Vine Crops Session

Managing Mildews and Phytophthora Blight Successfully in 2019

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Managing diseases is an important component of a successful production program for cucurbit crops because there are several diseases that can reduce yield or fruit quality when not adequately managed. The mildews are among the most common. And Phytophthora blight arguably is the most destructive disease. Fungicides are an important tool for managing these diseases. Fungicides recommended routinely change as new products are registered and pathogens develop resistance to fungicides that have been in use for several years. Modern fungicides because of their targeted mode of action typically have medium to high risk for resistance to develop in the pathogen. These need to be used in alternation to delay development of resistance, avoid control failure when resistance develops, and comply with label use restrictions. Most research on resistance has been for the mildews. Successful control with fungicides necessitates starting applications preventively (especially with Phytophthora blight) or when symptoms have just started to appear, maintaining a weekly application schedule, avoiding delays because of rain, and using other management practices. Resistant varieties can be valuable components of an integrated management program when available (powdery mildew and cucumber for downy mildew), but typically when used without fungicides will not achieve sufficient control to avoid a reduction in yield or fruit quality. Managing soil moisture to avoid saturation is important for Phytophthora blight. Reduced tillage and mustard biofumigation have been used to manage Phytophthora blight. The Vegetable MD Online website has Information about managing these diseases that is up-dated routinely (see News Articles section) and photographs of symptoms (see Photo Gallery).

Powdery mildew. An integrated program with both management tools (resistant varieties and fungicides) is recommended to maximize likelihood of effective control and reduce selection pressure on the pathogen to overcome one of these tools. It has demonstrated ability to evolve and become less effectively controlled by both tools. Resistant cucumber varieties have an exceptional level of resistance and often develop no symptoms. Resistant melon varieties have race-specific resistance. Those with resistance to pathogen races 1 and 2 have not exhibited as high a level of powdery mildew suppression recently as in the past indicating presence of a new race. Resistant pumpkin varieties like Progress with a resistance gene from both parents (PMRR, homozygous) have been less severely affected by powdery mildew than varieties with a resistance gene from one parent which confers intermediate resistance. Later were less severely affected, but not significantly, than a variety with no resistance in recent trials.

Alternate among targeted, mobile fungicides in the 6 chemical groups below (principally the first 3; listed in recommended order) and apply with protectant fungicide to manage resistance development. Begin before or at start of disease development (one older leaf out of 50 with symptoms).

Vivando (FRAC Code U8) has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. It is recommended used with a silicon adjuvant. Do not mix with horticultural oils. Can be applied three times per year with no more than two consecutive applications. REI is 12 hr. PHI is 0 days. Prolivo is a new fungicide with a new active ingredient in this FRAC group registered in NYS April 2018. It was not as effective as Quintec for managing powdery mildew on lower leaf surfaces in a fungicide evaluation conducted at LIHREC in 2016.

DMI fungicides (Code 3) include Proline*, Procure, Luna Experience*†, and Rhyme*† (these considered most effective) plus Aprovia Top*, Inspire Super*, Mettle, and Rally. Resistance is quantitative. Highest label rate is recommended because the pathogen has become less sensitive to this chemistry. Efficacy has varied in fungicide evaluations. Proline is thought to have the greatest inherent activity. Procure applied at its highest label rate provides a higher dose of active ingredient than the other Code 3 fungicides. Five applications can be made at this rate. REI is 12 hr for DMI fungicides. PHI is 0 days for some including Procure; 7 days for others including Proline. *Fungicides labeled for additional cucurbit diseases. †not labeled for use on Long Island. TopGuard is labeled but not recommended because it has Code 11 ingredient plus same DMI ingredient in Rhyme.

Quintec (Code 13) has been consistently effective in fungicide evaluations; however, insensitivity to a high concentration of Quintec (similar to the dose when applied in the field) has been detected in some pathogen isolates collected from commercial fields and/or fungicide-treated research fields at the end of the growing season on Long Island since 2015. Resistant isolates evidently are sufficiently uncommon most of the season not to impact Quintec efficacy. Because resistance has developed, Quintec is now recommended to be used less than the label permits, which is a crop maximum of four applications. Aerial applications are not permitted and no more than two consecutive applications. Activity is limited to powdery mildew. It is the only mobile fungicide that does not move into leaves: it redistributes to foliage where spray was not directly deposited, including the underside of leaves, through diffusion and a continual process of absorption and desorption in the cuticular waxes of foliage. Labeled for use on non-edible peel crops: melons, pumpkin, and winter squash. REI is 12 hr. PHI is 3 days.

Carboxamide fungicides (Code 7) include Luna fungicides†, Merivon†, Endura, Pristine and Miravis Prime (not registered yet in NY). †not for use on Long Island. Powdery mildew pathogen strains resistant to boscalid, ctive ingredient in Endura and Pristine, have been detected since 2009 in NY and likely are the reason its efficacy has been poor in some fungicide evaluations. In laboratory assays boscalid-resistant strains exhibited sufficient cross resistance with Merivon that it is expected to be ineffective as well, but not with Luna fungicides. However, Luna Sensation failed in experiment at LIHREC in 2017. Luna Experience is the best choice because it also contains tebuconazole (Code 3), which needs to be considered when developing an alternation program. Luna Sensation is not recommended because it also contains trifloxystrobin (Code 11); resistance to this chemistry is very common. Limited use of Luna Experience is recommended. REI is 12 hr. PHI is 7. Maximum number of applications is 2-5, depending on rate used. Low rate is not recommended.

Torino (Code U6) exhibited excellent control in fungicide evaluations until recently. Resistant isolates have been detected on Long Island since 2017 when their existence was associated with control failure in a fungicide efficacy experiment. 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. PHI is 0 days. One application at most is recommended.

Gatten (Code U13) is the newest fungicide; it was introduced in 2018. It is not yet registered in NY. First cucurbit crops registered are cantaloupes, cucumbers, and squash. REI is 12 hr. PHI is 0 days. Five applications can be made.

Resistance continues to be very common to MBC fungicides (FRAC code 1; Topsin M) and QoI fungicides (Code 11; Quadris, Cabrio and Flint); therefore these are not recommended, nor combination products with an additional active ingredient.

Several protectants are labeled for powdery mildew. Chlorothalonil and sulfur are highly effective, especially on upper leaf surfaces. Oils also have exhibited good efficacy. There are several botanical and mineral oils. Copper is moderately effective. Numerous biopesticides now available have exhibited poor to good efficacy in university trials. Results from some of these are summarized in a downloadable file posted at http://blogs.cornell.edu/livegpath/organic/organic-management-of-vegetable-diseases/ under 'Specific Management Practices and Tools'.

Downy mildew is primarily managed with fungicides. Resistance has only been bred in cucumbers. Varieties with a new source of resistance are becoming available. Some suppression, albeit variable, can be obtained with varieties bred to be resistant to pathogen strains present before 2004. In a variety evaluation conducted on Long Island in 2017 under very high disease pressure, DMR 401 exhibited the highest level of resistance, Bristol and Citadel (pickling type suitable for fresh market) were moderately resistant but were not significantly less severely affected than SV3462CS, SV4719CS, and Diamondback. Marketmore 76 exhibited limited resistance while Speedway was not significantly less severely affected than Straight Eight, the susceptible check variety. In evaluations conducted in 2016 and 2017 at University of Massachusetts, NY264, DMR 401 (both sold at http://commonwealthseeds.com/), and Bristol exhibited good resistance with NY264 and Bristol performing best under high disease pressure.

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 USA is forecast and posted three times a week. Forecasts enable timely fungicide applications. Label directions for some fungicides state to begin use before infection or disease development. The forecasting program helps ensure this is accomplished. 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 two clades and pathotypes within each that differ in their ability to infect the various cucurbit crop types. Clade 1 pathotypes are A1 mating type and infect cucumber, pumpkin and cantaloupe. Clade 2 pathotypes are A2 mating type and infect squashes and watermelon. 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. Photographs of symptoms are posted at: http://blogs.cornell.edu/livegpath/gallery/cucurbits/ http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cuc_Downy.htm

Alternate among targeted, mobile fungicides in different FRAC groups and apply with protectant fungicide (chlorothalonil and mancozeb are more effective than copper) to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions on number of consecutive and total applications allowed. Label directions for some fungicides state to begin use before infection or disease development. The forecasting program helps ensure this is accomplished. 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. Resistance has been confirmed in the USA to FRAC Codes 4, 11, 28, 40, and 43. Frequency of resistance was higher in isolates from cucumber than other cucurbits in a study on Previcur Flex and Presidio, therefore these and Code 40 fungicides might be effective on other cucurbits; however, no or limited use is recommended for downy mildew on these crops to minimize selection pressure. FRAC Code 27 and 45 fungicides have exhibited poor control in some seedling bioassays suggesting resistance may also have developed to these chemistries. Most fungicides labeled for downy mildew are also labeled for Phytophthora blight, which is caused by a related (oomycete) pathogen. Table of fungicides for this and other main cucurbit diseases is at http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cucurbit%20Fungicide%20List%202018-NY.pdf

Fungicides for downy mildew (DM) and/or Phytophthora blight (PB):
Both diseases often are of concern in a crop. Many of the same targeted fungicides are labeled for both as they are caused by oomycete pathogens.

Orondis (49). The novel active ingredient, oxathiapiprolin, has exhibited excellent activity in fungicide evaluations. It is formulated with mandipropamid as Orondis Ultra (REI is 4 hr) for managing both DM and PB and with chlorothalonil as Orondis Opti (REI is 12 hr) for managing only DM. Orondis Gold 200, is only labeled for application to soil for Phytophthora blight. REI is 4 hr. Its use in a crop prohibits foliar application of Orondis fungicides for DM or PB. PHI is 0 day for all 3 fungicides. With all, make no more than 2 consecutive applications before rotating to a different fungicide. When at least 3 applications will be made, Orondis fungicides can be no more than 33% of the applications, or a maximum of 4 applications per planting, whichever is fewer. Orondis Opti is labeled for several other diseases because it contains chlorothalonil. It is only recommended used for these diseases when DM is also present. Orondis Gold 200 is considered the best choice for PB in a crop that has drip irrigation set up for applying pesticides and DM is expected to be manageable with other fungicides.

Presidio (FRAC Code 43). Recommended used early in the season for PB when DM not a concern. Control of DM has been poor in cucumber and resistance has been documented. Apply no more than 4 times in a season with no more than 2 consecutive applications. Must be applied with another fungicide.

Ranman (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.

Zing! and Gavel (22). These are the only products that have a targeted fungicide and a protectant fungicide (chlorothalonil or mancozeb). Only Gavel is labeled for PB as well as DM. REI is 12 hr for Zing! and 48 hr for Gavel. PHI is 0 and 5 days, respectively. Apply no more than 8 times in a season with no more than 2 in

succession. Limit total use with all products used to 1.6 lb zoxamide and 9.44 lb chlorothalonil per acre per season. The amount of chlorothalonil in an application of Zing! (1.18 lb/A) is less than the highest label rate of chlorothalonil fungicides for downy mildew (1.5 lb/A) and is below the range for other diseases including powdery mildew (1.5-2.25 lb/A). Increasing the amount of chlorothalonil applied is prudent for these diseases. 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!. Elumin is a new fungicide not yet registered in NYS.

Omega (29). REI is 12 hr. PHI is 7 days for squash/cucumber subgroup, which includes pumpkin, and 30 days for melons. Apply no more than 7.5 pts/A to a crop or 4 applications applied at highest label rate of 1.5 pts/A. Omega is more expensive than other fungicides.

Zampro (40, 45) and Revus (40). While in the same fungicide chemical group (40), there is indication they may have slightly different mode of action, thus there may be benefit to using one for the first application of a product in this group in a fungicide program and then switching to the other product later in the program. REI is 12 hr. PHI is 0 day. Apply no more than 3 times (4 for Revus) in a season with no more than 2 consecutive applications (none with Revus). Revus must be applied with a spreading/penetrating type adjuvant. Only Zampro is recommended for DM. Revus has not controlled DM on cucumber in recent university fungicide evaluations and in seedling bioassays, and resistance has been documented. Forum is no longer recommended; it has the same FRAC Code 40 ingredient as Zampro. Not labeled for use on Long Island.

Ariston, 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. Curzate and Tanos must be tank-mixed with a protectant; Ariston also contains chlorothalonil. 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. Ariston and Curzate are not labeled for PB. Tanos also has a FRAC Code 11 ingredient. It is recommended used for DM only when this ingredient is needed for other diseases that are also occurring, such as Plectosporium blight, or where needed to also manage PB.

Phosphorous acid fungicides (33). There are numerous products (e.g. Agri-Fos, Fosphite, K-Phite, Phostrol, ProPhyt, Rampart), all effective only for PB. They are recommended used at a low label rate tank mixed with the targeted fungicides listed above for PB.

Previcur Flex (28). Activity is limited to DM. Use sparingly (less than label limit of 5 times in a season) because of suspected resistance. REI is 12 hr. PHI is 2 days.

Recommended protectant fungicides. Chlorothalonil and mancozeb are the main protectant fungicides for DM and PB. Copper is also good for PB, but isn't as effective for DM.

No longer recommended for downy mildew. Resistance to mefenoxam and metalaxyl (Ridomil) and to strobilurins (e.g. Cabrio) are sufficiently common that fungicides with these ingredients, which use to be highly effective, have been ineffective since 2004.

Targeted fungicides no longer recommended for DM. Resistance has been documented in the USA in the cucurbit downy mildew pathogen to the following fungicides. 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. Seedling bioassays have also documented poor control presumed due to fungicide resistance. Poor control has also been reported in commercial cucumber crops. Research has almost exclusively been done with cucumber. In a study examining resistance in pathogen isolates from various cucurbit crops, most resistant isolates were from cucumber. Revus was effective for downy mildew in pumpkin but not cucumber in adjacent fungicide evaluations.

Previcur Flex (FRAC Code 28). Only labeled for DM; activity is limited to DM. REI is 12 hr. PHI is 2 day.

Presidio (43). Recommended used early in the season for PB when no DM.

Revus and Forum (40). Could be used early in the season for PB when no DM.

Fungicides with mefenoxam and metalaxyl (FRAC 4), e.g. Ridomil, or a strobilurin active ingredient (FRAC 11), e.g. Cabrio, have not been recommended for DM since 2004 as they have been ineffective due to resistance. The PB pathogen has developed resistance to FRAC 4 fungicides.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede this information, if there is a conflict. Before purchase, make sure product is registered in your state. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.