

Top Facts to Know about Managing Vegetable Diseases

Meg McGrath

Cornell University, School of Integrative Plant Sciences
Plant Pathology and Plant-Microbe Biology Section
Long Island Horticultural Research and Extension Center
Riverhead, New York. mtm3@cornell.edu

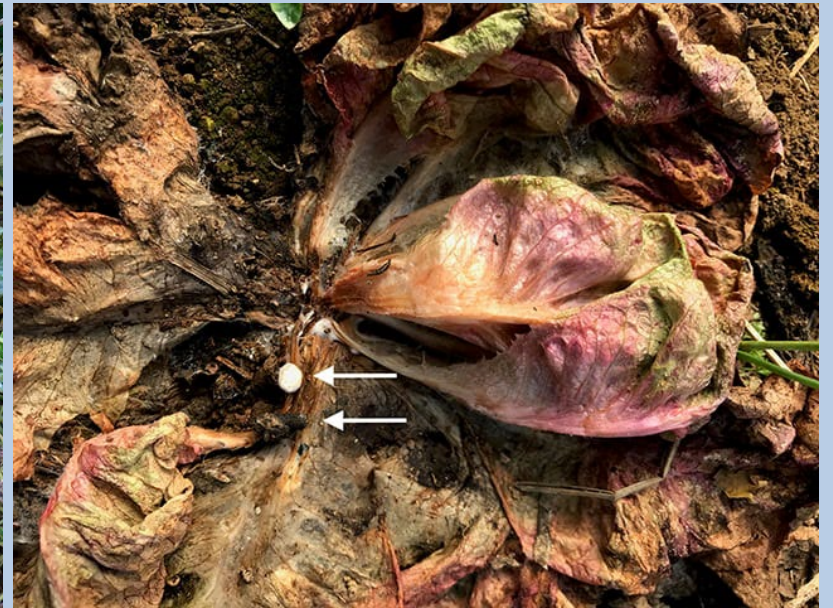


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Why Manage Plant Diseases?

1. Direct impact on marketable part.
2. Indirect impact on yield and fruit quality from foliage dying prematurely.
3. Pathogen survives in soil and numbers increase when not managed eventually causing major losses and becoming hard to manage.



Top Facts – Managing Vegetable Diseases

Accurate diagnosis:

- essential for selecting appropriate management practices.**

Pathogens vary in how they survive and spread
plus favorable conditions.

Vegetable Pathology – Long Island Horticultural Research & Extension Center

<https://blogs.cornell.edu/livepath/organic/organic-management-of-vegetable-diseases/>

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Organic management of vegetable diseases

Know what diseases occur in New York and elsewhere in the northeastern US

- [Vegetable disease factsheets](#) – Images, diagnostic information, management, etc.
- [Organic Production Guides for Vegetables](#)
- [Commercial Vegetable Management Guidelines for NY](#) – covers diseases and insect pests occurring in N.Y.

Obtain accurate diagnosis.

[General tips on diagnosing plant diseases](#)

Plant Disease Diagnostic Laboratories:

- [Long Island](#)
- [Upstate NY](#)
- [Other States](#)

Contact

[Margaret McGrath](#)

Associate Professor

School of Integrative Plant Science

Plant Pathology and Plant-Microbe
Biology Section

[Long Island Horticultural Research &
Extension Center](#)

Riverhead, NY 11901-1098

(631) 727-3595

Email: mtm3@cornell.edu

Need help ...

... diagnosing or managing diseases?

Contact [your local office of Cornell](#)

[Cooperative Extension](#). Not from New

York? [Find your office here](#). Or find

help through the [National Plant](#)

[Diagnostic Network](#).



Disease factsheets and articles

If you were a big fan of the pioneering [Vegetable MD Online](#) website, much of that content has been moved here. We are in the process of moving over the rest.

- **(LIHREC)** indicates information from the Long Island Horticultural Research and Extension Center Vegetable Pathology website.
- List also **includes some herbs** (parsley, basil) and **abiotic disorder**
- Some content is available as printer-friendly .pdf versions.

Get started:

[General tips on diagnosing plant diseases](#)

Diseases and management practices affecting multiple crops

- [Phytophthora Blight and Its Management in Cucurbit Crops and Other Vegetables](#)
- [Reduced-tillage for Managing Phytophthora Blight and Other Soil-Borne Pathogens](#)
- [Biofumigation for Managing Phytophthora Blight and Other Soil-Borne Pathogens](#)
- [White Mold and Its Management in Cabbage, Beans, and Other Vegetables](#)
- [Diseases of Winter Greens: Downy Mildews, Powdery Mildews, Cladosporium Leaf Spot, and Root Rot](#)
- [Table: Fungicides for Cucurbit Crops](#)
- [Table: Mobile Fungicides for Managing Three Major Cucurbit Diseases: Powdery Mildew, Downy Mildew, and Phytophthora Blight](#)
- [Weeds and Crops Susceptible to Viruses in the Northeast](#)
- [Disease-resistant varieties](#)
- [Managing Pathogens Inside Seed with Hot Water](#)
- [Treatments for Managing Bacterial Pathogens in Vegetable Seed](#)
- [Do Rotations Matter within Disease Management Programs?](#)
- [Cropping Sequences and Root Health](#)
- [On-Farm Soil Bioassays for Assessing Root Pathogens](#)
- [General Guidelines for Managing Fungicide Resistance](#)
- [When is the Best Time to Apply Fungicides for Foliar Diseases?](#)
- [Managing Diseases With Sulfur: Is There A Role For Burners + Evaporators?](#)
- [Organic Management of Vegetable Diseases](#)
- [Biopesticides for Organic and Conventional Disease Management in Vegetables](#)
- [Copper Fungicides for Organic and Conventional Disease Management in Vegetables](#)
- [Minimizing Injury from Copper Fungicides](#)

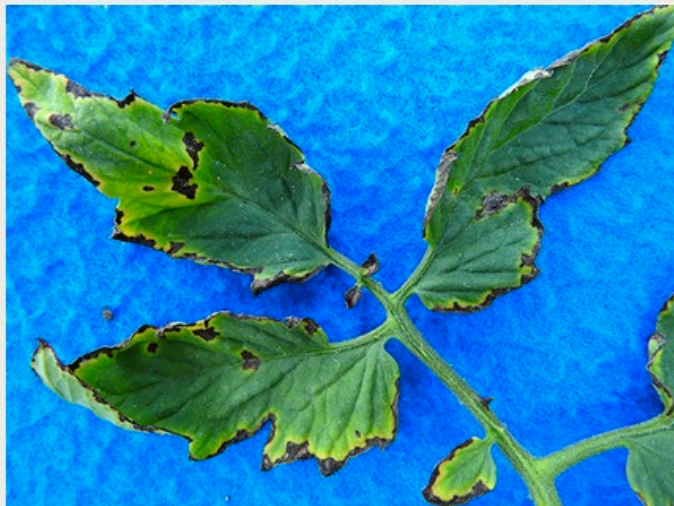


Diseases	Arugula	Celery	Cucurbits	Garlic	Peppers	Spinach
▪ Phytophthora blight	▪ Downy mildew (LIHREC)	▪ Anthracnose	▪ Table: Fungicides for Cucur	▪ Anthracnose of garlic scap	▪ Anthracnose (LIHREC)	▪ Downy mildew
▪ Vegetal	▪ Powdery mildew (LIHREC)	▪ Septoria leaf spot (LIHREC)	▪ Table: Mobile Fungicides for Cucur	▪ Bloat nematode (LIHREC)	▪ Bacterial leaf spot (LIHREC)	▪ Stemphylium leaf spot (LIHREC)
▪ Reduce	Asparagus	Corn (sweet)	▪ Diseases: Powdery Mildew, Blight	▪ Botrytis neck rot (aka dry rot)	▪ Chimera (genetic disorder)	▪ White rust (LIHREC)
▪ Pathogen	▪ Herbicide injury (LIHREC)	▪ Sweet corn diseases	▪ Alternaria (LIHREC)	▪ Garlic rust (LIHREC)	▪ Cucumber mosaic virus (LIHREC)	▪ Diseases of winter greens: downy mildew, Cladosporium leaf spot, and root rot
▪ Biofumi	Basil	▪ Common corn smut	▪ Angular leaf spot (LIHREC)	▪ Waxy breakdown (LIHREC)	▪ Pythium crown and root rot	Tomatoes
▪ Pathogen	▪ Basil downy mildew	▪ Holcus spot (LIHREC)	▪ Anthracnose	Horseradish	▪ Phytophthora blight	
▪ White M		▪ Northern corn leaf blight	▪ Anthracnose (LIHREC)	▪ Cercospora and Alternaria	▪ Powdery mildew	▪ Managing Tomato Diseases Successfully
▪ Disease	Beans	▪ Rust (LIHREC)	▪ Bacterial leaf spot (renamed)		▪ Sunscald (LIHREC)	▪ Table: Fungicides for Managing Bacterial Diseases in Tomato
▪ Leaf Sp	▪ Anthracnose	▪ Virus diseases of sw	▪ Choanephora fruit rot (LIHREC)	Lettuce	▪ Tomato chlorotic spot virus	▪ Anthracnose (LIHREC)
▪ Table: F	▪ Bacterial brown spot	Crucifers (aka brassica)	▪ Downy mildew	▪ Crown girdling (LIHREC)	▪ Tomato spotted wilt virus	▪ Bacterial canker of tomatoes
▪ Table: M	▪ Bacterial diseases	▪ Alternaria leaf spot on	▪ Fusarium crown rot and fruit	▪ Downy mildew (LIHREC)	▪ White mold (LIHREC)	▪ Bacterial canker of tomatoes (LIHREC)
▪ Powder	▪ Chimera (genetic disorder)	▪ Alternaria leaf spot on	▪ Fusarium fruit rot of other c	▪ Powdery mildew (LIHREC)	Potatoes	▪ Bacterial speck of tomatoes
▪ Weeds	▪ Ozone injury (LIHREC)	▪ Bacterial leaf spot on	▪ Gummy stem blight and bla	▪ Septoria leaf spot (LIHREC)	▪ Detection of potato tuber	▪ Bacterial speck of tomatoes (LIHREC)
▪ Disease	▪ Phytophthora blight	▪ Black leg on kale (LIHREC)	▪ Ozone injury (LIHREC)	▪ White mold (LIHREC)	▪ Black dot disease	▪ Blossom-end rot (fruit disorder) (LIHREC)
▪ Managi	▪ Tomato chlorotic spot	▪ Black rot on Brussels sprouts	▪ Phytophthora blight	▪ Diseases of winter greens	▪ Blackleg caused by damping-off	▪ Buckeye fruit rot (LIHREC)
▪ Treatme	▪ Virus diseases of snap	▪ Black rot on cabbage	▪ Plectosporium blight (LIHREC)	▪ spot, Botrytis crown rot, and	▪ Blackleg stem rot and tuber rot (LIHREC)	▪ Chimera (genetic disorder) (LIHREC)
▪ Do Rota	Beets and Swiss Chard	▪ Black rot on ornamentals	▪ Powdery mildew	Onion	▪ Early blight (LIHREC)	▪ Drought stress (LIHREC)
▪ Croppir	▪ Alternaria leaf spot	▪ Cabbage chimera (genetic disorder)	▪ Pythium fruit rot (LIHREC)	▪ Black mold (LIHREC)	▪ Fusarium dry rot	▪ Early blight (LIHREC)
▪ On-Far	▪ Bacterial leaf spot	▪ Clubroot of crucifers	▪ Pythium root rot (LIHREC)	▪ Stemphylium leaf blight (LIHREC)	▪ Gray mold (LIHREC)	▪ Gray mold (LIHREC)
▪ Genera	▪ Cercospora leaf spot	▪ Clubroot on bok choy	▪ Scab		▪ Late blight	▪ Late blight
▪ When is	▪ Cercospora leaf spot	▪ Diseases of winter greens	▪ Sunscald of pumpkin and winter squash		▪ Leaf spot caused by Phytophthora	▪ Late blight resistant tomato variety evaluations
▪ Managi	▪ Phoma leaf spot and	▪ Downy mildew on cauliflower	▪ Virus diseases of cucurbits		▪ Ozone injury (LIHREC)	▪ Leaf mold
▪ Organic	▪ Rhizoctonia crown an	▪ Downy mildew on seedlings	▪ White mold on cucurbits (LIHREC)		▪ Potato virus Y (LIHREC)	▪ Ozone injury (LIHREC)
▪ Biopest	Carrots	▪ Fusarium yellows of	▪ Xanthomonas leaf spot (for	Parsley	▪ Rhizoctonia canker and late blight	▪ Phytophthora blight
▪ Vegetal		▪ Head rot (soft rot) of	Dill	▪ Septoria leaf spot of parsley	▪ Scab	▪ Pith necrosis (LIHREC)
▪ Copper	▪ Leaf blight diseases	▪ Heat stress damage	Eggplant	Peas	▪ Silver scurf of potato	▪ Powdery mildew (LIHREC)
▪ Vegetal	▪ Powdery mildew (LIHREC)	▪ Powdery mildew (LIHREC)	▪ Anthracnose (LIHREC)	▪ Powdery mildew (LIHREC)	▪ Tomato spotted wilt virus	▪ Septoria leaf spot (LIHREC)
▪ Minimiz		▪ Virus diseases of crucifers	▪ Phytophthora blight		▪ Virus and viroid diseases	▪ Stemphylium (aka gray) leaf spot (LIHREC)
			▪ Verticillium wilt (LIHREC)			▪ Tomato brown rugose fruit virus

Bacterial speck of tomato

Bacterial speck is the most common disease of tomato caused by a bacterial pathogen on Long Island. Symptoms develop on leaves, fruit spurs, stems and petioles, and occasionally fruit.

Often symptoms first appear and are most common on more susceptible younger leaves, but they can appear first on older leaves. Leaf spots appear water-soaked when they are starting to develop and during rainy periods. They are dark brown to black, sometimes with a yellow halo, and typically small (up to 1/4 inch wide). But on young, developing leaves spots are often larger, irregular in shape, and cause leaves to be distorted and sometimes torn. Also as the disease progresses, spots coalesce forming large, irregular brown areas. Margins of leaves can be brown, sometimes extending down into the leaf forming a wedge of brown tissue. Severely affected leaves often turn yellow and then die.



Fruit spots are tiny (usually less than 1/16 in.), dark brown, and superficial (usually removable by scraping with a finger nail). They may be indented. Only green fruit are susceptible to infection.



Occasionally symptoms have been seen on transplants growing in a greenhouse. This can occur when contaminated seed is planted or there was not adequate sanitation of the greenhouse and planting materials being reused following a previous outbreak.



Initial sources of the pathogen include infested seed, infected transplants, wind-driven rain from affected plants in another planting nearby, and contaminated tools or hands from exposure at another planting. After bacterial speck has occurred in a field, the bacteria can survive in plant debris and seeds in the soil, on stakes used to support plants, and in weeds (especially those in the nightshade family). Bacteria can also survive on greenhouse structures and planting materials after developing on seedling. These are all potential sources of the pathogen for subsequent crops. This pathogen can become established in an area, surviving on the surface of non-host plants.

Manage bacterial speck by selecting resistant varieties. There are few currently available. See [resistant variety tables](#). Clean and disinfect before planting including greenhouse benches and trays plus other planting materials that are being re-used. Use seed that was tested and/or treated for bacteria causing speck. When using your own seed or seed from a non-commercial source, before planting treat it with hot water following [guidelines](#) carefully to increase success and not damage seed.

Inspect transplants carefully at time of purchase: select plants with no leaf spots, but note that plants without symptoms could be infected. Rotate where tomatoes are grown so there is at least 2 years between plantings. Destroy any volunteer tomato plants. Manage weeds in the nightshade family. Use drip rather than overhead irrigation. Mulching under plants with straw or plastic minimizes the potential for any bacteria on debris to be splashed from the soil up onto the plants. Trellising will improve air movement around the plants, thereby promoting drying and reducing the time plant tissue is wet and able to be infected.

Actigard is the most effective fungicide to use in commercial plantings, but applications need to start before infection to obtain the most benefit as this is a plant activator. It can be applied starting within one week of transplanting for up to 8 weekly sequential applications until 2 weeks before start of harvest. LifeGard is a new biological activator approved for organic production that can be applied from before transplanting through harvest (0 day PHI). Other fungicides are also best used on a preventive schedule.

BacStop, Double Nickel, OxiDate, Regalia, and Serenade are approved for use on organically-produced crops. There are several copper fungicides, including organic formulations. They differ in amount of metallic and biologically active copper. The conventional fungicide ManKocide also has mancozeb, which can increase copper activity. Do not use an air-blast sprayer when a bacterial disease is present as these pathogens can be easily moved in the spray as it is driven through the plant canopy to adjacent rows.

Cucurbit Powdery Mildew

Updated: June 2022 [Printer-friendly .pdf version of the management information on this page.](#)

See also:

- Newsletter articles:
 - [Why Manage Cucurbit Powdery Mildew?](#)
 - [Managing Cucurbit Powdery Mildew Organically – Key Points for Success](#) [Updated 2022-01-25]
 - [Managing Cucurbit Powdery Mildew Conventionally – Key Points for Success](#) [Updated 2022-01-25]
 - [Conventional Fungicide Recommendations for Cucurbit Powdery Mildew](#)
- LIHREC [Cucurbit powdery mildew](#) photo gallery (**includes diagnostic images**)
- [Research](#) on powdery mildew conducted at LIHREC.
- [Guidelines on managing cucurbit powdery mildew in 2022.](#)
- Podcast: [Avoiding the Powdery Mildew Blues](#) – Meg McGrath, plant pathologist at Cornell's Long Island Horticultural Research and Extension Center, discusses how with other members of the Great Lakes Vegetable Working Group on 24 June 2020. This and other recordings are in the green-bordered box at the bottom of [this page](#).
- Listen to Meg McGrath talk about managing powdery mildew in a teleconference hosted by Steve Bogash of Marrone Bio Innovations on 22 July 2020. Dial 515-604-9875. At prompts enter 832191 for access code and 14 for reference number.
- [Results from research on fungicide resistance in the cucurbit powdery mildew pathogen](#)
- [Targeted Fungicides for Cucurbit Powdery Mildew](#)
- [Table: Fungicides for Cucurbit Crops](#)
- [Table: Mobile Fungicides for Managing Three Major Cucurbit Diseases: Powdery Mildew, Downy Mildew, and Phytophthora Blight](#)

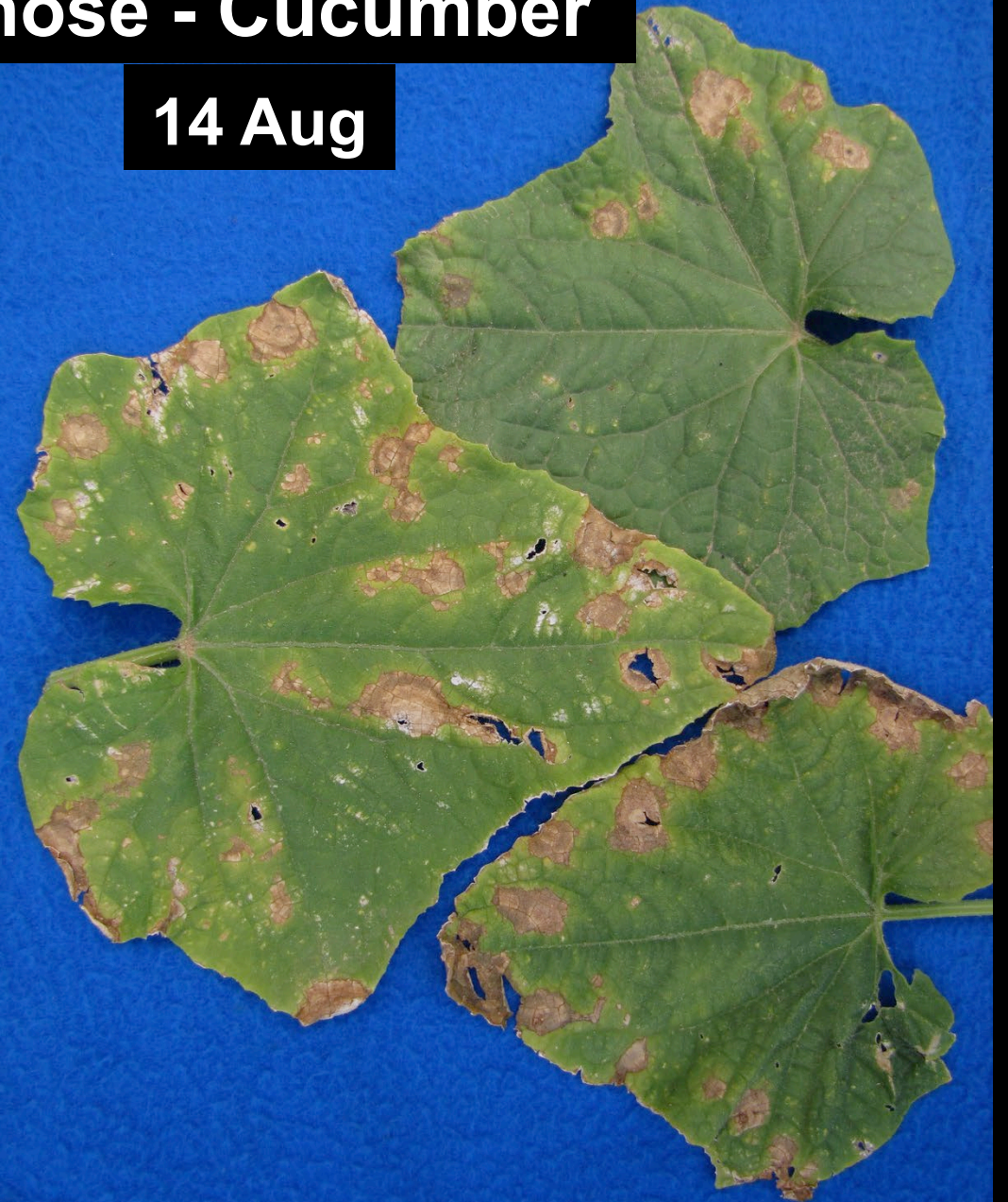
Topics on this page:

- [Impact and causal fungi](#)
- [Symptoms and signs](#)
- [Disease cycle](#)
- [Managing cucurbit powdery mildew – Overview](#)
- [Cultural and biological controls including resistant varieties](#)
- [Chemical control – General information](#)
- [Recommended targeted fungicides](#)
- [Organic fungicides for powdery mildew](#)
- [Summary points about managing powdery mildew successfully](#)

Anthracnose - Cucumber

7 Aug

14 Aug



Symptoms can change!



Spinach Stemphilium leaf spot

**New diseases
can appear!**



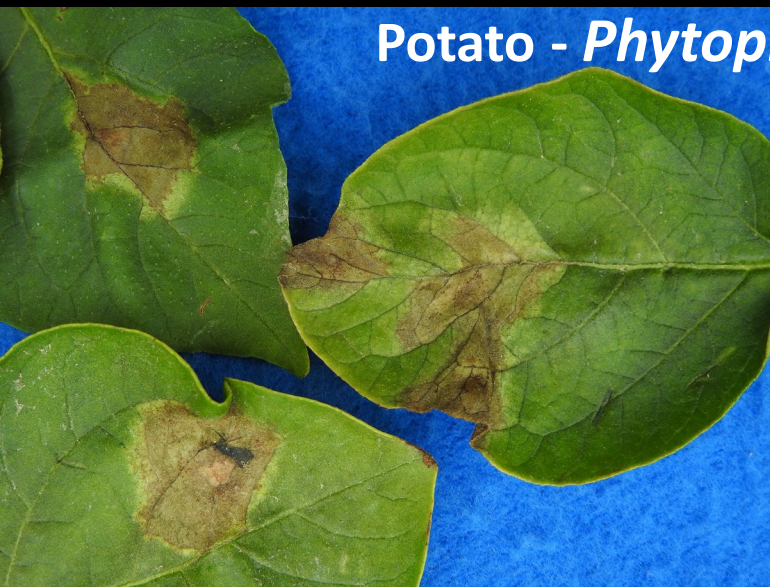
Pepper powdery mildew



Basil downy mildew



Garlic Rust



Potato - *Phytophthora nicotianae*



Potato - *Dickeya*

Top Facts – Managing Vegetable Diseases

Cultural management practices:

- vary among diseases.**
- based on knowledge about pathogen's biology.**
- best implemented before pathogen has built up.**

Foundation of a good plant disease management program.

Cultural Disease Management Practices

Resistant varieties.

Pathogen-free seed.

Rotate crop plantings. Target = pathogens that survive in soil.

Separate crops susceptible to same water- or wind-dispersed pathogens.

Mulch: plastic and organic.

Sanitation in greenhouse (target surviving pathogens):


- clean + disinfect benches + planting materials.
- don't reuse trays following bacterial disease.

Sanitation in field (target surviving pathogens; spread):

- clean + disinfect equipment and boots between fields.
- clean + disinfect tomato stakes. Discard after tomato canker.
- don't work in crops when leaves wet, esp with bacterial disease.

Avoid wounds.

Specific Management Practices and Tools:

- Resistant varieties 
- Hot-water treatment for seed-borne pathogens
- Biopesticides: General information and product lists
Presentation at BiocontrolsEast in 2018
Presentation + handouts at NOFA-NY 2019
- Efficacy results from McGrath's research at LIHREC
- Efficacy results from University evaluations of organic products are in an excel file at the Biopesticides webpage.
- Copper fungicides

Disease Resistant Vegetable Varieties

See also: [Tips on Using Resistant Varieties](#)

Disease resistance reported in these lists is based on information obtained from seed company catalogs. If you see an error, please contact mtm3@cornell.edu.

- Beans
- Beets
Article: [Evaluations of Beet Varieties Resistant to Cercospora Leaf Spot](#)
- Broccoli
- Brussels Sprouts
- Cabbage
- Carrots
- Corn (sweet)
- Cucurbits (cucumbers, melons, pumpkins, squash)
Cucurbit variety evaluations: [downy mildew](#) (cantaloupe, cucumber LIHREC) | [powdery mildew](#) (cantaloupe, pumpkin, squash LIHREC)
Article: [Cucumber and Cantaloupe Varieties Resistant to Downy Mildew](#)
- Eggplant
- Leeks
- Lettuce
- Onion
- Peas
- Peppers
Article: [Pepper Varieties Resistant to Phytophthora Blight and Bacterial Leaf Spot](#)
- Spinach
- Tomato
Article: [Tomato varieties with multiple disease resistance from Cornell](#)
Article: [Late blight resistant tomato variety evaluations](#)

Prefer to view disease-resistant variety information in spreadsheets? [Download disease-resistant variety spreadsheets from this Box folder](#).

Disease-resistant tomato varieties


- Information is from seed catalogs for 2018, 2019, 2021 and 2022. Occasionally varieties are listed as resistant without the disease(s) or disorder(s) specified.
- Follow links below to tables with more details about these varieties including seed companies marketing them and whether organic seed is available, as well as variety resistance to disorders.
- Prefer to view disease-resistant variety information in spreadsheets? [Download disease-resistant variety spreadsheets from this Box folder](#)

Cherry Tomato

- **Aligote F1:** Fusarium Wilt 1, Fusarium Wilt 2, Fusarium Wilt 3
- **Amarillo F1:** Fusarium Wilt 2, Tobacco Mosaic Virus, Verticillium Wilt
- **Apero F1:** Fusarium Wilt, [Leaf Mold](#), Root Knot Nematode, Tobacco Mosaic Virus
- **Apple Yellow F1:** Fusarium Crown & Root Rot, Late Blight, Tomato Mosaic Virus, Tobacco Mosaic Virus, Tomato Yellow Leaf Curl Virus
- **Apricot Zebra:** Disease resistance not specified
- **Artemis F1:** Fusarium Wilt 1, Fusarium Wilt 2, Root Knot Nematode, Tomato Mosaic Virus, Tobacco Mosaic Virus
- **Astoria:** Bacterial Speck, Fusarium Wilt, Fusarium Wilt 1, Tomato Spotted Wilt Virus, Verticillium Wilt, Verticillium Wilt 1, Verticillium Wilt 2
- **Baby Cakes F1:** Fusarium Wilt 2, Tomato Spotted Wilt Virus, Verticillium Wilt
- **Bartelly F1:** [Leaf Mold](#), Tobacco Mosaic Virus
- **Baxters Bush:** Resistant to disorders
- **Bellini F1 (orange):** Resistant to disorders
- **BHN-268 F1:** Fusarium Wilt 1, Fusarium Wilt 2, Verticillium Wilt
- **BHN-762 F1:** Fusarium Wilt 1, Fusarium Wilt 2, Verticillium Wilt
- **BHN-968 F1:** Fusarium Wilt, Root Knot Nematode, Tobacco Mosaic Virus, Tomato Spotted Wilt Virus, Verticillium Wilt
- **Bing:** Resistant to disorders
- **Black Cherry:** Resistant to disorders
- **Blush (oval cherry):** Resistant to disorders
- **Braveheart F1:** Fusarium Wilt 1, Gray Leaf Spot, [Leaf Mold](#), Tomato Mosaic Virus
- **Bumble Bee Pink:** Resistant to disorders
- **Camelia F1:** Fusarium Wilt 1, Tobacco Mosaic Virus, Verticillium Wilt, Verticillium Wilt 2
- **Chadwick Cherry:** Disease resistance not specified
- **Cherry Bomb F1:** Late Blight
- **Cherry Buzz:** Resistant to disorders
- **Cherry Ember:** Resistant to disorders
- **Chocolate Sprinkles:** Fusarium Wilt, Root Knot Nematode, Tomato Mosaic Virus, Tobacco Mosaic

[illegible]

Specific Management Practices and Tools:

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- Copper fungicides

Managing Pathogen How should seed

Ensuring seed is not a source of patho
Some pathogens can be on or in seed.
seed, but some important pathogens ca
of tomato and Alternaria leaf spot of cr
include black rot of crucifers, bacterial l
seed can be an important first source o
example is the new downy mildew of br
when a pathogen is present at the start
difficult to manage because a surface d
treatment can get in to these pathogen

What seed should be

Likelihood that a particular batch of see
pathogens affecting it, and the seed's h
cannot be effectively treated with hot w
than other seed-borne pathogens. For
the northeast while the pathogen causi
crucifers are crops affected by some of
seed that can be treated are listed in T
are listed in Table 2. The seed's history
treatment is warranted. If you save you
well be worthwhile. Some seed compar
becoming contaminated and also to tes
and/or where environmental conditions
clean seed. Determine the likelihood th
seed was produced in a way to minimiz
seed was tested for their presence. It is
with hot water as treating again could a
primed or old seed should not be treat
which makes these seed very difficult to

While hot-water seed treatment c
done effectively on a stovetop, it
much better to use a precision wa
bath or sous vide machine. Use a
porous container to hold the seed
as organza bag, package made o
fiberglass window screen, or con
coffee filter. First put in a weight
as a quarter so the package will s
submerged in the water. Put
identification information for the
on a plastic pot label to go in fibe
window screen packages or write
directly on coffee filter. Partly fill
container. Do not fill to the point t
water will not be able to easily m
into the center of the seed mass
there will be stress on the seems
coffee filter. Roll top of package
twice to close then staple shut wi
gaps that could enable seed to
escape. Attach a string to each
package to facilitate moving the
packages as needed in the bath and
removing them from the bath. String
from packages can be tied to a dowel
rod. A large slotted cooking spoon
also can be used to quickly remove
seed packages from water at treatment
end.

What to do after treating seed?

Immediately after treatment seed needs to be
dried. Packages can be put in a vegetable
dehydrator that has a fan only (no heat)
setting. Packages with small quantities of
seed can be laid out on paper towels. Larger
quantities of seed should be removed from
the package and spread out on paper towels.

It is recommended to sow seed soon after it
has been dried because seed will imbibe
some water during treatment which can prime
it and hasten germination. While it is not
recommended to keep hot-water-treated seed
until the next season, no loss of germination
was detected in 2021 with tomato seed
treated in 2013.



Immediately after treatment, put packages of seeds in a vegetable dehydrator that has a fan only (no heat) setting to dry them.

Table 1: Hot-Water Seed Treatment Protocols

Printer-friendly .pdf versions of Tables 1 and 2.

Prepared by Margaret Tuttle McGrath, Cornell University, Long Island Horticultural Research and Extension Center, 3059 Sound Avenue, Riverhead, NY. mtm3@cornell.edu

Crop	Temperature and time		Reference
Brussels sprouts	122°F	25 minutes	1, 3, 4
Broccoli	122°F	20 minutes	1, 2, 3
Cabbage	122°F	25 minutes	1, 3, 4
Carrot	122°F	20 minutes	1, 2, 3
Cauliflower	122°F	20 minutes	1, 3, 4
Celeriac	118°F	30 minutes	3
Celery	118°F	30 minutes	1, 3
Chinese cabbage	122°F	20 minutes	1, 4
Collards	122°F	20 minutes	1, 3, 4
Coriander	127°F	30 minutes	4
Cress	122°F	15 minutes	1, 3, 4
Cucumber	122°F	20 minutes	1, 4
Eggplant	122°F	25 minutes	1, 3, 4
Kale	122°F	20 minutes	1, 3

Table 2: Diseases of Vegetable Crops Caused by Seed-borne Pathogens

Printer-friendly .pdf versions of Tables 1 and 2.

Seed companies manage and test for many of the diseases listed here.

Prepared by Margaret Tuttle McGrath, Cornell University, Long Island Horticultural Research and Extension Center, 3059 Sound Avenue, Riverhead, NY. mtm3@cornell.edu

Crucifers (Cabbage, broccoli, cauliflower, Brussels sprouts, kale)

- Alternaria leaf spot
- Bacterial leaf spot (peppery leaf spot)
- Black leg
- Black rot

Carrot

- Alternaria leaf blight
- Bacterial leaf blight
- Cercospora leaf spot
- Crater rot and foliar blight

Celery

- Bacterial leaf spot
- Early blight (aka Cercospora leaf spot)
- Late blight (aka Septoria leaf spot)
- Phoma crown and root rot

Eggplant

- Anthracnose
- Alternaria early blight
- Phomopsis
- Verticillium wilt

Lettuce

- Anthracnose
- Bacterial leaf spot
- Lettuce mosaic virus
- Septoria leaf spot

Cultural Disease Management Practices

Healthy (microbially active) soil.

- Compost + other soil organic amendments.
- Reduced tillage.

Biofumigation.

Promote good soil drainage (*Pythium*, *Phytophthora*).

Minimize leaf wetness:

- drip irrigation. Overhead irrigation during dry period.
- wide plant spacing. Trellis. Good air movement. No shade.

High tunnel avoids favorable conditions for many pathogens.

Manage weeds in greenhouse and in field.

Rogue diseased plants.

Destroy crop when done: Remove or mow + incorporate.



Black Rot – Cabbage + Cauliflower



Top Facts – Managing Vegetable Diseases

Resistant varieties vary substantially in:

- degree of suppression provided.**
- durability of their resistance.**

Bayhorse Gold



Copyright © Rupp Seeds

Uniform, slightly elevated hybrid with strikingly gorgeous, very dark orange fruit and elongated dark handle. Can be used for roadside sales or wholesale shipping in 40 count bins. Gaining popularity with growers!

Attributes

Item Number	V38061
Maturity (days)	100
Weight (lbs)	15 - 20
Skin	Very Dark Orange
Powdery Mildew	Intermediate Resistance

Betternut 1744



Copyright © Rupp Seeds

Powdery mildew tolerant. Developed by Rupp breeders. Slightly larger than Betternut 900 for farm markets and roadside stands.

Taybelle PM



Copyright © Seminis

A direct conversion from Taybelle to include intermediate resistance to powdery mildew.

Squashes and Pumpkins
Intermediate resistance
Powdery mildew tolerant
control improved with fungicides

Cantaloupe: **Race specific resistance.** Excellent but specific

Arangina



Copyright © Seminis

Arangina is a delicious mid-season ESL Italian melon. Strong plant vigor with good and uniform fruit setting. The fruit is blocky shaped, hard course netting, deep green sutures, dark orange flesh with great firmness and small cavity. Outstanding eating quality. Harvest indicator is when rind changes colors.

Disease Resistance

Fusarium Wilt (0,1,2)

Powdery Mildew (1,2)

Disease Resistance

Fusarium Wilt 0,1,2

Powdery Mildew 1,2,3,5

Athena



Copyright © Syngenta

Firm flesh, harvest closer to slip than Super Star. Resembles Saticoy. Excellent disease tolerance.



19
Races
so far



Spinach Downy Mildew:

Race specific resistance. Excellent.



Corvair

Organic (F1) Spinach Seed

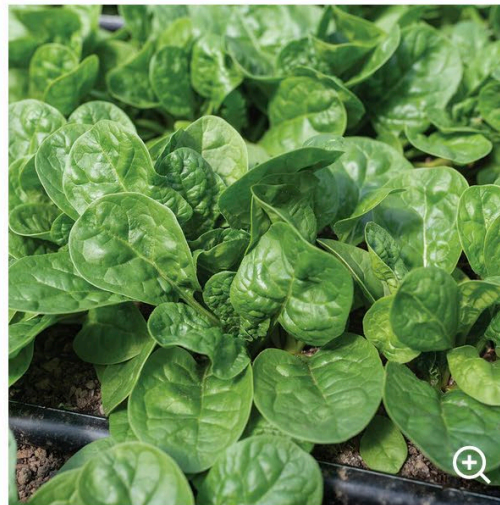
Product ID: 2571G

Organic all-season spinach.

Very dark green, uniform, round leaves. Slow-bolting plants for baby and full size. High resistance to downy mildew races 1–11, 13, 15, 16, 18. USDA Certified Organic. Avg. 44,700 seeds/lb. Packet: 1,000 seeds.

Races 1 - 11, 13, 15, 16, 18

Races 1 – 19; 10 IR



Sunangel

(F1) Spinach Seed

Product ID: 4542

Heavily savoyed DMR spinach for spring, fall, and winter.

A good balance of speed, dark color, savoy, and bolt tolerance for ample harvests through most of the year. More uniform and upright than Emperor, with a less cupped leaf. High resistance to downy mildew races 1–9, 11–19 and intermediate resistance to race 10; intermediate resistance to white rust. Avg. 25,500 seeds/lb. Packet: 1,000 seeds.

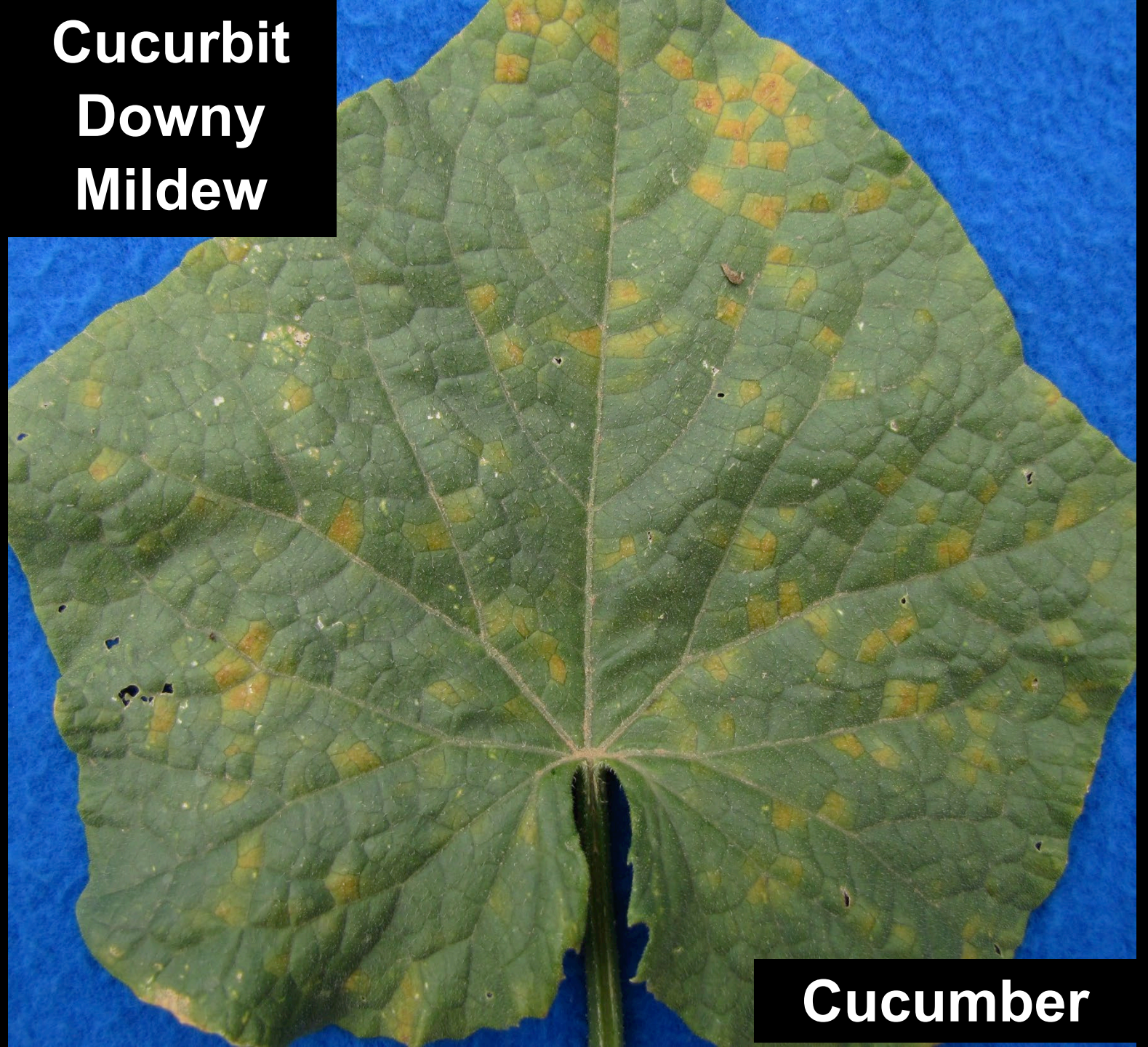
Top Facts – Managing Vegetable Diseases

Many pathogens (esp. foliar):

- reproduce asexually; sexually too.
- latent period of ~7 days (infection to symptoms).
- life cycle of ~7 days.



**Cucurbit
Downy
Mildew**



Cucumber

Downy Mildew

Cantaloupe





18 Aug 05



25 Aug 05



29 Aug 05

Top Facts – Managing Vegetable Diseases

Pathogen host range – varies a lot and can be unexpected.

- Downy mildews and powdery mildews have narrow host range; often one host
- Cucurbit downy mildew. Cucumber + cantaloupe affected by different clade than squash + pumpkin + watermelon.
- White mold pathogen's host range is >400 plant species.
- Cucurbit powdery mildew pathogen also infects verbena.

Top Facts – Managing Vegetable Diseases

Pathogens evolve. Diseases change.

- Overcome host genetic resistance.
- More virulent / aggressive.
- Expand host range.
- New pathogens. Tomato brown rugose fruit virus.



Phytophthora Blight

all cucurbits
pepper, eggplant
tomato
NOT potato
weeds (purslane)



Beans – Phytophthora blight



Top Facts – Managing Vegetable Diseases

Organic fungicides:

- protectant activity; not curative.**
- contact activity.**
- best applied preventive schedule; before rain.**
- reapplication on weekly interval typically needed.**
- efficacy is not a requirement for registration in USA.**
- potential environmental and health risks.**

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS
DANGER

CORROSIVE. Causes irreversible eye damage. Causes skin irritation or temporary discoloration on exposed skin. May be fatal if swallowed. Do not breathe vapor. Do not get in eyes, on skin or on clothing. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Handlers who may be exposed to the undiluted product through mixing, loading, application, or other tasks must wear: coveralls over long-sleeved shirt and long pants, rubber gloves, chemical resistant footwear plus socks, and protective eyewear (goggles or face shield). Handlers who may be exposed to the dilute through application or other tasks must wear: long-sleeved shirt and long pants, and shoes plus socks. Follow manufacturer's instructions for cleaning and maintaining PPE. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product. Do not reuse them. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet. Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

**Pesticide
labels are
legal
documents**



ENVIRONMENTAL HAZARDS

This product is highly toxic to bees and other beneficial insects exposed to direct contact on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area. Do not apply this product or allow it to drift to crops where beneficials are part of an Integrated Pest Management strategy.

This pesticide is toxic to fish. Begin treatment along the shore and proceed outward in bands to allow fish to move into untreated areas. Consult with the State agency with primary responsibility for regulating pesticides before applying to public waters to determine if a permit is needed.

This pesticide is toxic to birds who eat treated seed exposed on soil surface.

Do not apply directly to treated, finished drinking water reservoirs or drinking water receptacles when the water is intended for human consumption.

Do not contaminate water when disposing of equipment washwaters or rinsate.

Do not apply directly to treated, finished drinking water reservoirs or drinking water receptacles when the water is intended for human consumption.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the State or Tribal Agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for protection of agricultural workers on farms, forests, nurseries and greenhouses and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 48 hours without required PPE.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water, is:

REI = 48 hours for most copper fungicides

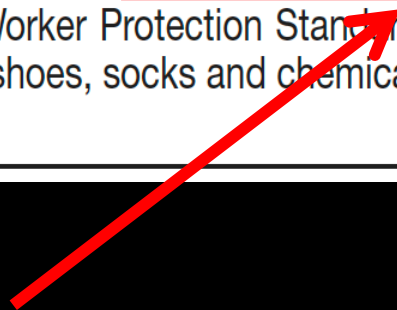
- Coveralls
- Chemical-resistant gloves made of any waterproof material
- Shoes plus socks
- Protective eyewear

Agricultural Use Requirements

Use this product in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), restricted-entry interval, and notification to workers. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard (WPS).

Entry-Restrictions: Do not enter or allow worker entry into treated areas during the restricted-entry interval of 4 hours.

PPE required for early-entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, wear: long sleeved shirt, long pants, shoes, socks and chemical-resistant gloves made of any waterproof material, such as polyvinyl chloride, nitrile rubber, or butyl rubber.



**REI = 4
hours**

Resources on diseases and their management prepared by Meg McGrath:

<https://blogs.cornell.edu/livepath/organic/organic-management-of-vegetable-diseases/>

General:

- [Top facts to know about managing vegetable diseases](#)
- [Biology basics: plant diseases and management](#)
- [General management guidelines](#)
- [YouTube presentation on plant disease management for organic systems made at VABF 2015 Conference](#)
- [Presentation on vegetable diseases and management made July 2019](#)
- [Presentation on managing diseases made at NOFA-NY 2020 conference](#)

Specific Management Practices and Tools:

- [Resistant varieties](#)
- [Hot-water treatment for seed-borne pathogens](#)
- Biopesticides: [General information and product lists](#)
[Presentation at BiocontrolsEast in 2018](#)
[Presentation + handouts at NOFA-NY 2019](#)
- [Efficacy results from McGrath's research at LIHREC](#)
- Efficacy results from University evaluations of organic products are in an excel file at the [Biopesticides webpage](#).
- [Copper fungicides](#)

Specific Diseases:

- [Vegetable disease factsheets](#) – most have information about specific diseases and their management for both organic and conventional production, as well as photographs.
- Downy mildew diseases: [article](#), [presentation](#)
- [Late blight in tomato and potato](#) – See also [Late blight on tomato](#) photo gallery/information page.
- [Phytophthora Blight](#)
- [Biopesticides for Managing Phytophthora Blight in Cucurbits and Other Vegetables](#)
- Winter greens: [webpage](#) | [proceedings](#) | [presentation](#)

Other resources on management

- [Organic Production Guides for Vegetables](#)
- [Resource Guide for Organic Insect and Disease Management](#)
- [Video: Identifying and Scouting for Late Blight on Organic Farms](#)
- [Searchable database of downloadable organic and conventional pesticides registered in New York \(except products exempt from registration\)](#)
- [Searchable database with federal labels for most organic and conventional fungicides](#)
- [Lists of products verified to meet organic standards by OMRI](#)
The OMRI Products List booklet can be downloaded at this webpage. To search for specific products in the on-line database, click on 'Search' in the bottom left section of the webpage.

Specific Management Practices and Tools:

- Resistant varieties
- Hot-water treatment for seed-borne pathogens
- Biopesticides: General information and product lists
Presentation at BiocontrolsEast in 2018
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Biopesticides for Organic and Conventional Disease Management in Vegetables and Strawberries

More information:

[Printer-friendly .pdf version of this page.](#)

Biopesticides registered in New York for specific crops in the Northeast

Lists do not include the few conventional biopesticides (e.g., copper) permitted in organic production.

- [Beet](#)
 - [Brassica crops](#)
 - [Bulb crops](#)
 - [Carrot](#)
 - [Cucurbit crops](#)
 - [Eggplant](#)
 - [Leafy vegetables](#)
 - [Pepper](#)
 - [Potato](#)
 - [Strawberry](#)
 - [Tomato](#)
 - [Biopesticides labeled for bacterial diseases](#)
- 

- Tables of biopesticides to facilitate comparing products for labeled diseases (see webpages above for more information about the products):
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- [Database of results from biopesticide evaluations published in PDMR](#) (.xlsx)
- [References for results from biopesticide evaluations in database](#)
- [Efficacy of microbial biopesticides published in PDMR](#) (summary of results for products tested singly from database linked above)
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- [Evaluations of Biopesticides and other Organic Fungicides conducted at LIHREC](#)
- [Biocontrol Bytes biopesticides posts](#) (blog from Amara Dunn, Biocontrol Specialist, NYSIPM)

Text below updated May 2022

Biopesticides are defined by EPA as pesticides derived from natural materials. There are three types. Biochemical pesticides contain naturally occurring substances that control pests. Substances that control diseases include potassium bicarbonate, hydrogen dioxide, phosphorous acids, plant extracts, and botanical oils. Microbial pesticides contain microorganisms that function as biocontrol agents, affecting the pathogen directly or indirectly through the compounds they produce. Plant-incorporated protectants or PIPs are the least common type of biopesticide. These are pesticidal substances produced by plants that contain genetic material added to the plant often through genetic engineering. The genetic material

Biopesticides for Organic

Printer-friendly .pdf version of this page

Following is a list of some biopesticides that follow product name. Most products are for diseases of bell and chili pepper included below. This information is for products listed with OMRI (Organic Materials Review Institute) registration: each product may be used before purchasing any product. This list does not include the few products not permitted in organic production.

If you know a biopesticide not listed, please contact us.

Actinovate AG. 0.0371% *Streptomyces* and soil-borne diseases on many crops; colonizes roots, protecting them from plants, which thus are more resistant to diseases. Indicates to use a non-ionic surfactant (formerly Natural Industries, Inc.).

AgriPhage. < 1% Bacteriophage and *Pseudomonas syringae* products not reviewed. EPA Reg. No. 67

AgriPhage-CMM. < 1% Bacteriophage. Labeled for bacterial canker. Not distributed by Certis USA, LLC.

AVIV. 0.08% *Bacillus subtilis* strain gray mold, late blight, powdery mildew, *Phytophthora*, *Rhizoctonia*, and others. 91473-1-86182. Seipasa S.A.

BioST Nematicide 100. 95% thionyl chloride. Labeled for several nematodes. Albaugh, LLC.

Bio-Tam. 2% *Trichoderma* strain. Beneficial fungi have different strains at 45°F) and environmental conditions. *Rhizoctonia*, *Pythium* and others. USA; distributed by Bayer CropScience.

Brandt Organics Aleo. 78% copper. Bacterial speck, gray mold, and others. EPA registration. Brandt CropScience.

Carb-O-Nator. 85% potassium. Powdery mildew. OMRI-listed.

Cease. 1.34% *Bacillus subtilis*. Labeled for bacterial spot, late blight, and tomato. OMRI-listed. EPA Reg. No. 71

Cinnerate. 60% cinnamon. Late blight and leaf mold. OMRI-listed.

Companion. 0.03% *Bacillus* strain. Including bacterial spot, but not blight caused by *Sclerotinia* in tomato. EPA Reg. No. 71

DiTera DF Biological Nematicide. and solubles. Labeled for several nematodes. Valent BioSciences LLC.

Double Nickel 55 LC and 108. Broadly labeled for foliar and early blight, gray mold, late blight, *Pythium*, *Phytophthora*, *Rhizoctonia*, and 108, respectively. Certis USA, LLC.

EcoSwing Botanical Fungicide. early blight) and powdery mildew.

ECOWORKS EC. 70% copper. Anthracnose, etc. and also others. Technologies LLC.

FungOUT. 1.07% citric acid. Late blight. OMRI-listed. Exempt from EPA registration. EPA Reg. No. 1

GreenFurrow BacStop. 7.5% thyme, 3.0% garlic, 2.0% cinnamon. Blight and late blight. Exempt from EPA registration.

GreenFurrow EF 400. 5.6% clove. Diseases of vegetable crops: mildew, and white mold. Exempt from EPA registration.

Howler. 50% *Pseudomonas citricarpa* (gray mold) and *Colletotrichum* *Pythium*, *Rhizoctonia*, and *Sclerotinia*.

Kaligreen. 82% potassium bicarbonate. 11581-2. Arysta LifeScience North America.

KeyPlex 350 OR. 0.063% yeast proteins (alpha-keto acids) and plants against fungal and bacterial diseases. Approval for organic production.

LALSTOP G46 WG. 93% *Gliocladium* soil-borne diseases caused by *Rhizoctonia*, *Sclerotinia*, and *Verticillium* (some species cause mildew. *These diseases are not listed. Specialties Inc.

LifeGard WG. 40% *Bacillus* strain. Bacterial speck, early blight, gray mold, and others. USA, LLC.

Majestene. 94.5% heat-killed *Trichoderma* media. Bionematicide for root-knot and ingestion. OMRI-listed. EPA Reg. No. 64137-

MeloCon WG. 6% *Paecilomyces* parasitic nematodes, including nematodes. OMRI-listed. EPA Reg. No. 1

MilStop. 85% potassium bicarbonate. Anthracnose, *Alternaria* (ear rot), and others. OMRI-listed. EPA Reg. No. 1

Minuet. 9.89% *Bacillus subtilis* strain. *Phytophthora*, *Pythium*, *Rhizoctonia*, and others. CropScience.

Mycostop. 35% *Streptomyces* strain. Labeled for seed and root rot in potting mix, applied as a seed treatment, or through drip irrigation. Tomato. OMRI listed. EPA Reg. No. 6853

Organocide. 5% sesame oil. OMRI-listed. Exempt from EPA registration.

OSO. 5% polyoxin D zinc salt. Powdery mildew. OMRI-listed.

OxiDate 2. 27% hydrogen dioxide. Bacterial spot, early blight, gray mold, and others. Systems, LLC.

PerCarb. 85% sodium carbonate. Speck, early blight, and late blight.

Prestop. 93% *Gliocladium* strain. Soilborne diseases (such as anthracnose, bacterial canker, late blight, and powdery mildew). *Rhizoctonia*, Southern blight. Listed. EPA Reg. No. 64137-

Prevont. Renamed AVIV.

Probiad Verde. 20% *Banda* strain. OMRI-listed. EPA Reg. No. 1

Procidic. 3.5% citric acid. Late blight. Citrex. Procidic was reviewed. Exempt from EPA registration.

Promax. 3.5% thyme oil. Late blight. Diseases and plant parasitic diseases. Registration. Bio Human Nutrition.

Rango. 70% cold pressed mildew, and foliar disease applications for nematode control. *Rhizoctonia solani* (label text). Terramera, Inc.

Regalia. 5% extract of *Regium* certain fungal and bacterial diseases: late blight, *Phytophthora* late blight, *Pythium*, and *Rhizoctonia*.

Romeo. 94.1% cerevisian gray mold, late blight and others. Corporation.

RootShield Granules, Advanced. transplant roots, soil (green roots) protecting them again. Listed. EPA Reg. No. 6853

RootShield Plus WP. 1.1 strain G-41. See previous.

Serenade ASO. 1.34% *Bacillus* colonizes roots and produces to activate the plant's natural. Anthracnose, bacterial canker, late blight, and powdery mildew. *Rhizoctonia*, Southern blight.

Serenade Opti. 26.2% *Bacillus* bacterial spot, buckeye fruit. No. 264-1160. New formula. Serenade Optimum. Baye.

Serifel NG. 11% *Bacillus* strain. Applied to soil for root rot, mold and powdery mildew. Corporation.

Serifel. 9.9% *Bacillus* strain. Anthracnose, bacterial spot, blight, and powdery mildew.

Sil-Matrix. 29% potassium. Production. OMRI-listed.

SoilGard. 12% *Gliocladium* damping-off and root rot in *capsici* plus *Fusarium* crown.

Sonata. 1.38% *Bacillus* strain. Mildew in field and green.

Sporan EC2. 16% rosen spot, early blight, gray mold. Registration. KeyPlex.

Stargus. *Bacillus amyloliquefaciens* *Phytophthora* blight, and *Verticillium*). OMRI-listed.

Taegro 2. 13% *Bacillus* strain. Speck and spot, early blight pathogens *Fusarium*, *Phytophthora*. Novozymes Biologicals, Inc.

Tenet WP. Same as BioSipcamAdvanced.

TerraClean 5. 27% hydroxide. Borne plant diseases such as *Rhizoctonia*; crops not released vast amounts of growth. OMRI-listed. EPA Reg. No. 67702-22-70051.

TerraNeem EC. 84.9% copper. Mildew, and foliar diseases: applications for nematode control. *Rhizoctonia solani* (label text). Terramera, Inc.

Thymox Control. 27% thyme oil. Proprietary nano emulsion technology. Broadly labeled for fungal diseases such as powdery mildew and grey mold, and bacterial diseases; crops not specified. OMRI-listed. Exempt from EPA registration. Kemin Industries, Inc. Manufactured by Laboratoire M2.

Thyme Guard. 23% thyme oil extract. Broadly labeled for diseases like *Botrytis* gray mold, late blight, powdery mildew and others caused by fungi, bacteria, viruses, and nematodes; crops not specified. Exempt from EPA registration. Determined to be NOP compliant by Washington State Dept of Ag. Agro Research International.

Timorex Act. 12.5% tea tree oil. Labeled for anthracnose, bacterial diseases (speck, spot, canker), early blight, gray mold, late blight, leaf mold, powdery mildew, and applied to soil for damping-off, crown and root rot caused by *Fusarium*, *Pythium*, *Rhizoctonia*, *Sclerotinia*, *Phytophthora*, or *Verticillium*. OMRI-listed. EPA Reg. No. 86182-3-88783. Summit Agro USA, LLC.

Triathlon BA. 98.85% *Bacillus amyloliquefaciens* strain D747. Labeled for controlling gray mold and suppressing bacterial speck and spot (label states to tank mix or rotate with copper-based fungicides to improve control), early blight, late blight, powdery mildew, and applied to soil for suppressing damping off, seedling blights, and root or crown diseases caused by *Pythium*, *Rhizoctonia*, *Fusarium*, *Phytophthora*, or *Verticillium* spp. OMRI listed. EPA Reg. No. 70051-107-59807. OHP, Inc.

Trilogy. 70% clarified hydrophobic extract of neem oil. Labeled generally for several insects and diseases. Labeled diseases that occur in tomato include anthracnose, early blight, *Botrytis* (gray mold), and powdery mildew (label has separate lists of crops and diseases). OMRI-listed. EPA Reg. No. 70051-2. Certis USA, LLC.

Zonix biofungicide. 8.5% rhamnolipid biosurfactant. Kills zoospores, which is one spore type produced by Oomycete pathogens which cause diseases such as late blight. OMRI-listed. EPA Reg. No. 72431-1. PropTera, LLC.

Below are some organic fungicides with active ingredients that are considered to be biocompatible, but the ingredients have not been reviewed by EPA or are not naturally occurring substance and thus are not in the [US EPA biopesticide active ingredient list](#):

DES-X insecticidal soap. 47% potassium salts of fatty acids. Labeled for powdery mildew and several insects and mites. OMRI-listed. EPA Reg. No. 67702-22-70051. Certis USA, LLC.

KOPA insecticidal soap. 47% potassium salts of fatty acids. Labeled for powdery mildew and several insects and mites. OMRI-listed. EPA Reg. No. 67702-11-59807. OHP, Inc.

M-Pede insecticidal soap. 49% potassium salts of fatty acids. Labeled for powdery mildew and several insects and mites. OMRI-listed. EPA Reg. No. 10163-324. Gowan Co.

Organic JMS Stylet-oil. 97.1% paraffinic oil. Labeled for several insect pests, viruses vectored by aphids, and powdery mildew. OMRI-listed. EPA Reg. No. 65564-1. JMS Flower Farms, Inc.

TriTek. 80% mineral oil. Labeled for several insect pests and powdery mildew. OMRI-listed. EPA Reg. No. 48813-1. Previously named Saf-T-Side. Brandt Consolidated, Inc.

LifeGard WG. 40% *Bacillus mycoides* isolate J. Biological Plant Activator. Labeled for bacterial spot, bacterial speck, early blight, gray mold, and late blight. OMRI-listed. EPA Reg No. 70051-119. Certis USA, LLC.

Majestene. 94.5% heat-killed *Burkholderia* spp. strain A396 cells and spent fermentation media. Bionematicide for root-knot, lesion, and other parasitic nematodes. Controls by contact and ingestion. OMRI-listed. EPA Reg. No. 84059-14. Marrone Bio Innovations, Inc.

MeloCon WG. 6% *Paecilomyces lilacinus* strain PL251. This soil fungus parasitizes many types of plant parasitic nematodes, including root knot and root lesion, without adverse impact on beneficial nematodes. OMRI-listed. EPA Reg No. 72444-2. Certis USA, LLC.

Mildew Cure (formerly GC-3 Organic fungicide). 30% cottonseed oil, 30% corn oil, 23% garlic extract. Labeled only for powdery mildew. OMRI-listed. Exempt from EPA registration. JH Biotech, Inc.

MilStop. 85% potassium bicarbonate. Labeled diseases of agricultural crops that occur in tomato include anthracnose, *Alternaria* (early blight), *Botrytis* (gray mold), powdery mildew, and **Septoria** leaf spot. OMRI-listed. EPA Reg. No. 70870-1-68539. BioWorks, Inc.



septoria



Highlight All



Match Case



Match Diacritics

Biopesticides for Organic and Conventional Disease Management in Vegetables and Strawberries

More information:

[Printer-friendly .pdf version of this page.](#)

Biopesticides registered in New York for specific crops in the Northeast

Lists do not include the few conventional biopesticides (e.g., copper) not permitted in organic production.

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- [Database of results from biopesticide evaluations published in PDMR](#) (.xlsx)
- [References for results from biopesticide evaluations in database](#)
- [Efficacy of microbial biopesticides published in PDMR](#) (summary of results for products tested singly from database linked above)
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Text below updated May 2022

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Database of results from biopesticide evaluations published in Plant Disease Management Reports from 2007 to spring 2021.																			
2	Types of treatment tested were solo use and combined with other biopesticides or organic copper in a program (designated in columns F and G).																			
3	When an organic copper or sulfur product was included in the evaluation, the results were added to the database.																			
4	Data from 2 disease ratings in the report were entered in the database and used to calculate % control. 'Yes' under 'More' in column U indicates there is additional disease ratings in report.																			
5	In % control columns (V - Y), E = effective (treatment rating significantly different from control) and ie = ineffective (treatment rating not significantly different from control).																			
6	Full reference for the reports is in a separate file.																			
7											Rating 1					Rating 2				
8	Crop Type	Crop	Disease	Product	Rate	Trt Type	Program	State	Year	Reference	Trt	Control	Unit			Trt	Control	Unit		
229	Cucurbits	Pumpkin	Powdery mildew	Mildew Cure	1%	Solo		NY	2006	PDMR 1:V145	31 bc	102 a	AUDPC Upper Surface			75 ab	102 a	AUDPC Lower Surface		
230	Cucurbits	Pumpkin	Powdery mildew	MilStop	3 lb/A	Solo		NY	2007	PDMR 2:V141	6.2 ab	8.9 ab	8/6 % Severity Upper			243.3 ab	316.6 a	AUDPC Upper Surface		
231	Cucurbits	Pumpkin	Powdery mildew	MilStop	2.5 lb/A	Solo		NY	2006	PDMR 1:V145	36 b	102 a	AUDPC Upper Surface			78 ab	102 a	AUDPC Lower Surface		
232	Cucurbits	Squash, Butternut	Powdery mildew	MilStop	3 lb/A	Solo		NY	2009	PDMR 4:V024	7.55 b	20.67 a	9/8 % Severity Upper			30.43 b	41.69 a	9/8 % Severity Lower Surface		
233	Cucurbits	Zucchini	Powdery mildew	MilStop	2.5 lb/A	Solo		NY	2016	PDMR 11:V013	102.8 de	567.3 a	% Mean Severity AUDPC							
234	Cucurbits	Zucchini	Powdery mildew	MilStop	2.5 lb/A	Solo		NY	2011	PDMR 6:V104	3.7 a	28.5 d	7/13-7/27 % Leaf Area			19.2 a	230 a	AUDPC Upper Surface		
235	Cucurbits	Zucchini	Powdery mildew	MilStop WP	2.5 lb/A	Solo		NY	2012	PDMR 7:V051	10 d	87.5 ab	8/29 % Leaf Area Inf			15 b	141.5 a	AUDPC		
236	Cucurbits	Pumpkin	Powdery mildew	Organocide	2 oz/gal	Solo		NY	2007	PDMR 2:V141	5.6 ab	8.9 ab	8/6 % Severity Upper			153.3 bc	316.6 a	AUDPC Upper Surface		
237	Cucurbits	Pumpkin	Powdery mildew	Organocide	1.5%	Solo		TN	2014	PDMR 10:V027	60 b	66.3 ab	% Defoliation - Boon			60 b	63.8 b	% Defoliation - Mist Blight		
238	Cucurbits	Pumpkin	Powdery mildew	Organocide	2 oz/gal	Solo		NY	2004	F&N Tests Vol 60	77 de	371 ab	AUDPC Upper Surface			573 cd	939 a	AUDPC Lower Surface		
239	Cucurbits	Pumpkin	Powdery mildew	Organocide	2 oz/gal	Solo		NY	2005	F&N Tests Vol 61	572 defg	1049 a	AUDPC Upper Surface			1272 abc	1367 a	AUDPC Lower Surface		
240	Cucurbits	Pumpkin	Powdery mildew	Organocide	2 oz/gal	Solo		NY	2006	PDMR 1:V145	13 cde	102 a	AUDPC Upper Surface			64 abc	102 a	AUDPC Lower Surface		
241	Cucurbits	Squash, Butternut	Powdery mildew	Organocide	2 fl oz/gal	Solo		NY	2009	PDMR 4:V024	3.47 bcd	20.67 a	9/8 % Severity Upper			30.89 b	41.69 a	9/8 % Severity Lower Surface		
242	Cucurbits	Summer Squash	Powdery mildew	OSO SC	6.5 fl oz/A	Solo		MD	2015	PDMR 10:V094	5.33 b	23.5 a	7/31 % Upper Leaf Surface			65.38 ab	82.13 a	8/13 % Upper Leaf Surface		
243	Cucurbits	Cantaloupe	Powdery mildew	OxiDate	48 fl oz/A	Solo		MD	2013	PDMR 8:V210	14.2 cd	32.8 a	8/27 % PM							
244	Cucurbits	Pumpkin	Powdery mildew	OxiDate	1%	Solo		CA	2009	PDMR 4:V085	63.3 bc	80 ab	10/2-10/7 % Incidence			85 abc	81.7 abc	10/2-10/7 % Incidence		
245	Cucurbits	Pumpkin	Powdery mildew	OxiDate	128 fl oz/100 gal	Solo		NY	2005	F&N Tests Vol 61	1001 ab	1049 a	AUDPC Upper Surface			1312 abc	1367 a	AUDPC Lower Surface		
246	Cucurbits	Summer Squash	Powdery mildew	OxiDate 2 29.1% L	1%	Solo		GA	2013	PDMR 8:V272	71.3 ab	73.8 a	7/18 Severity			853.1 a	809.4 a	AUDPC		
247	Cucurbits	Zucchini	Powdery mildew	OxiDate 2.0	128 fl oz/100 gal	Solo		NY	2016	PDMR 11:V013	360.5 bc	567.3 a	% Mean Severity AUDPC							
248	Cucurbits	Zucchini	Powdery mildew	OxiDate FL	128 oz/A	Solo		NY	2011	PDMR 6:V104	14.9 bc	28.5 d	7/13-7/27 % Leaf Area			82.7 a	230 a	AUDPC Upper Surface		
249	Cucurbits	Zucchini	Powdery mildew	OxiDate FL	128 oz/A	Solo		NY	2012	PDMR 7:V051	52.5 c	87.5 ab	8/29 % Severity			97.8 a	141.5 a	AUDPC		
250	Cucurbits	Pumpkin	Powdery mildew	Potassium bicarbonate	5 lb/A	Solo		TN	2014	PDMR 10:V027	72.5 a	66.3 ab	% Defoliation - Boon			65 ab	63.8 b	% Defoliation - Mist Blight		
251	Cucurbits	Cantaloupe	Powdery mildew	Regalia	1% v/v	Solo		FL	2009	PDMR 4:V103	3 a	56.3 c	5/13 % Dis Severity			86.3 fg	93.3 g	5/28 % Dis Severity		
252	Cucurbits	Cantaloupe	Powdery mildew	Regalia	1% v/v	Solo		FL	2010	PDMR 5:V062	39.5 abc	54.1 a	6/4 % Dis Severity			351 bcde	575 a	AUDPC		
253	Cucurbits	Cucumber	Powdery mildew	Regalia	80 fl oz/A	Solo		MO	2016	PDMR 12:V085	7.33 bc	8 bc	8/23 % Severity on Leaf			7.16 bc	12.58 bc	AUDPC		
254	Cucurbits	Summer Squash	Powdery mildew	Regalia	64 fl oz/A	Solo		FL	2015	PDMR 10:V055	42.8 b	62.3 a	3/20 % Severity			316.5 c	551.8 b	AUDPC		
255	Cucurbits	Summer Squash	Powdery mildew	Regalia	64 fl oz/A	Solo		GA	2009	PDMR 4:V141	46.7 a	50.4 a	AUDPC Upper Surface			86.9 ab	93.5 a	AUDPC Lower Surface		
256	Cucurbits	Cantaloupe	Powdery mildew	Regalia 5% SC	64 fl oz/A	Solo		GA	2009	PDMR 4:V145	7.5 bc	9.3 a	7/23 PM Severity, 0-			80.5 c	140 a	AUDPC		
257	Cucurbits	Cantaloupe	Powdery mildew	Regalia 5BC	128 fl oz/A	Solo		AZ	2012	PDMR 7:V107	3.5 NA-LSD	4.2 NA-LSD	6/18-6/20 Dis Severity			4 NA-LSD	4.3 NA-LSD	6/18-6/20 Dis Severity		
258	Cucurbits	Squash, Acorn	Powdery mildew	Regalia 5L	64 fl oz/A	Solo		VA	2012	PDMR 7:V038	97 a	97.5 a	8/22 % Incidence			67.5 a	71.3 a	8/22 % Severity		
259	Cucurbits	Squash, Acorn	Powdery mildew	Regalia 5L	128 fl oz/A	Solo		VA	2012	PDMR 7:V038	95.8 a	97.5 a	8/22 % Incidence			61.3 ab	71.3 a	8/22 % Severity		
260	Cucurbits	Summer Squash	Powdery mildew	Regalia 5L	64 fl oz/A	Solo		VA	2012	PDMR 7:V039	98.3 a	99.5 a	8/17 % Incidence			62.5 abc	73.8 a	8/17 % Severity		
261	Cucurbits	Summer Squash	Powdery mildew	Regalia 5L	128 fl oz/A	Solo		VA	2012	PDMR 7:V039	98.5 a	99.5 a	8/17 % Incidence			76.3 a	73.8 a	8/17 % Severity		
262	Cucurbits	Squash, Acorn	Powdery mildew	Regalia 5SC	0.50%	Solo		VA	2010	PDMR 5:V119	97.3 ab	100 a	9/24 % Incidence			73.8 abc	86.3 a	9/24 % Severity		
263	Cucurbits	Summer Squash	Powdery mildew	Regalia 5SC	0.50%	Solo		VA	2010	PDMR 5:V128	42.5 ab	65 a	8/10 % Incidence			19.3 bc	35 a	8/10 % Severity		
264	Cucurbits	Zucchini	Powdery mildew	Regalia EC	128 fl oz/A	Solo		NY	2016	PDMR 11:V013	129.3 de	567.3 a	% Mean Severity AUDPC							
265	Cucurbits	Cantaloupe	Powdery mildew	Regalia SC	64 fl oz/A	Solo		AZ	2009	PDMR 4:V050	3 NA-LSD	4.4 NA-LSD	6/22-6/23 Severity Upper			3 NA-LSD	4.4 NA-LSD	6/22-6/23 Severity Lower		
266	Cucurbits	Pumpkin	Powdery mildew	Regalia SC	1%	Solo		NY	2008	PDMR 3:V124	109 b	221.7 a	AUDPC Upper Surface			232 a	268.4 a	AUDPC Lower Surface		
267	Cucurbits	Summer Squash	Powdery mildew	Regalia SC	1%	Solo		FL	2010	PDMR 4:V112	2.8 c	4.3 a	1/22 Disease Rating			97 a	124 a	AUDPC		
268	Cucurbits	Pumpkin	Powdery mildew	Serenade AS	128 fl oz/A	Solo		NY	2003	F&N Test Vol 59:V	31 cd	72 ab	AUDPC Upper Surface			144 a	160 a	AUDPC Lower Surface		
269	Cucurbits	Pumpkin	Powdery mildew	Serenade AS	128 fl oz/A	Solo		NY	2004	F&N Test Vol 60:V	104 bc	206 a	AUDPC Upper Surface			180 bc	340 a	AUDPC Lower Surface		
270	Cucurbits	Cantaloupe	Powdery mildew	Serenade ASO	96 fl oz/A	Solo		AZ	2018	PDMR 13:V043	37.5 c	75 a	6/20-6/22 Dis Severity							
271	Cucurbits	Cantaloupe	Powdery mildew	Serenade Max	2 lb/A	Solo		AZ	2006	PDMR 1:V073	2.6 NA-LSD	3.7 NA-LSD	6/15-6/16 Dis Severity			3.1 NA-LSD	4.5 NA-LSD	6/15-6/16 Dis Severity		

	A	B	C	D	F	V	W	X	Y	Z	
1	Database of results from biopesticide evaluations published in Plant Disease Management Reports from 2007 to spring 2021.										
2	Types of treatment tested were solo use and combined with other biopesticides or organic copper in a program (designated in columns F and G).										
3	When an organic copper or sulfur product was included in the evaluation, the results were added to the database.										
4	Data from 2 disease ratings in the report were entered in the database and used to calculate % control. 'Yes' under 'More' in column U indicates there is additional disease rating.										
5	In % control columns (V - Y), E = effective (treatment rating significantly different from control) and ie = ineffective (treatment rating not significantly different from control).										
6	Full reference for the reports is in a separate file.										
7						% Control					
8	Crop Type	Crop	Disease	Product	Trt Type	Rating 1		Rating 2		Information (CTE = conventional treatment (included in	
229	Cucurbits	Pumpkin	Powdery mildew	Mildew Cure	Solo	69.6	E	26.5	ie	Mildew Cure (was named GC-3 organic fungicide) effective.	
230	Cucurbits	Pumpkin	Powdery mildew	MilStop	Solo	30.3	ie	23.2	ie	MilStop ineffective on upper and lower leaf surfaces.	
231	Cucurbits	Pumpkin	Powdery mildew	MilStop	Solo	64.7	E	23.5	ie	Milstop effective on upper surface only (2006).	
232	Cucurbits	Squash, Butternut	Powdery mildew	MilStop	Solo	63.5	E	27.0	E	MilStop moderately effective, IPM schedule.	
233	Cucurbits	Zucchini	Powdery mildew	MilStop	Solo	81.9	E			MilStop effective. Preventive.	
234	Cucurbits	Zucchini	Powdery mildew	MilStop	Solo	87.0	E	91.7	E	MilStop very effective, best in 2 trials. Applications successful.	
235	Cucurbits	Zucchini	Powdery mildew	MilStop WP	Solo	88.6	E	89.4	E	MilStop WP very effective, best in 2 trials. Application successful.	
236	Cucurbits	Pumpkin	Powdery mildew	Organocide	Solo	37.1	ie	51.6	E	Organocide moderately effective, IPM schedule. Ineffective on lower leaf surfaces.	
237	Cucurbits	Pumpkin	Powdery mildew	Organocide	Solo	9.5	ie	6.0	ie	Organocide ineffective, Microthiol Disperss effective.	
238	Cucurbits	Pumpkin	Powdery mildew	Organocide	Solo	79.2	E	39.0	E	Organocide very effective on upper leaf surfaces, some control on lower surfaces.	
239	Cucurbits	Pumpkin	Powdery mildew	Organocide	Solo	45.5	E	6.9	ie	Organocide effective on upper surfaces, provided some control on lower surfaces.	
240	Cucurbits	Pumpkin	Powdery mildew	Organocide	Solo	87.3	E	37.3	ie		
241	Cucurbits	Squash, Butternut	Powdery mildew	Organocide	Solo	83.2	E	25.9	E	Organocide moderately effective, IPM schedule.	
242	Cucurbits	Summer Squash	Powdery mildew	OSO SC	Solo	77.3	E	20.4	ie	Ineffective on lower leaf surfaces on both rating dates.	
243	Cucurbits	Cantaloupe	Powdery mildew	OxiDate	Solo	56.7	E			OxiDate applied in alternation with copper (Champ)	
244	Cucurbits	Pumpkin	Powdery mildew	OxiDate	Solo	20.9	ie	-4.0	ie	CTE. Nufilm P used as adjuvant.	
245	Cucurbits	Pumpkin	Powdery mildew	OxiDate	Solo	4.6	ie	4.0	ie	OxiDate ineffective applied following the IPM or a copper program.	
246	Cucurbits	Summer Squash	Powdery mildew	OxiDate 2 29.1% L	Solo	3.4	ie	-5.4	ie	OxiDate 2 29.1% L ineffective, applied with Yucca Ag.	
247	Cucurbits	Zucchini	Powdery mildew	OxiDate 2.0	Solo	36.5	E			OxiDate 2.0 moderately effective.	
248	Cucurbits	Zucchini	Powdery mildew	OxiDate FL	Solo	47.7	E	64.0	E	OxiDate FL moderately effective applied with Yucca Ag.	
249	Cucurbits	Zucchini	Powdery mildew	OxiDate FL	Solo	40.0	E	30.9	ie	OxiDate FL moderately effective applied with Yucca Ag.	
250	Cucurbits	Pumpkin	Powdery mildew	Potassium bicarbonate	Solo	-9.4	ie	-1.9	ie	Potassium bicarbonate ineffective, Microthiol Disperss effective.	
251	Cucurbits	Cantaloupe	Powdery mildew	Regalia	Solo	94.7	E	7.5	ie	Regalia very effective at 5/13 assessment, not 5/28; effective at 5/21 assessment, not 6/4.	
252	Cucurbits	Cantaloupe	Powdery mildew	Regalia	Solo	27.0	ie	39.0	E	Regalia effective at 5/21 assessment, not 6/4.	
253	Cucurbits	Cucumber	Powdery mildew	Regalia	Solo	8.4	ie	43.1	ie	Symptoms present at first application. CTE. Expt also	

Keys to Success in Disease Management

Be Proactive!

Know what diseases have + could occur.

Become familiar with symptoms.

Understand biology of pathogen; survival and dispersal.

Learn practices for managing main diseases.

Implement Basic Cultural Management Practices.

Rotation, separation. Minimize leaf wetness.

Manage weeds. Sanitation: before + after crop.

Be Observant!

Look for disease symptoms. Record with camera.

Ensure Diseases are Accurately Identified.

Be Prepared to Act!

Rogue diseased plants when appropriate.

Have sprayer ready to apply fungicides.

Plant Disease that was Sought After!!

Tulip Breaking Virus

- the streaked flowers were considered beautiful; valuable.
- 1663-67. peak of Tulip Mania. Soaring prices. Price structure for the tulips collapsed, leaving many in financial ruin.
- Now illegal to cultivate infected bulbs. Variegated varieties have been bred.



are YOU awake for Questions?!?



