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2018-2020 Chart Book: Disease Management

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DISEASE MANAGEMENT 2018 - 2020

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UPRIGHT DIEBACK

Cranberry plants affected by this disease typically have individual uprights that die back from the growing point toward the runner. Every upright may be infected on some runners, while other runners may only have one or a few infected uprights. In severe cases, the entire runner will be stressed or dying. Scattered uprights may be infected in the bed or whole patches of dieback may show up, particularly in younger beds. There are three phases during the season when symptoms appear: one shortly after the winter flood has been withdrawn, another in June and early July, and another phase in late August and September. Damage caused by this disease appears to be worse during growing seasons with prolonged periods of drought or heat stress. Stress weakens the vines and makes them more susceptible to infection by fungal pathogens. Suspected upright dieback infections should be diagnosed by a plant pathology lab before applying fungicides to manage the infection.

Three different fungi have been associated with this disease. *Phomopsis vaccinii* (the fungus that causes viscid rot in fruit) is routinely isolated from symptomatic uprights and has been proven to cause symptoms by artificial inoculations. *Fusicoccum putrefaciens* (often) and *Synchronoblastia crypta* (rarely) are also isolated from infected uprights and have been shown to cause symptoms in artificial inoculations. Infection by these fungi in the field probably occurs during or shortly after bud break when tissues are particularly susceptible. Infection may also occur during the entire growing season. Symptoms do not appear, however, until weather-related stresses weaken the plants. At this point, the tips are killed at the growing point and the symptoms progress downward on the upright.

The disease can be partially controlled through **avoidance of stress on the plants** through the hottest (and potentially the driest) portion of the growing season. **Early season fungicide applications at bud break** and/or early bud expansion have given excellent control of the disease. Spores of the primary causal agent *Phomopsis* begin to be produced from overwintering cranberry tissue in April and May and the emerging buds are particularly susceptible to the infection. Fungicides targeted for fruit rot control also provide a degree of protection against this disease during early and mid-season infection periods.

DISEASE - UPRIGHT DIEBACK

TIMING - April 25 through May 15		
PESTICIDE/FORMULATION	**RATE (amt/A)**	**COMMENTS/RESTRICTIONS**
Champ DP Dry Prill	5.3 lb	Must be applied pre-bloom. 48-hour restricted entry interval.
Champ Formula 2 Flowable	5.33 pt	
Champ WG	4.2 lb	
CHLOROTHALONIL FORMULATIONS		
Bravo Ultrex, Equus DF	3.8 – 6 lb	One pre-bloom application should be applied after the terminal bud has broken dormancy (begun to swell or has begun new growth). Exact timing will depend on whether the variety is early or late-season. 12-hour restricted entry interval.
Bravo Weather Stik	4 – 6.5 pt	
Chlorothalonil 720 SC	4 – 6.5 pt	
Chloronil 720, Equus 720 SST	4 – 6.5 pt	
Echo 720	4 - 7 pt	
Echo 90DF	3.25 - 5.75 lb	
Equus 500 ZN, Initiate ZN	5.75 – 9.25 pt	

For all above chlorothalonil formulations: Hold water for 3 days after application. When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers must follow the required process to determine if these products may be used. See Zone II section. The maximum allowable number of chlorothalonil applications is 3. **If a chlorothalonil application is used for upright dieback control, only 2 chlorothalonil applications are allowed for fruit rot.**

PHYTOPHTHORA ROOT ROT

Suspected Phytophthora infections should be diagnosed by a plant pathology lab before applying fungicides to manage the infections. Adequate control of the disease can be achieved only through several integrated strategies. It is essential that drainage be improved in low areas of the bed. Tile, stones, or other materials can be utilized, and new ditches can be dug. Existing ditches should be maintained to the proper depth. Areas of dieback should receive a uniform addition of sand to get the areas up to grade with the remainder of the bed. Stressed plants on the margin of dieback areas should be given an extra dose of fertilizer to stimulate root growth. If applicable, use of a soil fumigant can be employed on renovations. After the drainage has been improved, fungicides should be applied several times per season until the vines have completely filled in the bare spots. Once this has been achieved, only a single spring application should be necessary.

Precautions should be taken to avoid spread of the pathogen from infested beds to uninfested beds. Machinery, equipment, footwear, etc., should be sterilized using steam, bleach (freshly prepared 10% bleach solution), or 70% alcohol. If possible, the sequence of flooding the beds during water harvest should be adjusted to flood heavily infected beds last. When vines are purchased from other growers, the grower should be certain that they have not come from infected beds. Though very few roots are present in such vine deliveries, it only takes a few infected roots to initiate infection in a new location.

Two to three fungicide applications per season are recommended for **newly diagnosed instances**. The first two spring applications will be critical to slow down the infection process. As areas of dieback recover, consult with the Extension Plant Pathologist regarding the fungicide schedule. The first application should go on between April 25 and May 15. The second application should occur 60-90 days after the first but 45 days before harvest if using mefenoxam (e.g., Ridomil). A third application can be done after harvest, preferably prior to November 15. Poor drainage should be improved BEFORE applying any fungicide to the affected bed.

DISEASE - PHYTOPHTHORA ROOT ROT

TIMING - April 25 through May 15			
	PESTICIDE/FORMULATION	**RATE (amt/A)**	**COMMENTS/RESTRICTIONS**
Foliar Applications (Phosphonate fungicides)	Aliette WDG	5 lb	Rates are for chemigation application!
	Fungi-Phite	2-4 pt	Read label for each product to determine application interval, re-entry period, and number of applications per season. Read label, some do not tank mix!
	ProPhyt, Reveille	4 pt	
	Reliant	2-6 pt	
	Confine Extra, Fosphite	4-8 pt	
	K-Phite Rampart	4-8 pt	
	Alude, Phiticide, Phostrol	5-6 pt	
	Oxiphos	5-10 pt	
Soil Applications (Phenylamide fungicides)*	Metastar 2EC	4-7 pt	Ground or chemigation only. No aerial application!
	Ridomil Gold SL	1-1.75 pt	
	Ultra Flourish	2-3.5 pt	
	Ridomil Gold GR	20-35 lb	Ground or air only. No chemigation!

***Soil applications** must be watered in after application. Run the sprinklers for 3 hours after application to water the fungicide into the root zone. Too much water, however, may push the chemical past the root zone. Therefore, do not apply if more than 0.5 inch of rainfall is forecasted or if sprinklers will run for more than 5 hours during the first few days after the application.

FRUIT ROT

This is the most prevalent disease problem that cranberry growers face from season to season. Cranberry fruit can be infected by many different fungal pathogens.

Some of the most common fruit rot pathogens in MA include:

Allantophomopsis lycopodina and A. cystisporea (black rot)
Botryosphaeria vaccinii (Botryosphaeria fruit rot)
Coleophoma empetri (ripe rot)
Colletotrichum gloeosporioides (bitter rot)
Colletotrichum acutatum (bitter rot)
Fusicoccum putrefaciens (end rot)
Phomopsis vaccinii (viscid rot)
Phyllosticta vaccinii (early rot or bull's eye rot)
Physalospora vaccinii (blotch rot)

The degree of fruit rot that occurs in different beds during different growing seasons is dependent on many factors. Weather is probably the most important variable that affects the amount of rot that occurs. Temperature, humidity, rainfall, as well as special events such as hailstorms, are important on a regional basis. Local microclimatic variations can also lead to particular sections of a bog that are more prone to the development of rot. The density of vine growth and drainage are important because they have a direct bearing on the length of time vines remain wet from rain, fog, dew or irrigation. Excessive vine growth and poor drainage prevent rapid drying and favor the infection by rot fungi. Practices that promote rank (excessive) vine growth, such as excessive fertilizer, frequent late water, holding water high in ditches, and too frequent irrigation should be avoided to minimize conditions that are favorable for fruit rot development.

Spores of the fungi are dispersed from overwintering sources by wind or wind-driven rain. These spores land on the blossom or small developing fruit and, if there is a suitable layer of moisture present for 6 to 8 hours, the fungi will infect the plant tissue. If conditions are favorable and the cultivar is susceptible, berries may show rot symptoms 1 week after fungal infection. If conditions are unfavorable and if the cultivar is less susceptible, symptom development may be delayed. Many of the fruit rot fungal pathogens infect the berry but remain latent, and no rot symptoms will be apparent. Once the berry reaches a certain maturation or physiological stage, fungi will break down plant tissues and rot symptoms will be visible. Symptoms may not be visible until later in the growing season, or they may not be visible until after the berries have been harvested and held in storage.

Fungicides are an important strategy for the control of fruit rot. For adequate fruit rot control, fungicide applications should have good coverage and take place before fungi infect plant tissues. Most fruit rot infections occur during the bloom period and early fruit set, before berries start to size up. Applications typically begin during early bloom (mid-June). Your first fungicide spray should happen before 50% of flowers have opened and fruit have begun to set. Once the fruit has set and begun to increase in size (mid-late July), fungicides are no longer necessary or effective. The choice of fungicides, the rate of the fungicide, and the time interval between applications are dependent on the individual bed and its past history of fruit rot severity.

Fungicide decisions should be based on the Keeping Quality Forecast (KQF) found on the Station's website https://ag.umass.edu/cranberry/keeping-quality-forecast and products allowed by fruit handlers. If the KQF forecast is good to excellent, consider fewer applications and/or longer application intervals. Cranberry beds prone to fruit rot may need up to 4 fungicide applications. One or two fungicide applications may be adequate for a bed with very little fruit rot in previous growing seasons. Storage rot is usually not a concern for berries that are water harvested, as these berries will immediately be frozen in most cases. If in doubt, call the Extension Plant Pathologist.

FUNGICIDE RESISTANCE MANAGEMENT FOR FRUIT ROT

Fungicide resistance, defined as reduced fungicide sensitivity in fungal populations, is a real and serious threat in MA. It could severely impact the efficacy of fungicides used against fruit rot pathogens. Repeated and ineffective use of certain fungicides can accelerate the development of resistant pathogen populations and once this occurs, fungicide applications will provide very little or no disease control.

Newer fungicides can be highly effective in controlling fruit rot fungi and are considered to be less harmful to human and environmental health when compared to older chemicals. However, most of these fungicides have **single-site modes of action**, which poses a much higher risk of selecting for fungicide-resistant pathogens than older fungicides with a **multi-site mode of action** (e.g., chlorothalonil and EBDCs). In order to preserve the effectiveness and durability of fungicides such as Abound, Indar, and Proline, it is **CRITICAL** to incorporate the fungicide resistance management strategies listed below:

- Follow ALL label instructions, including application interval and recommended rate. Never use less than the lowest recommended rate on the label.
- Alternate or mix fungicides with different modes of action.
    - Use FRAC codes on labels to determine mode of action. The same FRAC codes indicate that fungicides have the same mode of action. For example, Indar and Proline have a different trade name and active ingredient, but they have the SAME mode of action and FRAC code (3).
- For best fruit rot control and fungicide resistance management, mix Abound with Indar or Proline.
- Apply Indar/Abound and Proline during bloom period and use multi-site contact fungicides (chlorothalonil or mancozeb) in later applications.

DISEASE - FRUIT ROT

TIMING – Begin early to mid-bloom (10-50%), then at 7 -14 day intervals.
Read label for each product to determine application interval, re-entry period, and number of applications per season.

NEWER CHEMISTRIES

Abound Satori (azoxystrobin)	FRAC Group 11	6.0-15.5 fl oz	No more than 2 sequential apps. See Resistance Management notes below and in Resistance Management chapter. Hold water for 14 days. Avoid drift if the bed is next to a McIntosh apple orchard, as the fungicide is highly phytotoxic to this cultivar.
Indar 2F (fenbuconazole)	FRAC Group 3	6.0-12 fl oz	No more than 2 apps due to resistance concerns. Do not use prior to bloom. 30-day PHI.
Proline 480SC (prothioconazole)		5 fl oz	No more than 2 apps. 45-day PHI.

POLYOXIN-D ZINC SALT

Oso	FRAC Group 19	3.75-13 fl oz	No more than 6 apps of Oso or 3 apps of Ph-D when using maximum rate. Limitied research on efficacy. For best results alternate or incorporate into a program with other fungicides for fruit rot.
Ph-D		6.2 oz	

FRUIT ROT (continued)

TIMING – Begin early to mid-bloom (10-50%), then at 7 - 10 day intervals

CHLOROTHALONIL FORMULATIONS*

Bravo Ultrex	All FRAC Group M5	3.8-6.0 lb	**Restricted use!!**
Bravo Weather Stik		4-6.5 pt	
Chloronil 720, Initiate 720		4-6.5 pt	Use the maximum rate in beds with high rot incidence on a 10-day schedule. Zone II restricted.
Chlorothalonil 720 SC		4-6.5 pt	
Echo 720		4-7 pt	
Echo 90DF		3.25-5.75 lb	3 apps per season, 12-hr REI (6.5 day eye irritant). Hold water for 3 days after application.
Equus DF		3.8-6.0 lb	
Equus 500 ZN		5.75-9.25 pt	
Equus 720 SST		4-6.5 pt	
Initiate ZN		5.75-9.25 pt	50-day PHI

* For all chlorothalonil formulations: When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers must follow the required process to determine if these products may be used. See Zone II Section. The maximum allowable number of chlorothalonil applications is 3. If 1 Bravo application was used for upright dieback control, only 2 fruit rot applications are allowed. Do not mix with Dipel.

Ferbam Granuflo	FRAC Group M3	6 lb	Do not apply more than 5 times. Apply at 14-day intervals. Using rates below recommended rate will be ineffective. 50-day PHI, 24-hr REI.

MANCOZEBS

Dithane F-45 Rainshield	All FRAC Group M3	2.4-4.8 qt	
Dithane M-45		3-6 lb	Addition of spray adjuvants will improve distribution and deposition for all of the mancozeb compounds.
Penncozeb 75DF		3-6 lb	
Penncozeb 80WP		3-6 lb	
Koverall		3-6 lb	May delay color development in some varieties! Restricted by some handlers!
Roper DF Rainshield		3-6 lb	
ManKocide		7 lb	
Manzate Flowable		2.4-4.8 qt	30-day PHI. All 24-hr REI, except ManKocide 48-hr REI.
Manzate Max		2.4-4.8 qt	
Manzate Pro-Stick		3-6 lb	

TIMING – Begin mid- to late-bloom (>50%), then at 7 - 10 day intervals

COPPERS

Multiple products (e.g. Champ, Cuprofix, Badge, Kocide, etc.) See page 2 for full list of copper products.	All FRAC Group M1	Do not mix copper fungicides with insecticides. Do not tank mix with Aliette or phosphites unless spray solution has been buffered first. Call Extension specialist for information on buffering.

FRUIT ROT FUNGICIDE EFFICACY

	Fungicide	Trade Names	Comments
High efficacy	Chlorothalonil	Bravo, Echo, Equus, etc.	Check with handler for market restrictions.
	Mancozeb	Dithane, Manzate, Penncozeb, etc.	May delay fruit color. Efficacy comparable to chlorothalonil. Low risk of resistance. Should be used as a resistance management tool if using 'newer' fungicides (see resistance management section). Restricted by some handlers.
	Prothioconazole Fenbuconazole	Proline Indar	Moderate risk of resistance. No more than 2 applications recommended. For best results and resistance management, use during bloom and combine with azoxystrobin.
	Azoxystrobin	Abound, Satori	High risk of resistance. No more than 2 applications. For best results combine with prothioconazole or fenbuconazole.
	Polyoxin-D zinc salt	Oso and Ph-D	Moderate risk of resistance. Maximum of 3 Oso applications or 6 Ph-D applications. Limited research on efficacy of polyoxin-D fungicides in MA. For best results alternate or incorporate into a program with other fungicides for fruit rot.
Low efficacy	Ferbam, Coppers, SDHI, plant extracts	Champ, Kocide, Kenja, Regalia, etc.	Limited research on efficacy of Kenja and Regalia in MA. These products were not effective against rot in 2016 trials. It is possible that better results could be obtained if alternated with other fungicide products with higher efficacy ratings.

FRUIT ROTS - CULTURAL PRACTICES

Canopy Management: Fruit rot fungi will thrive in areas with poor air circulation, retention of high humidity, and slow drying-out of heavy dew. Poor fruit quality can be expected in areas with overgrown vines where N rates are excessive. Management practices that increase air circulation such as pruning will reduce disease pressure. Sanding of bogs can also reduce disease pressure by burying excess runners and improving air flow, as well as burying sources of disease inoculum.

Late Water: Holding late water (flooding from mid-April to mid-May) will improve berry quality by disrupting the life cycles of rot-inducing fungi and increase fungicide application efficacy by synchronizing bloom. In late water years, fungicide rates and/or the number of total applications can be reduced in beds with low fruit rot disease pressure. The fungicide program should not be eliminated completely or vine diseases may be a problem the following growing season. The number of fungicide applications can be reduced and the lowered rates can also be used during the first year after late water. Fungal inoculum will begin to build up during the second year after late water.

Trash Removal: Cranberry leaves, stems, and fruit left behind after harvest are colonized by several fungi that cause field and storage rot. Trash can harbor pathogens that can infect uprights, blossoms, or fruits in following growing seasons. Remove trash from water-harvested beds during harvest, or as soon after as possible. If the bed was dry-harvested, trash should be removed from the bed with a post-harvest flood in the fall or from the winter flood before it is withdrawn. Trash piles should not be left next to the bed, and should be deposited at least a quarter mile from the bed if possible. Self-pollinated seeds in berries left behind on the bog may germinate in the soil and possibly produce plants that are the typical "mongrels". These genotypes may produce much vegetation but few berries, and in worst case scenarios, may take over the productive vines in the bed.

Irrigation: When irrigation is necessary, sprinkler systems should be run in the early morning, and not in the early evening. Morning watering allows vines to be watered with minimal evaporation, and the surface of the vines can then dry out in the sun's heat. When watering is done in the early evening, the vines are kept wet for an extended time period, thus creating favorable conditions for infection by the fruit rot fungi. On days with excessive temperatures (>100°F on the bed), particularly in newly planted or recently sanded beds, sprinklers should be run in the late morning or early afternoon to cool the vines and berries and may prevent injury. Sprinklers should be run to prevent scalding of the fruit when all of the following conditions persist: (1) dewpoints of 55°F or less during midday and afternoon hours, (2) high temperatures of 80°F or more, (3) clear or scattered sky conditions during the day, (4) bed soil moisture is low, (5) wind speeds average greater than 11 mph, and (6) no rainfall has occurred during the last 48 hours. This "forecast" is based on research performed in New Jersey. Scalded berries are typically browned on one side, with a clear demarcation between the brown area and the green (usually) area of the fruit. The rotted area in a berry affected with fruit rot typically has an area of anthocyanin production (reddish border) adjacent to the affected area. After 7 days, a scalded berry will be hard to discern from a totally rotted berry, particularly since fungi will colonize the stressed scalded berry.

Resistant Varieties: When replanting bogs or planting new bogs, varying levels of disease resistance against fruit rot among varieties should be considered. A summary chart with some of the most common cultivars and their relative field rot resistance (highest-moderate-low) is presented below.

Highest field rot resistance	Moderate field rot resistance	Lowest field rot resistance
Scarlet Knight, Mullica Queen, Howes, Haines, Black Veil	Stevens, Crimson Queen, Demoranville, Early Black	Ben Lear

Note: One or two fungicide applications during the first two years after planting will help reduce fungal inoculum and may reduce fruit rot in subsequent years.

FAIRY RING

This disease is sporadic in occurrence and the severity of symptoms varies from year to year. It can be spread from one bed to another through uprooted vines during wet or dry harvest and their subsequent dislodgment in the next harvested bed. Picking machines should be freed of vines before moving to the next bed. Damage is usually worst during periods of drought; keep vines well irrigated.

DISEASE - FAIRY RING

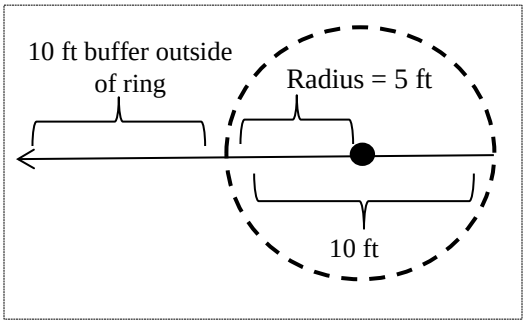
TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
MAY	Abound and Indar	15.5 fl oz/30-100 gal 12 fl oz/30-100 gal	Make first app at budbreak. Irrigate for 1-2 hours before and following application. Repeat 2-4 weeks later if necessary. Make sure to have Indar supplemental label. *See below for drench instructions.**
JUNE - JULY	Ferbam Granuflo	9 lb/100 gal	Apply 1 gal of this mixture to 1 sq ft area. Treat the area 3 feet beyond the advancing line of dying vines and 2 feet within the line. Do not apply after July 31. Only 1 app!
MID-AUGUST THROUGH OCTOBER	Sul-Po-Mag Or K-Mag 0-0-22	4000 lb/A or 1.5 oz/sq. ft.	Follow-up applications may be necessary. This may help vines out-compete the fungus.

* Indar and Abound soil drench. Using a drench method, one can treat up to a tenth of each acre while remaining within the label restrictions (one tenth of an acre is approximately 4,300 ft^2).

A. Estimate the area to be treated:

1. Measure across the center of the fairy ring (this give you the diameter).
2. Divide by 2 to get the radius.
3. Add 10 ft to the radius to include a buffer around the fairy ring.
4. Use the formula

   Area = $r^2 \times \pi$. (r is radius, π is ~ 3.14)



The fairy ring in this example has a 5 ft radius + 10 ft buffer = 15 ft.

Area to be treated = 15 x 15 x 3.14 = 706.5 ft^2

B. Calculate the rates of Indar and Abound for your fungicide mix.
The rate for Indar will be equal to the fairy ring area (ft^2) multiplied by 0.0028 fl oz.
The rate for Abound is equal to the fairy ring area (ft^2) multiplied by 0.004 fl oz.

For every ft^2 to be treated, use 0.1 to 0.2 gallons of water. Apply the tank mix evenly over the affected area (entire ring area plus the 10 ft outer margin). If the fairy ring area is larger than one tenth of each acre, contact the Station.

20 DISEASES

DISEASE MANAGEMENT NOTES

1. Read and follow label instructions. Always check label for variations in restricted entry interval and worker protection standards.

2. Make all pesticide applications in a manner to prevent contamination of streams, ponds and public ways. Impound water (as per label) for as long as possible after applying.

3. RESISTANCE DEVELOPMENT to Abound, Indar, and Proline by the fruit rot fungi is a very real and serious threat. Applications of the fungicide should be made pre-infection rather than post-infection to minimize resistance development. See Resistance Management section.

   These products are most effective when applied during early to mid-bloom (20-50%) and it is highly recommended to mix Abound with Indar or Proline. The number of fungicide applications should be based on the label instructions and the Keeping Quality Forecast.

4. When applying half-rates, the maximum number of applications (not material applied) must not be exceeded. It is not recommended to use a rate below the lowest recommended rate on the label.

5. Use Abound very carefully and avoid drift if the bed is next to a McIntosh apple orchard, as the fungicide is highly phytotoxic to this cultivar. See Resistance Management section.

6. PRE-MIX fungicides with a small amount of water until a smooth suspension is obtained before final dilution. Use immediately. Blossom injury may occur with concentrate sprays especially when sprayed by air when the temperature on the bog is above 85°F. Do not combine any copper fungicide with an insecticide. Do not tank mix copper compounds with Aliette or any of the phosphites for Phythophthora unless appropriate precautions have been taken to buffer the spray solution or severe phytotoxicity will result. Call plant pathologist for information on buffering.

7. Consider delaying harvest to obtain acceptable color in thick vines or when mancozeb is used.

8. SANDING and FERTILIZING. Frequent sanding and fertilizing helps reclaim beds infected with false blossom disease. Regular uniform sanding most likely helps to reduce inoculum of the fungi that cause fruit rot. Sanding should not be done during the same year late water is to be held.

9. SPREADER STICKERS are contained in most fungicides. The addition of wetting agents or spreader stickers to Bravo, Echo, or Equus may cause phytotoxicity damage. Please check the fungicide label. NOTE: the addition of spray adjuvants will improve the distribution and deposition of all mancozeb chemicals.

10. STORED PESTICIDES may deteriorate. Avoid freezing liquid formulations. It is not advisable to use old materials in opened containers. Follow Pesticide Bureau regulations for disposing of pesticides and their containers.

11. Review the Disease Management BMP in the UMass Best Management Practices Guide: ag.umass.edu/cranberry/publications-resources/best-management-practices

12. Organic Options. Some fungicides are certified organic for disease management in cranberry. They include many of the coppers, but check with OMRI (www.omri.org) or your certifier for approved products.