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Michigan Blueberry Facts

MICHIGAN STATE UNIVERSITY

Mummy Berry

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Pathogen

Monilinia vaccinii-corymbosi (Reade) Honey
Kingdom: Fungi; Class: Ascomycetes

Introduction

Mummy berry is a serious disease of blueberry in Michigan and also occurs in other blueberry-growing regions of the United States. The disease is characterized by blighting of young shoots and a dry fruit rot that mummifies the berries — hence the name "mummy berry." There is a zero tolerance for mummified fruit in the blueberry market.

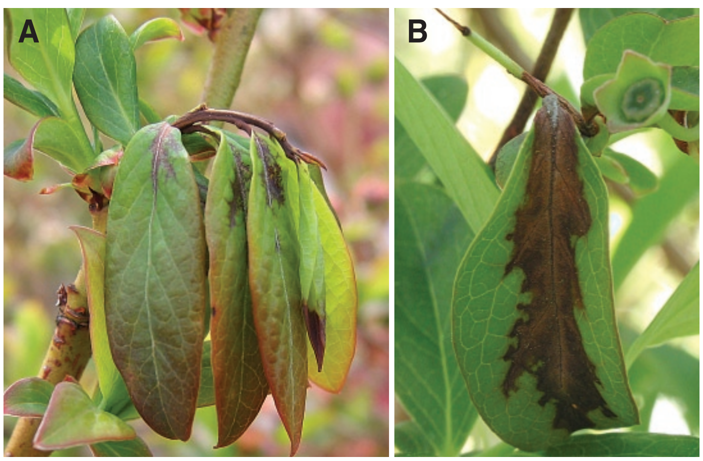

Figure 1. Mummy berry shoot strikes on blueberry shoots. **A)** Initial symptoms include wilting and brown discoloration of veins starting at the base of the leaf. **B)** Advancing infection indicated by oak-leaf pattern necrosis along leaf midrib.

Symptoms

Leaf, shoot and flower blight

The first symptom of mummy berry disease in the spring is wilting of young leaves and shoots and a browning of the midribs and lateral leaf veins (Fig. 1A). Browning occurs in a characteristic oak-leaf pattern along the main leaf vein (Fig. 1B). Eventually, the entire shoot dies and takes on a shepherd's-crook appearance (Fig. 2). The term "shoot strike" is often used to describe blighted shoots. Under humid conditions, tan to gray powdery spores (conidia) develop on infected shoots (Figs. 2, 3A). Occasionally, individual flowers or whole flower clusters may also become blighted (Fig. 3B). Flower strikes are less common than shoot strikes and may be confused with blossom blight caused by other fungi, such as *Phomopsis vaccinii* or *Botrytis cinerea*. However, the layer of gray spores on the pedicel (flower stem) is characteristic of mummy berry (Fig. 3B). Blighted tissues eventually dry up and fall off the blueberry bush.

Figure 2. Advanced infection of blueberry shoot showing leaf necrosis and gray spores on petioles.

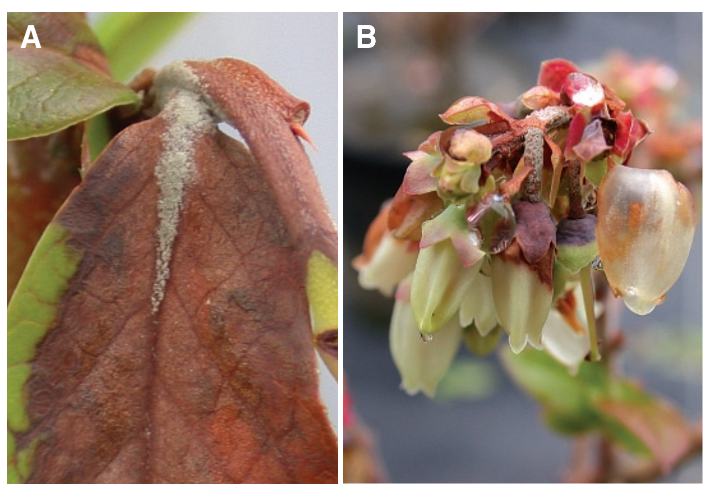

Figure 3. A) Close-up of gray layer of conidia along the midrib of a blighted blueberry leaf. **B)** Mummy berry flower strike (note gray spores on pedicel). *(Photo by Peter Oudemans, Rutgers University)*

Fruit mummification

No outward symptoms can be seen during the early stages of fruit infection. As the fruit approaches maturity, infected berries turn pink or light brown, in contrast to the waxy green of healthy fruit (Fig. 4). They are initially soft and develop a lightly ridged, wrinkled appearance (Fig. 6). Diseased berries eventually shrivel up and harden, becoming whitish purple or pink (Fig. 5A). Most mummified berries drop to the ground before harvest (Fig. 5B). As the fruit skin wears off during fall and winter, they start to look like tiny black pumpkins (Fig. 5C).

Figure 4. Blueberries infected by *M. vaccinii-corymbosi* turn pink to tan in contrast to the waxy green color of healthy fruit.

Disease cycle

The fungus overwinters in mummified berries (pseudosclerotia) on the ground below blueberry bushes (Fig. 5B). Pseudosclerotia (mummies) are tough survival structures made up of both fruit and fungal tissues. They can survive summer in warm climates and winter in cold climates. In the early spring as the temperature rises above 50°F (10°C), the mummies germinate to produce brown, goblet-shaped apothecia (Figs. 7, 8).

To germinate, the pseudosclerotia require a certain amount of moisture and a cold period of at least 900 to 1,200 chill hours (the number of hours with temperatures between 32° and 45°F [0° and 7°C]). This range is similar to that required for adequate bud break in northern highbush blueberry and allows apothecial development to coincide with early shoot development.

Figure 6. Blueberries infected by *M. vaccinii-corymbosi* develop ridges as berries mature. In the early stages, they are soft and rubbery. *(Photo by Bill Cline, North Carolina State University)*

An individual pseudosclerotium may produce anywhere from one to 10 stalked apothecia (Fig. 8). Apothecia are brown and up to 1 inch (2.5 cm) tall and 2/5 inch (1 cm) in diameter when fully mature. The inside of an apothecium is lined with a layer of tightly packed asci (Fig. 7), each of which contains eight ascospores (Fig. 10C). When the apothecia are at least 1/12 inch (2 mm) in diameter, they start to eject ascospores into the air (Fig. 9).

As apothecia expand, the number of ascospores released increases. Ascospore discharge depends on temperature, relative humidity and wind speed. Apothecia can persist for about 3 to 4 weeks under cool conditions — 50° to 59°F (10° to 15°C) — but are shorter lived as temperatures rise. At 68° to 77°F (20° to 25°C), they may persist for only 1 to 2 weeks.

Figure 5. A) Blueberry fruit infected by *M. vaccinii-corymbosi* shrivel up and take on a whitish cast as they mummify. **B)** Mummified berries on the ground after harvest. **C)** Mummified berries look like tiny pumpkins and turn black as the fruit skins wear off over the fall and winter.

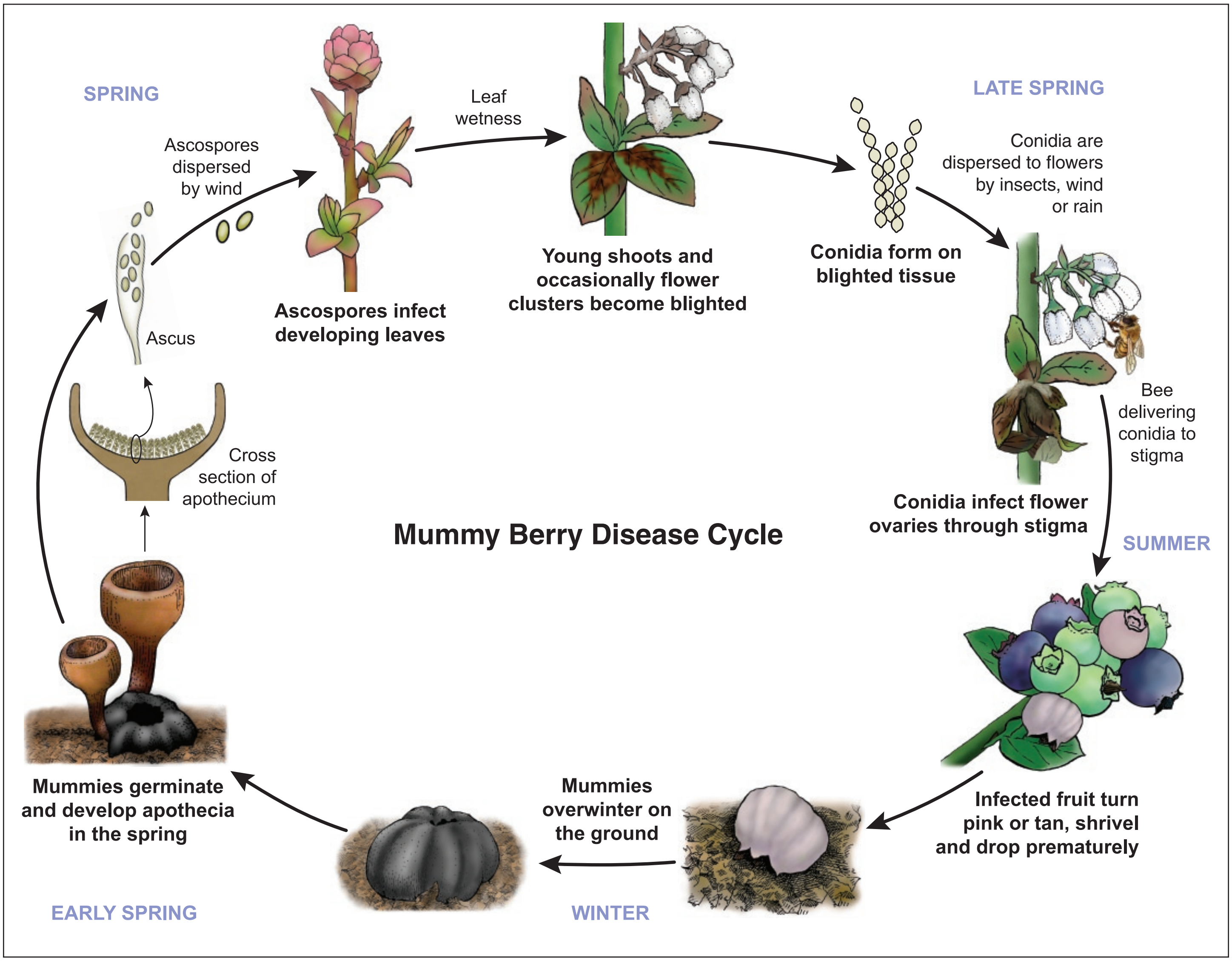

Figure 7. Disease cycle of mummy berry of blueberry caused by *Monilinia vaccinii-corymbosi. (Illustration by Marlene Cameron)*

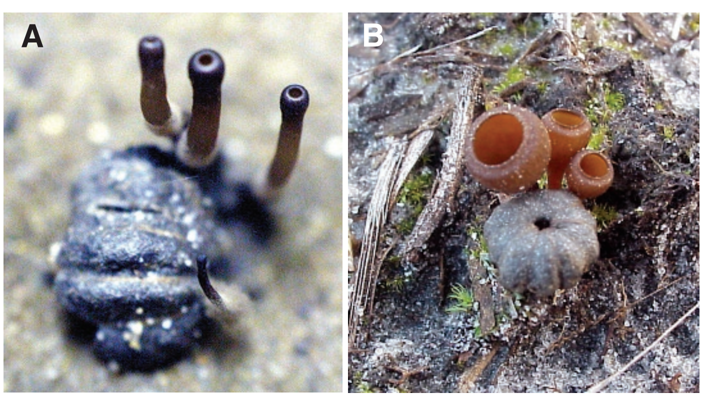

Figure 8. Germinated mummies (pseudosclerotia) of *Monilinia vaccinii-corymbosi*. **A)** Stalked, immature apothecia. **B)** Mature, open apothecia resembling small goblets or trumpets.
(Photo by Bill Cline, North Carolina State University)

Figure 9. Clouds of ascospores are shot into the air by apothecia of *M. vaccinii-corymbosi*. Ascospores are airborne and can be carried several miles on wind currents.

Apothecia may be damaged by a hard freeze or desiccate under hot, dry conditions.

Ascospores (Figs. 9, 10A) are carried by air currents to emerging leaves and flowers. Ascospore germination requires free water. The optimum temperature for infection is 57ºF (14°C). Vegetative buds are susceptible to infection as soon as green tissue is exposed. At 57ºF, with adequate moisture, germination and infection can occur within 4 hours; at 36ºF (2°C), at least 10 hours of leaf wetness are required for infection.

Shoot strike symptoms appear about 2 weeks after infection. In lowbush blueberry, young leaf and flower tissues are more susceptible to infection after exposure to freezing temperatures, and this susceptibility can last for up to 4 days after the freeze event. Freezing also predisposes shoots of highbush blueberry to infection. Under high relative humidity, asexual spores called conidia (Fig. 10B) are produced, forming tan to gray powdery masses on infected tissues (Fig. 3B).

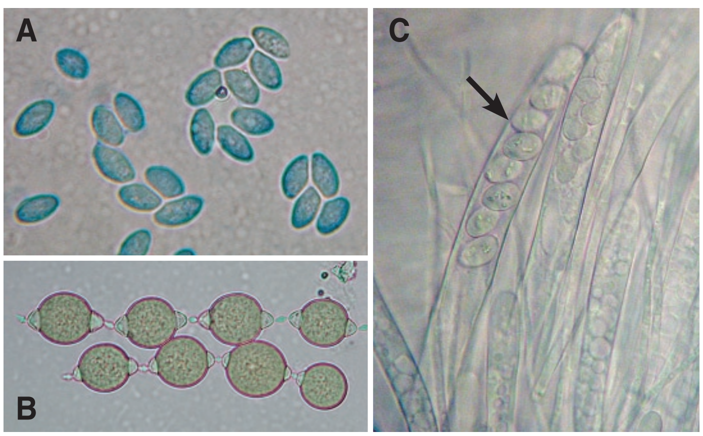

Figure 10. Spore types produced by *Monilinia vaccinii-corymbosi*. **A)** Ascospores (stained blue for microscopy). **B)** Conidia are produced in chains on shoot and flower strikes. **C)** Mature ascus containing eight ascospores (arrow) surrounded by immature asci.

Bees and flies are attracted by the UV light patterns reflected from infected shoots and may feed on a sugary substance in spore masses. They unwittingly deliver conidia to flowers during pollination (Fig. 11A). Conidia are also spread by wind and rain splash. Once on the stigma, the conidia germinate and grow down the style into the ovary (Fig. 11B). The presence of pollen enhances conidial germination and flower infection.

The fungus colonizes the developing berry from the inside, initially producing no visible external symptoms. However, if infected green fruit are cut open, white, cottony mycelium can be seen in the ovaries of the berry (Fig. 12A, E). As the infected berry begins to mature, the fungus slowly colonizes

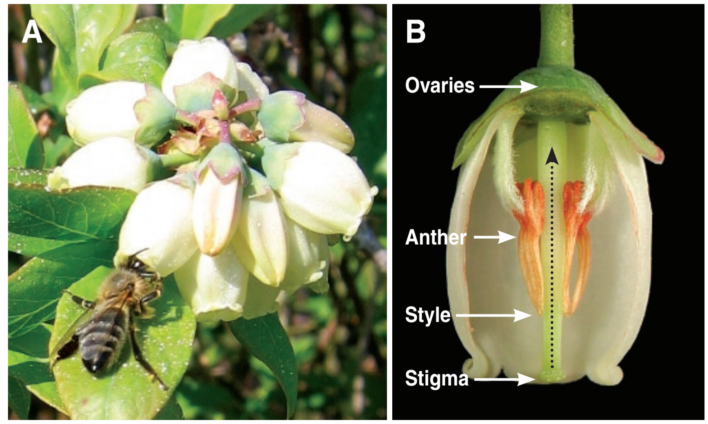

Figure 11. A) Bees and other insects inadvertently spread conidia of *M. vaccinii-corymbosi* to blueberry flowers, which are most susceptible on the day they open. **B)** The conidia germinate on the flower stigma and grow through the style into the ovaries (dotted arrow). *(Photo by Patricio Brevis)*

the entire fruit (Fig. 12B, C). The fungus lays down a darker, thick wall just below the fruit skin (Fig. 12D). By the time the berries are ready for harvest, all that is left of the fruit is a thin epidermal layer covering a hollow fungal structure called a pseudosclerotium (Fig. 12F). Infected berries shrivel and fall to the ground. During the fall and winter, the skin of the mummified berry decays, exposing the pseudosclerotium, which resembles a small, hollow, black pumpkin.

Management

Monitoring. Annual monitoring is important to determine if the disease is present in a field. Mummified berries are usually partially buried in the soil and leaf litter with the apothecia only just showing above the surface. They are well camouflaged, and it may be necessary to move leaf litter aside to find them. The first observation of apothecia on mummies indicates that there is an infection risk if green tissue is showing on the plant. Apothecial cups need to be at least 1/12 inch (2 mm) in diameter before they can discharge ascospores. The presence of blighted shoots (shoot strikes) in the spring or mummified berries on the bush in the summer is also a good indication of the disease.

Shoot strikes can be identified by the brown oak-leaf pattern and tan to gray powdery spore masses on the midrib (Fig. 3). Also, shoot strikes do not usually display browning of the wood beyond the green tissue of the infected shoot. Flower strikes may be distinguished from other blossom blights by the tan to gray spore masses on the pedicel.

Resistant varieties. Growing resistant varieties can aid in the control of mummy berry disease. For instance, Elliott and Duke are resistant to mummy berry; Rubel and Blueray are susceptible (Table 1).

The susceptibility of shoots and flowers to infection may vary within the same cultivar.

Cultural control. Cultural control of mummy berry is mostly aimed at the removal or inactivation of the primary source of infection, the mummified fruit. In the fall before leaf drop, mummies can be removed by raking or vacuuming, though this may not be practical on a large scale. Growers can also reduce disease by burying mummies — i.e., by shallow cul-

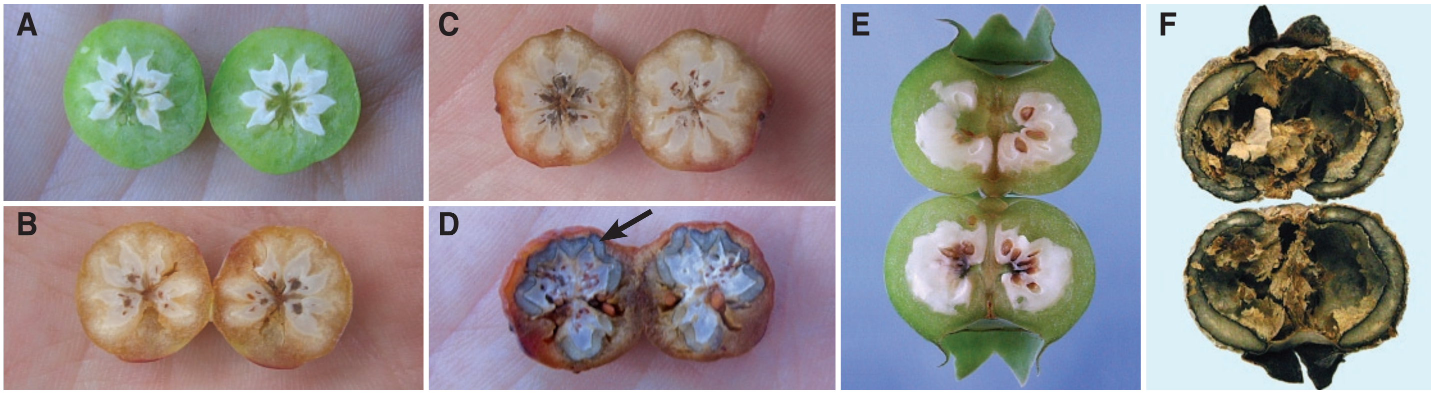

Figure 12. Progressive colonization of blueberries by *Monilinia vaccinii-corymbosi*. **A)** White mycelium in ovaries of outwardly symptomless green blueberries. **B, C)** Fungal mycelium expands and increases in density as the fruit turns brown. **D)** Dark, thick wall forms under the fruit skin (arrow). **E)** White mycelium in ovaries of green berry (transverse section). **F)** Mature pseudosclerotium is thick-walled and hollow and is surrounded by papery remnants of the fruit skin.

Table 1. Susceptibility of shoots and developing fruit of higbush blueberry cultivars to mummy berry.

Cultivar	Shoot susceptibility	Fruit susceptibility	Cultivar	Shoot susceptibility	Fruit susceptibility
Atlantic	I*	S	Herbert	S	S
Berkeley	I/S	S	Jersey	R/S	I
Bluechip	I	S	June	I	R
Bluecrop	I	I	Lateblue	I/R	S
Bluegold	S	R	Legacy	R	I
Bluehaven	S	S	Murphy	I	S
Bluejay	R	R	Nelson	R	I
Blueray	S	S	Northblue	S/R	R
Bluetta	R/S	I	Northland	I/S	R
Bounty	–	I	Northsky	S/R	R
Burlington	I/R	S	Patriot	–	R
Cabot	R	R	Pemberton	R	I
Collins	S	I	Pioneer	R	I
Concord	–	S	Rancocas	R/I	I
Croatan	S	S	Reveille	–	R
Coville	S/MR	I	Rubel	R/S	I
Darrow	R	I	Sharpblue	–	R
Dixi	R	S	Sierra	S	I
Duke	R	I	Spartan	I	I
Earliblue	R/S	S	Stanley	R	S
Elizabeth	R	S	Toro	R	S
Elliott	R	S	Weymouth	I/S	R

* S = susceptible, I = intermediate, MR = moderately resistant, R= resistant and -- = information not available.

The first rating in each column is based on artificial inoculation in New Jersey (Stretch, A. W., *et al.*, 1995. HortScience 30:589-591 and Stretch, A.W., and Ehlenfeldt, M.K., 2000. HortScience 35:1271-1273); the second rating, where present, is based on field observations in Michigan. Differences may be due to variation in the virulence of fungal isolates between regions.

tivation in the rows or by covering them with a layer of mulch. Mummies must be covered by at least 1.5 inches (4 cm) of soil or mulch to prevent germination. In the early spring, exposed apothecia can be burned off by a well-timed application of concentrated liquid fertilizer (urea). However, this may destroy only a portion of the inoculum because apothecial development is spread out over a fairly long period.

Chemical control. Chemical control is aimed at protecting the developing foliage and flowers from infection. Both protectant and systemic fungicides are available. Protectant fungicides have to be applied before conditions become conducive to infection; systemic fungicides can be applied within a limited period (12 to 24 hours) after an infection period has taken place.

If disease pressure is high, susceptible foliage and blossoms should be protected with fungicide sprays from early green tip until the end of bloom. Dormant sprays with lime sulfur may also provide some protection against mummy berry shoot strikes. Consult MSU Extension bulletin E-154, "Michigan Fruit Management Guide," for currently available fungicides and application timing information.

Biological control. Biological control involves the use of one organism to control another organism. Currently, a biofungicide containing the bacterium *Bacillus subtilis* (Serenade) is the only biological control agent registered for use against mummy berry on blueberries. This fungicide is OMRI (Organic Materials Review Institute) listed and can therefore be used in organic production.

Table 2. Fungicide efficacy against shoot and fruit stages of mummy berry infection in blueberry in Michigan.

Fungicide	Active ingredient	Behavior	Shoot strikes	Fruit infection
Abound	azoxystrobin	systemic	fair*	fair to good
Bravo	chlorothalonil	protectant	fair	poor
Cabrio	pyraclostrobin	systemic	poor to fair	fair
Captan	captan	protectant	poor	poor to fair
Captevate	fenhexamid + captan	systemic + protectant	fair	fair
Elevate	fenhexamid	systemic	poor	poor
Indar	fenbuconazole	systemic	good to excellent	good to excellent
Orbit	propiconazole	systemic	good to excellent	good
Pristine	pyraclostrobin + boscalid	systemic + systemic	fair to good	good
Serenade	*Bacillus subtilis*	protectant	fair to good**	fair
Sulforix/lime sulfur	calcium polysulfide	protectant	fair	poor
Switch	cyprodinil + fludioxonil	systemic + protectant	poor	fair
Ziram	ziram	protectant	fair	poor to fair

* Abound works better against shoot strikes in the southeastern United States than in Michigan. This difference may be due to differences in springtime temperatures.

** Efficacy of Serenade can be improved by adding the adjuvant Nufilm-17.

We gratefully acknowledge critical review of this fact sheet by Harald Scherm and Dave Trinka.