Managing Cucurbit Powdery Mildew Successfully in 2015

Margaret Tuttle McGrath
Plant Pathology and Plant-Microbe Biology Section, SIPS, Cornell University
Long Island Horticultural Research and Extension Center
3059 Sound Avenue, Riverhead, NY 11901; mtm3@cornell.edu

Effectively managing powdery mildew is essential for producing a high-quality cucurbit crop. This foliar, fungal disease is common wherever cucurbits are grown, including in the northeastern U.S. This is because the pathogen produces an abundance of asexual spores (the powdery growth) easily dispersed by wind, thus it can spread widely, and the pathogen can produce a sexual spore in fall that enables it to survive over winter. Leaves affected by powdery mildew die prematurely which results in fewer fruit and/or fruit of low quality (poor flavor, sunscald, poor storability).

Powdery mildew is managed with resistant varieties and fungicides. An integrated program with both management tools is needed to achieve effective control because the pathogen is adept at evolving new strains resistant to individual tools that thus are not controlled as well by the tool. It is more difficult for new pathogen strains to develop when an integrated program is used, and effective control is more likely. Powdery mildew management program often needs adjustments as the pathogen and management tools change.

**Resistant varieties** are now available in most crop groups with new varieties released most years. Select melons with resistance to pathogen races 1 and 2. They provided good suppression when tested in 2012 and 2013 in variety evaluations conducted on Long Island. There are many types of resistant melons now. Select squash and pumpkins with resistance from both parents (homozygous resistance) when possible. This term is used in a few catalogues (for example Outstanding Seeds) whereas others use terms like ‘high resistance’ and ‘intermediate resistance’ to generally refer to homozygous and heterozygous resistance, respectively. Degree of disease suppression obtained with a variety also depends on modifying genes present. Resistant squash and pumpkin varieties have not provided as effective control in recent years as before. But they remain an important tool. Plant breeders are actively searching for new sources of resistance to powdery mildew.

**Fungicide program.** The most important component of an effective management program is an effective fungicide program. And the key to that is using mobile fungicides targeted to powdery mildew. Mobile fungicides are needed for control on the underside of leaves. Because these fungicides have targeted activity, additional fungicides must be added to the program when there is a need to manage other diseases such as downy mildew and Phytophthora blight.

Alternate among targeted, mobile fungicides and apply with protectant fungicide to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions. The powdery mildew pathogen has a long history of developing resistance to fungicides (it was the first occurrence of resistance in the USA), thus a diversified fungicide program applied to resistant varieties when possible is critical for success. Always implement a resistance management program. The goal is to delay development of resistance, not manage resistant strains afterwards.

**When to apply fungicides.** The action threshold for starting applications is one leaf with symptoms out of 50 older leaves examined. Examine both surfaces of leaves. Starting treatment after this point will compromise control and promotes resistance development. If the threshold is inadvertently missed, to minimize the reduction in control that will occur, consider starting the
program with a DMI fungicide or Torino; do not use Quintec in this situation. Powdery mildew usually begins to develop around the start of fruit production. Protectant fungicides applied before detection will slow initial development. After detection, continue applying fungicides weekly. Conditions are favorable for powdery mildew throughout the growing season.

**Recommended targeted fungicides.** Alternate among targeted, mobile fungicides in the following 5 chemical groups, and apply with protectant fungicide to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions. The first two products are new and thus avoid control failure if resistance occurs, and these other fungicides are the most important ones to have in a fungicide program. The pathogen population has been subjected to two products are new and thus avoid control failure if resistance occurs, and also to comply with label use restrictions. The first two fungicide groups, which are listed in order based on product efficacy in recent fungicide evaluations. The first three fungicides are the only ones in these chemical groups available in the USA. See “Mobile Fungicides for Mildews and Phytophthora Blight” for more information about these and other targeted fungicides. Federal pesticide labels can be viewed and downloaded at: http://www.cdms.net/labelsmsds/lmdefault.aspx. New York state labels are available at: http://pims.psur.cornell.edu/ProductName.php.

**Torino** (FRAC Group U6) is a new fungicide with a new mode of action. It has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. It can only be applied twice to a field in a 12-mo period. Consecutive applications are not recommended. REI is 4 hr and PHI is 0 days.

**Vivando** (FRAC Group U8) is another new fungicide with a new mode of action. It has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. Cucurbits are on a supplemental label with fruiting vegetables. Note that the supplemental label plus the entire label must be in the possession of the user when applying. Maximum number of applications per year is three with no more than two consecutive. REI is 12 hr. PHI is 0 days. Plant-back restriction is 365 days for crops that are not labeled.

**Quintec** (FRAC Group 13) has been consistently very effective in fungicide evaluations; however, pathogen isolates collected each year from fungicide-treated crops have slowly been exhibiting decline in sensitivity over recent years. It was first registered in the U.S. in 2007. Activity is limited to powdery mildew. Labeled crops are pumpkin, winter squash, gourd, and melon. The Quintec label specifies no more than two consecutive applications plus a crop maximum of four applications. REI is 12 hr. PHI is 3 days.

**DMI fungicides** (FRAC Group 3) include Proline, Procure, Rally, Tebuzol*, Folicur*, and Inspire Super. Resistance is quantitative. Highest label rate is recommended because the pathogen has become less sensitive to this chemistry. Efficacy has varied in fungicide evaluations. Procure applied at its highest label rate provides a higher dose of active ingredient than the other FRAC 3 fungicides. Five applications can be made at this rate (2 for Proline). REI is 12 hr. PHI is 0 days (7 for Proline and Inspire Super). Powdery mildew is the only labeled cucurbit disease for these fungicides, except for Proline, which is also labeled for Fuarium diseases and gummy stem blight, and Inspire Super, which contains another active ingredient (Code 9) and is labeled for several diseases. *not registered yet for this use in NY.

**SDHI fungicides** (FRAC Group 7) include Pristine, Fontelis*, and Luna fungicides* (labeled for use only on watermelon so far; there are 4 Luna formulations). Strains of the powdery mildew pathogen resistant to boscalid, the FRAC 7 active ingredient in Pristine, have been detected and likely are the reason its efficacy has varied from year to year in fungicide efficacy experiments. Strains resistant to boscalid were determined through laboratory assays to be highly cross resistant to other fungicides in this chemical group, thus these other fungicides would also not be effective on boscalid-resistant strains, with the exception of Luna fungicides,
which have an active ingredient that is sufficiently different chemically. *not registered yet for this use in NY.

In a fungicide evaluation conducted in 2012 at LIHREC (Cornell’s research facility on Long Island, NY), Quintec was very effective, Procure was moderately effective, while Pristine was ineffective when tested alone (this is neither a labeled nor recommended commercial use pattern for these fungicides; it is done in efficacy evaluations to determine if resistance affects control). Although Procure and Pristine alone were moderately effective at best, very good control was achieved with Quintec applied 3 times alternated with Procure (applied twice) and Pristine (once). Interestingly, in a similar experiment conducted in 2013 at LIHREC, all three fungicides provided excellent control (93-99% control on both leaf surfaces). In 2014, level of control achieved with Pristine and Procure was numerically (but not statistically) different than with Quintec (54%, 70%, and 96% control, respectively, on lower leaf surface).

No longer recommended. Resistant pathogen strains are sufficiently common to render the following fungicides ineffective: Topsin M (FRAC Group 1; MBC fungicide) and QoI fungicides (Group 11), which include Quadris, Cabrio and Flint. Resistant strains continue to be detected commonly every year in NY where monitoring is being conducted.

**Recommended protectant fungicides.** Many fungicides have contact activity for powdery mildew; mancozeb is an exception. They include chlorothalonil, sulfur, copper, oils (mineral and botanical), potassium bicarbonate, and biologicals. Many of these products are approved for organic production (see list below). Sulfur is one of the most effective and least expensive products. Its activity is limited to powdery mildew, thus it is especially useful early in disease development when other diseases are not a concern, including as a preventive application. Melons are sensitive to sulfur especially when hot; there are tolerant varieties.

**Organic fungicides.** Products labeled for cucurbit powdery mildew, in addition to several formulations of copper and sulfur, include:

- **Actinovate AG.** 0.0371% *Streptomyces lydicus* strain WYEC 108. For best results with applications to foliage, label indicates to use a non-ionic spreader-sticker. OMRI-listed. EPA Reg. No. 73314-1. Monsanto BioAg.

- **BacStop.** 2.0% thyme, 2.0% clove & clove oil, 1.5% cinnamon, 1.0% peppermint & peppermint oil, and 1.0% garlic oil. Recommended used with EF400. Exempt from EPA registration. USAgriTech, Inc.

- **Cease.** 1.34% *Bacillus subtilis* strain QST 713. Labeled for use on greenhouse vegetables. OMRI-listed. EPA Reg. No. 69592-19-68539. BioWorks, Inc.

- **Companion.** 0.03% *Bacillus subtilis* strain GB03. EPA Reg. No. 71065-3. Growth Products, Ltd.

- **Double Nickel 55 LC and WDG.** *Bacillus amyloliquefaciens* strain D747, 98.8% and 25%, respectively. OMRI-listed. EPA Reg No. 70051-107 and 108, respectively. Certis USA, LLC.

- **EF400.** 8.2% clove, 8.1% rosemary, and 6.7% peppermint. Exempt from EPA registration. No Ag Label. USAgriTech, Inc.

- **JMS Stylet-oil.** 97.1% paraffinic oil. OMRI-listed. EPA Reg. No. 65564-1. JMS Flower Farms, Inc.
Kaligreen.  82% potassium bicarbonate. OMRI-listed. EPA Reg. No. 11581-2. Arysta LifeScience North America LLC.

KeyPlex 350 OR. 0.063% yeast extract hydrolysate from *Saccharomyces cerevisiae*. Combination of defensive proteins (alpha-keto acids) and secondary and micronutrients. Elicits systemic acquired resistance in plants against fungal and bacterial pathogens. Labeled for general disease control in vegetables with specific mention of bacterial leaf spot in tomato. EPA approval for organic production. EPA Reg. No. 73512-4. KeyPlex.

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


Organocide. 5% sesame oil. Labeled broadly for several fungal diseases and insects. OMRI-listed. Exempt from EPA registration. No Ag Label. Organic Laboratories, Inc.

OxiDate.  27% hydrogen dioxide. OMRI-listed. EPA Reg. No. 70299-2. BioSafe Systems, LLC.

Procidic. 3.5% Citric acid. Labeled for damping-off, foliar diseases caused by fungal and bacterial pathogens, and post-harvest diseases. Previously marketed as Citrex. NOP compliant; registered for use in organic agriculture with Washington State Dept of Ag. Exempt from EPA registration. No Ag Label. Greenspire Global, Inc.

Promax. 3.5% Thyme oil. OMRI-listed. Exempt from EPA registration. No Ag Label. Bio Huma Netics, Inc.


Serenade Max and Serenade ASO. 14.6% *Bacillus subtilis* strain QST 713. OMRI-listed. EPA Reg. No. 69592-11 and -12, respectively. Bayer CropScience (formerly AgraQuest).


Sporatec AG. 18% rosemary oil, 10% clove oil, and 10% thyme oil. OMRI-listed. Exempt from EPA registration. Product no generally available anymore. Brandt Consolidated, Inc.

Trilogy. 70% clarified hydrophobic extract of neem oil. OMRI-listed. EPA Reg. No. 70051-2. Certis USA, LLC.

TriTek. 80% mineral oil. OMRI-listed. EPA Reg. No. 48813-1. Brandt Consolidated, Inc.

Products with “No Ag Label” do not have a section with agricultural use directions on the label that was found on the internet; these products are exempt from EPA registration. Before purchase confirm product is acceptable for agricultural use with your certifier or your NYS DEC regional office.
In summary, to manage powdery mildew effectively in cucurbit crops: 1) select resistant varieties, 2) inspect crops routinely for symptoms beginning at the start of fruit development, and 3) apply targeted fungicides weekly with protectant fungicides and alternate amongst available chemistry based on FRAC Group code, starting at the action threshold of 1 affected leaf out of 50 older leaves. Add new fungicides to the program when they become available; substitute new for older product if they are in the same FRAC group.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Note that some products mentioned are not yet registered for use on cucurbits in NY. Check state registration for all products and approval with certifier for organic products. Check labels for use restrictions. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.