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Using Sprinklers to Protect Blueberries from Spring Freezes

Mark Longstroth, MSUE Extension Educator

Table 1. Blueberry Critical Temperatures

Bud Stage	Tight Cluster	Early Pink Bud	Late Pink Bud - Pre bloom	Bloom	Green Fruit
Damage					
Slight	23° F	25° F	28° F	29° F	31° F
Severe	20° F	23° F	24° F	27° F	28° F

Many blueberry growers use sprinkler systems to protect blueberry flowers from spring freezes. Sprinklers are very effective under certain circumstances but can increase injury if used at the wrong time. Sprinklers used for irrigation do not protect below 23-24°F. If the system fails due to cold or wind the blueberries can get colder than in areas with no sprinkling. When you use sprinklers to prevent freezing injury, you are using the energy that water releases when it freezes, changing from a liquid to a solid, to keep the temperature in the ice at the freezing point 32°F. As long as you keep the ice WET, the ice temperature will stay at 32°F. If the ice dries out and water evaporates from the ice, it will chill the plant down colder than the air temperature as the ice evaporates.

Protection with sprinklers

The freeze protection from sprinkler systems is limited by the irrigation rate. Most sprinkler systems in Michigan blueberries are designed to provide from 0.10 to 0.15 inches of water per hour. This volume protects plants to about 22° F with no wind or 24° to 25° F with a light wind. More water is needed to protect at lower temperatures and higher wind speeds, see Table 2. Most irrigation systems cannot easily be changed to deliver more water and protect to lower temperatures. Increasing the operating pressure is not advisable because you need to increase the pressure 4 times to double the output. Higher pressures can break lines and reduces the uniformity of application. Larger nozzles can be installed, but the capacity of the system, mainlines, well and pump will limit the added volume. For example, 9/64-inch nozzles that deliver 0.12 inches water per hour require 60 gallons per minute per acre of

Table 2. Irrigation rate (inches/hour) needed to protect fruit buds under different wind and temperature conditions. (U of Florida Ext. Circ. 287)

Temp (°F)	Wind speed (mph)			
	0-1	2-4	5-8	10-12
27	.10	.10	.10	0.1
26	.10	.10	.14	0.2
24	.10	.16	.30	0.4
22	.12	.24	.50	0.6
20	.16	.30	.60	0.8
18	.20	.40	.70	1.0
15	.26	.50	.90	

blueberries. Switching to 5/32-inch nozzles would deliver 0.15 inches per hour but require 68 gallons per minute per acre. Irrigation systems are not designed to apply enough volume to protect from temperatures in the low 20s.

Critical temperatures

Growers should only use sprinklers to protect blueberry from freezing, around bloom time. The temperature range for sprinkler protection is relatively narrow from 24 to 32 F. This temperature range is also the range that damages open blueberry flowers. When blueberries begin to grow in the spring the buds can handle very cold temperatures. Swollen buds can easily tolerate temperatures down to 20° F. At bud burst or tight cluster temperatures in the 20° to 23° F range can cause damage. The lower end of the range is temperature at which almost all the flowers are killed and the upper end is where damage begins to occur. At "early pink bud" (individual flowers are visible in bud), injury occurs between 23° and 25° F. These temperatures are still colder than you can protect with an irrigation system. In “late pink bud”, when the flowers have separated in the cluster but the flower petals are still closed, the range is 24-27° F. This is in the range where we can protect. But if there is wind or the temperature gets a colder than predicted we could cause more damage than if we had not turned on the system. Once we turn on the system we need to keep it on until the temperatures are above freezing or you will cause a lot of damage as the temperature of the ice goes down colder than outside the irrigated area. Because of this narrow margin of error, I recommend that growers only try to protect at bloom when the temperature range that causes damage is well inside the range of protection with an irrigation system. Fully open flowers are killed between 27° and 28° F. Right after bloom when the petals fall, fruit is the most sensitive, 31° F will damage green fruit. If the temperature gets colder or if it is windy, we have a safety margin and our system can still protect the blueberries. When we operate the system at the edge of its effectiveness it is more likely to fail. Dr. Mike Mainland of North Carolina State says that he would not turn on his frost protect system in blueberries unless there were open flowers in the field.

When to turn on the System

Once you have looked at the field and see open flowers and checked the weather and see that the temperature is supposed to get down to 26° F. You need to decide if you are going to turn on the system that night. I would not turn on the system if the temperature were forecast to fall below 24 F. If windy conditions (more than 10 MPH) were forecast I would not turn on the system at all. When you turn the system on and start to irrigate the air temperature will fall in the field. This is because the water is evaporating and cooling the air. The dryer the air, the greater the temperature falls. How dry the air is will dictate when you turn the system on. This can be calculated from the dew point, which is measured with a wet bulb thermometer or a sling psychrometer.

Table 3. Starting temperature for overhead sprinkler freeze protection based on the dew point of the air.

Dew point	Start irrigation at
26° F	34° F
25 to 24	35° F
23 to 22	36° F
21 to 20	37° F
19 to 17	38° F
16 to 15	39° F

Once you start the system it is necessary to keep it running until the ice starts to melt on its own. If your system fail, as the ice dries and begins to evaporate it changes from a blueberry heating system to an effective refrigeration system that can significantly reduce your crop. As long as water drips from the ice the system is working. If the ice is clear, and the water is freezing uniformly and the system is working properly.

When can I stop irrigating?

Stop irrigating when the ice is melting and temperature is rising. Ice breaking free from branches indicates water is forming under the ice and it is likely safe to quit. Normally this is when temperatures are above freezing and rising. Beware of sudden dips in the temperature soon after sunrise.