Time to Start Thinking About Freeze Protection

Blueberries bloom in late winter or early spring in Florida, making the flowers and young fruit susceptible to freeze and frost injury. Killing freezes can occur as late as mid to late March throughout much of Florida, long after the initiation of bloom, especially for early-ripening southern highbush blueberry cultivars. If some method of freeze protection is not employed, freezes during flowering and early fruit development can be one of the greatest threats to southern highbush blueberry production in Florida.

In the deciduous production system, blueberry plants enter a dormant period during late fall and winter, during which there is no growth and greatly reduced metabolic activity of the plant's above ground structures. The development of dormancy and cold hardiness occurs gradually in response to shorter days and lower temperatures during the fall. Fully dormant blueberry plants are quite cold hardy and seldom suffer serious damage from cold weather in Florida. Once fully dormant, a blueberry plant must be exposed to a period of cool temperatures before it will break dormancy and grow normally the following spring. This is a result of its chilling requirement. Each cultivar has its own characteristic chilling requirement. Once chilling is satisfied, warm temperatures cause vegetative and floral buds to initiate growth. In Florida, most blueberry cultivars initiate flower bud growth before vegetative bud growth. As flower buds pass through the developmental stages from dormant buds to fully open flowers, they become more susceptible to cold temperatures.

Blueberry plants grown in the evergreen production system never go dormant, and retain their leaves throughout the fall and winter to support an early blooming and maturing crop.

Freezes and Freeze Protection

Several factors affect the severity of damage to blueberry plants, flowers, and fruit in particular freezes. Some of these factors are fairly well understood; others have received little study. Florida growers will need to decide whether and when to freeze protect depending on several factors, including (1) plant tissue and stage of hardiness; (2) forecasted temperatures, dewpoint, and wind speed; and (3) physical conditions in the field.

Plant Tissue and Stage of Hardiness

Completely dormant branches and flower buds in the deciduous system are very cold hardy in midwinter. However, any December or January warmth promotes growth and expansion of the flower buds, and some loss of hardiness accompanies each subsequent stage of flower bud development. Bloom in the evergreen system in central and south Florida can occur as early as December, and floral tissues are increasingly susceptible to freeze damage as buds open and bloom progresses (Figures 1 – 2). Among southern highbush cultivars, there appears to be wide variation in flower bud cold tolerance.

Lethal temperatures for southern highbush flowers at various developmental stages have not yet been determined. New vegetative flushes, as well as older foliage (especially in the evergreen production system), can also be damaged by the same temperatures that kill open flowers and fruit if there is no freeze protection (Figure 3). In addition, young blueberry plants are sometimes damaged in field nurseries during late fall and winter if they have not been properly hardened.

Figure 1. Freeze damage to blueberry flowers.
Credits: J. Williamson, UF/IFAS

Figure 2. Freeze damage to blueberry floral bud

Credits: E. Conlan, UF/IFAS

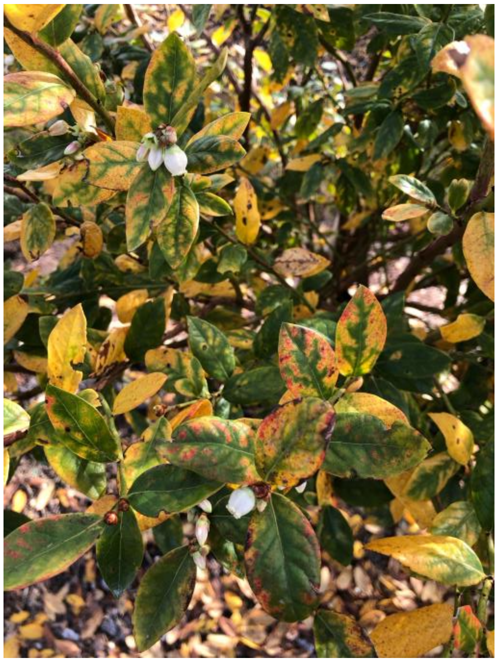

Figure 3. Freeze damage to blueberry foliage
Credits: D. Phillips, UF/IFAS

Temperature, Dew Point, and Wind Speed

Blueberry flowers and fruit should not freeze if temperatures in a weather bureau shelter located alongside the plants at the same height as the flowers stay at 32°F or above. See additional information on temperatures below under Freeze Protection Methods.

Dew point is the temperature at which water vapor in the air condenses, and is a good indication of the water vapor content of the air. The dew point is important because water vapor slows the rate of temperature drop during a freeze. A low dew point is always worse than a high dew point.

Wind can be bad or good during a freeze event. If overhead irrigation is being applied, wind can be a serious problem because it increases evaporative cooling, removing heat from the field, and interferes with the even distribution of the water. If water is not being applied, the wind is typically beneficial, as it can help prevent formation of a cold pool of air near the ground beneath a temperature inversion and prevents the flowers and berries from becoming colder than the air that surrounds them.

Physical Conditions in the Field

Elevation and air drainage patterns greatly affect field temperatures on calm nights with a low dew point, since cold air tends to drain to lower lying areas in the field. Pine bark mulch beds can result in lower air temperatures at flower level by as much as 5°F on calm nights with low dew points because they interfere with the transfer of heat from the soil to the air. Pine bark beds on hillsides with excellent air drainage would probably be less problematic because cold air in the planting would drain to lower ground. If the dew point is high, the pine bark has less of a cooling effect.

Dry soil lowers the temperature as compared to wet soil, since it provides little moisture to replenish the water vapor that is lost from the air by frost formation, and it conducts heat poorly from the warm depths of the soil to the cold surface. However, the effect of thoroughly wetting pine bark the afternoon before a freeze has not been studied.

Freeze Protection Methods

Overhead irrigation systems are the most widely used and practical method of reducing blueberry fruit losses to freezes in Florida (Figures 4 and 5). Large volumes of water must be pumped to get good protection. The number of gallons per minute needed to protect one acre depends on the temperature, wind speed, relative humidity, and design of the system. Table 1, adapted from Gerber and Martsolf (1965), attempts to describe the relationships between minimum temperature/wind speed combinations and water application rates needed for protection during a freeze. However, this table does not consider the water vapor content of the air. With unusually dry air, higher water application rates are needed than those indicated in the table. Before installing an irrigation system, seek advice from an irrigation specialist.

Figures 4a and b. Blueberry flower buds protected by overhead irrigation during a severe freeze. Clear ice, as seen here, is usually an indication of adequate freeze protection.
Credits: J. Williamson, UF/IFAS

The best use of an irrigation system for freeze protection requires experience and close attention to the weather. With a clear sky and no wind, a thermometer placed open to the sky will read about 2°F colder than the same thermometer at the same height in a weather shelter. By placing several thermometers throughout a blueberry field, one can learn a lot about the temperature distribution patterns in that field during radiation freezes.

If or when to turn on the irrigation system during a cold night can sometimes be a difficult decision to make. The answer depends on such factors as the capabilities of the irrigation system, state of development of the crop, relative humidity, temperature, and wind speed. Some of these factors cannot be predicted with certainty. The following guidelines should be helpful in most but not necessarily all situations. First, the system should not be used on nights where the temperature-wind combination produces conditions more extreme than the system was designed to handle. Refer to a reliable forecast and Table 1 to determine whether or not the system should be used.

Calm Nights

If there is no wind predicted and a decision is made to run the system, it is usually turned on when a thermometer hung under the open sky from a bare branch in the coldest part of the field reaches 32°F. However, if the dew point temperature is below 25°F, the system should be turned on at 34°F, which will probably be only about half an hour before the temperature reaches 32°F. During the morning following the freeze, if there is no wind and the sun is shining brightly, the irrigation can be turned off when icicles are falling rapidly from the plants and have been falling for more than half an hour. Never turn off the irrigation before icicles are falling no matter what the temperature. If the dew point temperature is below 20°F, continue running irrigation until the shaded air temperature rises to 40°F. If it is windy and the dew point is 26°F or lower, do not turn off the irrigation until most of the icicles have fallen.

Windy Nights

For windy freezes, the decisions about whether or not to run irrigation become complicated. Table 1 provides guidelines for determining the amount of water required to protect fruit at various temperature/wind speed combinations. However, the values in Table 1 assume normal relative humidity. If relative humidity is very low, as sometimes happens when a cold dry air mass moves into Florida, the values in Table 1 may underestimate the amount of water needed for adequate freeze protection.

The Florida Automated Weather Network (FAWN) (https:// fawn.ifas.ufl.edu/) maintains a series of weather stations throughout Florida and provides a useful resource for blueberry growers. FAWN offers long-range climate forecasts and historical and current weather conditions, including temperature, dew point, and wind speed, along with various tools, including a chill accumulation program. Growers can also find freeze and chilling tools at http://agroclimate.org, including freeze probabilities, and a chill hours calculator.

Preparations Before a Freeze Event

1. If using well water for overhead irrigation, inspect and clean the wellhead and make any necessary repairs.
2. Inspect and clean the well pump systems, including the pump motor, and make any necessary repairs.
3. If using surface water for overhead irrigation, inspect and clean the water inlet line from the surface water source and make any necessary repairs.
4. Inspect irrigation system for broken sprinkler heads and pipes, clean filters, and make any necessary repairs.
5. After inspecting, cleaning, and making any repairs, operate the overhead irrigation system to make sure it is working properly. Then drain the system and close or seal the drain plugs.
6. Make sure irrigation system fuel tanks are full.
7. Inspect weather station equipment to ensure it is working properly, and make any necessary repairs or replacement of equipment.

For additional details on system preparation, see University of Georgia Extension Circular 1128, Preparing Your Blueberry Freeze Protection System.

For additional information on Florida blueberry freeze protection, see Protecting Blueberries from Freezes in Florida (https://edis.ifas.ufl.edu/publication/HS216).

Table 1. Suggested overhead irrigation application rates for cold protection of blueberries under different wind and temperature conditions[1].

Minimum temperature expected	Wind speed (miles per hour)			
	0–1	2–4	5–8	10–12
	Application rate (inches per hour)			
27°F	0.10	0.10	0.2[2]	0.2[2]
26°F	0.10	0.10	0.2[2]	0.2
24°F	0.10	0.16	0.3	0.4
22°F	0.12	0.24	0.5	0.6
20°F	0.16	0.3	0.6	0.8
18°F	0.20	0.4	0.7	1.0
15°F	0.26	0.5	0.9	---

[1] Dry air accompanied by wind requires higher application rates than indicated for a given temperature/wind speed combination. From Gerber and Martsolf (1965).

[2] Higher application rates than originally suggested by Gerber and Martsolf (1965) due to possible evaporative cooling during windy conditions.