

Effectively Managing Cucurbit Mildews: What You Need to Know

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Producing a high-quality cucurbit crop necessitates effectively managing powdery mildew and downy mildew. These two foliar, fungal diseases are common in the northeast because the pathogens produce spores easily dispersed by wind that enable them to spread widely. Crops often are affected by both. While neither pathogen affects fruit directly, they cause leaves to 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. Resistant varieties have not provided as effective control in recent years as before. But they remain an important tool. There are now resistant varieties in most crop groups with new varieties released most years. Select cantaloupes with resistance to pathogen races 1 and 2. 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. Plant breeders are actively searching for new sources of resistance to powdery mildew.

The most effective fungicide program for powdery mildew is weekly applications of targeted, mobile fungicides tank mixed with a protectant fungicide beginning very early in powdery mildew development. Mobile fungicides are needed for control on the underside of leaves where the pathogen develops best. The action threshold for starting applications is one leaf with symptoms out of 50 older leaves examined. Powdery mildew usually begins to develop around the start of fruit production. Alternate among targeted 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. Some fungicides are no longer recommended because resistant pathogen strains are sufficiently common to render them ineffective: Topsin M (FRAC code 1; MBC fungicide) and QoI fungicides (Code 11), which include Quadris, Cabrio and Flint. Other fungicide chemistry has remained adequately effective to include in a fungicide program although the pathogen has developed some resistance, in particular the DMI fungicides (Code 3), which include Procure, Rally, Tebuzol, Folicur, and Inspire Super. They remain effective partly because resistance to this group is quantitative, whereas to the Code 1 and 11 fungicides it is qualitative (pathogen is sensitive or resistant), and these DMI fungicides are inherently more active than the first DMI fungicide, Bayleton, which is no longer registered for this use because of control failures due to resistance. Highest label rate is recommended when resistance is quantitative or might be (generally assumed to be until known). Procure applied at its highest label rate provides a higher dose of active ingredient than the other Code 3 fungicides. This fungicide was effective in the yearly fungicide efficacy experiment conducted on Long Island in 2011. Quintec (FRAC Code 13) has been the most consistently effective fungicide in fungicide evaluations, therefore it is recommended as the main mobile fungicide to use on labeled crops (pumpkin, winter squash, gourd, melon) where the crop rotational restriction of 12 months is acceptable. Recent crop additions to the Quintec label have increased the options of what can be planted within 12 months of the last application. The Quintec label specifies no more than two consecutive applications plus a crop maximum of four applications. FRAC Code 7 is the third fungicide chemistry recommended for managing powdery mildew. Boscalid is the

only active ingredient in this fungicide group labeled currently for this use. It is in the product Pristine. While highly resistant pathogen strains have been detected, Pristine has continued to provide some control, including in the Long Island 2011 evaluation when it was as effective as Procure.

Prospect looks good for improved control of powdery mildew in the future. There are new mobile fungicides on track for registration soon that are highly effective for powdery mildew. Similar to the targeted, mobile fungicides currently in use, they do have risk of resistance developing because they have single site mode of action. Therefore it will be critical to always use a resistance management program. Hopefully these fungicides will be registered before the pathogen has developed resistance to Quintec so that all can be used together in a fungicide resistance management program. Vivando, which is being developed by BASF, has the novel active ingredient metrafenone. It is a FRAC code U8 fungicide. 'U' designation means it is unknown mode of action. It was registered in the US in 2011 with approval for use on grapes. Additional crops including cucurbits are anticipated to be labeled in 2013. Resistance risk is considered medium; elsewhere strains of the wheat powdery mildew pathogen have been detected with reduced sensitivity. Torino, being developed by Gowan, is another product with a unique active ingredient unlike other fungicides. It is cyflufenamid, a FRAC code U6 fungicide. US federal registration is pending and anticipated in spring 2012 for cucurbits, grapes, and strawberries. The cucurbit powdery mildew pathogen has developed resistance elsewhere in the world where already registered. Like Quintec, both of these fungicides are only effective for powdery mildew diseases. Three new fungicides in development have an active ingredient that belongs to the carboxamide class of fungicides (FRAC Code 7), which is the same as boscalid. However, these fungicides have been more effective than Pristine in fungicide evaluations documenting differences in activity. Fontelis (aka LEM17), developed by DuPont, contains penthiopyrad. Federal registration is expected before the end of 2011, thus it will be the first new carboxamide available. The carboxamide ingredient in Merivon is fluxapyroxad. This product also contains pyraclostrobin. It is being developed by BASF. EPA approval is anticipated for the first label with pome/stone fruit in early 2012 and for additional crops including cucurbits in 2013. Bayer Crop Science has the ingredient fluopyram in their Luna series fungicides. Luna Experience is anticipated to be registered before the 2012 growing season but only on watermelon; other cucurbit crops will be added subsequently. Pristine, Merivon, Fontelis, and/or Luna Experience should not be used in alternation because they all have an active ingredient in the same chemical group (Code 7). This chemistry is also effective for gummy stem blight/black rot.

Downy mildew is primarily managed with fungicides. Resistance bred into cucumbers provides some suppression of the pathogen strains present recently, but substantially less than what was achieved against strains present before 2004. However, they are still considered a worthwhile component of an integrated program. Plant breeders are searching for new sources of resistance. As with powdery mildew, fungicide resistance is also a concern with the downy mildew pathogen and therefore the fungicide program recommended for downy mildew is also targeted, mobile fungicides applied in alternation on a weekly schedule and tank mixed with a protectant fungicide beginning very early in disease development. Resistance to mefenoxam and metalaxyl and to strobilurins is sufficiently common that fungicides with these active ingredients (e.g. Ridomil and Cabrio), which use to be highly effective, are no longer recommended.

The full list of mobile fungicides with different modes of action recommended for managing downy mildew includes: Ranman (FRAC Code 21), Forum (40), Revus (40), Presidio (43), Curzate (27), Tanos (27), Gavel (22), and Previcur Flex (28). These have been registered for this use in the US for a few years. Concern about resistance developing to single site mode of action fungicides like these increases with use. Alternating among fungicides in different FRAC Groups (different codes) and tank-mixing them with a protectant fungicide (except for Gavel which contains mancozeb) is recommended for delaying resistance development, minimizing the impact of resistance when it occurs and it is often required to comply with the restrictions on most labels. Curzate and Tanos have some curative activity (up to 2 days under cool temperatures) but limited residual activity (about 3-5 days). Presidio has an advantage over Curzate and Previcur Flex of also being effective for Phytophthora blight. Both diseases are often of concern for most cucurbit growers. Presidio has a long rotational interval of 18

months for non-labeled crops, which can be a constraint on production. All cucurbits, fruiting vegetables, tuberous and corm vegetables (except potato), and leafy vegetables are now labeled; carrot, sugar beet, potato and rotational wheat will be labeled soon; and rotational field corn is expected in 2012. All of the mobile fungicides listed above have proven effective in university fungicide efficacy evaluations. Efficacy of Revus has varied among crop types with control being good on pumpkin but poor on cucumber. Based on results from an analysis of all published data from these evaluations, Presidio is the most effective fungicide, followed by Previcur Flex and then Ranman. All of the mobile fungicides are at risk for development of fungicide resistance because of their single site mode of action. And the downy mildew pathogen is considered prone to developing resistance. Resistance to the active ingredient in Tanos and Curzate has been detected in Europe. The analysis of fungicide efficacy data also revealed that combining mobile fungicides with a protectant fungicide improved control; thus there is an additional benefit to this standard practice for managing resistance. None of the downy mildew fungicides are effective for powdery mildew unfortunately.

A new mobile fungicide developed by BASF, Zampro, is anticipated to be registered during the later part of 2012 for use on cucurbits as well as potatoes, grapes, brassicas and fruiting vegetables. It is effective for Phytophthora blight as well as downy mildew. Zampro contains new fungicide chemistry, ametoctradin (FRAC code 45), plus dimethomorph (40), the active ingredient in Forum. Once this fungicide is registered it will be recommended as a component of the fungicide program in place of the code 40 fungicide being used.

Chlorothalonil and mancozeb are the main protectant fungicides for downy mildew. Copper is not as effective. Dithane now has a supplemental label that includes pumpkin, winter squash and gourd. 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 throughout the eastern US is forecast and posted three times a week. Forecasts enable timely fungicide applications. Growers can now 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.

In conclusion, to manage the mildew diseases effectively in cucurbit crops: 1) select resistant 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 for downy mildew and fruit development for powdery mildew, 4) apply protectant fungicides when there is a risk of disease development, and 5) beginning when these diseases start to develop, apply targeted fungicides weekly and alternate amongst available chemistry based on FRAC code. Unfortunately there are no targeted fungicides effective for both mildew diseases because the causal pathogens are biologically very different. 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. Check labels for use restrictions. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.