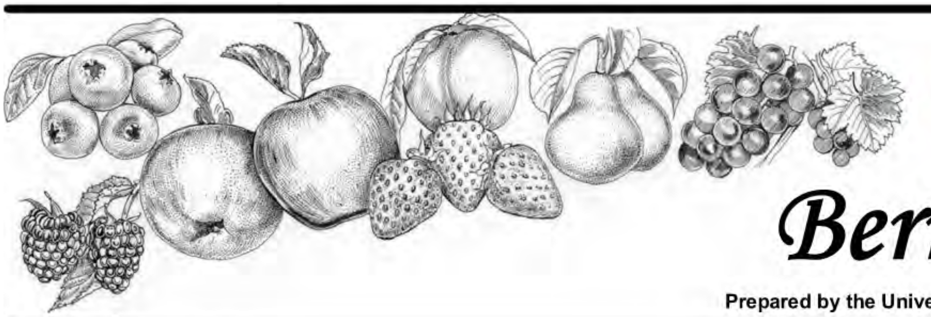

UMass Amherst EXTENSION

Berry Notes

Prepared by the University of Massachusetts Fruit Team

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www.umass.edu/fruitadvisor/berrynotes/index.html

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IN THIS ISSUE:

Current Conditions:

Crop development is advanced by 2-3 weeks ahead of average years and poses significant risk for frost/freeze damage, especially during bloom periods. Pay close attention to weather forecasts for cold nighttime temperatures and take protective measures as needed. See articles in this and last months Berry Notes for more information. **Strawberries** are in early to mid bloom in many areas. Row-covered fields are in full bloom. Once bloom begins, row-covers must be removed in order for pollination to occur. All fields should have irrigation in place for frost protection during bloom. See more in this issue on frost protection. Bloom is the most important period for controlling gray mold. Fields should be scouted for clipper and tarnished plant bug at this time. See Ontario's Crop IPM website for some great info on IPM scouting. New fields are being planted. **Raspberries** are fully leafed out and flower buds are visible. Winter injury appears light in most areas. Fall raspberry new cane growth is about 6". Watch for raspberry fruitworm feeding on new leaves. **Blueberries** are in full bloom. Frost/freeze damage may have occurred in some areas. Sublethal damage may predispose tissue to fungal infections, especially mummyberry. In this case pay particular attention to your fungicide programs and make sure to use correct rates and get excellent coverage. **Mummyberry** is active at this time. See information on this in past issues. Botrytis gray mold can also infect blossoms at this time. Be ready for pollination with adequate numbers of beehives or by providing habitat and nesting areas for native pollinators. The first fertilizer application should be made now and the second in about a month. **Grape** shoot growth ranges from 1" – 10" depending on variety and location. Frost/freeze damage may have occurred in some locations. This will reduce yield but vines may compensate by pushing secondary shoots to replace lost primaries. Some varieties have expanding flower clusters. Fungicide applications now for controlling early infections of Phomopsis are critical. Scout fields for Flea beetles damage. Fertilizer may be applied now as well as pre-emergent herbicides. **Currants and Gooseberries** are past bloom and showing excellent fruit set.

ENVIRONMENTAL DATA

The following growing-degree-day (GDD) and precipitation data was collected for a one-week period, April 29, 2010 through May 5, 2010. Soil temperature and phenological indicators were observed on or about May 5, 2010. Accumulated GDDs represent the heating units above a 50° F baseline temperature collected via our instruments from the beginning of the current calendar year. This information is intended for use as a guide for monitoring the developmental stages of pests in your location and planning management strategies accordingly.

Region/Location	2010 GROWING DEGREE DAYS		Soil Temp (°F at 4" depth)	Precipitation (1-Week Gain)
	1-Week Gain	*Total accumulation*		
Cape Cod	65	206	62˚F	*trace*
Southeast	80	219	62˚F	0.15"
East	94	232	58˚F	0.11"
Metro West	78	182	59˚F	0.21"
Central	80	187	58˚F	0.13"
Pioneer Valley	80	232	60˚F	0.03"
Berkshires	71	184	61˚F	0.56"
AVERAGE	78	206	60˚F	0.17"

(***Source***: *UMass Extension 2010 Landscape Message #10, May 7, 2009*) *-- = information not available*

STRAWBERRY

Irrigation For Frost Protection Of Strawberries

Pam Fisher and Rebecca Shortt – Ontario Ministry of Agriculture Food and Rural Affairs

Summary

- Frost injury can cause significant damage to strawberry plants, especially open bloom, but also to unopened buds if it is cold enough.
- Strawberry fields are often colder at ground level than the weather forecast suggests.
- Irrigation for frost protection works because heat is released as water freezes.
- Irrigation rates must be adjusted to account for evaporative cooling due to winds and relative humidity. More water is required on windy nights.
- Failure to apply enough water can result in greater damage than no irrigation at all.
- When to start up the irrigation is critical. Two tools can determine the optimum time for starting frost protection: dew point, and wet bulb temperatures. Use the dew point and table 5 to determine the temperature at which to start irrigation. Alternatively measure the wet bulb temperature; irrigation should start before the wet bulb temperature reaches the critical temperature (table 1).
- Dew point is also useful in predicting the lowest expected temperature, and how quickly the temperature will drop.
- In general, the start temperature for frost protection is higher when the humidity is low; the start temperature for frost protection is lower when the humidity is high.
- Where row covers are used, irrigation can take place over the cover. Information on temperatures under the cover can be determined by using digital thermometers and thermocouples.

Introduction

There's nothing colder than a strawberry field on a frosty spring night. Strawberry plants bravely bloom in early spring, often before the last frost. The blooms are close to the ground, and the ground, covered with straw, doesn't provide much heat. That's why many strawberry growers pull a few all-nighters each spring to run the irrigation system and use a thermodynamic principle to protect their crop from frost injury.

This paper will describe types of frost, frost injury, and how irrigation can be used to protect strawberry plants from frost injury.

Symptoms of Frost Injury

Frost occurs when the temperature around the plant drops below 0°C (32°F). At this temperature, pure water forms ice crystals on surfaces which have fallen below the freezing point of water.

Plant sap is not pure water; therefore strawberries have a lower freezing point than 0°C (32°F). When the critical temperature (Table 1) is reached, crystals form and damage cell membranes allowing cell fluids to leak out.

Frost can kill flowers outright, or injure them enough to cause misshapen berries. When a flower is injured by cold, the pistils are killed first. If killed after pollination, then embryos do not develop. A seedy spot on the berry forms, with hollow seeds. Sometimes fruit cracks at the bottom. Leaves can also be injured by the frost, especially when they are growing vigorously and very tender. The edges or tips of leaves blacken, and then dry out.

Figure 1: Frost-injured strawberry bloom

Figure 2: Misshapen berries resulting from blooms which are partially damaged by frost

Figure 3: Frost injury on strawberry leaves

Frost usually damages the biggest and earliest bloom. This represents the best and most lucrative part of the berry crop, because prices are highest at the beginning of the season. Further, the first flowers to open produce the largest fruit. If 5 percent to 7 percent of the flowers are lost, and these flowers are mostly king bloom, the total crop will be reduced by 10 to 15 percent.

Critical Temperatures for Frost Injury

Bloom and flower parts are most susceptible to freezing temperatures.

Table 1. Critical temperatures of strawberries based on stage of development (Perry and Poling, 1985)

Stage of Development	Approximate Critical Temp. °C (˚F)
Tight bud	-5.5 (22˚F)
"Popcorn"	-2.2 (26˚F)
Open blossom	-1.1 (30˚F)
Fruit	-2.2 (28˚F)

These temperatures are tissue temperatures, and a degree or two lower than the critical air temperature in the plant canopy. There are many variables that affect the actual critical temperature for a given plant and the amount of injury.

- Duration of cold
- Growing conditions prior to the cold event
- Cultivars: (because of plant habit, or avoidance, rather than genetic differences)
- Stage of development
- Super cooling (in the absence of ice nucleation points, plant sap can cool below the freezing point without forming ice crystals)
- Soil type and condition (moist dark soil holds more heat than dry light soil)

Understanding Heat Transfer

Cold conditions occur when heat is lost. Cold can not be added, only heat can be removed.

Heat can be transferred by:

- **Conduction**: transfer of energy within an object or system. Metal is a good conductor, water is a good conductor, but air is a poor conductor of heat. Ice is a good conductor.
- **Convection**: Transfer of heat by movement and mixing of liquid or gas. Most air is warmed by convection.
- **Radiation**: Is the transfer of energy through free space without a transporting medium. We receive energy from the sun by radiation. Objects on earth also radiate energy back to space.

- **Changes in state**: When water molecules change state, from gas to liquid to ice, heat is released. This potential energy is called latent heat. It is not measured by a thermometer, until it is released by a change in state of the water.

When water condenses, cools or freezes, the temperature around the water rises as latent heat is released. Water changing to ice on the surface of a plant will add heat to that plant. Conversely, when ice melts, or water evaporates, the temperature around the water is cooled, as heat moves to the water. Water evaporating from the surface of a plant will draw heat from that plant.

Table 2. Heat exchange due to changes in state: Positive signs indicate the water is cooling or freezing and air is warming. Negative signs indicate water is warming or evaporating and air is cooling

Change in state	**Heat exchange (calories/gram)**
Water freezes at 0°C (32°F)	+79.7
Water evaporates at 0°C (32°F)	-597.3
Water condenses at 0°C (32°F)	+597.3

Energy Budgets

During the day, the sun warms the soil and solid objects, i.e. crops. When these objects become warmer than the air, they pass heat to the air by conduction. This warm air is less dense, and rises, and is replaced by cooler air from above. This mixing of air is how the lower atmosphere is warmed. Normally, air near the surface of the earth is warmer than the air above it. Crops also radiate heat to outer space. Some of this energy is reflected back to the earth by clouds and $C0_2$ in the atmosphere.

At night, there is no incoming radiation from the sun. If the atmosphere is clear, there is little heat reflected back to earth. The soil and crops continue to radiate energy out to space. Temperatures drop near the earth's surface, forming a layer of air that is colder at the bottom and warmer at the top. If a wind or breeze is present, the warm air and cooler air are mixed. But on a still night, especially when the air is dry, the air temperature at ground level is coolest, and the temperature increases with height up to a certain level. Because this situation is the opposite of normal daytime conditions, the term inversion is used to describe these conditions.

Objects can radiate heat faster than the air around them. Frost can form on the roof of a building or the hood of a car when air temperatures are still a degree or two above zero. Strawberry blooms can also radiate heat quite quickly on a clear night.

Important Facts about Weather

Although the terms "frost" and "freeze" are used interchangeably, they describe two distinct types of cold events.

An advective, or windborne freeze, occurs when a cold air mass moves into the area, and brings freezing temperatures. Significant wind occurs as the cold front moves in. the thickness of the cold air layer is 500-5000 feet deep. It is difficult to protect crops from frost injury when these conditions occur.

A radiation frost, occurs when a clear sky and calm winds allow an inversion to develop and temperature near the surface of the earth drop below freezing. The thickness of the cold air inversion is 30-200 feet (with warm air above).

Table 3. Characteristics of a radiation frost and an advective freeze

Radiation frost	**Advective freeze**
Calm winds (less than 5 mph)	Winds above 5 mph
Clear skies	Clouds may exist
Cold air 30-200 feet deep	Cold air mass 500-5000 feet deep
Inversion develops: air next to the ground is cooler than air above it.	Protection success limited
Cold air drainage occurs	-
Successful frost protection likely	-

Microclimate monitoring

Air temperatures referred to in weather reports and forecasts are measured 5 feet above the ground. Temperatures can be much colder at ground level and even colder in the low parts of the field. Cloud cover and wind speeds are also important factors to consider when determining the risk of frost.

Use max/min thermometers to monitor the low temperatures in your fields. Compare these to the forecast lows. In cloudy breezy weather, forecast lows are likely to be similar to the observed low in a region. On clear calm nights, especially in a strawberry field, the observed low can be much lower than the forecasted low.

You can also use max/min thermometers to compare the temperatures at several locations on your farm on a given night. After several observations you will know just how much colder each field is compared to your back yard. A frost alarm can be installed in a convenient location if you know how much colder it gets in the field.

Factors affecting the risk of frost

Cold air is heavier than warm air, and it sinks and flows across a field like water. It also piles up where obstructions block its flow to a lower area. Road banks, hedge rows, berms are examples of obstructions to cold air flow. Cold air will drain from elevated areas, to lower storage areas, such as a large body of water. Strawberry fields on sloping fields, or in generally elevated areas, are less prone to frost damage. Be aware of frost pockets within the field.

Remove obstructions at the lower end of the field to improve air drainage. Windbreaks should be designed to slow the wind, not block all air movement. To allow air drainage through a windbreak about 50% air space at the bottom of the windbreak is recommended.

Soil moisture and compaction can have a significant effect on temperature. A moist compact soil will store more heat than a loose dry soil and therefore has more heat to transfer to the crop at night. Cultivation just before a frost can increase the risk of injury, because the soil is looser and drier after cultivation. Soil under a grassy cover crop will hold more heat if the grass is mowed short.

Irrigation for Frost Protection

Most growers rely on sprinkler irrigation for frost protection. When water from sprinklers turns to ice, the heat released protects the plant from injury. As long as a thin layer of water is present, on the bloom or on the ice, the blossom is protected. (This is important. It's not the layer of ice that provides the protection. It's the water constantly freezing that keeps the temperature above the critical point.)

System specifications

- Make sure the sprinkler irrigation system has the capacity to irrigate the whole field at one time.
- Use sprinkler heads designed for frost protection. These have low output nozzles, made of metal rather than plastic, and the spring is covered to prevent freeze-up. Sprinkler rotation should be rapid, at least 1 revolution per minute. The back nozzle should be plugged (Figure 4).
- Spacing of risers should not exceed 30-60% (depending on wind conditions) of the area wetted by each sprinkler. Generally an off-set pattern provides more uniform coverage than a square or rectangle, but this really depends on the nozzle and sprinkler you are using. The Center for Irrigation Technology has developed a program called SPACE, which predicts the distribution of water from the sprinklers, and calculates the efficiency of different designs. Tools like this are used by irrigation supply specialists who can help design your system.
- Traditional spacing is 60' by 60', not as many sprinklers required, but it takes longer for sprinklers to cover area. In areas where many advective freezes occur, with winds, a spacing of 30' x 30' is recommended.
- Need enough water on hand to irrigate for several nights in a row.

For example: For 1 acre, you need about 60 gallons per minute, to irrigate 0.125 inch/acre/hr. This is 3600 gallons per hour. If irrigation is required for 10 hours, you need 36000 gallons per night. Plan to irrigate for several nights in a row.

Figure 4: Sprinkler used for frost protection with back nozzle plugged

How much water to apply

The amount of water applied per hour is based on the amount of wind and the temperature (Table 4). Higher water application rates are required on windy nights, or when humidity is low because considerably more energy is removed when a gram of water evaporates than is added when a gram of water freezes (Table 2). A rate of 0.1 inch/hour is considered adequate to protect to -4.4°C (24°F) with no wind. When the water is frozen on the plant the ice should be clear, which indicates that there was enough water applied. If the ice is cloudy or milky white, the water application rate is not fast enough to protect the flower (Figure 5). In this case you can increase the water application rate by reducing the sprinkler spacing or changing to higher flow rate nozzles. At wind speeds above 16 km/hr or at temperatures below -6.7°C (20°F) sprinkler irrigation can do more harm than good because of rapid freezing.

Figure 5: Strawberry bloom coated in clear ice

When to start irrigation
To successfully use irrigation for frost protection, growers need information about the dew point. Dew point is especially important in determining the irrigation start-up point.

The dew point
The dew point is the temperature at which moisture condenses from the air to form dew. The dew point is related to relative humidity: when the air is humid the dew point occurs at a higher temperature than when the air is dry. Once dew begins to form, the air temperature begins to drop more slowly. When temperatures reach freezing, the dew turns to frost.

Dew points are available from agricultural weather forecasts, e.g.

- Environment Canada - provides current dew points and other current weather conditions, for certain locations
- Farmzone.com - provides forecasted dew points

Table 4. Inches of Water/Acre/Hour to Apply for Protection at Specific Air Temperatures and Wind Speeds (Martsoff and Gerber, Penn State University)

Wind speed at crop height (km/hr)	-2.8°C (27°F) air temperature at canopy	-4.4°C (24°F) air temperature at canopy	-6.7°C (20°F) air temperature at canopy	-7.8°C (18°F) air temperature at canopy
0 - 2	0.10	0.10	0.16	0.20
3 - 6	0.10	0.16	0.30	0.40
7 - 14	0.10	0.30	0.60	0.70
15 - 19	0.10	0.40	0.80	1.00
20 - 35	0.20	0.80	-	-

What is the significance of dew point?
Growers can use dew points to estimate how quickly the temperature might drop in any given night. Once dew begins to form, the air temperature drops more slowly because heat is released. Frequently, the nighttime temperature drops to the dew point, but not much below it. Sometimes the dew point is referred to as the basement temperature.

If the air is dry, then the dew point will be low. If the dew point is below 0°C (32°F), frost forms instead of dew. Black frosts occur when temperatures are below freezing but above the dew point. Don't wait for frost to form before starting the irrigation system (especially when the humidity is low).

Table 5: Suggested starting temperatures for irrigation, based on dew point. The lower the dew point, the sooner you should start to irrigate.

Dew Point	Suggested starting air temperature
-1.1°C (30.2˚F)	0°C (32.0˚F)
-1.7°C (28.9˚F)	0.5°C (32.9˚F)
-2.8°C (26.9˚F)	1.1°C (34.0˚F)
-3.8°C (25.2˚F)	1.6°C (34.9˚F)
-4.4°C (24.1˚F)	2.7°C (36.9˚F)
-5.5°C (22.1˚F)	3.3°C (37.9˚F)
-6.7°C (19.9˚F)	3.8° C (38.8˚F)
-8.3°C (17.1˚F)	4.4°C (39.9˚F)

Wet bulb temperature
Sometimes the term wet bulb temperature is used to determine when to start up irrigation systems. The wet bulb temperature represents the temperatures a wet

surface will cool to as the water evaporates. A wet bulb thermometer is covered with clean muslin soaked in distilled water. Air is passed over the bulb; the water evaporates, reducing the temperature around the thermometer.

If wet bulb temperatures are available, these can be used directly to determine when irrigation should begin, and when the system can be shut off. Start irrigation just before the wet bulb temperature reaches the critical temperature (Table 1).

When to stop irrigation
Irrigation can be stopped when ice on the plants begins to melt, usually after sunrise. Monitor carefully to make sure that the ice continues to melt and the temperature remains above freezing. Changes in wind speed could change temperatures near the plant surface. Irrigation should be started up again if water begins to freeze.

Ice does not have to be completely melted. The plant temperature will warm up as the sun rays hit the field. When the ice can be sloughed off the plant, you know that plant temperatures are above freezing and the water next to the pant has started to melt. At this point, you can turn off the irrigation water, usually around 7:30 or 8 am.

The best way to know when to turn off the irrigation is to monitor plant tissue temperatures beneath the ice. Digital thermometers, attached to thermocouples inserted into the plant tissue can indicate when plant temperatures begin to warm up above the critical temperature.

Negative side effects
One negative side effect of irrigation for frost protection is increased potential for disease outbreaks. Angular leaf spot is a bacterial disease that is spread by splashing rain or irrigation, and seems to get established in frosty conditions. Anthracnose, which can cause fruit rot, generally likes warm humid weather. However, even during cool periods, it will spread by water splashing on the plants and, after establishing itself, it will thrive when warm weather arrives (Figure 6).

Root rots, such as red stele, thrive in saturated soil conditions. Outbreaks of red stele and other root rots have occurred after long periods if irrigation for frost protection. The sites most suited for frost protection by irrigation are well drained sites with sand or sandy loam soils.

Figure 6a: Angular leaf spot

Figure 6b: Anthracnose fruit rot

Figures 6a, 6b: Splashing water can spread diseases like angular leaf spot and anthracnose fruit rot

Figure 7a: Standing water and water-saturated soil in a strawberry field

Figure 7b: Water-saturated soils favour root diseases such as red stele.

Disease and fungus can be limited by reducing the water applied. Water volumes can be reduced by:

- Low application rates / nozzles
- Stopping when ice begins to melt, not when all the ice is melted.
- Monitor the weather to irrigate only when needed.
- Using row covers. This can delay the start up time for irrigation by several hours.

Row Covers

Row covers reduce evaporative cooling and the rate of cooling under the cover. According to vendor's information, the heavier weight covers (1.5-2 oz/yd^2) can protect 4-6 degrees, but this varies both with the weight and between manufacturers. They do buy time on a frosty night.

When frost protecting with irrigation and row covers, you need to know plant temperature under the cover. Start when temperatures under the cover drop to 0.6 - 1.1°C. Irrigate right over the cover. Stop when plant temperatures start to climb. Digital thermometers attached to thermocouples, inserted in the flower buds before the frost event, are necessary for successful protection with covers.

Research suggests that 2 layers of 1 oz cover provide more protection than 1 layer of 2 oz material. Research on the use of low impact sprinklers, i.e. mini-wobblers, is in progress. These sprinklers, widely used in the ornamental industry, wet a smaller diameter, use lower pressures, and are less prone to freezing. By using irrigation and row covers it may be possible to frost protect in adverse conditions.

Related Links

- Environment Canada
- Farmzone.com
- Frost/Freeze Protection for Horticultural Crops,North Carolina State University Horticulture Information, Leaflet 705
- Rainbird Agricultural Irrigation - Technical resources, specifications
- Center for Irrigation Technology Technical resources, SPACE program
- Biometeorology Program, Atmospheric Science, University of California - web site with tables, theory, course on biometeorology
- Berry agent, North Carolina State University

(***Source**: OMAFRA Factsheets at:* *www.omafra.gov.on.ca/english/crops/facts/frosprot_straw.htm*)

BLUEBERRY

Fruitworm Management in Blueberries

Rufus Isaacs, Carlos Garcia-Salazar, John Wise, Keith Mason and Steve Van Timmerman, MSU

Cranberry fruitworm and **cherry fruitworm** are two early-season moth pests of blueberries in eastern North America. Both species have one generation per year and the female moths lay eggs during and after bloom, with cherry fruitworm activity being 7-10 days earlier than cranberry fruitworm. The larvae of both species develop inside berries through the period of fruit development, and left unchecked these insects can infest 50 to 75 percent of clusters in areas of high populations. This causes risk of reduced yield and load rejection, due to a very low tolerance for insects in fruit destined for the processing or fresh markets.

Effective management of fruitworms requires understanding how to monitor and scout for these insects, knowledge of their emergence and egglaying, and the performance of the available control options. Combining these approaches into an IPM program can help ensure that fruitworms do not cause economic losses. This document explains how to use the MSU degree day model for fruitworm management, and we report on some recent trials to test the performance of IPM programs that tested the degree day model and alternatives to Guthion. This insecticide has been the foundation of fruitworm control programs for years, but it is being phased out by 2012. Blueberry growers have many alternatives available and should be testing alternative programs on their farms to be prepared for this change.

Monitoring

Traps for cherry fruitworm should be placed in fields before bloom, while cranberry fruitworm can be placed at the start of bloom. These timings should provide a week or two of zero catches before moths are detected, to ensure accurate identification of the start of flight. This allows setting the biofix for running the degree day model to time insecticide applications (see below).

For both fruitworm species, we recommend placing white monitoring traps in the upper third of the bush, with foliage cleared near the entrances. Field edges near woods or tree-lines tend to have the highest catches, so place traps near these areas for the greatest chance of catching moths. Growers with multiple fields should be monitoring more than one area of the farm, including areas that have been hot-spots for fruitworm pressure in the past. One trap per 10 acres is a minimum density to determine which fields have the most pressure and to detect differences in timing of emergence. The large plastic delta traps work well for monitoring both fruitworm species, but smaller Pherocon or wing traps can work too. The plastic delta traps are useful because they are highly resistant to rain, irrigation, and tractors, plus this design can usually be used for more than one year. As with all pheromone monitoring traps, be careful to bait the trap with the pheromone lure for the right species, and be sure to avoid cross-contamination with other species' pheromone.

Some contaminant moths can be attracted to fruitworm traps in the spring, so be sure that the number counted are the right species. Once the period of moth emergence is near (early bloom for cherry fruitworm, mid-bloom for cranberry fruitworm), traps should ideally be checked twice a week. This will help ensure accurate identification of the start of moth flight, or biofix.

Degree days to predict fruitworm phenology

Cherry and cranberry fruitworm flights usually start during bloom in mid-May, with egglaying starting in late May during bloom when bee safety is a high priority. Farms with low fruitworm pressure can often get by with using an immediate post-bloom insecticide in early June as their first fruitworm spray. However, at fields and farms with higher pressure from these fruitworm pests, gaining high levels of control requires protection of berries using sprays applied during bloom. Additionally, sprays would ideally be applied based on the phenology of the pest, not the crop, which can vary widely among blueberry cultivars. Using degree days can help predict fruitworm phenology and identify the ideal times for sprays.

The activity of bees during bloom means that growers are restricted to only a few bee-safe products at the predicted start of egglaying: the insect growth regulators (IGRs) Intrepid or Confirm, and the biological insecticide B.t. Intrepid or Confirm must be applied close to the start of egglaying, which is timed by tracking growing degree days (GDDs) with a base temperature of 50oF. ***Egglaying is predicted to start at 85-100 GDD after the first sustained catch of cranberry fruitworm moths.*** For cherry fruitworm, it is not well understood how long after biofix egglaying starts. However, there is some guidance available from our recent trials in which Intrepid applied 100 GDD after biofix for cherry fruitworm worked well to control this pest.

The Cranberry Fruitworm Model on Enviroweather
The MSU Enviroweather system (**www.enviroweather.msu.edu**) can be used to track degree days for the weather station nearest to your farm. Click on the nearest weather station, select "Fruit" and then pick "Cranberry Fruitworm Model" from the list of available models. This will bring up a table that shows dates across the top and down the side. Select the date across the top when you set biofix for your farm (first sustained moth catch), and then look down the table to where it changes to red. This is the date when egglaying is predicted to start at that site. This model also predicts forward one week to show degree day accumulation and whether egglaying is expected in the coming days. [***Editor's Note****: UMass is presently working on including a similar model in the NEWA network and hope to have it available for New England growers in 2011*]

A model for cherry fruitworm is in development for displaying at the Enviro-weather page, but that is not yet ready to release online.

Insecticides for fruitworm control

In bloom. Both species of fruitworms lay their eggs in the calyx cup of blueberries, so the risk from these pests starts when moths are present, egglaying is predicted, and petal fall has started. If these conditions are met, protection of the young fruit should be considered. If warm weather brings a new round of petal-fall, growers with fields at high risk of fruitworm infestation should consider protecting these newly-exposed fruit.

If cranberry fruitworm moths are trapped and 85-100 GDD have elapsed from biofix, young berries should be protected using an IGR such as Intrepid at 10-12 oz/acre. For organic growers using B.t. formulations such as Dipel at 1-2 lb/acre or Javelin at 1 lb/acre, applications should be timed for egg hatch, which is a little later than egglaying. Although we do not have our research on egg hatch timing completed yet, we expect that to be another 50-100 GDD later, equivalent to 135-200 GDD after biofix. Applications of B.t. last 3-5 days under typical spring conditions and they are not rainfast, so reapplication is critical for crop protection during this period. In contrast, Intrepid has 10-14 days residual control and is the preferred option for non-organic growers.

EPA has released new Endangered Species restrictions for Intrepid that cover Allegan, Monroe, Montcalm, Muskegon, Newaygo and Oceana counties in Michigan. This restriction states "Do not apply this product within one mile of sandy habitats that support wild lupine plants...". See the Bulletin Live website for details. [***Editor's Note**: This does not apply to any New England State*.]

Post bloom. Guthion, Imidan, Asana, Danitol, Sevin, and Assail are all rated as being excellent broad-spectrum insecticide options for control of fruitworms. Lannate can provide high activity but has shorter residual control. There have also been recent registrations of the reduced-risk insecticides Delegate, Rimon, and Avaunt that are registered for fruitworm and provide good levels of control. These also will control other pests: Delegate is labeled for control of fruitworms, leafrollers and for suppression of gall midge, maggot, and thrips; Rimon for fruitworms, spanworm, leafrollers and maggot; and Avaunt for fruitworms and spanworm, with activity also expected on plum curculio.

Coverage is Critical

For any insecticide applied for fruitworm control, maintaining good coverage of the clusters is important, to get residue to the parts of the berry where fruitworms are found such as in the calyx cup where eggs are laid. Because the larvae move over such a small distance before they enter the berries, it is important to use sufficient water and to consider spray additives (spreader-stickers) that will help spread the material across the berry surface. This is especially important for insecticides that need to be eaten for activity such as B.t. and Intrepid.

On-Farm Fruitworm Control Trials

In 2009, we compared the level of fruitworm control at three 1-9 acre fields in each of four commercial blueberry farms in southwest Michigan (two in Ottawa and two in Van Buren counties). At each farm, three fields with a history of fruitworm infestation were compared that received one of three programs comprised of insecticide applications at bloom, petal fall, and 7-10 days after petal fall. The three programs were (rates are all per acre):

	Bloom	**Petal-Fall**	**7-10 days after petal-fall**
A)	Confirm @ 16oz	Guthion @ 1.25lb	Guthion @ 1.25lb
B)	Confirm @ 16oz	Asana @ 9.6oz	Asana @9.6oz or Mustang Max @ 4oz
C)	Intrepid @ 8oz using degree day model	Intrepid @ 8oz 10-14 days later	Assail @ 5.3oz 7-10 days later

All three programs were effective at protecting fruit from fruitworm damage. Single berry damage (indicative of cherry fruitworm damage or the early stages of cranberry fruitworm feeding) was lowest in Program C, but this was not significantly different between programs:

A) 1.1 percent damaged berries,

B) 0.7 percent damaged berries,

C) 0.5 percent damaged berries.

Similar results were seen for multiple berry damage, which is a sign of advanced cranberry fruitworm feeding. No multiple berry damage was found in any fields treated with the IPM program and very low levels of multiple berry damage were seen in the other programs. The percentage of berries with cranberry fruitworm damage was well below 1 percent in all fields and there was no significant difference among treatments.

Fruit collected from these fields and then held to measure larvae surviving to pupae revealed 2 cranberry fruitworm in the Guthion program,1 in the Pyrethroid program, and zero in the Intrepid-Assail program. One cherry fruitworm was found in the Optimal IPM program, but none in the others.

Summary

Fruitworm management can be highly effective if regular checking of monitoring traps is combined with tracking of degree days and application of effective insecticides. Our recent studies have demonstrated the excellent control provided by Intrepid/Assail and Confirm/Asana programs for controlling fruitworms, providing alternatives for growers preparing for the loss of Guthion. There are other options available for growers to consider to work into their IPM program while keeping resistance management in mind. Although the Intrepid/Assail program was more costly than the Guthion or Pyrethroid-based programs, insecticide costs of Assail and Intrepid are declining, and not all farms or fields will require three sprays for fruitworm control. Combining monitoring with degree days for accurate timing of early fruitworm sprays can help minimize economic losses to this complex of early-season moth pests. (***Source**: Michigan Crop Advisory Team Alert, May 4, 2010 -- Vol. 25, No. 4*)

Prebloom Foliar Nutrient Sprays

Alice Wise, Cornell University

Prebloom Foliar Nutrient Sprays: Given the cost of fertilizers and fuel, it is important to think through the benefits of all foliar nutrients. Visual verification as well as petiole and soil analysis can be helpful in diagnosis of deficiencies, even at this time of year.

Nitrogen – Long term nitrogen (N) needs of vines, particularly in sandy soils, can be addressed in whole or in part by improving soil organic matter. Otherwise, N fertilization is best addressed via ground application whether using a dry product or dripping in liquid N. The benefits of foliar N are debated but experience dictates that periodic foliar applications can be of benefit in maintaining a green, photosynthesizing canopy. Some growers feel foliar N helps sluggish early spring growth; others feel the primary benefit is later in the season both in terms of maintaining canopy and helping to avoid sluggish and/or stinky fermentations. There are many different products from which to choose. Price may dictate what a vineyard can afford to use. Note that some phosphorous acid products contain nitrogen.

Magnesium – Many growers include Epsom salts (magnesium sulfate) in a few of their prebloom sprays. Though replicated research trial results are lacking, there is universal agreement among growers that this foliar nutrient is essential in maintaining a green, healthy canopy.

Zinc - Considered essential for proper cluster development, berry set and normal shoot growth. Deficiency is seen early summer. New leaves are smaller, distorted and may be chlorotic with darker green veins. Straggly clusters and shot berries may also occur. Soil application of Zn is less effective because Zn can be tightly bound in soil (though past recommendations for our vineyard were soil applications of zinc sulfate). Zinc sulfate, zinc oxide and chelated Zn are used as foliar sprays; follow label for rates and timing. Rely on your soil and petiole analyses to gauge the need for this nutrient.

Boron – Distorted basal 1-2 leaves at this time of year might indicate B deficiency (a lab can verify this). We are currently seeing this on some of our Chardonnay. Soil levels are listed as deficient (0.4 ppm), thus we will include a foliar spray or two this spring. Later symptoms are stunted zigzag growth and death of shoot tips, poor set with shot berries, often flattened or oblong. Soil treatment is effective since boron (B) moves with the soil water, however this is best applied in the fall or with the spring herbicide. Common boron products include Solubor and Borosol. For foliar sprays, no more than 0.2 lb./a actual B in 1 or 2 prebloom sprays is the standard recommendation. The low rate reflects the high risk of phytotoxicity with boron. Boron interferes with the dissolving of water-soluble packets used for certain pesticides. When tank mixing, dissolve the packet thoroughly in the spray tank and then add B to the spray mix.

Manganese - Deficiency is seen mid-late summer starting as interveinal chlorosis on basal leaves. A her- ringbone pattern is characteristic. At soil pH's >6.0, e.g. properly limed soils, Mn availability in the soil is relatively low. Where a deficiency is confirmed by petiole analysis, foliar applications of manganese sulfate (2-3 lbs./100 gal.) are recommended as a corrective measure. Other manganese products used at label rates may also be effective. Foliar manganese oxide materials are considered to be less effective. (***Source****: Long Island Fruit & Vegetable Update, No. 8, May 6, 2010*)

GENERAL INFORMATION

Critical Spring Temperatures for Tree Fruit and Small Fruit Bud Stages

Compiled by Mark Longstroth, MSU Extension

Pome Fruit

Apples	Silver Tip	Green Tip	½ inch green	Tight Cluster	First Pink	Full Pink	First Bloom	Full Bloom	Post Bloom
Old temp	16	16	22	27	27	28	28	29	29
10% kill	15	18	23	27	28	28	28	28	28
90% kill	2	10	15	21	24	25	25	25	25

Pears	Bud Swell	Bud Burst	Tight cluster	First White	Full White	First Bloom	Full Bloom	Post Bloom
Old temp	18	23	24	28	29	29	29	30
10% kill	15	20	24	25	26	27	28	28
90% kill	0	6	15	19	22	23	24	24

Stone Fruit

Apricots	Bud Swell	Bud Burst	Red Tip	First White	First Bloom	Full Bloom	In the Shuck	Green Fruit
Old temp	--	23	--	25	--	28	--	31
10% kill	15	20	22	24	25	27	27	28
90% kill	--	0	9	14	19	22	24	25

Peaches	Bud Swell	Calyx Green	Calyx Red		First Pink	First Bloom	Full Bloom	Post Bloom
Old temp	23	--	--		25	--	27	30
10% kill	18	21	23		25	26	27	28
90% kill	1	5	9		15	21	24	25

European Plums	Bud Swell	Side White	Tip Green	Tight Cluster	First White	First Bloom	Full Bloom	Post Bloom
Old temp	--	--	--	--	23	27	27	30
10% kill	14	17	20	24	26	27	28	28
90% kill	0	3	7	16	22	23	23	23

Sweet Cherries	Bud Swell	Side Green	Green Tip	Tight Cluster	Open Cluster	First White	First Bloom	Full Bloom	Post Bloom
Old temp	23	23	25	28	28	29	29	29	30
10% kill	17	22	25	26	27	27	28	28	28
90% kill	5	9	14	17	21	24	25	25	25

Tart Cherries	Bud Swell	Side Green	Green Tip	Tight Cluster	Open Cluster	First White	First Bloom	Full Bloom	
10% kill	15	24	26	26	28	28	28	28	
90% kill	0	10	22	24	24	24	24	24	

Small Fruits

Concord Grapes	First Swell	Full Swell	Bud Burst	First Leaf	Second Leaf	Third Leaf	Fourth Leaf
10% kill	13	21	25	27	28	28	28
90% kill	-3	10	16	21	22	26	27

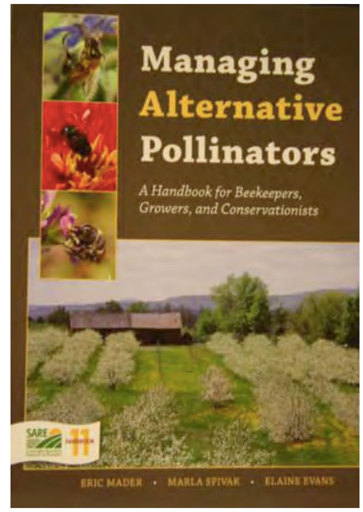
Strawberries	Buds Emerged	Buds Closed	Bloom	Small Fruit
Damage	10	22-27	28	28

Blueberries	Bud Burst	Pink Bud	Open Flower	Petal Fall	Green Fruit
Damage	< 20	< 25	27	28	28

Old standard temperature is the lowest temperature that can be endured for 30 minutes without damage. This chart also shows the temperature that will kill 10 % and 90 % of normal fruit buds. These numbers were taken from Washington (WSU), Michigan (MSU) and North Carolina (NCS) Extension Bulletins. Apple - WSU EB0913, Pears - WSU EB0978, Sweet Cherries - WSU EB1128, Peaches - WSU EB0914, Apricots - WSU EB1240, Tart Cherries - MSU Research. Rpt. 220, Portions of these bulletins are posted at Gregg Lang's Fruit Bud Hardiness Page at the MSU Horticulture Department (***Source****: MSU Fruit Program Frost/Freeze page* *http://web1.msue.msu.edu/vanburen/frost.htm*)

NRAES Pollinator Conservation Handbook Available

Managing Alternative Pollinators: A Handbook for Beekeepers, Growers, and Conservationists



The new book is now available from NRAES (Natural Resource, Agriculture, and Engineering Service). The handbook is a first-of-its-kind, in-depth, full-color guide to rearing and managing bumble bees, mason bees, leafcutter bees, and other alternatives to honey bee pollinators.

The 162 page book features 130+ color photos, 10 chapters, 7 appendices, nest construction details, parasite and disease management guidelines, and much more. For a detailed description, including sample pages, and instructions on how to order the book: http://www.nraes.org/nra_map.html. Quantity discounts are available.

For more information about NRAES visit http://www.nraes.org, or phone 607 255 7654. The book was published with support from the US Department of Agriculture's Sustainable Agriculture Research and Education program (SARE).

UPCOMING MEETINGS:

May 11, 2010 - *Harvest Equipment*, 4-7 p.m. Montpelier. (registration deadline: May 5). **Registration is required** as space is limited to 10 participants per workshop. Cost is $35. To register go to http://tinyurl.com/UVMtractors101 or call 223-2389 x 203, or email newfarmer@uvm.edu. Participants should come prepared for the weather, bring a bag dinner, and wear sturdy shoes, gloves, and work clothes.

May 12, 2010 - *NH Fruit Growers' Twilight Meeting*. Carter Hill Orchard, Concord NH. 5:30-8:00pm. For info, contact George Hamilton at george.hamilton@unh.edu or 603-641-6060.

May 18, 2010 - *UMass Extension Fruit Program Twilight Meeting* in cooperation with Massachusetts Fruit Growers' Association, Outlook Farm, 136 Main Road, Westhampton. Meeting starts at 5:30, 1 pesticide credit. For more information contact Jon Clements at clements@umext.umass.edu.

May 19, 2010 – *UMass Extension Fruit Program Twilight Meeting* in cooperation with Massachusetts Fruit Growers' Association, Honey Pot Orchard, 144 Sudbury Road, Stow. Meeting starts at 5:30, 1 pesticide credit. For more information contact Jon Clements at clements@umext.umass.edu.

May 20, 2010 – *UMass Extension Fruit Program Twilight Meeting* in cooperation with Massachusetts Fruit Growers' Association, Noquochoke Orchard, 594 Drift Rd., Wesport. Meeting starts at 5:30, 1 pesticide credit. For more information contact Jon Clements at clements@umext.umass.edu.

May 25, 2010 – Connecticut Pomological Society Twilight Meeting, Belltown Orchard, Glastonbury CT. 5:30-8:00PM. Focus on how to do a self-audit for GAP certification. For more info, contact Lorraine Los, (860)486-6449, lorraine.los@uconn.edu

May 26, 2010 - *Drip Irrigation for Vegetable & Fruit Growers*. Brookdale Fruit Farm, Hollis NH. 5:00-8:00pm. For info, contact George Hamilton at george.hamilton@unh.edu or 603-641-6060.

June 15, 2010 - Connecticut Pomological Society Twilight Meeting, Lyman Orchard, Middlefield, CT. 5:30-8:00PM. Farm tour highlight will include Cornell Vertical AXIS System, Asia Pear Block, New Peach Blocks and much more followed by a brief meeting and refreshments. For more info, contact Lorraine Los, (860)486-6449, lorraine.los@uconn.edu

June 22-26, 2011. *10th International Rubus and Ribes Symposium, Zlatibor, Serbia***.** For more information contact: Prof. Dr. Mihailo Nikolic, Faculty of Agriculture, University of Belgr, Belgrade, Serbia. Phone: (381)63 801 99 23. Or contact Brankica Tanovic, Pesticide & Environment Research Inst., Belgrade, Serbia. Phone: (381) 11-31-61-773.

July 29, 2010. *2010 Cornell Fruit Field Day,* Geneva, NY. Save the date! Program details and registration information forthcoming.

August 19-21, 2010. *North American Fruit Explorers.* Best Western Motel/Conference Center, Lafayette, IN. To view the program and registration form, check: http://web.extension.illinois.edu/edwardsvillecenter/foodcrophort3031.html. For additional details or questions: contact Ed Fackler at cefackler@gmail.com or 812-366-3181.