

# The Plant Doctor: Greenhouse Basil Downy Mildew



Greenhouse grown basil plants.

## Greenhouse Basil Downy Mildew

### ***Most common seasons***

Late fall, winter and early spring.

### ***Weather***

A number of days with rains and high humidity, especially originating from the Gulf of Mexico. Temperatures between 53°F and 77°F.

### ***Basil types affected***

Especially bad on sweet basil. Colored types and other species are not so susceptible.

### ***Quick symptoms***

Chlorotic (yellow) area in center (mid-rib) of leaf. May develop fuzzy gray growth on underside of leaves. In very conducive situations, fuzzy growth may be on upper leaf surface, as well.

## A Very Short History of the Pathogen (*Peronospora belbahrii*)

Downy mildews are members of the water mold group. Other well-known water mold plant pathogens are Pythium and Phytophthora. Pathogens in this group thrive in wet or moist environments, and the plant-pathogenic members develop resistance to chemicals used for their control.

Basil downy mildew was first noticed on a significant commercial basis in Switzerland in 2001. In 2003, it was found in Italy. By 2004, it was found in most Italian growing regions and in France. The disease was in several African countries in 2005. By 2008, it was found in at least nine U.S. states. It is considered established in Florida.

The rapid spread of basil downy mildew is due to two key characteristics:

- Its spores can move many miles on winds.
- It is seed-borne.

Another key point that is crucial to the spread of basil downy mildew is ***it is very difficult to manage and control.***



Figure 1. Young basil plant with a downy mildew infection. Note the yellow (chlorotic) blotches on the leaves and the black mycelia on the underside of the leaf seen on the opposite side of the plant.



Figure 2. The upper and lower sides of sweet basil 'Nufar' infected with downy mildew. Note the chlorotic areas on the upper side of the leaf (left), which relate to mycelial growth on the lower side of the leaf (right).

## Life Cycle of Basil Downy Mildew

### Seeds

Movement of the pathogen between continents is probably a result of the unintentional distribution of contaminated seeds. Basil plants grown from known infected seeds were systemically and latently infected (plants did not express symptoms), so contaminated seeds were harvested from these plants. Recently, seed companies have started to decontaminate their seeds by steaming.

### Symptoms

The first symptom is a slight chlorosis (yellowing), usually in the central area of the leaf around the mid-rib. Further disease development produces dark-colored (gray) "thread-like" structures similar to fungal hyphae, on the lower side of the leaf (Figure 1). They may take on a "fuzzy" appearance (Figures 2 and 3). In very conducive conditions, the dark hyphal-like threads may emerge on the upper side of the leaf. These dark, "fuzzy" threads produce spores.

### Environmental Conditions

Spore production requires very high humidity for some hours after symptoms develop. Symptom severity depends on the length of the leaf wetness period that produces infection. Six hours of leaf wetness is needed for minimal infection, whereas 12 hours of leaf wetness will produce severe infections, prolific sporulation and rapid spread of the disease.

Optimum pathogen growth occurs at 68°F – not

much warmer than the energy-saving winter temperature settings used in many greenhouses. Pathogen growth is suppressed at or below 53°F or above 77°F. Growth in warmer temperatures suppresses expression of the dark mycelial threads on the lower side of the leaf, but chlorotic patterns will still be present (Figure 4).

Spores are easily moved on wind currents. They apparently can travel many miles.

## Observed Patterns in the Greenhouse

Early symptoms of the disease (leaves with a chlorotic central area) will appear in a patchy pattern in areas of the greenhouse where temperatures and relative humidity are highest and air movement is lowest. This is usually in the central part of the greenhouse and in the middle of benches.

## Management

### Management overview

Basil downy mildew is a fairly difficult pathogen to manage. To do so successfully requires use of all or most of the strategies discussed in this section.

- Probably the most significant advancement in the management of this disease is the development of resistant varieties. Use them. Their use will reduce disease pressure and allow you more leeway in the use of management tools other than expensive fungicides to which the pathogen may develop insensitivity (resistance).
- Night time illumination prevents asexual spores from forming, greatly reducing both spread and severity.





Figure 3. Sweet basil plant (cv. 'Nufar') infected with downy mildew. Note the yellow or chlorotic splotches on the upper side of the leaves. The dark-colored mycelia will grow from the chlorotic areas on the underside of the leaf—and on the top of the leaf if the environment is very conducive



Figure 4. Sweet basil infected with downy mildew growing in 80–95° F temperatures. The chlorotic splotches are visible (above), but the mycelia is not expressed (inset photo).

- Fans reduce local humidity and prevent free water (guttation and dew) from forming. Both are essential for pathogen sporulation and infection.
- Temperature manipulation:
  - Heat mats to raise the soil temperature around the plant roots permit air temperatures to be maintained around 68° F (20° C) while still reduce pathogen growth.
  - Daytime solar heating, using plastic tenting, can kill or suppress pathogen asexual spores and mycelium.
  - Supplemental nutrition.
  - Proper application, timing and choice of fungicides.
  - Sanitation after sale and during the crop, especially the removal and destruction of old plants and plant parts which can harbor sexual spores that can reinfect following crops.

### Host resistance: The first line of defense

- **Other than sweet basil:** In general, the less it looks and tastes like conventional sweet basil, the less basil downy mildew infection. Sweet basil (*Ocimum basilicum*) is most susceptible and spice species (*O. americanum*, *O. basilicum* var. *americanum*), are the most resistant to the disease. In between, Thai basil (*O. basilicum* var. *tenuiflorum*, *O. basilicum* var. *thyrsiflorum*), cinnamon basil (*O. basilicum* 'Cinnamon'), and 'Red Rubin' basil (*O. basilicum*) are susceptible, but noticeably less so than sweet basil (*Ocimum basilicum*). Fewer disease symptoms will be seen in citrus basil (*O. citriodorum*).
- **Sweet basil:** Over the last few years, basil breeders have

done a remarkable job developing varieties resistant to basil downy mildew, and it appears future advancements are likely. While none of the new sweet basil varieties are immune, some are very good and should be your first line of defense, if your market allows. Notable resistant varieties are: Prospera, Rutgers Obsession DMR, Rutgers Passion DMR, Rutgers Thunderstruck DMR, Rutgers Devotion DMR, and Amazel. While some of these employ the same resistance genes, so resistance breaking basil downy mildew strains might be a problem, there is a gene combination coming that should avoid it for years to come.

### Ventilation and air movement: Reduced humidity and guttation/dew reduces infection and sporulation

Greenhouse ventilation is a key management tool. Reducing relative humidity (RH) and free moisture (especially water in the form of guttation/dew) will prevent spores from infecting the plants or spores from being produced in the first place. The target is less than 85 percent RH to prevent spore formation, and constant air circulation to reduce local humidity and guttation/dew formation.

- Asexual spore formation by *P. belbahrii* is almost nothing at 85% RH and is maximized at 97.6 to 100% RH. But even a decrease to 94.6% RH results in many fewer spores being produced than at 97.6% RH.
- Even with humid winds from the Gulf of Mexico, fans can reduce local humidity sufficiently (<95% RH) to make a notable difference. This is especially critical at night, to reduce spore germination and keep standing moisture from occurring, preventing plant infection by the spores.

- To reduce humidity inside the greenhouse, ventilate the greenhouse in the late afternoon, starting about 3–3:30 p.m. in the winter. Heat the air. Exhaust the air by opening all the vents and running all fans. Close the vents. Repeat at least three to five times. Make sure that you have internal circulation fans going one direction on one side of the greenhouse and the other direction on the opposite side.
- Automatic controllers should be set to ventilate the greenhouse during the night. The more air changes you can afford, the better. Make sure that the internal circulation fans work.

### ***Temperature: Warmer temperatures can be used to kill and suppress the pathogen or reduce its growth***

Basil Downy Mildew develops in the temperature range of 41 to 86° F (5 to 30° C), with the least disease occurrence at 41 and 86° F. Most spores germinate (in the dark) in a temperature range of 68 to 73° F (20 to 23° C). For economic reasons, most Mississippi greenhouses set their night temperatures at about the optimum temperature for disease development.

- Raising root temperatures to 79 to 88° F (26–31° C) while maintaining the upper plant parts at an air temperature of 68° F (20° C), suppresses canopy downy mildew, apparently killing all but the sexual (oospores) in the leaves. But even they appear not to be viable as favorable conditions failed to germinate them. Apparently high heat may make sweet basil an unfavorable host. Heat mats which maintain soil temperatures at 79 to 88° F may allow you to reduce disease while not expensively heating the entire greenhouse. You can maintain the air temperature at 68° F.
- Air temperatures greater than 77° F (25° C) reduce disease severity. Higher temperatures can kill the pathogen altogether. Covering shade cloth houses with polyethylene to increase the air temperature to 136°F (58°C) for a few hours on three consecutive days killed the pathogen, suppressed.
- Inside your greenhouse, you might try a similar technique by tenting the basil benches with plastic to raise the local

temperature to 136° F (58° C) for a few hours on 1 to 3 successive days.

### ***Light: The use of the right color and photoperiod can reduce infection and disease***

Light<sup>1</sup>, especially red light, suppresses the formation of spores of basil downy mildew, but not the hyphal-like, fuzzy growth. Stopping spore production will suppress disease spread.

Light levels ranging from 150 to 500 mmol · m<sup>-2</sup> · s<sup>-1</sup> with photoperiods of 14 to 16 hr are adequate for basil production. Continuous nighttime light levels like these increase yields of sweet basil (Patel et al., 2018). Less light is needed for suppression of basil downy mildew. Studies have shown as little as continuous 3.7 to 240 mmol · m<sup>-2</sup> · s<sup>-1</sup> is effective. The amount of light (irradiance) is somewhat dependent on the color.

Red light is the most effective, but keep the following in mind:

- For this to work, the temperature must be at least 60° F (15.6° C).
- Continuous light with long nighttime photoperiods work best.
  - Intermittent light is less effective.
  - Do not allow more than 7 hours of dark.
- As the plants grow, the leaves will start to shade one another. Shaded leaves will start to produce spores. Direct light on the leaves, especially on the leaf underside, is required for this to work.
- Red light hitting the lower side of the leaf is more effective than hitting the upper side.
  - You may choose to use light colored materials on the bench top to scatter the light and improve the light contacting the lower leaf surface. Lamp placement other than directly above the basil canopy should be tried.
- Space traditional fluorescent lamps about every 3.5 feet. A reflector may be used.
- LED lamps are more energy-efficient than equivalent incandescent and most fluorescent lamps. The difference

<sup>1</sup> The light terms used here can be confusing to most people, especially because they appear so complicated. The reason the terms are used here to make artificial grow lighting easier for you to find and compare in discussions with vendors.

Most of us are used to thinking of light in terms of watts, a measure of the amount of power used, or the amount of light emitted by a lamp as lumens and the color of that light as “temperature (warm white, daylight, etc.). When growing plants with lamps, it has been found to be more useful to think in terms of light that is usable by the plants. Both the quantity and quality of light.

For plant use, light quantity is measured by the number of photons (a single particle of light, each of which could be captured by the plants photosynthetic system) that hits a square meter surface every second. This unit is called the Photosynthetic Photon Flux Density (PPFD). It is written as the “μmol m<sup>-2</sup>s<sup>-1</sup>.”

Deciphering this: the first character is usually going to be “μ” for micro- (10<sup>-6</sup>) or “m” for milli- (10<sup>-3</sup>). This is a measurement of the number of photons produced, and they differ by a factor of 1000. The second abbreviation in the string is “mol”, which stands for moles. Moles is a standardized unit used in chemistry and physics which specifies a uniformly exact number of particles in the measurement. The “m<sup>-2</sup>s<sup>-1</sup>” is an easier printing method for “μmol/m<sup>2</sup>/s, or square meters per second. The quality of light is measured by its wavelength (λ), which runs a spectrum from high energy (ultraviolet, 320-400 λ) through blue (400-500 λ), green (500-600 λ), red (600-700 λ), and finally far red (often termed infrared) (lower energy, ca. 700-750 λ). The photosynthetic systems in the plant primarily use some wavelengths of blue and red light. This is why some, especially older LED grow lights are in these two colors. Lighting suppliers will be using these measurements.

may mean money savings in a reasonable time. They also emit light in a narrower color range (wavelength  $\lambda$ ), than incandescent and fluorescent lamps, so choose the wavelength carefully.

- Commercially available LED top lighting sold for greenhouses with red (max  $\lambda$  = 670 nm) and blue (max  $\lambda$  = 458 nm) used at night will suppress basil DM sporulation.
- Full supplemental lighting is not necessary for basil downy mildew suppression. Continuous illumination with as few as 8 to 240  $\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$  of red light at  $\lambda$  (max)=625 is effective. This would reduce upfront costs but fail to make them satisfactory for plant growth.
- The wavelength of known basil downy mildew suppressive sporulant colors are  $\lambda$  = 625 max, 670 max, 575-662 with peak at 625 nm (irradiance of 12  $\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ ). Blue (not quite as effective as red) ( $\lambda$  max = 458 nm).
- Other tested lamps:
  - 20W daylight (6400K) fluorescent bulbs (Leelite, China)
  - Approximately 40W cool white fluorescent light producing anywhere from 6, 21, and 35  $\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$  is adequate.
  - 40W incandescent bulbs (Osram Sylvania, Indiana, USA). 3.7  $\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$  is adequate.
- Basil plants exposed to UV-B ( $\lambda$  max = 292 nm; 1,368  $\text{J} \cdot \text{m}^{-2}$  over a 120 minute period) for 3 and 6 days before *P. belbahrii* inoculation exhibited reduced sporulation compared with nonexposed plants but caused plant burn. This is mentioned for completeness because UV light is often used for plant-pathogen control.

### **Macro and micronutrients: Judicious sprays and fertigation amendments can help or hurt**

Macro- and micronutrients can often encourage or discourage disease (*The Plant Doctor: Plant Disease and Fertilization*). Several groups conducted extensive testing of nutrients either added to the fertigation solution or sprayed on plant foliage. Some treatments encouraged disease, some decreased disease severity and two not only decreased disease severity but increased sweet basil fresh and dry weight and essential oil production.

- Decrease disease severity and increase sweet basil essential oil production and fresh and dry weight.
  - An Egyptian study sprayed various potassium (K) salts (mono- & di-potassium phosphate, potassium carbonate) and anti-transpirants (potassium silicate, aluminum silicate (kaolin), and silicon dioxide) at weekly intervals prior to downy mildew infection.

Two products increased essential oil production and fresh and dry weights of sweet basil, Dibasic potassium phosphate ( $\text{K}_2\text{HPO}_4$ ) (20 mM) and potassium silicate ( $\text{K}_2\text{O}_3\text{Si}$ ) (20 mM).

- To make 4000 mL (milliliters) (7.25 fluid ounce more than gallon) of 20 mM dibasic potassium phosphate ( $\text{K}_2\text{HPO}_4$ ), add 14 grams (about  $\frac{1}{2}$  ounce) of the powder to 4000 mL of water and mix.
- To make 4000 mL (7.25 fluid ounce more than gallon) of 20 mM potassium silicate might be more difficult since there is variability in the amount of water incorporated into the molecular formula. If other than anhydrous potassium silicate is used, then make sure the label states the molecular weight and use the link in the next bullet to figure the amount to use.
- If you want to make a differing amount, use the calculator provided by [www.physiologyweb.com](http://www.physiologyweb.com). The molecular weight of dibasic potassium phosphate is 174.2. The molecular weight of anhydrous potassium silicate is 248.5. Enter the molecular weight in the top row. In the third row, enter the total number of mL (milliliters) you want to make and click the radio button next to 'mL' in the right box. In the bottom line, enter 20 and click the radio button next to the 'mM' in the right box. In the second line, click the radio button next to the 'g' for grams. Click the 'Calculate' button in the bottom right box. The 'Mass of solute' box in the second line should return the amount of chemical you need to add for the number of mL you entered.
- Decrease disease severity.
  - Sprays made twice a week for three weeks of 1 percent foliar applications of KCl (134 mM K) and  $\text{K}_2\text{SO}_4$  (114 mM) suppressed disease.
  - Sprays of low concentrations of Zn (applied as Zn-EDTA, 0.006% solution) and Mn (applied as Mn-EDTA, 0.014% solution) or applied as part of the irrigation solution (1-2 mg/L in the irrigation solution). In some cases, the combination of microelements and fungicide (applied separately), reduced disease significantly as compared with fungicides alone.
  - Increasing concentrations of:
    - ♦ Ca in the fertigation solution from 0.5 to 1.56 mM.
    - ♦ Mg in the fertigation solution to 3.0-4.94 mM, unless the Mg in the water is already high enough.
- Increased downy mildew severity.
  - Increased K concentration (0.5, 0.8, 1.3, 2.6 and 5.1 mM) in the fertigation solution. The high rate much more so than the second highest rate.

### **Conventional Fungicides**

Downy mildew is a type of water mold organism. In general, water molds, and downy mildew in particular,



develop tolerance (or resistance) to fungicides fairly quickly. To guard against this, you need to rotate among fungicides which target the downy mildew in different parts of its physiology. Fungicide experts term these different modes of action FRAC groups. At least on label specifies a co-mixture.

The very real threat of resistance necessitates the use of three or more products belonging to different FRAC groups. Most FRAC groups consist of a number only. There are a few FRAC groups which have both a number and a letter, such as 'M', which in this case means it has multiple modes of action.

Because of cloudy days and humid winds from the Gulf Coast, Mississippi growers will need to rely on fungicides more than basil growers elsewhere, especially if they do not employ other management options discussed in this publication. Using alternative management tools can reduce the number of fungicide sprays needed to produce a healthy and attractive crop.

A current listing of fungicides labeled for use on basil for downy mildew may be found in the annual issue of the Southeastern U.S. Vegetable Crop Handbook ([www.vegcrophandbook.com](http://www.vegcrophandbook.com)). The products do not include biological fungicides, presumably because they are mostly ineffective against basil downy mildew. The listing also does not tell you if the product is labeled for greenhouse use. You need to check the labels themselves.

Also, between the time the product listing was made and your reading, a substantial number of months may have passed, so check and see if anything has been added or removed for use. A pesticide label database can help you do this, and you can learn more about the labels by reviewing Extension publication ***P3155 Pesticide Label Databases***. In these databases you can search for the occurrence of multiple factors, such as: basil as the host, and downy mildew as the pest.

Doing this in December of 2021 showed that a new active ingredient had been labeled, oxathiapiprolin, a product in a brand new FRAC group, 49. This is vitally important because it provides a unique FRAC group and trials have shown that the oxathiapiprolin is quite effective against basil downy mildew. Sold as Segovis, it may be used on greenhouse grown basil to be sold to consumers. Table 1 provides a fungicide product summary current as of December 2021.

An extensive set of fungicide trials was conducted in New York and Illinois for control of basil downy mildew.

- The spray program should be done weekly.
- All products work best if applications are started prior to infection. Some labels state the application must be started prior to infection.
- The spray application should cover the entire plant, including the lower side of the leaves. Use sufficient water and correct water pH and adjuvant.

- Consider using drop nozzles to ensure good vertical coverage of the plants.
- The application of a particular active ingredient needs to follow label instructions for the total number of applications and sequential applications made (see Comments in Table 1 for examples).
- Tank mixing a P07 fungicide, such as ProPhite, with non-P07 fungicides will probably increase product efficacy.
- Illinois work suggests a program alternating among azoxystrobin, cyazofamid and mandipropamid, each mixed with ProPhyt (a P07), yields consistent results. This work was done prior to the approval of oxathiapiprolin, which tests well individually. So incorporating it into the program would probably improve this program.

The proper use of fungicides will likely help you only if you are implementing the other management tools discussed here.

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**Table 1. A search of pesticide databases as of December 2021 lists these products as labeled for basil downy mildew. The list does not include biological fungicides, because none have proven effective against this pest. Eight FRAC groups are represented, however, only seven might be construed as labeled for greenhouse production. Any spray program should use at least three of these in rotation with one another. Each label should be read individually prior to purchase and designing your program. A program for greenhouse grown transplants and field basil is discussed in the text.**

Active ingredient	FRAC group	Trade names	Label rates	Harvest (days)	Reentry (hr)	Comments
Azoxystrobin	11	Heritage (and roughly 18 other azoxystrobin generics)	0.18 oz/1000 ft sq (0.25 lb a.i./A)	0 days	4	For transplants to be sold to consumers. One application during plug production & 1 application after transplant to tray using 3.4 gal water/5000 ft sq. No more than 1.5 lb a.i./A year of azoxystrobin. If using Fenamidone (also FRAC 11) see other rotation directions.
Fluopicolide	43	Adorn Presidio (no greenhouse use on food crops for either product)	4 fl oz/A	1	12	Presidio Fungicide must be tank mixed with a labeled rate of another fungicide active against the target pathogen, but with a different mode of action. 7 – 14 day intervals.
Cyazofamid	21	Ranman 400 SC (greenhouse)	2.75-3 fl oz/A	0	0.5	50-75 gal/A. Tank-mix with an organosilicone surfactant when the disease infection is severe, or a non-ionic surfactant or a blend of organosilicone and a non-ionic surfactant when disease infection is moderate or light. Apply up to 9 times with no more than 3 consecutive applications before switching FRAC for at least three applications. Do not apply more than 27 fluid oz/A/yr.
Cyazofamid	21	Segway O (greenhouse)	2.75-3 fl oz/A	0	0.5	For water volumes less than 60 gallons per acre, SEGWAY O should be tank-mixed with an organosilicone surfactant when the disease infection is severe.
Fenamidone*	11	Reason 500 SC (field and greenhouse)	6 fl oz/A	2 days	12	Minimum of 7 days between applications. Do not make more than a single application before switching to a different FRAC code. Do not make more than 4 FRAC 11 applications total. Maximum of 24 fl oz/A/year. The number of FRAC group 11 applications should be no more than one-third the total number of fungicide applications for basil downy mildew, but can go to half of the total, if pre-mixes or tank mixes of the FRAC 11 are made with another FRAC.
Mandipropamid	40	Revus (no greenhouse)	8 fl oz/A	1 or shipping	4	Can be applied up to four times with no more than 2 consecutive applications before switching to another FRAC. The addition of a spreading/penetrating type adjuvant such as a non-ionic based surfactant or crop oil concentrate or blend recommended.



Active ingredient	FRAC group	Trade names	Label rates	Harvest (days)	Reentry (hr)	Comments
Mandipropamid	40	Micora (greenhouse)	8 fl oz/A	1 or shipping	4	For use in basil grown for re-sale to consumer grown in enclosed greenhouse with permanent flooring.
Mefenoxam	4	Subdue Maxx (greenhouse; some resistance)	21.7 mL/1000 ft sq	21	48	Must be mixed with another FRAC group. Apply at seeding. As a transplant tank mix. One application each.
Oxathiapiprolin	F 09 (formerly U 15)	Segovis (greenhouse)	4-8 mL/5,000 ft sq (1.1-2.4 fl oz/A)	NA, trans-plants only	4	For re-sale as consumer transplants only. Apply in at least 15 gal/A
Potassium phosphite	P 07	ProPhyt (label is silent on greenhouse use)	3-4 pt/A	0 days	4	7-day interval; 30 gal/A. Water pH >5.5
Mono- and di-potassium salts of Phosphorous Acid & Mono- and di-potassium phosphite (many possible brands. These have been used in-house and are a known treatment.)		Confine Extra (greenhouse)	3-4 quarts/A	Up to day of harvest	4	General warnings. Read label for specifics. Apply in at least 20 gal/. Do not apply in less than 3-day intervals. Do not apply foliarly to plants treated with copper-based compounds at less than 20-day intervals. Do not apply when conditions favor wet tissue for prolonged periods (>4 hr). Do not use acidifying type compatibility agents.
		K-Phite	1-4 quarts in a minimum of 50 gallons of water/acre.	Apply up to the day of harvest (0-day PHI).	4	Lower rate 7-28 days, higher rate at 7 to 14-day intervals until control is reached. Under severe circumstances, application can be made at intervals of up to every three days. Do not apply when conditions favor wet tissue for prolonged periods.
	P 07	Resist 57 (greenhouse)	1-3 quarts/A	Up to day of harvest	4	Apply in at least 20 gallons/A. Apply in 2 to 3-week intervals. Do not apply at less than 3-day intervals. Do not apply when conditions favor wet tissue for prolonged periods (>4 hours). Do not apply to foliar of plants treated with copper-based compounds at less than 20-day intervals.
		Rampart Fungicide (greenhouse)	3-4 quarts/A	Up to day of harvest	4	Apply in at least 20 gal/A. Do not apply in less than 3-day intervals. Do not apply when conditions favor wet tissue for prolonged periods (>4 hours). Rampart Fungicide is a slightly acidic buffer solution. Avoid mixing Rampart Fungicide with strongly acidic or alkaline materials or compatibility agents. Do not apply to foliar of plants treated with copper-based compounds at less than 20-day intervals.









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