

## Proceedings for 2023 Mid-Atlantic Fruit and Vegetable Convention

### REVIEW OF POWDERY MILDEW MANAGEMENT

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Powdery mildew is the most common disease of cucurbit crops partly due to the quantity of wind-dispersed spores the pathogen produces and the fact it doesn't need leaves to be wet to infect as other fungal pathogens do. Management is needed to avoid reduction in yield and/or fruit quality. Powdery mildew is best managed with an integrated program including both management tools (resistant varieties and fungicides) that is based on efficacy results from research. The pathogen has demonstrated ability to evolve and become less effectively controlled by both tools, but especially conventional, targeted fungicides. An integrated program maximizes likelihood of effective control.

#### Guidelines on Managing Cucurbit Powdery Mildew.

1) Select resistant varieties. Resistant varieties are now available in most crop groups with new varieties released most years. Resistance in cucumber is standard in modern varieties and is so strong it is easy to forget this cucurbit type is susceptible until an Heirloom type is grown. Cantaloupe with resistance to pathogen races 1 and 2 have exhibited excellent suppression; however, this will change if a new race evolves. Resistance in other cucurbit crop types is not adequate used alone (without fungicide treatment) to prevent impact of powdery mildew on yield and fruit quality.

2) Inspect crops routinely for symptoms beginning at the start of fruit production, or start applying fungicides then. This physiological stress makes plants susceptible. It is especially important to examine the lower surface (underside) of leaves because powdery mildew develops there best. The IPM action threshold for starting a fungicide program is one leaf with symptoms out of 50 old leaves examined. It is worthwhile to assess control after about half and three quarters of the applications have been made, especially when conventional, targeted fungicides are used. Symptoms becoming severe on lower leaf surfaces is most likely because of resistance in the pathogen to the targeted fungicides applied or poor application timing. Continuing to apply targeted fungicides will likely not be worthwhile due to limited benefit. Do a final assessment of control achieved 7-10 days after last application. It is especially important to examine lower leaf surfaces when targeted fungicides are used.

3) Apply fungicides weekly starting at the IPM action threshold or onset of fruit production.

Organic fungicide program. There are many biopesticides labeled for powdery mildew. See <https://www.vegetables.cornell.edu/ipm/diseases/biopesticides/>. Sulfur is the most effective organic fungicide. Micronized formulation is a better choice than wettable powder. Recent research documented that sulfur (Microthiol Disperss) applied in alternation with a biopesticide was as effective as sulfur applied weekly. Copper is not as effective; it is recommended when bacterial disease is also a concern. Achieving control on the lower surface of leaves is challenging because these are all contact fungicides, and the cucurbit canopy makes it difficult to deliver spray directly to the lower surface.

Conventional fungicide program. Fungicides with targeted activity for powdery mildew have proven very important because they are able to move through leaves to the underside where the pathogen develops best, but because of their targeted mode of action they have medium to high risk for resistance to develop in the pathogen. It is very difficult to deliver fungicide directly to

the underside of large cucurbit leaves even with air assist sprayers. Consequently, contact fungicides (sulfur, chlorothalonil, biopesticides) provide good control on the upper but not the lower leaf surface, and thus do not prevent premature leaf death due to powdery mildew. Fungicides recommended for powdery mildew routinely change as new products are registered and the pathogen often develops resistance to fungicides after they have been in use for several years. Targeted fungicides need to be used in alternation to delay development of resistance, avoid control failure when resistance develops, and comply with label use restrictions on number of consecutive and total applications allowed. Alternate among available, recommended chemistry based on FRAC code and apply with protectant fungicides. Some targeted fungicides have narrow activity (just powdery mildew) necessitating applying additional products when other diseases are occurring.

Fungicide recommendations are based on results from university research assessing product efficacy, which varies due to inherent differences in fungicide activity and can be reduced when the pathogen develops resistance, and research on resistance occurrence in the pathogen. Every year at LIHREC seedling bioassays and isolate testing have been done to determine current status of resistance and impact of fungicide programs. Through this work fungicide resistance has been confirmed in NY to FRAC 1, 3 (triadimefon; no longer labeled), 7 (boscalid), 11, 13, and U6 fungicides. Resistance likely has or could develop elsewhere. For examples, bioassays conducted in OH in 2020 revealed resistance to FRAC 7 (Pristine, Fontelis and Merivon) and U6 (Torino); Rally (3) was also ineffective. Quintec (13) was moderately effective suggesting some resistant isolates present. Vivando (50), Gatten (U13), and Procure (3) were most effective.

Alternate among targeted, mobile fungicides in the chemical groups below (first two most important), and apply with contact, protectant fungicide to manage resistance development. Begin very early in disease development (one older leaf out of 50 with symptoms).

Vivando or Prolivo (FRAC 50). Activity is limited to powdery mildew. They can be applied 3 times (4 for Prolivo at low label rate which is not recommended) with no more than 2 consecutive applications. REI is 12 and 4 hr, respectively. PHI is 0 days. Do not mix Vivando with horticultural oils. Less sensitive isolates have recently been detected. Prolivo has exhibited variable efficacy on lower leaf surfaces in university trials which could be due to whether an adjuvant as recommended by the company was used, application timing (started before or after disease onset), and conditions. Prolivo was effective when tested in 2022 at LIHREC. It was not as effective as Vivando in OH in 2021 or as Gatten in PA in 2021.

DMI fungicides (FRAC 3) include Proline, Procure, and Rhyme (these considered most effective) plus Aprovia Top, Folicur, Inspire Super, Mettle, Rally, Tebuzol, and TopGuard (also has FRAC 11 ingredient). Efficacy varies from moderate to excellent (Proline) in fungicide evaluations. Cevya is not as effective for powdery mildew on lower leaf surface as most others. Resistance is quantitative. Highest label rate is recommended because the pathogen has become less sensitive to this chemistry. 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. REI is 12 hr for these fungicides. PHI is 0 to 7 days. Powdery mildew is the only labeled cucurbit disease for some of these.

Carboxamide fungicides (FRAC 7) currently recommended include Luna fungicides (Luna Experience recommended), Aprovia Top, and Miravis Prime (also has FRAC 12 ingredient which targets other diseases). REI is 12 hr. PHI is 0-7 day. Maximum number of applications is 2-5, depending on rate used. Low rate is not recommended. Powdery mildew pathogen strains resistant to boscalid, active ingredient in Endura and Pristine, have been detected since 2009 on Long Island and likely are the reason for poor efficacy in some fungicide evaluations. In laboratory assays, boscalid-resistant strains exhibited sufficient cross resistance with Fontelis and Merivon that these are expected to be ineffective as well, but not with Luna fungicides. However, Luna Sensation failed in experiment at LIHREC in 2017. Luna Experience also contains tebuconazole (FRAC 3), which needs to be considered when developing an alternation program. Luna Sensation is not recommended because it also

contains trifloxystrobin (FRAC 11); resistance to this chemistry is very common. Limit use of Luna Experience as less sensitive isolates have been detected recently.

Gatten (FRAC U13) was not as effective for powdery mildew on lower leaf surfaces as Vivando when tested at LIHREC in 2018 and OH in 2021; it was moderately effective in PA.

Switch (FRAC 9+12) ingredient with activity for powdery mildew (9) has greater activity for other labeled diseases and is recommended for powdery mildew only when needed for other diseases.

Resistance is a major issue. Recent testing has revealed that most resistant isolates are resistant to up to five different fungicide chemical (FRAC) groups. Occurrence of multi-fungicide resistant isolates is a concern for successfully managing powdery mildew because it means applying any one of these fungicides to a crop can select for these multi-fungicide resistant isolates, potentially resulting in none of these fungicides being adequately effective. Resistant isolates are fully resistant (growth not reduced on fungicide-treated leaf tissue in bioassays) and they have not exhibited reduced fitness. Frequency of resistant isolates in a commercial planting can increase a lot in response to fungicide use during a growing season. This pathogen is expected to continue developing resistance to targeted fungicides.

Testing of powdery mildew pathogen isolates collected from commercial crops of pumpkin and winter squash in NY (west, east, and Long Island) at the end of the 2021 season revealed a high percentage of isolates (67-100%) being resistant to Quintec from the three crops treated twice with Quintec even though the fungicide program was good with alternation amongst targeted chemistry and all applications included a protectant fungicide. Many Quintec-resistant isolates were also resistant to Torino (FRAC U6) and Endura (7) although these or related fungicides were not applied. Almost all isolates tested were also resistant to MBC fungicides (FRAC 1; Topsin M), although now in limited use on cucurbits generally, and QoI fungicides (FRAC 11; Quadris, Cabrio and Flint). Quintec-resistant isolates were detected in only two of the nine crops where this fungicide was not applied (29 and 50% of isolates tested). Only contact fungicides were applied to one of these crops, thus there was no selection pressure in that field for resistance. Torino was applied once to the other crop, and 50% of isolates were resistant to Quintec, Torino, and Endura. These fungicides are no longer recommended based on these research results, as well as results from previous research. An application of one of these might contribute to control, but that cannot be predicted.

Additional information about powdery mildew and its management, both conventionally and organically, is posted at <https://www.vegetables.cornell.edu/pest-management/disease-factsheets/cucurbit-powdery-mildew/>. There is a link to webpages with research results.

*Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Check labels for use restrictions. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended. Confirm state registration before purchase.*

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