fruit. Whether in spring or over the winter, damage to flowers and floral buds increases in severity with the duration of exposure to freezing temperatures. The damage varies depending on where the flowers are in their development. According to a study done in Nova Scotia by Agriculture and Agri-Food Canada, flowers that are open or about to open suffer severe damage when the temperature is below -3.5°C for more than two hours (Hicklenton et al., 2002). A study in Maine found that although floral buds can tolerate temperatures below  5°C, flowers that are fully open are vulnerable to temperatures below -2.2°C (Yarborough, 2002). Leaf buds, stems and fruits are also frost-sensitive but to lesser degrees.

For a visual presentation of the different stages of development of floral buds and their tolerance to different temperatures, see: *http://umaine.edu/blueberries/factsheets/production/flower-primordia-development-stage/* (Yarborough, 2002).

## PRINCIPAL TYPES OF FROST AND THE DAMAGE THEY CAUSE

There are two main types of frost in blueberry fields: radiative frost, caused by the cooling of air at ground level, and winter frost, associated with a thin snow cover or the formation of a layer of ice. Radiative frost is the cause of damage by late frosts in spring, or early frosts in fall. Tables 1 and 2 below list the various kinds of damage caused by each type of frost.

Radiative frost occurs at night and can happen at any time during the growing season. It is characterized by the absence of wind and cloud cover. In these conditions, heat escapes into the upper atmosphere without being radiated back to the ground, where the air becomes increasingly cold. Being heavier, cold air flows with gravity down the primary slope toward the lowest point in the landscape. The specific physical characteristics of each blueberry field, from microtopographic features to woodlots and windbreaks, all have an effect upon the flow of cold air. If these elements obstruct the airflow and cold air accumulates in hollows, forming frost pockets, a late or early frost can occur with consequent damage to buds, flowers and fruits.

In the case of winter frost, the blueberry plant is damaged when temperatures fall below the frost resistance threshold. Rhizomes and stems that are in winter dormancy suffer frost damage at around -25°C. At such temperatures, sufficient snow is needed to blanket the plants completely. The protective effect of snow cover is due to the insulation it provides from the frigid air, the ground beneath being warmer. Snow cover is needed as soon as winter begins, since risky temperatures can occur as early as December.

Table 1. Description of radiative frost

| | Late frost in spring | Early frost in autumn |
|---|---|---|
| Period | During flowering and the first stages of blueberry development | At harvest time |
| Cause of damage | Sensitivity of leaf buds, floral buds and flowers to freezing temperatures if duration of exposure is significant | Sensitivity of fruits and buds to August and September frosts |
| Description of damage | Leaf buds blackened, growth characterized by a rosette of leaves surrounded by a few developed leaves (Figure 1)<br>Floral buds that abort (completely or partly, depending on severity of frost), closed flowers that never develop and open flowers that turn brown (damaged ovary) | Protective covering on the blueberries (bloom) disappears, impairing the conservation of harvested fruit<br>Softening and dehydration of blueberries<br>Leaf and floral buds affected during the aouting period |

Table 2. Description of winter frost

| | Frost due to inadequate snow cover | Formation of an ice layer |
|---|---|---|
| Period | December to March<br>Temperatures around -25°C | Thaw or rain in winter |
| Cause of damage | Thin snow accumulation, wind-erosion of snow in winter: lack of windbreaks, flat terrain or knoll subject to erosion, low shrubby vegetation (less than 30 cm in height) | Root asphyxiation caused by water accumulation in hollows and the formation of a layer of ice covering the ground<br>Protective effect of snow diminished (reduced depth) |
| Description of damage | Desiccation of stem tips: browning visible the following spring (Figure 2)<br>Destruction of floral buds<br>Tall stems the most frequently damaged<br>Destruction of rhizomes on knolls | Damage to rhizomes, potentially leading to plant mortality |

Figure 1. Frost-blackened leaf buds
Source: MAPAQ

Figure 2. Blueberry stems desiccated by winter frost
Source: MAPAQ

## FROST PREVENTION MEASURES

In some blueberry fields, natural protection from frost is provided by topographical features such as dunes and ravines, windbreaks and bordering forests. Such elements must however permit drainage of the cold air responsible for radiative frost. For example, windbreaks must be located and designed so that they do not trap cold air on the field. Presented below are recognized frost prevention measures that are currently in application in blueberry fields.

### Creation of air outlets

This measure against radiative frost consists of providing outlets at key locations based on the direction of cold air flow. For example, in a woodlot located below a blueberry field, a passage at least 15 m wide should be opened by either clearing trees or removing their lowest branches, thus allowing cold air to continue flowing downslope. Along this passage, any small knolls, earth dikes or other elements that could impede air flow should also be eliminated.

### Creation of windbreaks

Windbreaks of trees are very effective at improving the accumulation, retention and distribution of snow in uniform layers, thereby indirectly reducing the risk of winter frost. Since any obstacle to winter winds encourages snow accumulation, windbreaks are most effective when planted perpendicular to prevailing winds. However, to avoid trapping cold air and heightening the risk of radiative frost, windbreaks in hollows should be thinned by partial cutting. In some cases the windbreak should be angled to deflect cold air away from the field toward a safer area downslope. With a windbreak that is perpendicular to the slope, to prevent it from trapping cold air the lower branches should be removed to a height of at least 90 cm.

### Snow fences

Snow fences can be used as temporary windbreaks while waiting for a newly planted windbreak to grow high enough to be effective. As with tree windbreaks, porosity, spacing, orientation and height should all be considered in the placement of snow fences.

### Strip mowing

Strip mowing (Figure 3) is another technique for protecting against winter frost. This type of mowing, done in the fall, consists of leaving unmowed strips that will be mowed the following spring. The unmowed strips will contribute to snow-retention over the winter. To facilitate work in the spring, fall mowing should be done so that unmowed strips are left at regular intervals and are slightly narrower than the width of the mower. Strips should be perpendicular to prevailing winds or parallel to windbreaks

Figure 3. Strip mowing
Source: Stéphane Gauthier, MRC Maria Chapdelaine

### Sprinkler irrigation

Sprinkler irrigation is an active measure to protect against radiative frost. It can protect both the flowers (late frost) and the fruits (early frost) and can be applied over large areas. Since heat is released when water turns to ice, the temperature of the ice cannot fall below 0°C as long as a film of water surrounds the ice-coated blueberry plants. This technique can raise the temperature by 6 to 7°C, making it an effective way to prevent frost damage in a blueberry field. Note that sprinkling must continue until all danger of freezing is past and all ice on the plants has completely melted, since otherwise the plants could be injured or even freeze completely.

### Checkerboard distribution

If growing parcels and producing parcels are distributed in a checkerboard pattern, harvesting can be done in every part of the blueberry field, reducing the risk of damage should frost occur. This is a simple matter of spatially alternating parcels of the blueberry field that are either in the growing phase or in the first or second crop year.

In the 1980s the Groupe de recherche sur les bleuetières de la Sagamie at Université du Québec in Chicoutimi studied weather hazards and frost risks in the region's blueberry fields. Some twenty redevelopment plans were prepared by the group for fields in Saguenay–Lac-Saint-Jean, most of them still being applicable today to help blueberry farmers protect their fields from frost. For more information, see the website at:
*http://decouverte.uquebec.ca/primo_library/libweb/action/search.do?scp.scps=scope%3A(%22UQAC%22)%2Cscope%3A(UACANA)%2Cscope%3A(RESINTUQ)&srt=rank&tab=default_tab&mode=Basic&dum=true&fn=search&frbg=&ct=search&vid=UQAC&indx=1&vl(freeText0)=gel%20en%20bleuetiÃ¨re&vl(69065447UI1)=all_items&vl(11972214UI0)=any*

## COMPLEMENTARY LEAFLETS

*8. Windbreaks and Shelterbelts*

*11. Irrigation*

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**PRODUCED BY**

Agrinova — Recherche et innovation en agriculture

Club Conseil Bleuet

Agriculture, Pêcheries et Alimentation Québec

CRAAQ — Centre de référence en agriculture et agroalimentaire du Québec

**FUNDED BY**

SPBQ — Syndicat des Producteurs de Bleuets du Québec

Association des producteurs de bleuets de la Côte-Nord

CDAQ — Conseil pour le développement de l'agriculture du Québec; Financé par : Agriculture et Agroalimentaire Canada / Agriculture and Agri-Food Canada; Canada

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