Outlook for Powdery and Downy Mildew Control in Vine Crops – Fungicides, Variety Resistance and More!

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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.

Diseases and management practices affecting multiple crops

- **Phytophthora Blight and Its Management in Cucurbit and Other Vegetables**
- **Reduced-tillage for Managing Phytophthora Blight and Other Borne Pathogens**
- **Biofumigation for Managing Phytophthora Blight and Other Borne Pathogens**
- **White Mold and Its Management in Cabbage, Beans, and Vegetables**
- **Diseases of Winter Greens: Downy Mildews, Powdery Mildew, Closipporin 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 Vegetables**
- **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 Disease Management?**

Diseases and management practices affecting specific crops

**Arugula**
- Downy mildew (LIHREC)
- Powdery mildew (LIHREC)

**Asparagus**
- Herbicide injury (LIHREC)

**Basil**
- Basil downy mildew

**Beans**
- Anthracnose
- Bacterial brown spot
- Bacterial diseases

**Chimera (genetic disorder)**
- Onion injury (LIHREC)
- Phytosphera blight
- Tomato chlorotic spot virus (TCSV)
- Virus diseases of snap and dry beans

**Beets and Swiss Chard**
- Alternaria leaf spot
- Bacterial leaf spot
- Cercospora leaf spot
- Cercospora leaf spot (LIHREC)
- Phoma leaf spot and root rot
- Rhinocotania crown and root rot

**Carrots**
- Leaf blight diseases
- Powdery mildew (LIHREC)

**Celery**
- Anthracnose
- Septoria leaf spot (LIHREC)

**Corn (sweet)**
- Sweet corn diseases and control measures
- Common corn stunt (LIHREC)

**Crucifers**
- Alternaria leaf spot of brassicas
- Alternaria leaf spot of brassicas (LIHREC)
- Blackleg leaf spot on crucifers (LIHREC)
- Blackleg on kale (LIHREC)
- Black rot on brassicas (LIHREC)
- Black rot on cabbage (LIHREC)
- Black rot on ornamental kale and ornamental cabbages (LIHREC)
- Clubroot (Brassica erubescens) (LIHREC)
- Collar of crucifers
- Clubroot on brussel sprouts (LIHREC)
- Diseases of winter greens: downy mildew, Closipporin leaf spot, bacterial leaf spot, root rots on cabbage and kale (LIHREC)
- Downy mildew on cabbages (LIHREC)
- Downy mildew on member (LIHREC)
- Eschrigia violaceae of cabbage & related crops
- Heat stress response in broccoli leaves (LIHREC)
- Powdery mildew (LIHREC)
- Virus diseases of crucifers

**Cucurbits**
- Table: Fungicides for Cucurbit Crops
- Table: Mobile Fungicides for Managing Three Major Cucurbit Diseases: Powdery Mildew, Downy Mildew, and Phytophthora Blight
- Alternaria (LIHREC)
- Antrical leaf spot (LIHREC)
- Anthracnose (LIHREC)
- Bacterial leaf spot and downy scissors (Monilinia fructicola) (LIHREC)
- Blackleg leaf spot (LIHREC)
- Blackleg on kale (LIHREC)
- Blackleg root rot (LIHREC)
- Blackleg on brassicas (LIHREC)
- Blackleg on ornamental kale and ornamental cabbages (LIHREC)
- Clubroot (Brassica erubescens) (LIHREC)
- Collar of crucifers
- Clubroot on brussel sprouts (LIHREC)
- Heat stress response in broccoli leaves (LIHREC)
- Powdery mildew (LIHREC)
- Virus diseases of crucifers

**Dill**
- Common leaf blight (LIHREC)
- Common leaf blight and root blight (LIHREC)
**Cucurbits**

- [Table: Fungicides for Cucurbit Crops (pdf)](click here for Excel version)
- [Table: Mobile Fungicides for Managing Three Major Cucurbit Diseases: Powdery Mildew, Downy Mildew, and Phytophthora Blight](
- [Alternaria](LIHREC)
- [Angular leaf spot](LIHREC)
- [Anthracnose](LIHREC)
- [Anthracnose](LIHREC)
- [Bacterial leaf spot (renamed Xanthomonas leaf spot)](LIHREC)
- [Choanephora fruit rot](LIHREC)
- [Downy mildew](LIHREC)
- [Fusarium crown rot and fruit rot of pumpkin](LIHREC)
- [Fusarium fruit rot of other cucurbits](LIHREC)
- [Gummy stem blight and black rot](LIHREC)
- [Ozone Injury](LIHREC)
- [Phytophthora blight](LIHREC)
- [Plectosporium blight](LIHREC)
- **Powdery mildew** (LIHREC)
- [Pythium fruit rot](LIHREC)
- [Pythium root rot](LIHREC)
- [Scab](LIHREC)
- [Sunscale of pumpkin and winter squash](LIHREC)
- [Virus diseases of cucurbits](LIHREC)
- [White mold on cucurbits](LIHREC)
- [Xanthomonas leaf spot (formerly Bacterial leaf spot)](LIHREC)
Extension & Outreach

Providing growers with information about diseases of vegetable crops and their management is the goal of my program. I conduct applied (translational) research generating practical results that are relevant for crop production. Gardeners will find some information at this website useful; I also conduct a Master Gardener class on plant diseases focused on vegetables. See About for additional general information on my program.

- For gardeners
  - Vegetable and herb disease factsheets and articles
  - Resistant vegetable variety tables
  - Organic management of vegetable disease
  
List of Extension presentations made by M. T. McGrath

Some recent presentations


- **What was Learned From Over 20 Years of Evaluating Biofungicides**, 2023 Mid-Atlantic Fruit and Vegetable Convention. Biocontrol Session. Hershey, PA. 1/31/23.


Disease factsheets and articles

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- On-Farm Soil Bioassays for Assessing Root Pathogens
- General Guidelines for Managing Fungicide Resistance
- When is the Best Time to Apply Fungicides for Foliage 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
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 mjm3@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 cucubit varieties

- Information is from seed catalogs for 2018, 2020, 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.

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Cucumbers – Slicers

- 201: Cucumber Mosaic Virus, Downy Mildew, Powdery Mildew, Papaya Ringspot Virus, Scab, Watermelon Mosaic Virus (Strain 2), Zucchini Yellow Mosaic Virus
- Alcazar F1: Cucumber Vine Yellowing Virus, Powdery Mildew, Scab
- Ashley: Angular Leaf Spot, Downy Mildew, Powdery Mildew
- Bella: Corenespora Leaf Spot/Blight, Powdery Mildew, Scab, Target Leaf Spot
- Brager: Resistant to disorders
- Brickyard: Angular Leaf Spot, Anthracnose, Cucumber Mosaic Virus, Downy Mildew, Powdery Mildew, Papaya Ringspot Virus, Scab, Watermelon Mosaic Virus (Strain 2)
- Bristol F1: Cucumber Mosaic Virus, Downy Mildew, Powdery Mildew, Papaya Ringspot Virus, Scab, Watermelon Mosaic Virus, Zucchini Yellow Mosaic Virus
- Burpee II: Cucumber Mosaic Virus, Downy Mildew
- Burpless Beauty: Disease resistance not specified
- Bush Champion: Cucumber Mosaic Virus
- Bush Crop: Scab
- Camaro F1: Powdery Mildew
- Centella F1: Cucumber Mosaic Virus, Downy Mildew, Powdery Mildew, Papaya Ringspot Virus, Scab, Watermelon Mosaic Virus (Strain 2), Zucchini Yellow Mosaic Virus
- Cobra F1: Angular Leaf Spot, Anthracnose (Co: A2), Cucumber Mosaic Virus, Downy Mildew, Powdery Mildew, Papaya Ringspot Virus, Scab, Watermelon Mosaic Virus (Strain 2), Zucchini Yellow Mosaic Virus
Cucumber

Cucurbit Downy Mildew

Cantaloupe
Cucurbit Downy Mildew – important facts

- Pathogen survives overwinter in S Florida, moves northward.

- Occurrence is monitored, but no longer forecasted. Sign up for alerts. https://cdm.ipmpipe.org/

- Pathogen is host-specialized. Cucumber + cantaloupe affected first; pathogen Clade 2.

- Squash, pumpkin, and watermelon affected later in season if at all pathogen Clade 1.
Managing Cucurbit Downy Mildew

- **Learn about the disease** at https://www.vegetables.cornell.edu/pest-management/disease-factsheets/downy-mildew-of-cucurbits/.

- **Plan fungicide program** based on information at above website about fungicide efficacy, resistance, and label use restrictions.

- **Select resistant varieties.** Cucumber: DMR 401, Brickyard, new Tokita lines. Cantaloupe: Trifecta.

- Sign up to **receive alerts** when downy mildew has been detected nearby at The Cucurbit Downy Mildew Forecast webpage: https://cdm.ipmpipe.org/.

- **Monitor** https://cdm.ipmpipe.org/ to know when and where downy mildew is developing in different cucurbit crops.

- Become familiar with **early symptoms**. See http://blogs.cornell.edu/livegpath/gallery/cucurbits/downy-mildew-o-cucurbits-early-symptoms/

- **Scout** for symptoms at least weekly, especially cucumbers.

- **Report** occurrence to extension specialist or post at https://cdm.ipmpipe.org/.

- Start applying **targeted fungicides** as soon as symptoms detected in crop or nearby, or risk high. Apply in alternation and with protectant fungicides (chlorothalonil, mancozeb, copper, biopesticides). Protectants alone recommended when preventive application used.

- **Rate success** of management program and identify ways to improve if inadequate.
Management – Downy Mildew – Cantaloupe

Downy Mildew Resistant Varieties

Trifecta   Edisto 47   Planter’s Jumbo

29% control (AUDPC values); 72% control (defoliation)

Conventional Fungicide Program

Ranman alt.  Previcur Flex alt.  Orondis Ultra

7-27 started preventive applications.

8-17 started IPM program.

98 – 100% control including on susceptible variety.
Conventional Fungicide Programs + Resistant Varieties
Downy Mildew on Cantaloupe
Fungicide Efficacy – Downy Mildew – Cucumber

Biopesticides tested in 2022 and copper (Kocide 3000-O) ineffective based on symptom severity and % leaves affected.

Symptoms first seen 16 days after the first application.

**Biopesticides tested:**
- Serifel (microbial)
- Theia (microbial)
- Trillium (thyme oil)
- Regalia + Stargus (extract giant knotweed + microbial)

Conventional fungicide program very effective (99% control):
- Ranman alt. Orondis Ultra alt. Previcur Flex

Documents CDM is difficult to manage with contact fungicides.
8-29-22. 24 days after first symptoms. 1 day before 7th app.
<table>
<thead>
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# Fungicide Efficacy - Bioassays - South Carolina

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<th>Butternut squash, Clade 1</th>
<th>Watermelon, Clade 1</th>
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* Ineffective is some bioassays, 2018 – 2020.
## Fungicides – Phytophthora Blight

<table>
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<tr>
<th>FRAC Code</th>
<th>Fungicide</th>
<th>Active Ingredient</th>
<th>Registered</th>
<th>Resistance</th>
<th>Downy Mildew</th>
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<td>mefenoxam</td>
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<td>Not effective</td>
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<td>Resistance – Clade 2?</td>
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<td>lab</td>
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<td>2008</td>
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<td>armetoctradin + dimethomorph</td>
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<td>Omega</td>
<td>fluazinam</td>
<td>2012 / 2016</td>
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<td>EFFECTIVE</td>
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</table>
Fungicides – Phytophthora + Downy Mildew

**Cucumber and Cantaloupe** (downy mildew pathogen clade 2):
- **Omega** early. PHI is 30 days.
- **Zampro, Orondis, Gavel. Tanos?**
- **Ranman** if not used a lot for Phytophthora in past on farm.

**Squash, Pumpkin and Watermelon** (downy mildew pathogen clade 1; concern late summer - fall):
- **Revus** or **Forum, Tanos** early when downy mildew not a concern.
- **Revus, Zampro, Omega** (7 d PHI), **Orondis, Gavel**.
- **Ranman** and **Presidio** if not used a lot for Phytophthora.
- Resistant varieties provide limited (pumpkin, squash) to excellent (cucumber, cantaloupe) suppression.

- Onset coincides with start of fruiting.

- Many biopesticides and protectant fungicides (sulfur, chlorothalonil) effective on upper leaf surfaces.

- Targeted fungicides can be excellent.

  Effective on lower leaf surface.

  Resistance is major issue.

  Isolates with multi-fungicide resistance.

  Inherent differences in efficacy including within FRAC group
Squashes and Pumpkins
Intermediate resistance
Powdery mildew tolerant
Homozygous best
control improved with fungicides

Betternut 1744
Developed by Rupp breeders. Slightly larger than Betternut 900 for farm markets and roadside stands.

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

HARRIs
Pumpkin Gladiator
Our #1 variety! Its improved disease protection and grower-preferred fruit size have made Gladiator the number one variety of growers across the country. Raised next to other varieties in field comparisons, Gladiator shows improved homoyzgous intermediate resistance to powdery mildew. The round, deep orange fruit have moderate ribbing and measure 13” wide x 12” high. Gladiator’s long handles are thick and firmly rooted to the 20 to 25 lb. fruit. Vigorous, semi-vine plants produce good yields of these classic, attractive pumpkins that are uniform for size and shape. US Patent 7,166,772.
Cantaloupe: Race specific resistance.

Arangina

NEW

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.

Copyright © Seminis

Athena

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

Copyright © Syngenta

Disease Resistance
Fusarium Wilt (0,1,2)
Powdery Mildew (1,2)

Disease Resistance
Fusarium Wilt 0,1,2
Powdery Mildew 1,2,3,5
Fungicide Sensitivity Bioassay

Fluopyram 50 ppm

Fluxapyroxad 50 ppm

Penthiopyrad 50 ppm

Control
# Powdery Mildew Isolate Bioassays – Fungicides

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Concentration</th>
<th>Field Rate</th>
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<tr>
<td>Endura (7)</td>
<td>500 ppm (= field rate)</td>
<td></td>
</tr>
<tr>
<td>Torino (U6)</td>
<td>50 ppm (= field rate)</td>
<td></td>
</tr>
<tr>
<td>Quintec (13)</td>
<td>200 ppm (= field rate)</td>
<td></td>
</tr>
<tr>
<td>Rally (3)</td>
<td>40, 80 ppm</td>
<td>field rate = 300 ppm</td>
</tr>
<tr>
<td>Vivando (50)</td>
<td>50, 150 ppm</td>
<td>field rate = 600 ppm</td>
</tr>
<tr>
<td>Luna Privilege (7)</td>
<td>50, 150 ppm</td>
<td>field rate = 390 ppm</td>
</tr>
</tbody>
</table>

**Field rate** = highest label rate applied at 50 gpa.

Luna Privilege used instead of Luna fungicides labeled for this use because Luna Experience and Luna Sensation have another AI.

Fungicide resistance is result of change in single or multiple genes.
2012. Registered for this use in USA.

Label restrictions stronger than any other at-risk fungicide: no consecutive applications allowed; maximum 2 applications.

Other at-risk fungicides not yet impacted by resistance available to use in a sound resistance management program: Quintec and DMIs plus Vivando 2 years later.

2017. Fully resistant isolates detected.

Resistance detected to QoIs after 3 yrs, Endura after 6 yrs, and Quintec after 8 yrs.
Fungicide Resistance Occurrence in Powdery Mildew Isolates from Cucurbit Crops, Eastern NY, 2021

<table>
<thead>
<tr>
<th>Powdery Mildew Fungicides used</th>
<th>Percent Resistant Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Just protectants (copper, chlorothalonil)</td>
<td>Torino</td>
</tr>
</tbody>
</table>


## Fungicide Resistance Occurrence in Powdery Mildew Isolates from Cucurbit Crops, Eastern NY, 2021

<table>
<thead>
<tr>
<th>Powdery Mildew Fungicides used</th>
<th>Percent Resistant Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just protectants (copper, chlorothalonil)</td>
<td>Torino 0</td>
</tr>
<tr>
<td>Quintec, Vivando, Vivando (all applied with protectants)</td>
<td>Torino 0</td>
</tr>
</tbody>
</table>
### Fungicide Resistance – Powdery Mildew - Eastern NY, 2021

<table>
<thead>
<tr>
<th>Powdery Mildew Fungicides used</th>
<th>Resistant Isolates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Torino</td>
</tr>
<tr>
<td>Just protectants (copper, chlorothalonil) **</td>
<td>0</td>
</tr>
<tr>
<td>Quintec, Vivando, Vivando *</td>
<td>0</td>
</tr>
<tr>
<td>Vivando, <strong>Quintec</strong>, Rhyme, Vivando, <strong>Quintec</strong> *</td>
<td>0</td>
</tr>
<tr>
<td><strong>Quintec</strong>, Vivando, <strong>Quintec</strong> + Vivando *</td>
<td>67</td>
</tr>
<tr>
<td><strong>Quintec</strong>, Rhyme, Prolivo, Gatten, Prolivo, <strong>Quintec</strong>, Prolivo, Gatten ** *</td>
<td>71</td>
</tr>
</tbody>
</table>

* all applied with protectants

** Fields about 2 miles apart
## Fungicide Resistance – Powdery Mildew - Eastern NY, 2021

<table>
<thead>
<tr>
<th>Powdery Mildew Fungicides used</th>
<th>Resistant Isolates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Torino</td>
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<tr>
<td>Just protectants (copper, chlorothalonil)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Quintec, Vivando, Vivando</strong> *</td>
<td>0</td>
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<tr>
<td><strong>Vivando, Quintec, Rhyme, Vivando, Quintec</strong> *</td>
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<tr>
<td><strong>Quintec, Vivando, Quintec + Vivando</strong> *</td>
<td>50</td>
</tr>
<tr>
<td><strong>Quintec, Rhyme, Prolivo, Gatten, Prolivo, Quintec, Prolivo, Gatten</strong> *</td>
<td>71</td>
</tr>
<tr>
<td>Gatten, Vivando, Gatten *</td>
<td>11</td>
</tr>
</tbody>
</table>

* all applied with protectants
Fungicide Resistance - Cucurbit Powdery Mildew

Resistant isolates are fit. Found in plantings not treated.

Frequency of resistance in a planting can change with fungicide use during a season.

Applying a fungicide ineffective due to resistance may not be evident when other fungicides used are effective.

Pathogen isolates with resistance to multiple fungicide chemistry groups have been found increasingly.

All 2020 isolates found to be resistant to Quintec were also resistant to Torino, Endura, and QoI fungicides.

Change in 2022 reflecting fungicide use.

Expect resistance to develop to additional fungicides.
Fungicide Resistance - Cucurbit Powdery Mildew

2022 Preliminary Results:

76 isolates tested. 37 resistant to Endura.
6 resistant to Torino. 8 resistant to Quintec.

JUST ONE MULTI-FUNGICIDE RESISTANT ISOLATE SO FAR!!

Fungicides used: Quintec applied once in 1 crop.
Vivando or Prolivo. Rhyme, Inspire Super. Miravis Prime
Fungicide Programs - Cucurbit Powdery Mildew

Proline, Vivando, Proline, Vivando, Procure, Vivando

Vivando, Vivando, Aprovia Top, Aprovia Top, Vivando

FRAC: 50 3 3 + 7 7

Others: Prolivo Rhyme Luna Experience Miravis Prime leftover Quintec or Torino 1 application

Gatten has not been as effective in efficacy trials.

Start preventive (start of fruit formation) or at threshold (1 of 50 older leaves)

Apply with protectant:
sulfur, mineral oil, chlorothalonil, biopesticide
Luna Experience – sensitivity to fluopyram (FRAC 7)

Most 2022 isolates tolerate 50 ppm. Few tolerate 150 ppm.

Luna Experience 6 fl oz/A applied at 50 gpa = 165 ppm.

Luna Experience 17 fl oz/A applied at 50 gpa = 468 ppm.

Higher gallonage, lower concentration.
Cucurbits

- Table: Fungicides for Cucurbit Crops (.pdf) (click here for Excel version)

- Table: Mobile Fungicides for Managing Three Major Cucurbit Diseases: Powdery Mildew, Downy Mildew, and Phytophthora Blight

- Alternaria (LIHREC)

- Angular leaf spot (LIHREC)

- Anthracnose

- Anthracnose (LIHREC)

- Bacterial leaf spot (renamed Xanthomonas leaf spot) (LIHREC)

- Choanephora fruit rot (LIHREC)

- Downy mildew

- Fusarium crown rot and fruit rot of pumpkin (LIHREC)

- Fusarium fruit rot of other cucurbits (LIHREC)

- Gummy stem blight and black rot (LIHREC)

- Ozone injury (LIHREC)

- Phytophthora blight
Table contains many conventional fungicides labeled for diseases of cucurbit crops, approximate cost per acre of an application, number of acres that can be treated with the package size available, and diseases labeled. Most products listed have mobility and/or targeted activity. The last nine are contact protectant fungicides.

<table>
<thead>
<tr>
<th>Product*</th>
<th>FRAC</th>
<th>Max # consecutive applications</th>
<th>Maximum # applications to a crop</th>
<th>Pre-harvest Interval (PHI) days</th>
<th>Restricted Entry Interval (REI) hours</th>
<th>Labeled for use in greenhouse</th>
<th>Classified Restricted Use in NY</th>
<th>Not for use on Long Island</th>
<th>Price</th>
<th>Unit</th>
<th>Pkg Size</th>
<th>Rate/A Unit</th>
<th>Rate/A Unit</th>
<th>Cost/A</th>
<th>A/treated</th>
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</thead>
<tbody>
<tr>
<td>Actigard</td>
<td>P01</td>
<td>-</td>
<td>4-8</td>
<td>REI 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$59.00</td>
<td>oz</td>
<td>8 oz</td>
<td>0.5-1 oz</td>
<td>$30-59</td>
<td>8-16</td>
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<tr>
<td>Aprovia Top 1.62 EC</td>
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<td>4</td>
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</tr>
</tbody>
</table>

**Max # consecutive applications**

**Maximum # applications to a crop**

**Pre-harvest Interval (PHI) days**

**Restricted Entry Interval (REI) hours**

**Labeled for use in greenhouse**

**Classified Restricted Use in NY**

**Not for use on Long Island**
<table>
<thead>
<tr>
<th>Product*</th>
<th>Alternaria blight</th>
<th>Alternaria leaf spot</th>
<th>anthracnose</th>
<th>angular leaf spot</th>
<th>bacterial leaf spot</th>
<th>downy mildew</th>
<th>Fusarium blight aka Fusarium crown rot and fruit rot</th>
<th>gummy stem blight</th>
<th>Phytophthora blight</th>
<th>Plectosporium blight</th>
<th>powdery mildew</th>
<th>scab</th>
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</thead>
<tbody>
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<td>Actigard</td>
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<td>R</td>
<td>L</td>
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<td>Aprovia Top 1.62 EC</td>
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<tr>
<td>Cabrio EG</td>
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<td>Flint Extra</td>
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<td>Forum 4.17 SC</td>
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<td>Fungicides – Cucurbit Powdery Mildew – Cost + Acreage</td>
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<tr>
<td>Microthiol Disperss $10 - 40/A (low rate effective)</td>
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<tr>
<td>Bravo Weather Stik $8 - 15/A</td>
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<td>Proline (3) $32 56 A (2.5 gal)</td>
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<td>Procure (3) $16 - 33/A 4 - 8 A</td>
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<td>Rhyme (3) $24 - 33/A 7 - 10 A</td>
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<tr>
<td>Inspire Super (3 + 9) $32 - 40/A 6 - 8 A</td>
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<td>Aprovia Top (3 + 7) $32 - 41/A 10 - 12 A</td>
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<tr>
<td>Luna Experience (3 + 7) $34 - 96/A 2 - 5 A</td>
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<tr>
<td>Miravis Prime (7 + 12) $37 - 45/A 28 - 35 A (2.5 gal)</td>
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<tr>
<td>Vivando (50) $35/A 7 - 10 A</td>
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<tr>
<td>Prolivo (50) $19 - 23/A 2 - 3 A</td>
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</tbody>
</table>
organic Biopesticides
Cucurbit Mildews + Other Diseases

Double Nickel.  *Bacillus amyloliquefaciens* strain D747
Taegro 2.  *Bacillus amyloliquefaciens* strain FZB24
Serifel.  *Bacillus amyloliquefacinens* strain MBI 600
LifeGard.  *Bacillus mycoides* isolate J
Sonata.  *Bacillus pumilus* strain QST 2808
Aviv.  *Bacillus subtilis* strain IAB/BS03
Companion.  *Bacillus subtilis* strain GB03
Serenade.  *Bacillus subtilis* strain QST 713
LALSTOP G46 / Prestop.  *Gliocladium catenulatum* J1446
Romeo.  cerevisane (cell walls of *Saccharomyces cerevisiae*)
Howler.  *Pseudomonas chlororaphis* strain AFS009

Carb-O-Nator.  potassium bicarbonate
Kaligreen.  potassium bicarbonate
MilStop.  potassium bicarbonate

Regalia.  extract of giant knotweed.
EcoSwing.  extract of *Swinglea glutinosa*.
Problad Verde.  Banda de Lupinus albus doce.
ECOWORKS.  cold pressed neem oil.
Rango.  cold pressed neem oil.
TerraNeem.  cold pressed neem oil.
Trilogy.  extract of neem oil.
Timorex Act.  tea tree oil.
Thymox Control.  thyme oil.
GreenFurrow BacStop.  several botanical oils.
GreenFurrow EF400.  several botanical oils.
Mildew Cure.  several botanical oils.
Sporan EC².  several botanical oils.

Sil-MATRIX.  potassium silicate
OSO.  polyoxin D zinc salt
PerCarb.  sodium carbonate peroxyhydrate
Seican.  cinnamaldehyde
Role of Biopesticides in Cucurbit Disease MGT

Organic production.

Good coverage important because of contact activity.

Conventional production:

In place of contact fungicides (chlorothalonil, copper) tank mixed with targeted fungicides.

Applied in place of targeted fungicides.

Preventive and late season best.
Powdery Mildew on Pumpkin
## Biopesticide Efficacy – Powdery Mildew - Pumpkin

% Control based on AUDPC on both leaf surfaces 2022

<table>
<thead>
<tr>
<th>Fungicide (7-day)</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serifel</td>
<td>69 b</td>
<td>27 abc</td>
</tr>
<tr>
<td>Stargus + Regalia</td>
<td>71 bc</td>
<td>17 ab</td>
</tr>
<tr>
<td>Trillium</td>
<td>73 bc</td>
<td>24 abc</td>
</tr>
<tr>
<td>Theia</td>
<td>76 bc</td>
<td>24 abc</td>
</tr>
<tr>
<td>Microthiol Disperss (sulfur)</td>
<td>99 d</td>
<td>33 bc</td>
</tr>
<tr>
<td>Stargus + Regalia alt. sulfur</td>
<td>96 d</td>
<td>35 bc</td>
</tr>
<tr>
<td>Theia alt. sulfur</td>
<td>96 d</td>
<td>37 bc</td>
</tr>
</tbody>
</table>

Trial conducted on powdery mildew intermediate resistant ‘Bayhorse Gold’. First application 21 July before powdery mildew seen.

Values in column with same letter not statistically different. a=ineffective.
Microthiol Disperss (sulfur)

Stargus + Regalia alt. sulfur

Theia alt. sulfur

Serifel, Proline, Vivando

9-7-22
## Biopesticide Efficacy – Powdery Mildew - Pumpkin

% Control based on AUDPC on both leaf surfaces 2022

<table>
<thead>
<tr>
<th>Fungicide (7-day)</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theia (2), Proline alt Vivando (3), Theia (2)</td>
<td>95</td>
<td>c</td>
</tr>
<tr>
<td>Serifel (2), Proline alt Vivando (3), Serifel (2)</td>
<td>93</td>
<td>bc</td>
</tr>
<tr>
<td>TACT (2), Proline alt Vivando (3), TACT (2)</td>
<td>91</td>
<td>bc</td>
</tr>
<tr>
<td>Proline alt Vivando (3)</td>
<td>68</td>
<td>b</td>
</tr>
<tr>
<td>Proline alt Vivando alt Procure (5)</td>
<td>99</td>
<td>c</td>
</tr>
</tbody>
</table>

Trial conducted on powdery mildew susceptible ‘Gold Challenger’.
First application 21 July before powdery mildew seen.
TACT = Timorex ACT
Values in column with same letter not statistically different. a=ineffective.
Control

Serifel, Proline, Vivando

sulfur, Proline, Vivando

Proline, Vivando
3 apps; 8/3 – 8/17

Proline, Vivando
6 apps; 8/3 – 9/9
<table>
<thead>
<tr>
<th>Fungicide/Herbicide</th>
<th>Rate/Coverage</th>
<th>Disease Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microthiol Disperss</td>
<td>$10 - 40/A</td>
<td>Alternaria, Anthracnose, DM, GSB, Scab</td>
</tr>
<tr>
<td>Bravo Weather Stik</td>
<td>$8 - 15/A</td>
<td>Alternaria, Anthracnose, DM, GSB, Scab</td>
</tr>
<tr>
<td>Proline (3)</td>
<td>$32</td>
<td>Fusarium, Gummy Stem Blight (GSB)</td>
</tr>
<tr>
<td>Procure (3)</td>
<td>$16 - 33/A</td>
<td>Gummy Stem Blight</td>
</tr>
<tr>
<td>Rhyme (3)</td>
<td>$24 - 33/A</td>
<td>Gummy Stem Blight</td>
</tr>
<tr>
<td>Inspire Super (3 + 9)</td>
<td>$32 - 40/A</td>
<td>Alternaria, Anthracnose, GSB, Plectosporium</td>
</tr>
<tr>
<td>Aprovia Top (3 + 7)</td>
<td>$32 - 41/A</td>
<td>Alternaria, Anthracnose, GSB, Plecto, Scab</td>
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<td>Alternaria, Anthracnose, GSB</td>
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<tr>
<td>Miravis Prime (7 + 12)</td>
<td>$37 - 45/A</td>
<td>Alternaria, Gummy Stem Blight, Scab</td>
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<tr>
<td>Vivando (50)</td>
<td>$35/A</td>
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</tr>
<tr>
<td>Prolivo (50)</td>
<td>$19 - 23/A</td>
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Thank You!

Questions?