

# Effectively Managing Cucurbit Downy Mildew in the Northeastern USA

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Producing a high-quality cucurbit crop necessitates effectively managing downy mildew. This foliar disease is common in the northeast because the pathogen produces a large quantity of asexual spores that are easily dispersed long distances by wind, which enables it to spread widely. There has been no evidence that the pathogen is surviving between growing seasons where winter temperatures kill cucurbit crops (outdoors above the 30<sup>th</sup> latitude); however, recently both mating types have been found, albeit typically on different cucurbit crop types, thus there is the potential for the pathogen to produce oospores (sexual spores) that could enable the pathogen to survive in northern areas of the USA. The downy mildew forecasting program has documented based on downy mildew occurrence movement of the pathogen throughout the eastern USA each year via its wind-dispersed asexual spores. The pathogen does not affect fruit directly; however, affected leaves die prematurely which results in fewer fruit and/or fruit of low quality (poor flavor, sunscald, poor storability).

The most important component of an effective management program for downy mildew is an effective, properly-timed fungicide program. And the key to that is applying mobile fungicides targeted to the pathogen starting when there is a risk of the pathogen being present. Mobile (or translaminar) fungicides are needed for control on the underside of leaves. Each year there often are changes to the fungicides recommended as the pathogen develops resistance or new products are registered. 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 powdery mildew. Most targeted fungicides effective for downy mildew are also effective for *Phytophthora* blight.

*Resistant varieties.* Resistance was the main tool for cucumbers until a new strain of the pathogen developed. Since 2004, varieties with this resistance, which include most hybrids, have provided some suppression of the new pathogen strains present, but substantially less than the excellent suppression that was achieved against strains present before 2004. However, these resistant varieties are still considered a worthwhile component of an integrated program. Fortunately, a new source of resistance has been found and cucumber varieties with these new genes for resistance are starting to become available. DMR 401 Cucumber developed by Cornell plant breeders is available at <http://commonwealthseeds.com/varieties-offered/>.

*Fungicide program.* Alternate among targeted, mobile fungicides in different FRAC 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 pathogen has demonstrated ability to develop resistance to fungicides, thus a diversified fungicide program applied to resistant varieties when possible is critical for success.

*When to apply fungicides.* An important tool for determining when fungicide application is warranted is the forecast web site for this disease at <http://cdm.ipmpipe.org>. Cucurbit plants are susceptible to downy mildew from emergence; however, this disease usually does not start to develop in the northeast until later in crop development when the pathogen is dispersed by wind into the region. The forecast program monitors where the disease occurs and predicts where the pathogen likely will be successfully spread. The pathogen needs living cucurbit crops to survive, thus it cannot survive where it is cold during winter. The risk of downy mildew occurring anywhere in the eastern USA is forecast and posted three times a week. Forecasts enable timely fungicide applications. Growers can subscribe to receive customizable alerts by e-mail or text message. Information is also maintained at the forecast web site of cucurbit crop types being affected by downy mildew. This is important because the pathogen exists as pathotypes that differ in their ability to infect the various crops. All pathotypes can infect cucumber; some also can infect melons, and squashes are susceptible to others. Success of the forecast system depends on knowledge of where downy mildew is occurring; therefore prompt reporting of outbreaks by growers is critical.

Scouting routinely for early symptoms is also important to ensure targeted fungicides are applied starting at the onset of disease development. While the forecast program has accurately predicted many outbreaks, a forecasted risk of infection may not result in infection if conditions are not as favorable as predicted, and the forecast program can miss predicting a risk in particular when downy mildew is not reported. The program is predicting movement of the pathogen from known sources of the disease. See <http://livegpath.cals.cornell.edu/gallery/cucurbits/> and [http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cuc\\_Downy.htm](http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cuc_Downy.htm) for photographs of symptoms.

*Recommended targeted fungicides.* Use in alternation and tank mixed with a protectant fungicide. Label directions for some state to begin use before infection or disease development. The forecasting program helps ensure this is accomplished. There is a table of fungicides for this and other key diseases of cucurbit crops at <http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cucurbit%20Fungicide%20List%202016.pdf>

Orondis (FRAC Code U15). The novel active ingredient, oxathiapiprolin, has exhibited excellent activity in fungicide evaluations. It is formulated with mandipropamid as Orondis Ultra (REI is 4 hr) and with chlorothalonil as Orondis Opti (REI is 12 hr). PHI is 0 day.

Ranman (FRAC Code 21). Use organosilicone surfactant when water volumes are less than 60 gallons per acre. REI is 12 hr. PHI is 0 day. Apply no more than 6 times in a season with no more than 3 consecutive applications.

Curzate or Tanos (27). These have some curative activity (up to 2 days under cool temperatures) but limited residual activity (about 3-5 days). They can be a good choice when it was not possible to apply fungicide at the start of a high risk period when temperature is below 80 F. Apply another targeted fungicide 3-5 days later. Both must be tank-mixed with a protectant. REI is 12 hr. PHI is 3 days. Apply no more than 4 times in a season (6-9 for Curzate depending on rate); no consecutive applications of Tanos are permitted. Tanos also has a FRAC Code 11 ingredient. It is recommended used only when this ingredient is needed for other diseases that are also occurring, such as Plectosporium blight.

Zing! or Gavel (22). These are the only products that consist of a targeted fungicide and a protectant fungicide (chlorothalonil or mancozeb). REI is 12 hr and PHI is 0 days for Zing!. REI is 48 hr and PHI is 5 days for Gavel. Apply no more than 8 times in a season. Some cantaloupe varieties are sensitive to Gavel (see label). Workers must be notified that a dermal sensitizer is applied both orally and by posting at entrance to treated area 24 hours before the

scheduled application and for 4 days afterwards. The amount of chlorothalonil in Zing! is an intermediate rate (1.18 lb/A chlorothalonil) of the labeled rate range for downy mildew in products with just chlorothalonil (1.125-1.5 lb/A). Chlorothalonil is labeled for use at a higher rate (1.5-2.25) to manage several other diseases including powdery mildew. Growers trying to manage these diseases as well as downy mildew should apply additional Bravo to bring the amount of chlorothalonil up to the higher rate. To obtain an application rate of 1.5-2.25 lb/A chlorothalonil, tank mix Bravo WeatherStik at 0.43-1.43 pt/A with Zing!.

Zampro (40 + 45) or Revus (40). Zampro is the best choice, but it is not labeled for use on Long Island due to groundwater contamination concern. Apply Zampro no more than 3 times in a season with no more than 2 consecutive applications before switching to a fungicide with different FRAC code. Revus can be applied 4 times; there is no label restriction on number of consecutive applications, but more than 2 is discouraged for resistance management. REI is 12 hr and PHI is 0 day for both products. There is a different FRAC code 40 fungicide ingredient in Zampro and Revus which may have slightly different mode of action, thus there may be benefit to using both in a fungicide program. Revus must be applied with a spreading/penetrating type adjuvant. Revus has exhibited differential activity, being effective for downy mildew in pumpkin but not in cucumber. Therefore it is not recommended for use in cucumber. Forum (40) is no longer recommended because it was ineffective in recent fungicide evaluations (see table).

*Targeted fungicides no longer recommended.* Resistance is suspected of having developed in the cucurbit downy mildew pathogen to the following fungicides based on the fact they have provided limited to no control of downy mildew when tested alone in recent university fungicide evaluations, in contrast with excellent control provided in the past (see table). Poor control has also been reported in commercial crops.

Previcur Flex (FRAC Code 28).

Presidio (43).

Additionally, fungicides with mefenoxam and metalaxyl (FRAC 4), e.g. Ridomil, or a strobilurin active ingredient (FRAC 11), e.g. Cabrio, have not been recommended since 2004 as they have been ineffective due to resistance.

*Recommended protectant fungicides.* Chlorothalonil and mancozeb are the main protectant fungicides for downy mildew. Copper is not as effective.

In summary, to manage downy mildew effectively in cucurbit crops:

- 1) select resistant cucumber varieties,
- 2) sign up to receive alerts about downy mildew occurrence and routinely check the forecast web site to know where the disease is occurring and what crops are affected,
- 3) inspect crops routinely for symptoms beginning at the start of crop development, and
- 4) apply targeted fungicides weekly with protectant fungicides and alternate among available chemistry based on FRAC code, starting when there is a risk of downy mildew for the specific crop based on the forecasting program. 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. 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. Some products mentioned are not registered in NY.*

**Efficacy for cucurbit downy mildew of fungicides at risk for resistance development in replicated field experiments conducted at university field facilities in the United States.**

Year and state of study	Control of downy mildew obtained with fungicides applied typically on 7-day interval (%) <sup>z</sup>							
	Curzate	Forum	Gavel or Zing!	Presidio	Previcur Flex	Ranman	Revus	Zampro
2009, Michigan			75	79	61	88	46	
2010, North Carolina	25		46	62	38	61		
2012, Michigan			29	91	75	86		
2013, North Carolina	42		49	21	74	75		57
2015, Michigan	31	<b>3<sup>y</sup></b>	49	23	<b>0</b>	49	<b>8</b>	49
2015, North Carolina		<b>3</b>		<b>5</b>	14	51	<b>7</b>	
2015, Ontario Canada				<b>13</b>		51		56
2015, Pennsylvania			98	63	<b>7</b>			99

<sup>z</sup> Efficacy calculated as percent control, relative to non-fungicide-treated plants, using AUDPC or severity near end of experiment.

<sup>y</sup> Values in bold italics indicate disease value not significantly different from non-treated control.