

Mummy berry disease

Forecasting Method

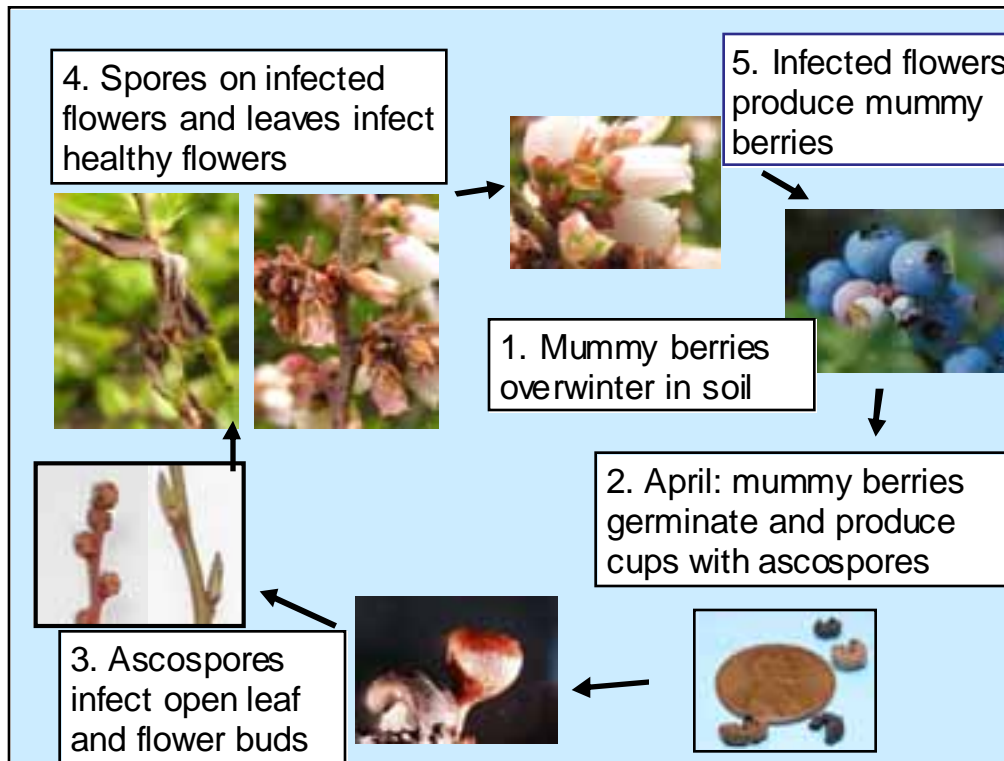
Seanna Annis, Kristen McGovern and Dave Yarborough



A Northeastern IPM grant entitled "Improving the control of mummy berry disease while decreasing the use of fungicides in blueberry production of Northern New England" was awarded to increase the use of the mummy berry forecast method by growers so that fewer, more accurate applications of fungicides can be used to control this disease. Funds from this grant and matching funds from the Wild Blueberry Commission of Maine will also support research on the effectiveness of lower risk fungicides to control mummy berry disease and the interactive effects of fertilizer, weed control and fungicide applications on the management of disease and health of the plants.

The photo on the left shows dead leaves producing the spores (called conidia) approximately 9 days after infection by the mummy berry fungus. These conidia will NOT re-infect leaves but will infect healthy flowers to produce mummy berries.

The photo on the right show a penny with 4 mummy berries, demonstrating their coloring, shape and small size. In the spring, the leaf and flower buds are infected by ascospores produced in cups from germinated mummy berries.



The life cycle of the mummy berry fungus (please follow the pictures and captions clockwise starting from the box 1 in the middle right of the diagram).

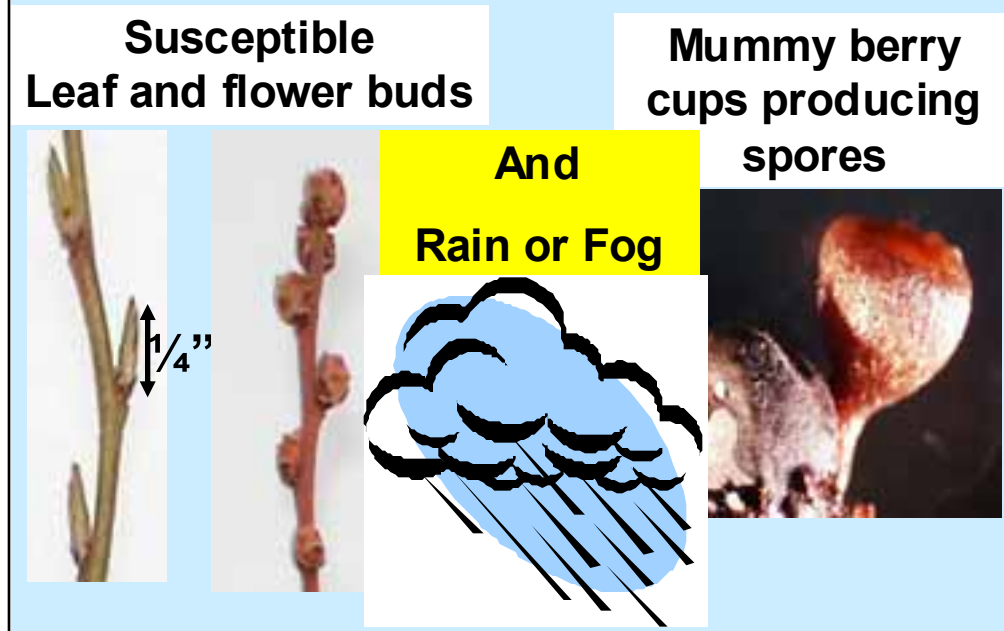
1. Mummy berries fall to the soil and overwinter in the leaf layer or in the top layers of soil.
 2. In the spring, end of April to May, the mummy berries germinate and produce cups that contain ascospores.

3. The ascospores are actively shot into the air from the cups and are carried by the wind to land on blueberry plants. These ascospores are on the plants as long as there are mummy berry cups in the field. The ascospores do not last long on the plants but they are constantly replaced by new ascospores being shot off into the air. Blueberry leaf buds are susceptible to the fungus once they have opened past green tip (approximately more than ¼ “) and the flower buds are susceptible once they look like small crowns (with pointy tips to the open outer scales around the flower buds).

4. If there is a long enough time where the surface of susceptible leaf and flower buds are wet (from rain or fog) then the fungus will penetrate into the plant and start to grow. There must be surface water on the plant for the fungal ascospores to germinate and infect the plant. (See chart on slide 4 for chance of infection and plant wetness information)
 The infected leaf and flower buds will look and develop normally for approximately 8 days, but then will rapidly die and produce a second type of spores at the base of the leaves and flowers. This second type of spores do NOT re-infect leaves or flower buds so they will not cause more death of leaves or flower buds.

5. The second type of spores are carried by pollinators to healthy open flowers where the spores infect the flowers and grow into the ovaries (where the seeds are produced). As the blueberry fruit develops, the fungus grows and replaces the fruit. At harvest, the infected fruit or mummy berry is grey, shriveled and smaller than normal fruit. During or after harvest, the mummy berry falls to the ground, and survives in the leaf litter and top layers of the soil over winter.

To Get Disease, You need:



To get disease you need these three things to be present at the same time in your field.

You need:

1) susceptible leaf or flower buds. Leaf buds that are greater than $\frac{1}{4}$ inch long and flower buds that are in the "crown" stage (open enough that the tips look like small crowns) are susceptible and remain susceptible through out their growth.

2) mummy berry ascospores (produced by mummy berry cups) on the leaf and flower buds. If there are active mummy berry cups in the field then there are spores on the plants. When the cups are too old to produce spores that is when there is no longer any chance of infection.

3) a long enough period of wetness on the plants for the fungal spores to grow and penetrate into the plant. Rain or Fog can cause a long enough period of plant wetness. Dew does not cause a long enough period of plant wetness. Please see next slide.

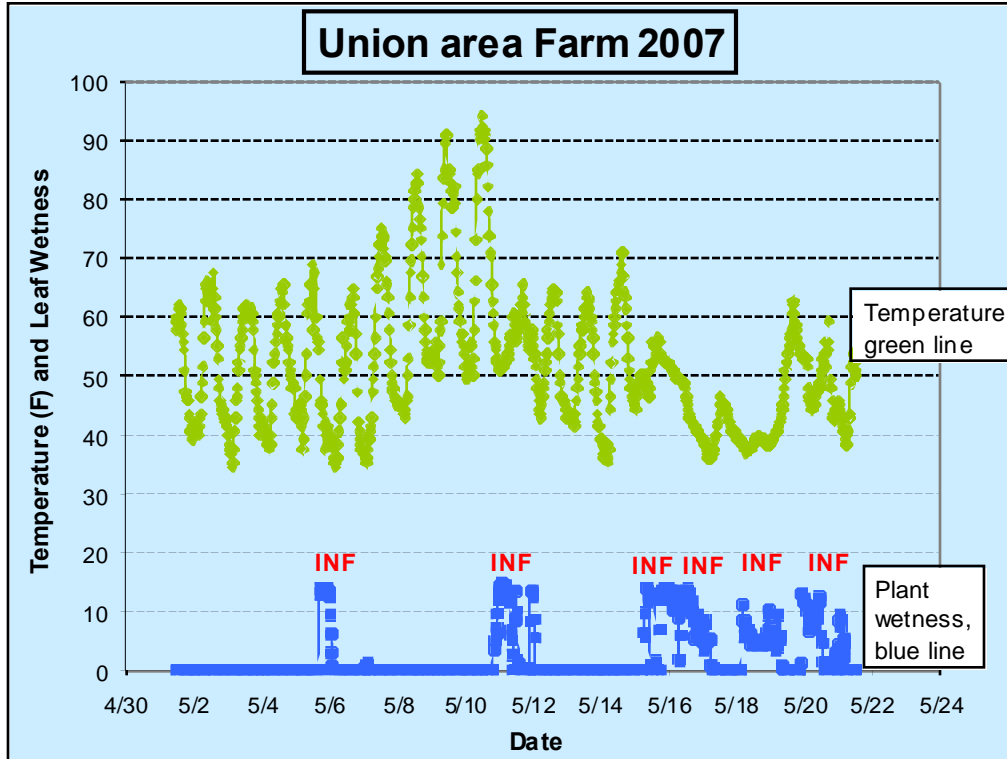
Risk of Mummy berry Infection (Fact Sheet 217)

Wetness Duration (Hours)	Mean Temperature (°F) during Wetness Period				
	36°	43°	50°	57°	65°
2	NONE	NONE	NONE	NONE	NONE
4	NONE	NONE	NONE	LOW	MOD
6	NONE	LOW	LOW	HIGH	HIGH
8	NONE	MOD	HIGH	HIGH	HIGH
10	MOD	HIGH	HIGH	HIGH	HIGH
15	MOD	HIGH	HIGH	HIGH	HIGH
24	HIGH	HIGH	HIGH	HIGH	HIGH

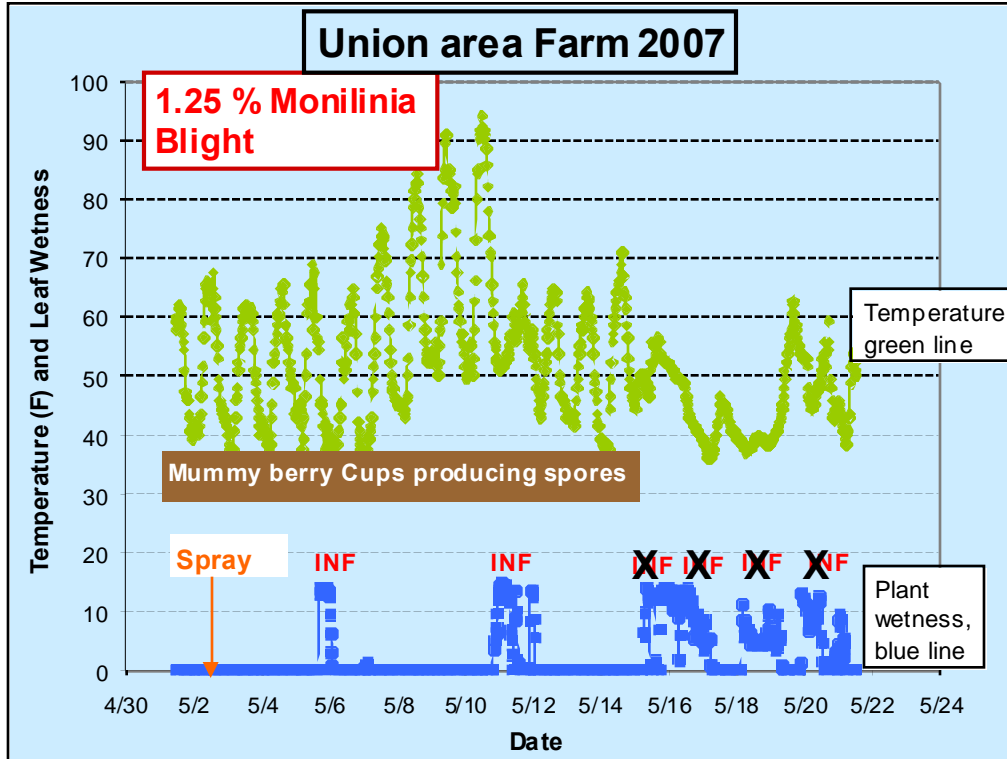
Data from Paul Hildebrand and Rick Delbridge,
Agriculture and Agri-Food Canada, Nova Scotia.

Like plants, the fungus grows faster at warmer temperatures and slower at cooler temperatures. At cooler temperatures, the fungus needs a long period of plant wetness for the fungus to be able to infect. At warmer temperatures, the fungus needs shorter lengths of plant wetness. For example at 36 F, the plant needs to be wet at least 24 hours for the fungus to infect, but at 50 F, the fungus only needs 8 hours of plant wetness to infect.

It is important to track how long rain or fog is in the area and the approximate temperature during the rain or fog to be able to predict if an infection period (time when the fungus can infect) has occurred.

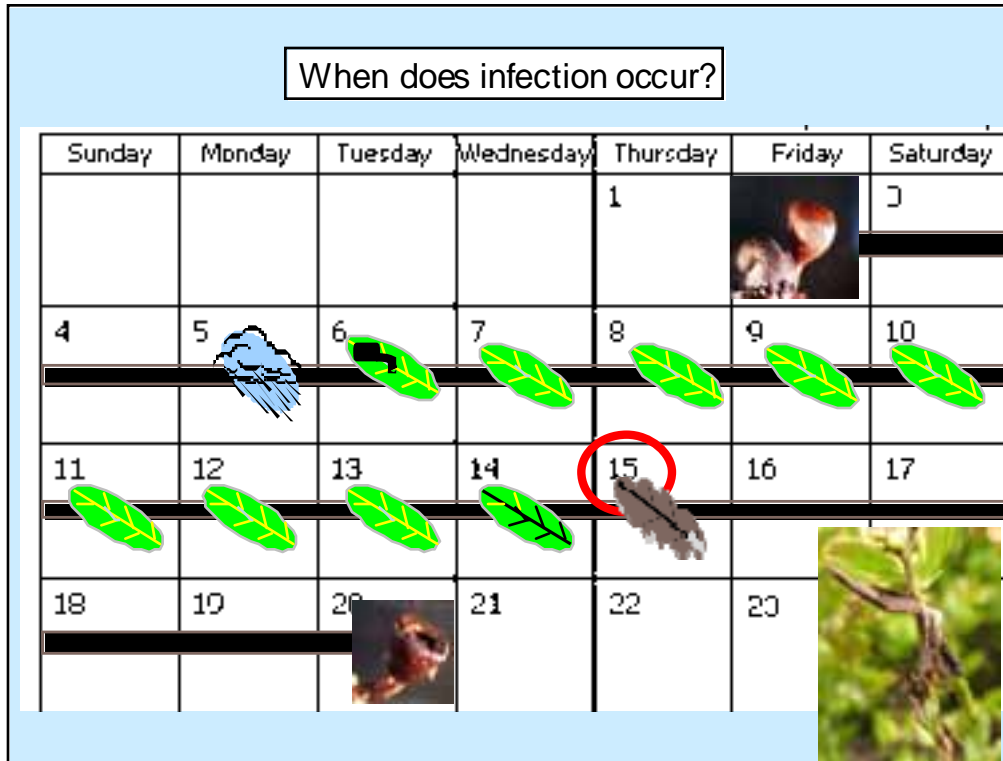


In 2007, we tracked the temperature and plant wetness in a field near Union. There was 6 days in May when the temperatures and length of plant wetness was long enough for the fungus to infect the plants (called an infection period and labeled in the diagram as “INF”. BUT... (see next slide).



BUT the mummy berries were only producing cups for a portion of that time from May 1st to May 15th (labeled with the brown box). So the weather events that occurred after May 15th do not matter since there were no fungal spores on the plants to infect them.

The grower was just plain lucky that year, since his fungicide application was on May 2nd which protected his plants during the two infection periods in his field. The mummy berry cups were finished producing spores by May 15th, but if the temperature had been a bit cooler from May 9th to May 11th (see graph) the cups would likely have still been producing spores during the rain from May 16th to 17th and this grower would have ended up with a lot of mummy berry disease in his field. Luckily he only ended up with 1.25% of stems with disease.







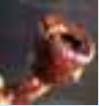


When does infection occur? Using the example, above let us assume that more than 40% of the plants are susceptible by May 2nd. Depending upon the weather, I have observed mummy berry cups producing spores from 2 ½ to 3 weeks. So in our example field, we might have active mummy berry cups from May 2nd (active mummy berry cup) to May 20th (dead cup).

However, even though there are fungal spores on the leaf and flower buds the fungus cannot infect the plants until there has been a long enough period of plant wetness. For example on May 5th (marked by the rain cloud) there has been an infection period (a long enough period of rain at a certain temperature to allow the fungus to penetrate the plant). So by May 6th the fungus has penetrated into the growing leaf.

This fungus is a stealth or sneaky fungus, since NO symptoms of disease will be seen on the plants and the leaves and flowers will develop normally for up to 8 days after infection. Sometimes you may see a blackening of the veins in the middle of the leaves on the day before they die. About the 8th or 9th day after infection, the leaves and flowers will suddenly die and produce grey powdery spores at the base of the leaves or flowers.

When you see dead leaves and flowers you are looking at the results of an infection that occurred 8 to 9 days before. There is NO point in applying fungicide to protect that plants against the spores produced on dead leaves and flowers, since this type of spore CANNOT infect leaves and will NOT kill off flowers. These spores are carried by wind and pollinators to healthy open flowers. The spores will infect healthy flowers and grow to eventually produce mummy berries.

The Calendar Method of timing fungicide applications						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		Some leaf buds opening	1 st SPRAY ORBIT	1		3
4	5 	6	7	8	9	10 
Protection				2 nd SPRAY ORBIT	Protection	
11	12	13 	14	15	16	17
Protection				Most leaves open		
18 	19 	20 	21	22	23	24

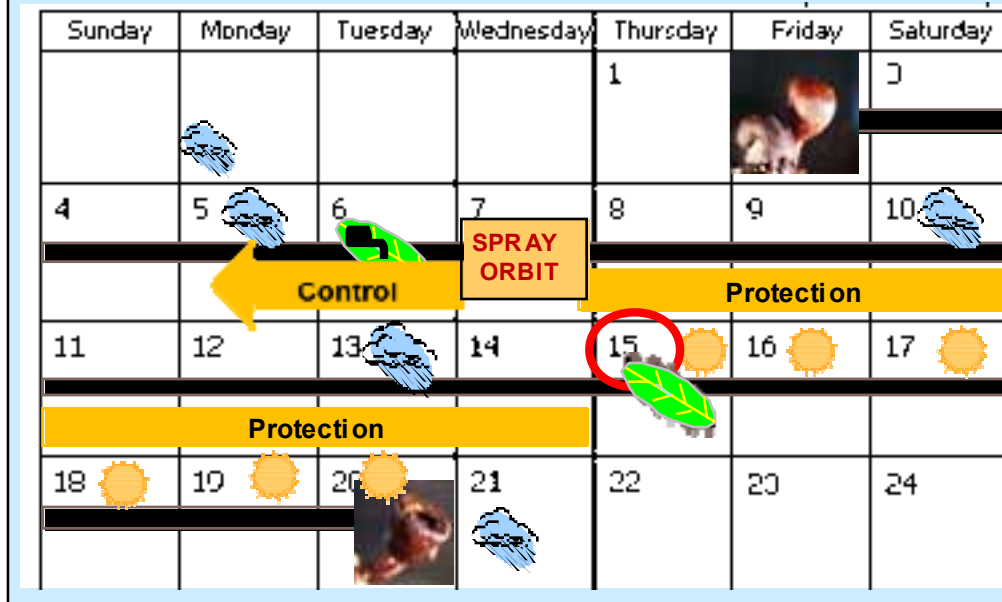
Following the calendar method, once some leaf buds are open, fungicide would be applied. If some leaf buds were open by April 30th, then fungicide would be applied on April 31st. But this application would have occurred before the fungus is even producing spores, or 2 days early. Even after the fungus starts to produce spores, there is not an infection period until May 5th. So while this first application of fungicide does protect the plants for 7 days and would protect the plant from the fungal infection period on May 5th, the fungicide was actually applied 5 days before there was any chance of the fungus infecting the plants.

Following the calendar method, if the weather was cool and wet, a second application of fungicide would be made about 7 days later, on May 8th. This would also protect the plant for another 7 days and through two more infection periods (May 10th and 13th). Once most of the leaves have unfurled, the grower will no longer spray fungicide, BUT the plants are still susceptible and in this case the fungus is still producing spores in this field.

If there is another infection period, for example on May 18th the plants are no longer protected and the fungus will infect the plants and cause disease 9 days later.

The end result is even though the grower thinks they got their fungicide applications on at the right times, there is still a lot of mummy berry disease in the field.

The Mummy berry Forecasting Method of timing fungicide applications



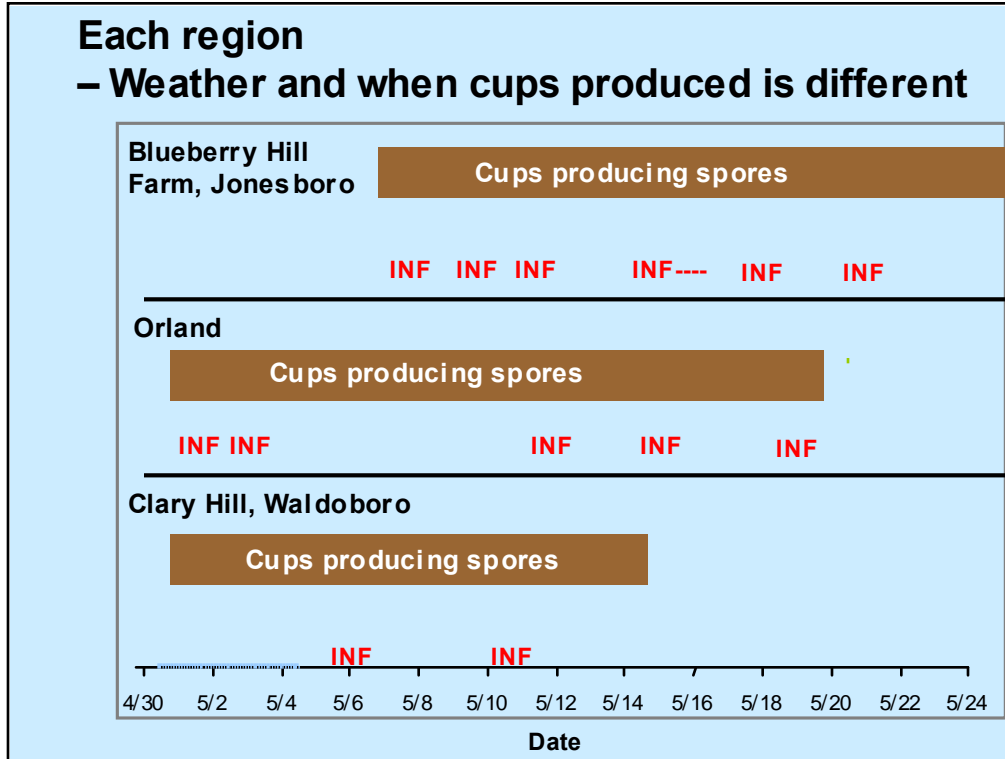
Using the Mummy Berry Forecasting Method, fungicides are not applied until an infection period has occurred. Using the same conditions as the previous example, an infection period occurs on May 5th so the fungus has gotten into the plants.

A fungicide application of propiconazole (Orbit, Bumper) or fenbuconazole (Indar) within 72 hours (3 days) of the start of an infection period will kill off the fungus in the plants. These fungicides have a 72 hour kickback effect because they can slightly penetrate into the plants and so kill off any fungus that has just infected the plants. In the above example, if fungicide is applied on May 7th it will kill off the fungus that infected the plants, and provide protection to the plants through 2 more infection periods on May 10th and May 13th.

The grower may only need to apply fungicide once in this field. If the weather is nice, sunny without rain, until May 20th when the fungus is no longer producing spores. There will be no infection periods and so no reason to apply fungicides. If the grower knows when the mummy berry cups are dead in their field then they also know when they no longer need to worry about mummy berry infection periods. So in this example, the rain on May 21st can be ignored because the grower knows there are no more mummy berry spores being produced in their field.

The Mummy Berry Forecasting Method has been used in Nova Scotia by blueberry growers for a number of years. Many years, growers need to apply fungicide once and in 2008, with the warm, dry weather, many growers did not need to apply fungicide at all.

**Each region
– Weather and when cups produced is different**



Weather events that can cause an infection period do vary by area, but not as much as the production of mummy berry cups. Usually weather events that can cause infection periods can be reasonably predicted for an area, since any weather event that will produce a long enough time of rain or fog (6 to 24 hours depending upon the temperature) is going to be a major storm and not scattered showers moving through an area.

However, I have found that when and how long mummy berry cups are actively producing spores in a field, varies a great deal by the field, region and year.

The figure above shows the length of time that active mummy berry cups were found in three fields and when infection periods occurred during 2007. In the Clary Hill field, active cups were produced for about 14 days and there was two infection periods. In a field near Orland, cups started being active about the same time as Clary Hill, but since the field was a wet one, the cups were active 5 days longer. Also there were more infection periods due to rain and fog events at the Orland site. At Blueberry Hill Farm in Jonesboro, the cups did not become active until May 7th but then stayed active for 18 days and there were 6 infection periods in this field.

Because of this variability among fields, the best way to predict when mummy berry cups are active in your field is to set up a mummy berry patch in the fall so you can follow the mummy berries progress in the spring.



Mummy berries are very hard to find if you don't know where to look. They are already scattered around fields that have had mummy berry disease previously. By setting up a mummy berry patch, you are not adding to the disease to your field, rather you are able to tell what the mummy berries are doing in your field, instead of them doing in any ways but without you knowing it.

For This Year – in Your Fields

To decide if and when you need to apply fungicides,

Answer these questions

1. Have you had mummy berry disease in your field before?
2. Are the plants in your field susceptible (>40% of stems have flower buds at the “crown” stage)?
3. Are mummy berries active in your area (use the Blueberry blog, or hot line to check the forecast)?
4. From the length of rain or fog and the temperature during this period, has an infection period to occurred (see bulletin #217)?

If YES to all 4 questions , then an application of fungicide will be needed to control disease.

For Optimal Control of Mummy berry disease:
Make a mummy berry patch in your field



1. This year before harvest, collect about 50 mummies
2. In a 2010 crop field, find a hollow that is typically a bit wet and clear off the leaf litter to the soil
3. Firmly press mummies into dirt (step on them)
4. Place stakes beside plot so you can find it next year
5. Track the progress of the mummies next year.



An example of a mummy berry patch with about 50 mummies. Takes about 2 inches by 2 inches of space.

Mummy Berry Cups

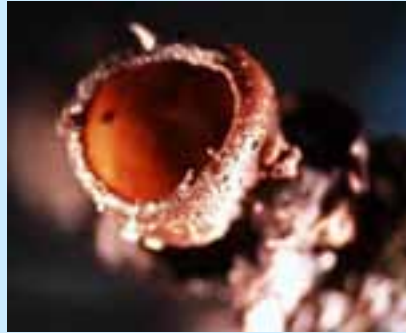


$\frac{3}{8}$ " to $\frac{5}{8}$ "

Developing Mummy Berry Cups



Mature Cups producing spores



**Old Cups
– NO spores**



For optimal control of mummy berry disease

1. **This Fall: Make** a mummy berry patch in YOUR field
2. **Next Spring: Track** development of mummy berry patch – when are spores produced?
3. **Track** when are buds susceptible (>40% of stems)
4. **Track** length of leaf wetness (rain or fog) and temperature
5. **Determine** risk of infection (Fact Sheet 217). Do you need to apply fungicide?