Powdery Mildew on Cucurbits and Tomatoes

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Tomato - Powdery Mildew
Tomato - Powdery Mildew
Managing Tomato Powdery Mildew

- When purchasing seedlings, ask producer about powdery mildew management program being used. Inspect plants thoroughly when received.
- Select resistant varieties.
- Manage weeds. Some likely are alternate hosts.
- Look for symptoms weekly. Check underside of leaves buried in canopy.
- Apply fungicides regularly starting at first detection of symptoms or preventively based on past occurrence. Thorough spray coverage.
<table>
<thead>
<tr>
<th>Product</th>
<th>Frequency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torino (FRAC code U6)</td>
<td>3 max.</td>
<td>14-day</td>
</tr>
<tr>
<td>Vivando (U8)</td>
<td>3 max.</td>
<td>2 consecutive.</td>
</tr>
<tr>
<td>Rally, Rhyme, etc (3)</td>
<td>4 max.</td>
<td></td>
</tr>
<tr>
<td>Aprovia Top (3 + 7)</td>
<td>4 max.</td>
<td>2 consecutive.</td>
</tr>
<tr>
<td>Quadris Top (3 + 11)</td>
<td>5 max.</td>
<td>2 consecutive.</td>
</tr>
<tr>
<td>Topguard (3 + 11)</td>
<td>4 max.</td>
<td></td>
</tr>
<tr>
<td>Inspire Super (3 + 9)</td>
<td>4 max.</td>
<td>2 consecutive.</td>
</tr>
<tr>
<td>Luna Tranquility (7 + 9)</td>
<td>4 max.</td>
<td>2 consecutive.</td>
</tr>
<tr>
<td>Priaxcor (7 + 11)</td>
<td>3 max.</td>
<td>2 consecutive.</td>
</tr>
<tr>
<td>Miravis Prime (7 + 12)</td>
<td>2 max.</td>
<td></td>
</tr>
<tr>
<td>Switch (9 + 12)</td>
<td>4 max.</td>
<td>2 consecutive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>followed by 2 apps of another.</td>
</tr>
<tr>
<td>Product</td>
<td>Application</td>
<td>Cycle</td>
</tr>
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Followed by 2 apps of another.
Organic Fungicides – Tomato Mildew

Sulfur

Cease (inside) or Serenade (out), Double Nickel, Prevont, Serifel, Sonata, Taegro 2

JMS Stylet-oil, Mildew Cure, Thyme Guard, Timorex Gold, Trilogy, TriTek

Regalia

MilStop or Kaligreen

M-Pede, OxiDate 2
Organic Fungicides – Tomato Mildew

Sulfur
Cease (inside) or Serenade (out), Double Nickel, Preveont, Serifel, Sonata, Taegro 2
JMS Stylet-oil, Mildew Cure, Thyme Guard, Timorex Gold, Trilogy, TriTek Regalia
MilStop or Kaligreen
M-Pede, OxiDate 2

Pre-harvest
Between Harvest
Tools for Managing Cucurbit Powdery Mildew

Resistant varieties
Fungicides

Need control on lower leaf surface.
Mobile fungicides prone to resistance.
# Vegetable MD Online

Contact for information in this section:
Meg McGrath &lt;mtm3@cornell.edu&gt;

## Tables of Disease Resistant Varieties available for the following crops (only varieties with resistance claims are listed):

- **Bean**: Dry [xls]
- **Bean**: French [xls]
- **Bean**: Green [xls]
- **Bean**: Half runner [xls]
- **Bean**: Italian [xls]
- **Bean**: Lima [xls]
- **Bean**: Pole [xls]
- **Bean**: Wax [xls]
- **Broccoli** [xls]
- **Cabbage**: Chinese [xls]
- **Cabbage**: Green [xls]
- **Cabbage**: Napa [xls]
- **Cabbage**: Oriental [xls]
- **Cabbage**: Red [xls]
- **Cabbage**: Savoy [xls]
- **Cabbage**: Processing [xls]
- **Cucumber/Pickles** [xls]
- **Cucumber/Slicers** [xls]
- **Eggplant** [xls]
- **Leeks** [xls]
- **Lettuce**: Boston [xls]
- **Lettuce**: Butterhead [xls]
- **Lettuce**: Green Leaf [xls]
- **Lettuce**: Red-Resistant [xls]
- **Muskmelon**
- **Onion (Early Yellow)** [xls]
- **Onion (Spanish Variety, Red)** [xls]
- **Onion (Bunching Variety)** [xls]
- **Onion (White Variety)** [xls]
- **Peas (shell)** [xls]
- **Peas**: Snap/snow [xls]
- **Peppers**: Hot [xls]
- **Peppers**: Jalapeno [xls]
- **Peppers**: Sweet Bell [xls]
- **Pumkins**
- **Specialty Melons**
- **Spinach** [xls]
- **Tomato**: Cherry [xls]
- **Tomato**: Grape [xls]
- **Tomato**: Heirloom [xls]
- **Tomato**: Plum [xls]
- **Tomato**: Slicer (mostly) [xls]
- **Watermelon**
- **Winter Squash** [xls]
- **Yellow Summer Squash**
- **Zucchini Squash**
News Articles and Research Reports on Evaluations of Resistant Varieties

- Cucumber - Downy Mildew Resistant Varieties
  Pickling type: 2008 | 2009
  Slicer type: 2008 | 2009 | 2012 | 2014

- Melon - Powdery Mildew Resistant Varieties

- Pumpkin - Powdery Mildew Resistant Varieties

- Tomato - Late Blight Resistant Varieties
  2014 | 2013 | 2012

- Summer Squash - Powdery Mildew Resistant Varieties
  Yellow summer squash: 2006 | 2007 | 2008 | 2009 | 2010 | 2011
  Zucchini: 2006 | 2007 | 2008 | 2009 | 2010 | 2011

- Winter Squash - Powdery Mildew Resistant Varieties
  Acorn type: 2006 | 2007 | 2008 | 2009 | 2010 | 2011
  Butternut type: 2008 | 2009 | 2010 | 2011
Cucurbit Powdery Mildew – Organic Fungicides

Actinovate
Companion
Double Nickel
LifeGard
Serenade
Serifel
Sonata
Taegro 2

BacStop
EF400
Kalogreen
M-Pede
Mildew Cure
MilStop
Organocide
OxiDate
Procidic
Regalia
Sil-Matrix
Sporatec
Timorex Gold
Trilogy

Active ingredient:
Microbial
Natural substance
Not biopesticide
copper
sulfur
mineral oil
Cucurbit Powdery Mildew – Organic Fungicides

Actinovate
Companion
Double Nickel
LifeGard
Serenade
Sonata
Taegro 2

BacStop
EF400
Kalogreen
M-Pede
Mildew Cure
MilStop
Organocide
OxiDate
Procidic
Regalia
Sil-Matrix
Sporatec
Timorex Gold
Trilogy

copper
sulfur - best
mineral oil

No data found
Always Effective
Usually Effective
Less Effective
Ineffective
Efficacy Chlorothalonil Alternatives For Powdery Mildew. Pumpkin, 2017

% Control based on AUDPC on both leaf surfaces

<table>
<thead>
<tr>
<th>Fungicide (7-day)</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bravo Ultrex (chlorothalonil)</td>
<td>97</td>
<td>c</td>
</tr>
<tr>
<td>Tritek (mineral oil)</td>
<td>86</td>
<td>b</td>
</tr>
<tr>
<td>Microthiol Disperss (sulfur)</td>
<td>96</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>ab</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>bc</td>
</tr>
</tbody>
</table>

Values with same letter not statistically different. a=ineffective.
### Organic Biofungicide Program - Powdery Mildew

**Powdery mildew severity** and **Percent control**

<table>
<thead>
<tr>
<th>Treatment (application dates)</th>
<th>Upper leaf surface</th>
<th>Lower leaf surface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24 Aug</td>
<td>31 Aug</td>
</tr>
<tr>
<td>Untreated control</td>
<td>2.5</td>
<td>18.0</td>
</tr>
<tr>
<td>Organic: LifeGard 3.25 oz/A (1,2), Milstop 3 lbs/A (3,6), Serifel 8 oz/A (4,7), Suffoil-X 1% v/v (5,8)</td>
<td>0.6</td>
<td>2.4</td>
</tr>
<tr>
<td>Organic program</td>
<td>77</td>
<td>87</td>
</tr>
<tr>
<td>Conventional program</td>
<td>100</td>
<td>99</td>
</tr>
</tbody>
</table>

## Fungicides - Cucurbit Powdery Mildew

<table>
<thead>
<tr>
<th>Fungicide Group</th>
<th>FRAC Code</th>
<th>Fungicide</th>
<th>Active Ingredient</th>
<th>Registered</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBC</td>
<td>1</td>
<td>Benlate</td>
<td>benomyl</td>
<td>1972</td>
<td>1967</td>
</tr>
<tr>
<td>DMI</td>
<td>3</td>
<td>Bayleton</td>
<td>triadimefon</td>
<td>1984</td>
<td>1990s</td>
</tr>
<tr>
<td>QoI</td>
<td>11</td>
<td>Quadris</td>
<td>azoxystrobin</td>
<td>1999</td>
<td>2002</td>
</tr>
<tr>
<td>DMI</td>
<td>3</td>
<td>multiple</td>
<td>multiple</td>
<td>2000-</td>
<td></td>
</tr>
<tr>
<td>SDHI</td>
<td>7</td>
<td>Pristine</td>
<td>boscalid + QoI</td>
<td>2003</td>
<td>2009</td>
</tr>
<tr>
<td>Aza-naphthalene</td>
<td>13</td>
<td>Quintec</td>
<td>quinoxyfen</td>
<td>2007</td>
<td>2015</td>
</tr>
<tr>
<td>Phenyl-acetamide</td>
<td>U6</td>
<td>Torino</td>
<td>cyflufenamid</td>
<td>2012</td>
<td>2017</td>
</tr>
<tr>
<td>Aryl-phenyl-ketone</td>
<td>U8</td>
<td>Vivando</td>
<td>metrafenone</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>SDHI</td>
<td>7</td>
<td>Luna series</td>
<td>fluopyram</td>
<td>2016</td>
<td></td>
</tr>
</tbody>
</table>
Research: Objectives + Methods

Determine efficacy of fungicides
replicated experiment conducted with field-grown, naturally-infected pumpkin.

Examine fungicide sensitivity in pathogen isolates collected at season end and tested with leaf-disk bioassay.
in-field seedling bioassay.
Pathogen Sensitivity to Fungicides + Efficacy

**MBC fungicides (FRAC Code 1) – Topsin M**
around 100% resistant; fungicide ineffective

**QoI fungicides (11) – Quadris, Cabrio**
around 100% resistant; fungicide ineffective

**DMI fungicides (3) – Proline, Procure, etc.**
variation in sensitivity; usually effective

**SDHI fungicides (7) – Pristine, Endura, Merivon**
resistant strains vary in occurrence; efficacy varies

**Quinoxyfen (13) - Quintec**
resistance detected since 2015; usually very effective

**Phenyl-acetamide (U6) - Torino**
resistance detected since 2017; ineffective in 2017
# Fungicide Efficacy – Cucurbit Powdery Mildew

% Control based on AUDPC on both leaf surfaces 2017

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<thead>
<tr>
<th>Fungicide (7-day)</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torino (FRAC U6)</td>
<td>69</td>
<td>b</td>
</tr>
<tr>
<td>Pristine (FRAC 7)</td>
<td>63</td>
<td>b</td>
</tr>
<tr>
<td>Luna Sensation (FRAC 7)</td>
<td>80</td>
<td>bc</td>
</tr>
<tr>
<td>Procure (FRAC 3)</td>
<td>80</td>
<td>bc</td>
</tr>
<tr>
<td>Quintec (FRAC 13)</td>
<td>81</td>
<td>bc</td>
</tr>
<tr>
<td>Vivando (FRAC U8)</td>
<td>97</td>
<td>c</td>
</tr>
<tr>
<td>Vivando, Quintec, Torino</td>
<td>98</td>
<td>c</td>
</tr>
</tbody>
</table>

Values with same letter not statistically different. **a=ineffective.**
13 Sep last application.  Photo taken 4 Oct.  2017
In-Field Seedling Bioassay conducted in commercial crops and research fields in 2018 for fungicide resistance

Funded by Friends of Long Island Horticulture
In-Field Seedling Bioassay – Results
Fungicide Resistance in Cucurbit Powdery Mildew

2 Squash plantings – 18 Jul - no PM fungicides
Topsin M (FRAC 1) - lot of PM = lot of resistance.
Flint (11) - some PM indicating some resistant isolates present.
Endura (7) - some PM indicating some resistant isolates present.
Quintec (13) - very little PM indicating very few resistant isolates present.
Torino (U6) - very little PM indicating very few resistant isolates present.

Only Topsin expected to provide no control.
In-Field Seedling Bioassay – Results
Fungicide Resistance in Cucurbit Powdery Mildew

Research plantings – 12 Sep - no PM fungicides and rotation (Procure 3X, Vivando 2X, Quintec 2X)

- Topsin M (FRAC 1) - lot of PM = lot of resistance.
- Flint (11) - lot of PM = lot of resistance.
- Torino (U6) - lot of PM = lot of resistance.
- Rally (3) - low rate ineffective; high rate effective.
- Endura (7) - half rate ineffective; full rate effective.
- Quintec (13) - low rate ineffective; high rate effective.
- Vivando (U8) - effective at ¼ to full label rates.

Vivando best choice late in season.
Laboratory Leaf Disk Assay
Fungicide Sensitivity Testing of Individual Isolates

Boscalid
50 ppm

Control

Myclobutanil (Rally)
100 ppm
50 ppm
Cucurbit Powdery Mildew Multi-Fungicide Resistant Strains

- MBC (FRAC Code 1)
- QoI (FRAC Code 11)
- boscalid (FRAC Code 7)
- quinoxyfen (FRAC Code 13)
- DMI (FRAC Code 3) – reduced sensitivity

Sources - resistant strains:
Research plots treated with quinoxyfen alone, boscalid alone, and fungicide programs.

Commercial fields
Sensitive strains from non-treated plants.

- Quinoxyfen 120 ppm
- Quinoxyfen 200 ppm
- DMI 120 ppm
- Control

2015
Fungicide Program for Managing Powdery Mildew & Fungicide Resistance

Alternate among mobile fungicides (different FRAC code; highest label rate):

- **U8** Vivando (2 consecutive, 3 total, recommend 2-3)
- **3** Proline or Procure (5 total, recommend 2-3)
- **13** Quintec (2 consecutive, 4 total, recommend 2+)
- **7+3** Luna Experience (2 consc + total, rec’d 1-2)

Other options early in season (recommend 1):

- Endura (7), Torino (U6), Pristine (7+11)

Tank-mix with protectant (eg Bravo, sulfur).

Start early. 1 of 50 older leaves affected.
News Articles/Disease Alerts

All Vegetables (also see specific vegetables plus herbs below)

All Vegetables - Diseases affecting multiple crops


All Vegetables - Insects

- Key Features of the Adult Brown Marmorated Stink Bug by Peter Jentsch (July 2011)

All Vegetables - Organic Disease Management

- Efficacy results from University evaluations of organic products

- Organic Disease Management (LIHREC website)

Cucurbits - Powdery Mildew

- Management guidelines based on research results

- Up-dated fungicide recommendations for New York [Outside New York]