

Strategies for Managing Multiple Pathogens on Pumpkins

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Every year in the northeast, pumpkins (and other cucurbit crops) are potentially affected by more diseases than most other vegetable crops! Powdery mildew always occurs due to the quantity of easily wind-dispersed spores that the pathogen produces and the breadth of conditions under which it can develop (no high moisture requirement). The downy mildew pathogen also can move long distance; its occurrence in the northeast varies yearly, especially on crops other than cucumber. Occurrence of other diseases varies among farms depending on whether the pathogen is in the soil (several including *Phytophthora* blight), surviving in alternative host plants including weeds (e.g. white mold, viruses), present in insect vectors (e.g. bacterial wilt) or present in/on crop seed (e.g. bacterial leaf spot). Infected crop at a near-by farm can also be a source of pathogens that move short distances such as during a rainstorm (e.g. *Plectosporium* blight). Most diseases are more severe during a rainy than dry season because wet leaves or soil are favorable conditions for most pathogens (exceptions include powdery mildew, bacterial wilt, and virus diseases). Successful management is based on knowledge of pathogen biology, in particular sources of inoculum and conditions favoring disease development, which is used to identify appropriate cultural management practices. Knowing early symptoms facilitates early detection. It is also important to have current information on fungicides and resistant varieties. Below is information on select diseases followed by an integrated management program. See also: vegetablemndonline.ppath.cornell.edu.

Powdery mildew. An integrated program with both management tools (resistant varieties and fungicides) is recommended to maximize likelihood of effective control. The pathogen has been evolving and becoming less effectively controlled by these. Alternate among targeted, mobile fungicides in the 4 chemical groups below, and apply with protectant fungicide to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions. Note that the main goal is delaying resistance development, not managing resistance. Begin very early in disease development (one older leaf out of 50 with symptoms).

Vivando (FRAC Code U8) is a new fungicide with a new mode of action. Cucurbits are on a supplemental label. It has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. Do not mix with horticultural oils. It can be applied three times per year with no more than two consecutive applications. REI is 12 hr. PHI is 0 days. 365 day plant back restriction for non-labeled crops.

Torino (Code U6) 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. PHI is 0 days.

Quintec (Code 13) has been consistently effective in fungicide evaluations. Activity is limited to powdery mildew. Label specifies no more than two consecutive applications plus a crop maximum of four applications, and no aerial applications. REI is 12 hr. PHI is 3 days.

DMI fungicides (Code 3) include Proline and Procure, which are considered most effective, plus Aprovia Top, 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 Code 3 fungicides. Five applications can be made at this rate. REI is 12 hr for these fungicides. PHI is 0 - 7 days. Powdery mildew is the only labeled cucurbit disease for these fungicides, except for Proline, which is labeled for *Fusarium*, and Aprovia Top and Inspire Super, which contain another active ingredient (Code 7 and 9, respectively) and are labeled for additional diseases.

Carboxamide fungicides (Code 7) could be included in the program used sparingly. Resistant pathogen strains have been detected, and are likely the reason efficacy has varied. Cross resistance was documented between Pristine, Aprovia Top, Fontelis, and Merivon, the products registered for use on pumpkins, but not with Luna fungicides, which are labeled for use only on

watermelon so far. Thus Luna fungicides will be recommended once registered. Carboxamides are labeled for additional diseases. REI is 12 hr. PHI is 1 day.

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.

There are several protectants for powdery mildew, including chlorothalonil, sulfur, copper, botanical and mineral oils, and several biopesticides.

Phytophthora blight. This destructive disease has more been severe recently in areas where there were intensive rainfall events, which created unusually favorable conditions. A key to successfully managing this disease is managing soil moisture to avoid saturated conditions. Achieving this is difficult when rainfall amounts are large. Another key has been fungicides registered in recent years with targeted activity for pathogens in this biological group (Oomycetes). Information about these follows section on downy mildew. These are considered the reason many growers have been effectively managing Phytophthora blight. A preventive fungicide program is considered essential. Ineffective control with fungicides has been associated with poor application timing in some fields (application missed when rain began before expected) while in others favorability of environmental conditions seemed to have been too great. Development of fungicide resistance is a concern with all targeted fungicides due to single site mode of action; therefore, alternation amongst chemistry is recommended. Resistance to Ranman has been detected in the southeastern US. Protectant fungicides, such as coppers, are not sufficiently effective to be recommended alone for Phytophthora blight; however, they are useful tank-mixed with targeted fungicides to manage resistance. Presidio has a long rotational interval of 18 months for non-labeled crops, which can be a constraint on its utility. Most vegetable crops are now on the primary or supplemental labels. An important notable exception is sweet corn, which is commonly grown in rotation with pumpkins.

Biopesticides There are several products (Actinovate, Double Nickel, Regalia, RootShield, Serenade Soil, SoilGard, Bio-Tam, etc.) that can be applied to soil pre-transplant, at planting, and via drip to manage the blight pathogen, *Phytophthora capsici*, in the root and crown zone and to induce resistance (Regalia). Most of these biopesticides can also be applied to foliage.

Typically Phytophthora blight begins to develop in low areas where water drainage is poor, but symptoms have been found first in sloped areas. This documents the need to look throughout a crop for symptoms and not focus exclusively on low areas. It is better to avoid planting low areas. While crops planted in a field lacking the pathogen (based on crop and disease history) typically will be free of Phytophthora blight, this is not absolute. The pathogen can be moved between farms via water. Two cultural practices that have proved useful are biofumigation and deep zone reduced tillage. Biofumigation can be accomplished by growing a biofumigant mustard cover crop typically in early spring, chopping into small pieces 4-6 weeks after onset of flowering, and immediately incorporating the mustard, then sealing the soil surface with a culti-packer and irrigation. At least 7 days afterwards, lightly disk then plant.

Downy mildew is primarily managed with fungicides. Cucumbers 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. An integrated program with fungicides applied to resistant varieties is recommended. As with powdery mildew, fungicide resistance is also a concern with the downy mildew pathogen and therefore the fungicide program recommended is also targeted, mobile fungicides applied in alternation based on FRAC Code (see list below) on a weekly schedule and tank mixed with a protectant fungicide (chlorothalonil or mancozeb) beginning very early in disease development.

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 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.

Fungicides for Phytophthora blight (PB) and/or downy mildew (DM):

Presidio (FRAC Code 43). Recommended used early in the season for PB when DM not a concern. No longer effective for DM because of resistance. 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!.

Zampro (40, 45) and Revus (40). While in the same fungicide chemical group, 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.

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. Curzate is not labeled for 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). Reduced efficacy recently is thought to be due to fungicide 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. Resistance to fluopicolide (active ingredient in Presidio), 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, are now ineffective.

Plectosporium blight. This disease is more common when weather is rainy providing favorable conditions. Rotate, clean equipment between fields, apply chlorothalonil before rain, and incorporate infested debris right after harvest.

Integrated Management Program for Pumpkin Diseases:

Sign up for alerts about downy mildew occurrence at <http://cdm.ipmpipe.org> before the season starts. Monitor this site during the season for information on outbreaks and crops affected.

Select resistant varieties. See vegetablemdonline.ppath.cornell.edu/Tables/TableList.htm.

Use fungicide-treated seed and/or seed that has been tested for pathogens. FarmMore commercial seed treatment also has an insecticide. Alternaria leaf blight, angular leaf spot, anthracnose, damping-off, Fusarium wilt, gummy stem blight/black rot, scab, Septoria leaf spot.

Rotate land to control diseases caused by pathogens that can survive in soil or on weeds in hedge rows, which include Alternaria leaf blight, anthracnose, angular leaf spot, Fusarium crown and fruit rots, Fusarium wilt, gummy stem blight/black rot, Phytophthora blight, Plectosporium blight, scab, Sclerotinia white mold, Septoria leaf spot, and viruses (which can survive in weeds).

Select a well-drained site to manage damping-off, Phytophthora blight, and scab.

Minimize leaf wetness. Select a site with good air movement and overhead irrigate when leaves will have time to dry before evening dew period to manage foliar diseases.

Physically separate cucurbit plantings.

Avoid moving infested soil into clean fields. Work last in fields where pathogens occur that survive in soil, then clean equipment before working in fields where these diseases haven't occurred (see list under rotate above). Apply pesticides to areas without soil-borne diseases first.

Scout for diseases regularly during the growing season. Focus on older leaves as diseases often start to develop there. Look on both leaf surfaces. It is especially important to scout once plants start to produce fruit. Check low areas for Phytophthora blight. Look for cucumber beetles.

Apply pesticides as needed (fungicides before rain for most diseases except powdery mildew):

Insecticide Admire Pro at planting or transplanting for cucumber beetles, which carry bacteria that cause bacterial wilt. Or use FarMore-treated seed. Planting Blue Hubbard or another cucurbit highly attractive to beetles around the crop to form a perimeter trap is an effective strategy that can result in insecticide only being needed on the trap plants.

Contans before or at planting for white mold.

Ridomil Gold EC (Code 4), Previcur Flex (28) or biopesticides (Actinovate, Bio-Tam, Double Nickel, Regalia, RootShield, Serenade Soil, SoilGard, etc) at planting for damping-off.

Biopesticides (see above) at planting for Phytophthora blight and Fusarium crown rot.

Protectant fungicides (chlorothalonil, mancozeb, and/or copper) before disease onset. A preventive schedule is especially important with copper for angular and bacterial leaf spots.

Where bacterial wilt is a concern, apply insecticide if treatment at planting is no longer killing cucumber beetles early in crop growth, especially prior to canopy closure. Labeled products are Asana, Assail, Baythroid, Brigade, Danitol, Lannate, Pounce, Sevin XLR Plus, Volium Xpress, and Admire applied through drip.

Apply targeted fungicides in alternation based on FRAC code when the following diseases occur starting at first symptom or when risk high, tank-mix with protectant fungicide:

Alternaria leaf spot. Fontelis (7), Inspire Super (3,9), Aprovia Top (3,7), Pristine (7,11), QoI fungicides (11), Reason (11), Tanos (27).

Anthracnose. Aprovia Top (3,7), Inspire Super (3,9), Pristine (7,11), QoI fungicides (11), Tanos (27), and Topsin M (1).

Downy mildew. Powdery mildew, Phytophthora. See sections above.

Gummy stem blight/Black rot. Fontelis (7)*, Aprovia Top (3,7), Inspire Super (3,9), Pristine (7,11)*, Proline (3), Switch (9,12), QoI fungicides (11)*, and Topsin M (1)*.

Plectosporium blight. Aprovia Top (3,7), Inspire Super (3,9), and QoI fungicides (11)*.

Septoria leaf spot. Aprovia Top (3,7) and Inspire Super (3,9).

* Resistance detected in the US.

Hasten decomposition of infested crop debris by chopping debris to break it up and then incorporating with disk, roto-till or plow. Do immediately after harvest.

Please Note: The specific directions on pesticide 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.