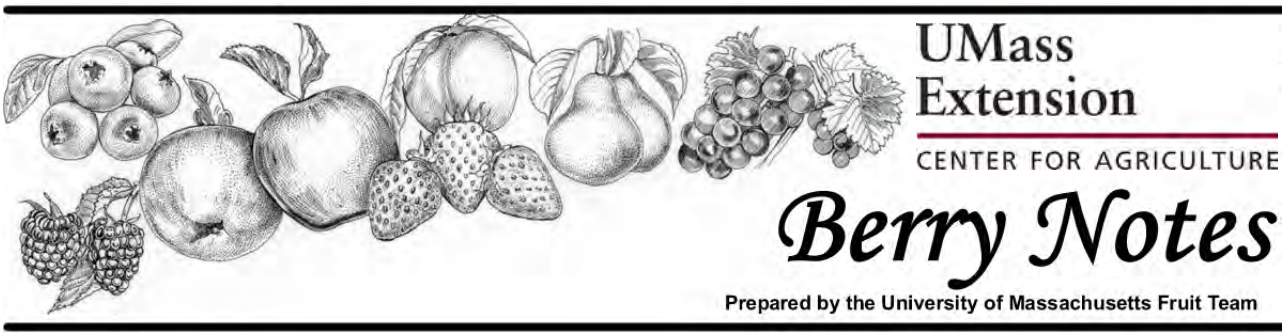

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IN THIS ISSUE:

Crop Conditions:

Strawberries: May is the time to begin scouting strawberries for insect problems. Cyclamen Mite, Tarnished Plant Bug, Strawberry Clipper and Two Spotted Spider Mites are becoming active in fields now. See upcoming IPM Berry Blasts for information on the specifics how to scout and manage these pests. Bloom time frost protection is an important activity in the month of May. I'm including the annual article from Ontario about this as it is the most thorough write-up on the topic I've found. Bloom time is also an important time for managing fruit rot diseases like Botrytis Gray Mold. **Brambles**: As fruiting laterals begin to expand in summer fruiting (floricane) varieties look for evidence of Raspberry Fruitworm. Tarnished Plant Bug can also become established in these varieties as they get close to bloom. Fruit rots like Botrytis Gray Mold can infect brambles during the bloom period. An open canopy with conditions for good air circulation and spray penetration are best for controlling fruit rot and other disease. Primocane varieties are showing some new growth. Brambles in tunnels are further along and should be monitored for insect pests mentioned above, especially two-spotted spider mite. **Blueberries**: Bushes will progress into bloom this month. Pollination is important at this time. Be sure that adequate pollinators (honey bees, bumble bees and/or native bees) are present for pollination. Damage from Winter Moth in Eastern coastal areas appears to be lower than usual this year. Gypsy Moth, however, may be a greater problem than in the past. Clean up application of Dipel or other B.t. products can still be made but no insecticide applications may be made during bloom because of the risk to pollinators. Look for apothecia (fruiting cups) of the overwintered mummy berry beneath the bushes after spring rains. If high infections were seen last year, be prepared to protect against this disease this year. **Grapes**: Rapid shoot growth happens this month. Stripping unwanted shoots from trunks/cordons and thinning shoots from spurs or canes is best done early before they are long and lignified. Make sure all trellis repairs are done. Monitor for Grape Flea Beetle, Climbing Cutworm and other early-season pests. Early season spray for Phomopsis, Black Rot and Powdery/Powdery Mildew are important on susceptible varieties where they were a problem last year.

ENVIRONMENTAL DATA

The following data was collected on or about April 26. Total accumulated growing degree days (GDD) represent the heating units above a 50° F baseline temperature collected via our instruments for the 2017 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	GDD		Soil Temp (°F at 4" depth)		Precipitation (in inches)
	1-Week Gain	*2017 Total*	*Sun*	*Shade*	*1-Week Gain*
Cape Cod	2.5	61	56	54	1.61”
Southeast	11	84	56	52	2.20”
North Shore	5	106	50	47	1.05”
East	8.5	121	54	51	2.24”
Metro West	12.5	100	47	45	1.38”
Central	18	128	48	45	1.26”
Pioneer Valley	17	94	54	50	1.60”
Berkshires	13	74	51	49	1.02”
AVERAGE	11	96	52	49	1.55”
n/a = information not available					

(***Source***: *UMass Landscape Message #6, April 28, 2017*)

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 that 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.

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)

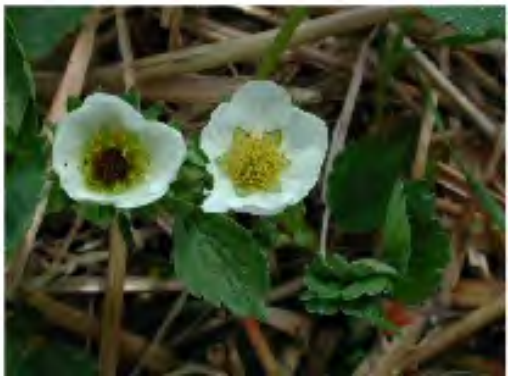


Figure 1: Frost-injured strawberry bloom

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

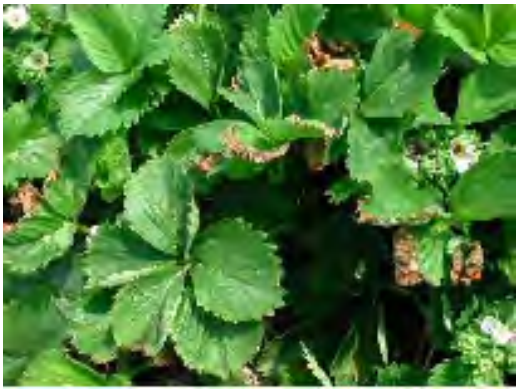


Figure 3: Frost injury on strawberry leaves

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).

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.

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	-

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.

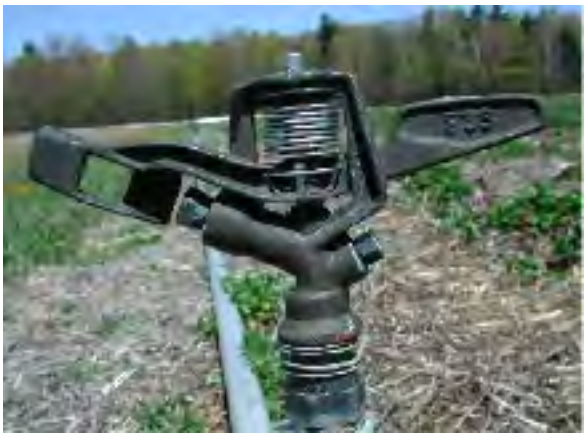


Figure 4: Sprinkler used for frost protection with back nozzle plugged

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.

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

Figure 5: Strawberry bloom coated in clear ice

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).

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).

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	-	-

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)

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

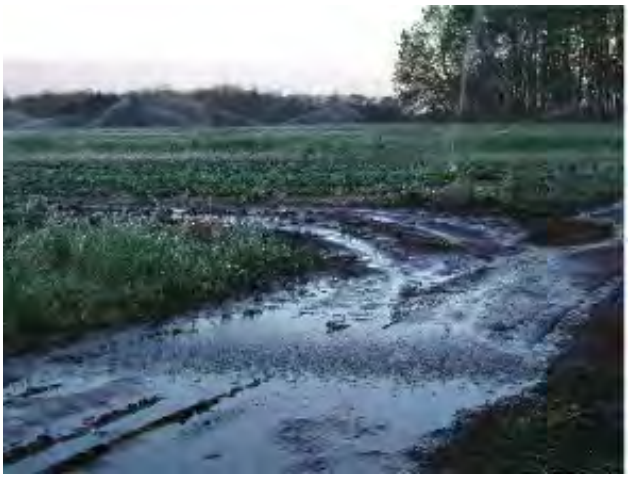


Figure 7a: Standing water and water-saturated soil in a strawberry field

Figure 7b: Water-saturated soils favor 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*)

Tarnished Plant Bug

Sonia Schloemann, UMass Extension

ID/Life Cycle: The tarnished plant bug (TPB) is a small bronze colored insect with a triangular marking on its back. It is a 'true bug' with piercing/sucking mouthparts. The immature stage, or nymph, is smaller and bright green, resembling an aphid, but much more active. TPB is a ubiquitous feeder with a wide host range.

Tarnished plant bug overwinters in protected areas such as leaf litter, plant debris, hedge rows and brush piles. Adults become active and lay eggs in grasses, broadleaf weeds, and in strawberries in early to mid-May. The eggs hatch to nymphs in 7-10 days depending on the temperature. The nymphs may be present on the plants as early as the second week of May. The first observation of nymphs usually occurs during full-bloom period of mid-season flowering cultivars. Nymphs undergo 5 stages of development. There are several generations per year.

(*TPB nymphal instars. Photo from Ontario Crop IPM website at www.omafra.gov.on.ca/IPM/english/index.html*)

Damage: This is the most significant insect pest in strawberries. Both adults and nymphs feed on the developing flowers and fruit, sucking out plant juices with straw-like mouth-parts. This results in deformed fruit: typically "cat-faced" berries, also called nubbins or button berries. Such fruit are generally unmarketable. Damage can cause significant crop loss.

Management

Monitoring: Monitor for TPB nymphs by shaking flower trusses over a white surface and counting the number of nymphs present. At each of five sites per field, shake 10 flower clusters over a white pan or paper to dislodge the nymphs. The action threshold for nymphs is 0.15 nymphs per blossom cluster. At this level, control measures can be applied to maintain berry quality and yield before too much damage occurs. White sticky traps are available for monitoring tarnished plant bug adults. These traps are used as an indicator of plant bug activity in the spring and a relative indication of their abundance, not as an indication of when to control this insect.

Control strategies

Cultural/Biological:

- Control weeds in and around the planting to reduce populations of this insect.
- Avoid mowing nearby fields during bloom or early fruit development.
- Avoid planting strawberries near alfalfa, which attracts high populations of TPB.
- Preserve natural enemies whenever possible by selecting spray materials that are less toxic to beneficials.

Chemical:

- Apply recommended insecticides if threshold levels are exceeded.
- DO NOT APPLY INSECTICIDES DURING BLOOM.
- If repeat applications are needed, rotate insecticides from different IRAC groups to reduce the chance of resistance development in the pest. Group designations can be found on product labels.

Conventional
Assail 30SG *acetamiprid* @ 4.0-6.9 oz/A
Beleaf 50SG *flonicamid* @ 2.8 oz/A
***Brigade WSB** *bifenthrin* @ 6.4-32 oz/A
Captiva *Capsicum extract & garlic and soy oil* @ 1-2pt/A
***Danitol 2.4 EC** *fenpropathrin* @ 10.6 fl oz/A
Rimon 0.83EC *novaluron* @ 9-12 oz/A
** restricted use material*

Organic
Aza-Direct *azadirachtin* @ 1-2 pt/A
AzaGuard (*azadirachtin*) @ 10-16 fl oz/A
Mycotrol O *Beauvaria bassiana* strain GHA @ 0.25-1 qt/A
PyGanic 1.4 EC$_{II}$ *pyrethrin* @ 16-64 fl. oz/A *or*
PyGanic 5.0 EC$_{II}$ *pyrethrin* @ 4.5-18.0 fl. oz/A
No product endorsement over like products intended.
Always read the label prior to use.

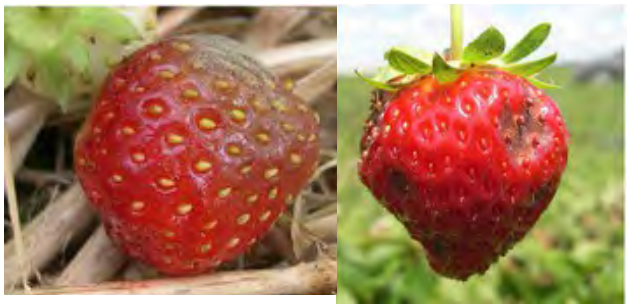
(Sampling for *TPB nymphs. Photo from Ontario Crop IPM website at www.omafra.gov.on.ca/IPM/english/index.html*)

Click here for more excellent images of TPB from Ontario.

Time for Strawberry Fruit Rot Protection

Cassandra Swett, University of Maryland

The strawberry bloom has begun and it's time for fruit rot protection. Our two main targets for bloom time protection of strawberries are gray mold/ Botrytis fruit rot (*Botrytis cinerea*), and, if you are growing susceptible varieties like Chandler, anthracnose fruit rot (Colletotrichum acutatum).



Left: gray mold; right: anthracnose fruit rot.

Fungicide Efficacy
Most fungicides are labeled for both pathogens, but if your main target is gray mold, you need to consider that the fungus has become resistant to several fungicides. If you use fungicides that the pathogen is resistant to, you will have no protection—it's essentially like missing a spray. Based on the fungicide resistance tests that Guido Schnabel conducted with Botrytis from Maryland, Topsin M is ineffective and at some sites, Scala is also ineffective.

Spray Guidelines to Manage Fungicide Resistance
Here's a strawberry spray guide that manages fungicide resistance, when your main objective is gray mold (Botrytis) protection:

1. Pre-bloom (crown rot protection)
Spray every 7-10 days
Rotating: Captan 50 WG or 80 WDG (group M)
With: Rovral 50 WG (Group 2) —this compound can only be applied once, and only pre-bloom

2. Early Bloom (10%) to fruit set
Spray every 7-10 days
Rotating: Elevate 50 WDG (group 17), CaptEvate (group M + 17), Switch 62.5 WG (group 9 + 12), Fontelis (group 7), Scala (group 12) and Pristine WG (group 7 + 11)
With: Captan, Thiram 24/7 or Thiram Granuflo (both group M)

An example: Captan+Fontelis, then Switch, then Captan, then Pristine, then Thiram, then Elevate, then Captan

3. After fruit set:
Spray every 7-10 days
Rotating: Captan and Thiram (both group M)
With: CaptEvate (group M + 17), Elevate (group 17), or Fontelis (group 7) -each applied only once during this interval.

Rates
For every compound, there is a range in the rate you can apply. For fungicides at risk of resistance (Switch, Pristine, Rovral, Scala), the lower rate is always recommended. For fungicides that are not at a high chance of resistance (Elevate, Fontelis, Captan, Thiram), the amount you apply should be adjusted, in part, based on how high disease pressure is. If it rained at least once since your last spray, and temperatures are between 65 and 75^0 F, you will want to use the higher concentration.

If, in contrast, it's been cooler than 65, warmer than 75 and / or dry, use the lower rate.

Timing
The same goes for how often you spray. We get a lot of rain this time of year, and every time it rains the fungus has a chance to infect plants. So long as it's raining about every week, plan to spray every 7-10 days.

Tips:
Control is improved when you rotate between Fontelis and Switch and when you tank mix Fontelis with Captan.

One of the compounds in Pristine is the same FRAC group as Fontelis, so don't use these sequentially.

Switch and Pristine are both highly effective, but are at high risk of resistance if they are used too often. Because of this, it is recommended that they are only used ONCE each year.

What about non-synthetic chemicals?
There is some interest in using non-synthetic chemicals for fruit rot control, as a rotation with synthetic chemicals, especially in post bloom control, and for organic management. One such compound is Regalia, a plant extract labeled for use on gray mold and anthracnose fruit rot in strawberry. Trials are lacking for strawberries, but in grape Regalia can be as effective as Pristine against *Colletotrichum*, and is moderately effective against *Botrytis*. In trials in California, disease control with Regalia is best when rotated with conventional compounds. We will be doing work on strawberry starting this year to evaluate Regalia and other bio-pesticides / biologicals, so we should have more information on this in future years. (***Source**: PA Fruit Times Newsletter, April 24, 2015*)

Strawberry Planting and Other Basics

Kathleen Demchack, Penn State University

A successful strawberry planting hinges on getting the basics right at planting time. If you can pay attention to the basics, you are well on your way to having a vigorous planting.

Different dormant plant sizes. ***Photo**: K. Demchak, Penn State*

Here are a few of the things that are most important when it comes to establishing a healthy planting:

Soil conditions
Working the soil when it's not quite dry enough is probably one of the worst things you can do for your strawberry plants. In a friable soil with good structure, the plants' roots will make good soil contact, which allows plants to take up the moisture and nutrients that they need to grow.

Plants planted in cloddy soils just won't grow well, in part because of poor root contact, but also because it is difficult to set the plants at the correct height. Either the plants settle too much, and soil washes into the crown making it rot, or the plants end up perched too high, and the roots become exposed and dry out. Neither scenario ends well. And of course, improving the soil organic matter content is something that helps with soil structure and drainage, so that is something to factor into crop rotations for the long haul.

Moisture!
This means making sure beds are trickle-irrigated in plasticulture plantings before planting, and then giving them a day or two to drain before planting. Planting is a lot easier when the beds are nicely moist, not dry or sopping wet. Keeping the plantings well-watered in dry spells will allow the plants in matted-row plantings to produce enough runners to fill in the beds, and will make it easier for the runners to root. It will also keep those plasticulture plants humming along.

Planting stock
One critical point with dormant plants is to leave the plants at the nursery until you are ready to plant, unless you have storage facilities that don't have apples in them and where the plants can be kept very cold (30-31 degrees). If the plants are held at warmer temperatures for even a couple of extra weeks, they are using carbohydrate reserves just to stay alive that they should have been putting into growing leaves and roots, plus they tend to send out leggy leaves that get broken off at planting.

A second point is to order a few more plants than you need, and give yourself the option of discarding very small ones. It seems that some smallish plants often are in the orders, but very small weak plants seen to spend a good part of the summer growing to the size they should have been in the first place, when instead they should be

producing runners to fill in the row in matted-row plantings, and branch crowns to increase yields in plasticulture ones. In matted-row plantings, those early-rooting daughter plants will provide much of the yield for the following year.

In plasticulture, a higher proportion of the small plants don't survive if planted, and those that do produce lower yields, resulting in a decrease in overall yields. It takes just as much (or more) time and money to take care of a partially filled weak bed as it does to take care of a vigorous one, and the payback is worse. In this photo, the two plants on the left would be fine to use, while the one on the right, only measuring about ¼" in diameter, is too small.

Nitrogen (in moderation)

Notice that your plants aren't looking so green, or aren't growing all that well? First, makes sure there is sufficient moisture in the soil, and if lack of moisture isn't the problem, 20-25 or so pounds of nitrogen per acre in matted row plantings, along with enough water to give the plants a good drink, often makes them jump. Apply the recommended fertilizer rates (according to your soil test results, of course!) at planting, and then fertilize when the first runners start being produced, and again in mid-August. In plasticulture plantings of June-bearers, the rule of thumb is still 60 pounds per acre of nitrogen pre-plant incorporated before planting, and 30 pounds of nitrogen per acre in the spring. For day-neutrals, 60 pounds per acre pre-plant and 1 pound of nitrogen per acre per week during the growing season has worked well.

The bottom line is that if the planting starts out vigorous, you won't have to spend money and time trying to coax it along later. Chances are that the plant growth will outpace much of the damage from diseases and insects, and competition from weeds. All of this together makes planting care easier in the long run, and helps ensure a good return on your investment. (***Source**: Penn State Fruit Times, April 28, 2017*)

RASPBERRIES/BLACKBERRIES

Orange Rust in Brambles

Bruce Bordelon, Purdue Univ.

Orange rust is one of the most common diseases of blackberries and black raspberries in the Midwest. It is a systemic disease that is confined to Rubus spp. (autoecious). There are two forms, a long-cycle form that occurs on black raspberry, and a short-cycle form that occurs on blackberries. There are two causal organisms: *Arthuriomyces peckiamus* (the long-cycle form) and *Gymnoconia nitens* (the short-cycle form). All varieties of black raspberry and many varieties of erect blackberries are susceptible. Red raspberries are immune to orange rust.

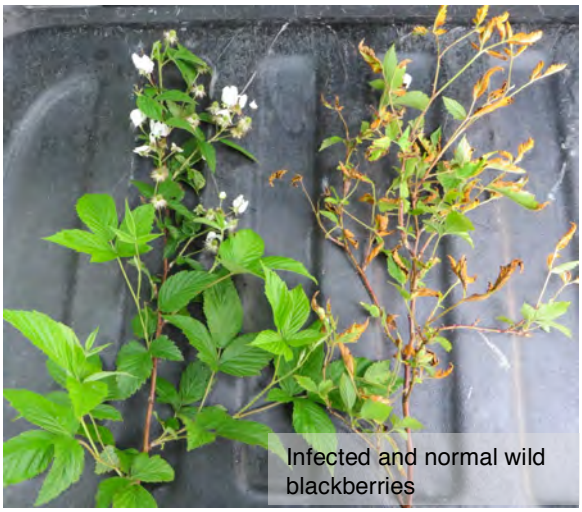
Wild blackberry showing normal and infected leaves

Symptoms of the disease can be seen in early spring when new primocanes emerge. Infected plants produce an abundance of spindly canes that have misshapen leaves that are often pale green or yellow. Within a few weeks of emergence, the lower leaf surfaces become covered with blister-like masses of orange aeciospores. This is the most characteristic stage of the disease. Infected plants are quite obvious with brilliant orange leaves. They are showing up now.

Close up of blister-like pustules on lower leaf surface

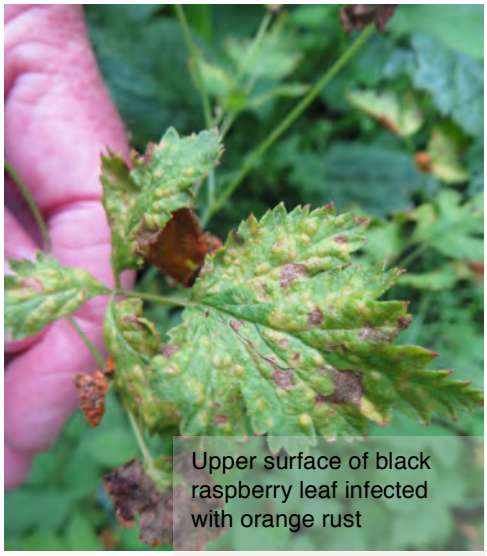
The disease cycle of orange rust is complex. Aeciospores from infected canes spread the disease to mature leaves on canes of other plants. Infected leaves develop teliospores later in the summer, which germinate to produce a basidium, which in turn produces basidiospores. The basidiospores infect buds on

primocanes at the base of the plants. These infections will spread down through the canes and into the crown, eventually infecting the entire plant. In subsequent years, new canes that emerge from infected crowns will be infected. The fungus persists in the crowns as perennial mycelium.



Infected and normal wild blackberries

Damage from orange rust is significant. Even though infected plants seldom die, they are weakened and do not produce quality fruit. Thus they represent a complete loss. That said, heavy infestation of plantings is not common. The disease is usually sporadic. This helps growers manage the spread.



Upper surface of black raspberry leaf infected with orange rust

Since orange rust is a systemic fungal disease, management and control is primarily through rouging infected plants. Once infected, a plant cannot be cured. Removing infected plants entirely, including the roots, is the best way to prevent spread. Remove infected plants as soon as they appear in the spring before they release spores. Eradicate infected wild *Rubus* plants in the near vicinity of your planting. Any management practice that encourages air circulation within the canopy such as thinning canes within the row, removing floricanes immediately after harvest, weed management and proper nutrition will aid in disease control by reducing the duration of leaf wetness. The multiple cycles of infection by the various spore stages make fungicide management very difficult. While a few fungicides are registered for use, chemical control alone is impractical. Proper management is key to controlling orange rust. Fungicide recommendations can be found in the 2017 Midwest Fruit Pest Management Guide. https://ag.purdue.edu/hla/Hort/Pages/sfg_sprayguide.aspx [**Editor's Note**: … or the 2017-18 New England Small Fruit Pest Management Guide] (***Source***: *Facts for Fancy Fruit, Issue 17-03, April 27, 2017*)

Lower surface of black raspberry leaf infected with orange rust

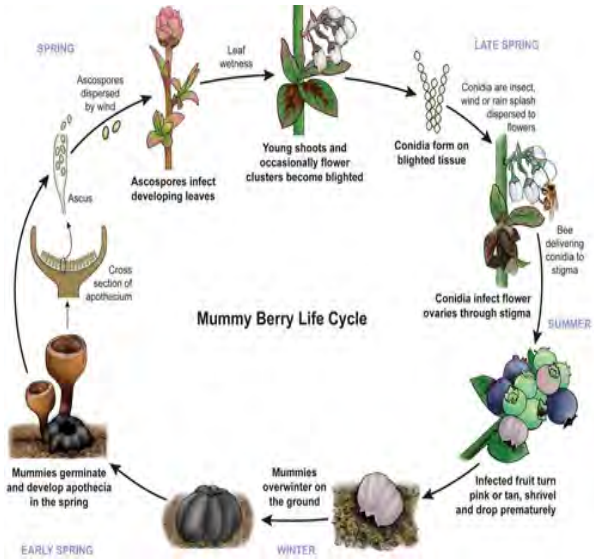
BLUEBERRY

Managing Mummy Berry Shoot Strike Infections

Mark Longstroth, and Annemiek Schilder, Michigan State University

With spring, a blueberry grower's thoughts turn to preventing mummy berry. Warm weather has blueberries growing rapidly and leaf tissue is quickly emerging. This young tissue is susceptible to infection by mummy berry (*Monilinia vaccinii-corymbosi*).

Mummy berry needs to infect blueberries twice every year to survive. Spores from overwintering mummies need to infect the new growing shoots. This primary phase of the disease is commonly known as shoot strike. Early disease control is focused on preventing shoot infections. Infected shoots die and spore from these infections are spread to the flowers during bloom.



The primary phase of mummy berry (shoot strike) is on the left side of this diagram of the mummy berry life cycle. Source: Michigan Blueberry Facts: Mummy Berry (E2846)

Mummy berry apothecia, called trumpets or mushrooms, have emerged from the mummies in southwest Michigan. Mushroom numbers so far are low to moderate, perhaps due to drier conditions since mid-April. Rains may result in a second or third flush of apothecia. If apothecia are present as well as green leaf tissue, blueberry growers need to protect against mummy berry.

As the leaf buds expand, the exposed leaves are susceptible to infection by ascospores from the apothecia. Ascospores are often discharged in the morning when relative humidity drops and the wind speed picks up. Ascospores are dispersed by the wind and can move a good distance from the apothecia. Spores can blow in from neighboring fields or from volunteer or wild blueberry bushes around the field. Growers should monitor their fields for mummy berry trumpets and watch the weather to anticipate disease infection periods.

The ascospores need water to germinate. For an infection to occur, the leaf tissue must be wet long enough for the fungal spore to germinate and infect the young tissue. Paul Hildebrand of Ag Canada in Nova Scotia has determined the infection conditions necessary for shoot infection in lowbush blueberry; these seem to hold up for highbush blueberry as well. At 57˚F (14˚C) with adequate moisture, infection occurs in five to six hours. At 36˚F (2˚C), 10 hours of leaf wetness are required for infection. The warmer the temperature, the shorter the wetting period required for infection. The optimum tempe-rature for infection is about 68˚F. Over 80˚F, conditions are less favorable for fungal growth and the fungus needs longer wetting periods for successful infection.

Table 1. Mummy berry shoot infection conditions.

Wetness	**Average temperature (F) during wet period**				
Duration (h)	**36**	**43**	**50**	**57**	**65**
2	0	0	0	0	0
4	0	0	0	0	0
6	0	Low	Low	High	High
8	0	Mod	High	High	High
10	Mod	High	High	High	High
15	Mod	High	High	High	High
24	High	High	High	High	High

Source: Paul Hildebrand, Ag Canada, Nova Scotia

Growers can use Table 1 to estimate risk in their blueberry fields. You can also use Michigan State University's Enviro-weather website to monitor for mummyberry infection conditions. There is no specific mummy berry model, but blueberry growers can use the Multi-Crop Disease Summary tool in the fruit section of Enviro-weather. This tool reports the hours of wetness and the average temperature during a wetting period for all the stations in the region. The columns for duration and average temperature are located near the middle of the table. This tool can be used to estimate the risk on your farm by comparing similar or nearby stations. This allows growers to determine the disease risk during or

soon after wetting events. In 2014, we plan to have a mummy berry model available for Enviro-weather.

Another important disease control decision is what fungicides to use in your mummy berry control program. Some of the more effective mummy berry fungicides are shown in Table 2. Some materials work well against both phases of the disease, but most are better against one or the other. Fungicides that are effective at preventing shoot strike are materials that are good at protecting young leaf tissue, usually under cooler spring temperatures. The table groups materials by whether they are systemic or protectant fungicides.

Table 2. Fungicide efficacy against mummy berry in blueberries

Fungicide		Specific infection controlled	
Trade Name	**FRAC Code**	**Shoot strike (primary phase)**	**Fruit rot (secondary phase)**
Systemic fungicides			
Indar	3	+++	+++
Quash	3	+++	+++
Orbit	3	+++	++
Omega	3	++	++/+++
Pristine	11/7	++	+++
Quit Xcel	11/3	++	++
Protectant fungicides			
Serenade + Nu-Film	44	++/+++	++
Sulforix	M2	+++	++
Bravo	M5	++	+
Ziram	M3	++	++

Protectant fungicides are deposited on the surface of the plant and kill fungal spores as they germinate. Protectant materials need to be applied before the infection event to be effective. Systemic materials are absorbed into the plant and kill the fungus as it tries to penetrate the plant. The table also shows the FRAC (Fungicide Resistance Action Committee) code. The FRAC code indicates the mode of action of the fungicide. To reduce the risk of fungicide resistance in the mummy berry fungus, it is a good idea to use fungicides with more than one mode of action to control mummy berry. This can be done by alternating materials with a different mode of action (FRAC code) between sprays or mixing materials with different modes of action.

The new fungicide Quash is as effective as the current grower standard Indar. Quash has a seven-day PHI (Indar and Orbit have a 30-day PHI) and has excellent activity against phomopsis and moderately good activity against anthracnose fruit rot. Quash, Indar and Orbit all belong to FRAC group 3, meaning they are sterol inhibiting (SI) fungicides and have the same mode of action. There are minor differences between the compounds in the same group, so some are more effective than others against the same disease.

The SI fungicides are readily absorbed into the leaves and kill the fungus as it penetrates the leaves. This group of fungicides moves throughout the leaves where they were applied and provides protection until the growth of the leaf dilutes the fungicide concentration, making it no longer effective. This period of protection is about four to five days or less, depending on the rate of growth of the plant. The SI fungicides can kill the fungus soon after the initial infection while the fungus is still small. This ability to kill the fungus after the initial infection gives these materials back action of about 24 hours. This gives growers the ability to wait for an infection period before applying a fungicide control.

FRAC group 11 comprises the strobilurin fungicides (e.g., Abound, Pristine). These materials are absorbed as well, but are generally weaker at killing fungi after an infection, i.e., they have less post-infection activity, and Michigan State University Extension recommends they only be used as protectant fungicides and should be applied before, not after, infection periods.

FRAC group 11 fungicides tend to have a strong affinity for the waxy layer on the plant surface and are less susceptible to wash-off from rain. However, they have a high risk of fungicide resistance development and a lower efficacy against mummy berry shoot strike. These products are recommended for application at or after bloom, when they also control other diseases such as phomopsis and anthracnose.

Finally, there are the true protectants such as Ziram and Bravo. FRAC codes beginning with M denote that the group has multiple modes of action and are less susceptible to fungicide-resistance problems. Protectant materials remain on the plant surface and are often tank-mixed with systemic materials. The advantage of mixing two materials with different modes of action is that it reduces the risk of fungal resistance to a specific group of

fungicides and mode of action and giving a longer period of control with a protectant material on the outside of the plant.

An effective mummy berry control strategy requires that growers understand the disease and the strengths and weakness of the control products available to them. (***Source**: Michigan Fruit IPM Update, May 3, 2013*)

Scouting And Managing Mummy Berry In Blueberries

Annemiek Schilder, Michigan State Univ.

Now is the time to scout under your blueberry bushes for mummy berry mummies. Michigan State University Extension advises scouting in "hot spots" first, especially wet areas and close to the woods with a history of the disease. Due to snow cover over the winter and a very wet spring, an early crop of apothecia is ready to shoot ascospores into the air and cause shoot strike infections (if green tissue is present).

If you haven't been monitoring mummy berry mummies under your blueberry bushes, now is the time to do so.

Mummy berry mummies look like tiny, black pumpkins (about 0.375 inch in diameter) and may be partially embedded in the soil or located underneath leaf litter. Germinated mummies have small brown finger-like projections that develop into apothecia that look like small brown trumpets or goblets. There can be anywhere from one to six or seven apothecia on a mummy. Germination is heavily influenced by soil moisture. During a wet spring, we have measured up to 40 percent germination in high pressure sites and 2017 may fall into that category. In dry fields or dry years, only about 5-10 percent of the mummies may germinate. Mummies can survive at least two years if they have not germinated, but once they germinate, they die.

Apothecia are now visible in fields and range from barely open to almost 0.125 inch in diameter in the most advanced sites. Remember that the larger the apothecial cup, the greater the number of ascospores released and the higher the infection risk. Apothecia can become dime-sized under the right conditions and can discharge millions of spores into the air per day. Also, the more apothecia occur per unit area, the greater the infection risk. Since most growers have done a good job of controlling mummy berry in past years, the number of apothecia in blueberry fields will generally be low, but it is good to keep an eye on the fungus to time fungicide sprays.

There are various options for managing mummy berry. First, is it important to ascertain that there are apothecia that are large enough to shoot ascospores (greater than 2 millimeters or roughly 0.0625 inch) in the field and that green leaf tissue is present. If you saw shoot strikes or mummified berries in the field last year, it is safe to assume there are apothecia present now. If there are neighboring fields with mummy berry, there is also a risk of infection since the ascospores are windborne and theoretically can travel at least a mile on the wind. However, in practice, most ascospores travel only about 30-100 feet from the source.

The wettest sites or areas in the field are at the highest risk unless they are completely flooded. In flooded fields, apothecial development will be somewhat delayed, but they will become visible when the field drains. Dormant sprays with lime sulfur suppress mummy germination, and a ground spray of urea can burn apothecia if they are present. Protective fungicide sprays can prevent shoot strikes, which are the primary infections.

Fungicides work best when applied preventatively (before infection). While the risk of fungicide resistance development appears to be low for this pathogen, it is nonetheless advisable to alternate fungicide chemical classes as indicated by different Fungicide Resistance Action Committee (FRAC) code numbers. If shoot strikes are controlled well (you can scout fields to confirm this) and no shoot strikes are present during the bloom period, the risk of fruit infection is minimal. Be careful with fungicide applications during bloom: avoid spraying after bee hives have been placed in the field or spray at night when bees are not active.

Fungicide efficacy against mummy berry in blueberries.

Trade name	Active ingredient	FRAC Code*	Shoot strike	Fruit infection
Systemic fungicides				
Indar	fenbuconazole	3	Good efficacy	Good efficacy
Proline	prothioconazole	3	Good efficacy	Good efficacy
Quash	metconazole	3	Good efficacy	Good efficacy
Tilt	propiconazole	3	Good efficacy	Moderate efficacy
Protexio	fenpyrazamine	17	Good efficacy	Good efficacy
Omega	fluazinam	33	Moderate efficacy	Moderate/ Good efficacy

Pristine	pyraclostrobin + boscalid	11/7	Moderate efficacy	Good efficacy
Quit Xcel	azoxystrobin + propiconazole	11/3	Moderate/Good efficacy	Moderate efficacy
Inspire Super	difenoconazole + cyprodinil	3/9	Good efficacy	Good efficacy
Protectant fungicides				
Bravo	chlorothalonil	M5	Moderate efficacy	Poor to fair efficacy
Ziram	ziram	M3	Moderate efficacy	Poor to fair efficacy
Serenade + Nu-Film P	*Bacillus subtilis* + terpene-based adjuvant	44	Moderate efficacy	Moderate efficacy
Double Nickel 55	*B. amyloliquefacies*	44	Moderate/ Good efficacy	Moderate efficacy
Sulforix	calcium polysulfide	M2	Moderate efficacy	Poor to fair efficacy
Oso	polyoxin D zinc salt	19	Moderate efficacy	Moderate efficacy
Regalia	giant knotweed extract	P5	Moderate efficacy	Moderate efficacy

*Fungicides sharing the same number belong to the same chemical class and thus have the same mode of action.

Dr. Schilder's work is funded in part by MSU's AgBioResearch.

*(**Source**: Michigan Fruit Crop Advisory, April 18, 2017)*

Trapping for Fruitworm Pests as Part of Your Blueberry IPM Program

***Rufus Isaacs**, Michigan State University*

The warm, spring weather heralds the start of blueberry integrated pest management (IPM) programs. Some of the most important early-season pest insects are cherry and cranberry fruitworms. These can cause fruit infestation that can reduce yield in severe cases and cause fruit contamination, especially in the earlier-harvested varieties. Future Michigan State University Extension articles will focus on the management of these with biological and chemical methods, but given the early phase of the season, this article will highlight use of monitoring traps to detect these pests and help growers know when to protect their crops.

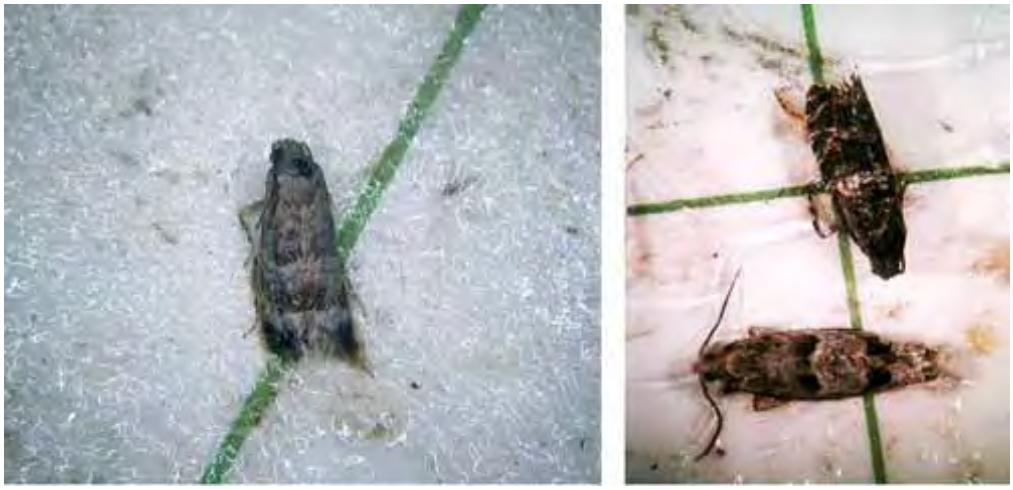
All insects, and blueberry bushes, develop based on heat accumulation, and this can be tracked with growing degree days (GDD). The table below shows the approximate growing degree days for Van Buren and Ottawa counties in Michigan for when various crop growth stages occurred, as well as key fruitworm pest events. This also shows the average growing degree days at two different base temperatures (42 and 50 degrees Fahrenheit) when these events occurred. The information was summarized from a four-year research project in Michigan blueberries.

Approximate dates and growing degree day (GDD) timings for key activity events in the lifecycle of cherry and cranberry fruitworms in Michigan blueberries

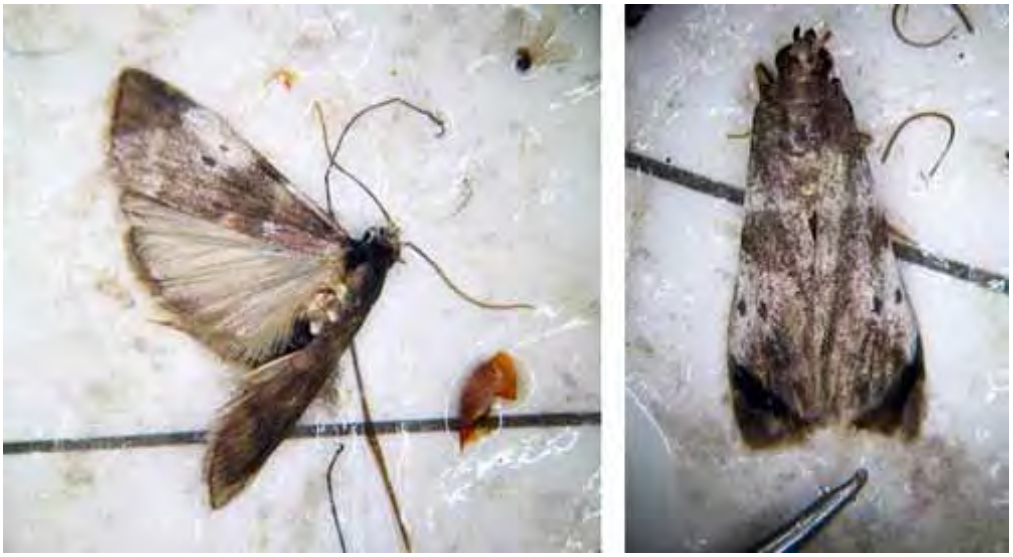
Event	**Date first seen**		**GDD 42**	**GDD 50**
	Van Buren Cnty	**Ottawa Cnty**		
Growth stages				
Bud break	April 17	April 18	224	108
Bloom	May 14	May 15	591	310
Petal fall	May 27	May 28	768	407
First harvest	July 15	July 15	2,060	1,313
Cherry fruitworm moths				
First	May 10	May 10	511	262
Peak	May 28	May 30	804	431
End	June 12	June 16	1,180	683
Cherry fruitworm eggs				
First	June 1	June 2	872	472
Peak	June 9	June 9	1,074	612
End	June 21	June 18	1,337	797
Cranberry fruitworm moths				
First	May 24	June 1	758	412
Peak	June 16	June 17	1,267	747
End	July 17	July 11	2,018	1,285
Cranberry fruitworm eggs				
First	June 6	June 11	1,235	732
Peak	June 9	June 13	1,264	776
End	June 19	June 15	1,401	856

This information can help you time when it is appropriate to place monitoring traps for fruitworms into blueberry fields, and we recommend that traps for cherry fruitworm are placed in fields this week to be sure to get one or more zero counts before the moths emerge. **This helps you identify the start of flight, and this can be used to time cherry fruitworm control treatments that should be started at 100 GDD**(base 50) **after the first moths are trapped.** If this pest has been causing significant damage in recent years, an application of Intrepid at 8 ounces per acre timed to coincide with early egglaying is an effective way to reduce this pest. Intrepid, as well as B.t. formulations such as Dipel, Javelin, etc., can control fruitworms without any risk to bees.

Moths of cherry and cranberry fruitworm as seen trapped in monitoring traps. Note the contaminant moth pictured in the upper right that can be confused with these fruitworm pests. It is an early-active moth that is attracted to the cherry fruitworm traps, but causes no economic injury to blueberries.



Left, male cherry fruitworm moth on trap. Right, male cherry fruitworm moth on trop (top) with contaminant moth below. Moth = 8-10 mm long.



Left, male cranberry fruitworm moth with wing opened. Right, male cranberry fruitworm moth on trap. Moth = 15-18 mm long.

To determine the start and activity periods of these two pests, each species can be monitored using a specific pheromone lure placed inside a monitoring trap. Use a pheromone trap with a sticky surface and place the lure inside the trap, ideally mounted on a pin to suspend it from the inside of the trap roof. Place the traps in the top third of the bushes and at field borders next to woods for the best chance of trapping the pests. Adding traps inside fields can help tell you whether they are abundant only at the field border. Traps of the two species should be placed at least three rows apart to separate the pheromones.

Check the traps weekly at a minimum and count and record the number of the target moth species detected. We typically keep records in a notebook, but the number and date can also be recorded on the bottom of the trap. During warm periods of the spring, more regular checking can help you get a more accurate handle on the first activity of the moths.

Lures and traps for these pests can be purchased from many suppliers, but a good local supply for these is Great Lakes IPM, 10220 E. Church Road, Vestaburg, MI 48891, telephone 1-800-235-0285. (***Source**: Michigan Fruit IPM Update, May 7, 2013*)

Prebloom Foliar Nutrient Sprays

Alice Wise, Cornell Cooperative Extension Suffolk County NY

Given the cost of fertilizers and fuel, it is important to think through the benefits of all foliar nutrients. Use tissue and soil analysis and vineyard observations to help determine the need for these. If possible, leave untreated areas to try and gauge the efficacy of the fertilizer.

Nitrogen – Some growers feel foliar N helps early spring growth; others feel the primary benefit is later in the season to maintain a green canopy and help avoid sluggish/stinky fermentations. Price may dictate what a vineyard can afford to use. Urea and proprietary NPK products are commonly used. Organic options include liquid fish and soy protein products.

Magnesium – Many growers include low rates (2-3 lbs/a) of Epsom salts (magnesium sulfate) in a few prebloom sprays. Several Mg app's (we use 3-4 total each season) through the course of the season are considered important in maintaining a green, healthy canopy.

Zinc - Considered essential for proper cluster development, berry set and normal shoot growth. Rely on soil and petiole analyses to gauge the need for this nutrient. Zinc sulfate, zinc oxide and chelated Zn are used as foliar sprays.

Boron – Also important for good fruit set. Boron (B) moves with the soil water, soil application is best used in the fall or with the spring herbicide. For foliar sprays, use ≤ 0.2 lb./a actual B in 1 or 2 prebloom sprays. The low rate reflects the high risk of phytotoxicity with boron. Improper calculation of foliar rates, sprays applied too close together and overzealous soil applications can all result in toxicity symptoms. Boron interferes with the dissolving of water-soluble packets used for certain pesticides - dissolve the packet thoroughly in the tank and then add B to the spray mix.

Manganese - At soil pH's >6.0, Mn availability in the soil is low. Where a deficiency is confirmed by petiole analysis, foliar applications of manganese sulfate (2-3 lbs./100 gal.) are recommended. Other manganese products used at label rates may also be effective. Foliar manganese oxide materials are considered to be less effective. Mn can be soil applied as well.

Calcium – Calcium (Ca) deficiency is best addressed through the soil via liming and use of gypsum (calcium sulfate). Foliar Ca is very common in apples but the case for Ca sprays in grapes is a little murkier. If choosing to try this observe label cautions as phytotoxicity can be an issue. If getting calcium into leaves is the goal, then earlier sprays might be useful. To improve fruit integrity, make the application when fruit is present as the mobility of Ca in the phloem is very limited.

Molybdenum – Molybdenum (Mo) deficiencies, though relatively rare, occur most commonly in sandy, acidic soils due to leaching. Quantities involved are minute but enough to trigger problems in some vineyard settings. There are studies, particularly from Australia, where Mo was effective in improving berry set in Merlot (esp. ownrooted vines) and a few other varieties. In one study, two sprays of sodium molybdate were applied in the prebloom period. Best candidate for these sprays: a Merlot block that frequently has less than optimal berry set which cannot be attributed to virus infection or other management issue.

Reference

Williams, C, Maier, N, Bartlett, L. 2004. Effect of Molybdenum Foliar Sprays on Yield, Berry Size, Seed Formation, and Petiolar Nutrient Composition of "Merlot" Grapevines. J.Plant Nutr. 27 (11): 1891-1916.

(***Source**: Long Island Fruit & Vegetable Update, No. 7, May 14, 2015*)

UPCOMING MEETINGS:

May 9, 2017 – *Wine Grape Producers: 2017 Updates*. 10am – 1:30pm. Newport Vineyards, 909 East Main Rd., Middletown, RI. Trunk Diseases , Dr. Elsa Petit, Exotic Insects, Dr. Lisa Tewksbury, Risk Management, Paul Russell, Worker Protection Update, Peggy Siligato. $10. For more information or to RSVP email: siligato@uri.edu or call 401-640-0484.

May 10, 2017 – UMass Fruit Twilight/Thinning Meeting. 5:30. Honey Pot Hill Orchards, 138 Sudbury Rd., Stow MA. http://www.honeypothill.com/ 1 pesticide credit will be offered. $20 admission. Light supper will be served. Contact: Jon Clements, 413-478-7219. Pre-registration is not necessary.

May 11, 2017 – UMass Fruit Twilight/Thinning Meeting. 5:30. UMass Cold Spring Orchard, 391 Sabin Street, Belchertown, MA. http://coldspringorchard.com/ 1 pesticide credit will be offered. $20 admission. Light supper will be served. Contact: Jon Clements, 413-478-7219. Pre-registration is not necessary.

May 11, 2017 – Rhode Island Fruit Growers Association Meeting. 5:30. Dame Farm & Orchards, 91B Brown Ave., Johnston, RI. Sonia Schloemann from UMass will be joining us and giving an update on SWD and other timely topics. Heather Faubert will talk about gypsy moths and winter moths. Pesticide credits available. Meeting is free for RIFGA members or $20 for non-members. For more information contact Heather Faubert at hfaubert@uri.edu.

May 17, 2017 – UNH Tree Fruit Twilight Meeting. 5:30-7:30pm. Stone Mountain Famr. 522 Laconia Rd., Belmont, NH 03220. For more information contact George Hamilton at George.hamilton@unh.edu or see: https://extension.unh.edu/events/index.cfm?e=app.event&event_id=43133

May 26, 2017 – *Early Season Blueberry Planning*. 3-5pm. Haynes Homestead, 172 Harvey Swell Rd., Colebrook NH, 03576. For more information see: https://extension.unh.edu/events/files/41FC38F1-5056-A432-4FDE26C7DAEDAFC2.pdf

May 31, 2017 - Lowbush Blueberry Field Meeting. 5-6:30pm. 355 Teneriffe Rd., Milton, NH. For more information see: https://extension.unh.edu/events/files/E4F25678-5056-A432-4FB4E03E00CE8C05.pdf