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### **What's new with Cucurbit Downy Mildew?**

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Cucurbit downy mildew caused by the fungus-like pathogen *Pseudoperonospora cubensis* has become more prevalent in the Great Lakes region and throughout the U.S. over the past 5 years. Growers of cucurbits (cucumber, squash, melon, pumpkin) in Wisconsin may recall rare occurrences of late season downy mildew on squash or watermelon crops over the last four decades. Why, since the mid-2000's, has downy mildew become problematic on cucumbers mid-production season? Why has this disease revisited Wisconsin with greater regularity and aggressiveness?

Wisconsin is not alone in its battle with cucurbit downy mildew. In 2004, North Carolina pickling cucumber growers experienced epidemic levels of downy mildew in their crops. One year later, Michigan also dealt with the management challenge of this destructive plant disease on pickles. While cucumbers in the top two pickle processing states have been severely affected by this disease, other cucurbits in the Great Lakes region, including Ontario Canada, have also been impacted.

Since 2005, the Great Lakes region has seen cucumber as the first cucurbit crop infected with downy mildew with symptoms detected as early as mid-June. In 2011, pumpkin, butternut squash, cantaloupe, watermelon, and yellow summer squash were also infected in several states, but symptoms were not detected until late-July. It is not known if Wisconsin has had two different strains of cucurbit downy mildew, an early-arriving strain aggressive on cucumber and a late-arriving strain aggressive on pumpkin, squash, and melon or if we have one strain that gets established on cucumber and spreads to other less susceptible cucurbits after inoculum has increased locally. We do know that once downy mildew is active on crops in a region, it can be a continual challenge until harvest or frost.

At this time it is not clear if Wisconsin's cucurbit downy mildew comes from a single or multiple sources. Using national disease reports and forecasting data from the CDM ipmPIPE, North Carolina researchers concluded that disease outbreaks in the Great Lakes region and mid-Atlantic regions may be due to spread of the pathogen from outbreaks near the Georgia/South Carolina/North Carolina border and not from South Florida. In recent work carried out in Michigan, the downy mildew on cucurbits from multiple states within the Great Lakes region was similar, based on results of molecular characterization studies. However, the Great Lakes downy mildew type was unique from the types collected from other U.S. vegetable production regions to our south.

Cucurbit crops in Wisconsin have typically not needed routine application of fungicides for downy mildew control. For approximately 40 years, varietal resistance in commercial cucumber and some melon varieties, conferred by the recessive *dm1* downy mildew resistance gene, was effective in controlling disease. Pumpkin, squash, and watermelon crops were without this

resistance and would sporadically become infected with downy mildew late in the production season. It had been standard recommendation that pumpkins in northern states were to be planted and harvested early to avoid risk of downy mildew because the pathogen could make its way north on late season air currents. The strain(s) of the downy mildew pathogen that have recently made their way to the Great Lakes region are not adequately controlled by *dml* resistance that held up for decades.

Whether there has been a change in the pathogen population by way of a genetic mutation or introduction of an invasive and aggressive cucumber strain, or if changes in environmental conditions have promoted increased virulence is unknown. North Carolina State University researchers determined that recent eastern U.S. populations of cucurbit downy mildew were much more diverse in host range and pathogenicity than was previously known, with *Cucumis* species (cucumber, melon) having greater susceptibility to most pathogen isolates than *Cucurbita* species (squash, pumpkin).

Currently, with mid-season risk of spore movement and lack of commercially available and durable varietal resistance in cucurbits, fungicide applications are essential for protection of yield and quality. The selection of fungicides, timing of application, and thoroughness of application are critical for effective disease control. Fungicides should be applied prior to or at first sign of infection to best control cucurbit downy mildew. Based on field research in multiple states including Michigan and North Carolina, effective fungicides for downy mildew control include zoxamide+mancozeb, fluopicolide, propamocarb hydrochloride, cyazofamid, and famoxadone+cymoxanil. The effective control program for cucumber established at Michigan State University by Dr. Mary Hausbeck, which I recommend to producers in Wisconsin, specifies a 7-day spray interval of the previously listed materials tank-mixed with either mancozeb or chlorothalonil when initiated **before** downy mildew is found in the field. Fungicides should be alternated so as to manage the potential development of fungicide resistance. Sprays are tightened up to a 5-day interval when initiated **after** disease is found in the field. For cucurbits other than cucumber, the program above is modified to expand the spray intervals from 7 to 10-day **before** disease, and 7-day **after** disease is found in the field. Downy mildew can be well controlled in cucurbit crops with use of effective fungicides, however, this adds a significant increase to the cost of production and success is contingent upon careful attention to regional extension vegetable disease reports and careful field scouting to appropriately time fungicide application.

To aid in tracking cucurbit downy mildew in your county and beyond, the website: <http://cdm.ipmpipe.org/> offers forecasting of the disease based on confirmed reports across the U.S. The ipmPIPE (or **i**ntegrated **p**est **m**anagement **P**est **I**nformation **P**latform for **E**xtension and Education) cucurbit downy mildew website provides a publicly accessible site for sharing of cucurbit downy mildew detections, as well as symptom descriptions and management recommendations by region. The site is maintained by researchers at North Carolina State University with collaboration from researchers across the U.S., including Wisconsin. With the multitude of tasks that growers have to manage in the field, office, and marketplace, I recommend use of the CDM ipmPIPE Alert System (link on left side bar of website) which sends you an email or text message when downy mildew is reported within a selected geographic radius around your farm. Also, be sure you are receiving the UWEX Vegetable Crop Update newsletter each week through the growing season for downy mildew status reports. Newsletters

may be sent out by your grower association or can be directly accessed each week at our UW-Vegetable Pathology website: <http://www.plantpath.wisc.edu/wivegdis/>.

Research is ongoing in the U.S. and worldwide to better understand the pathogenicity, host resistance, and spread of cucurbit downy mildew. Advances in resistance breeding will greatly aid in improved disease control and sustainability of cucurbit production in Wisconsin and worldwide.

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The causal agent of cucurbit downy mildew, *Pseudoperonospora cubensis*, is an oomycete or 'water mold' pathogen related to other infamous water mold diseases such as potato late blight. Downy mildew, like other members of the water molds, is favored by warm temperatures (65-85°F) and wet field conditions. In 2010, areas of Wisconsin received over 30 inches of rainfall from May to October, the highest quantity of precipitation recorded over the production season since 1895. Conducive weather coupled with presence of the pathogen resulted in downy mildew in multiple cucumber producing areas of the state.

While downy mildew does not cause direct fruit infection on cucurbits, the pathogen can rapidly defoliate plants leaving fruit at risk for sunscald and secondary infection. Foliar symptoms include pale green to yellow angular (squared off within veins) lesions on leaf surfaces with corresponding and distinctive fuzzy brown growth on leaf undersides. The fuzzy growth is the pathogen producing thousands of new sporangia, or spores, which can become airborne and further spread the pathogen within field and beyond at a rate of approximately 6 miles per day. Early infections can be tricky to identify, as they may mimic a nitrogen deficiency, angular leaf spot, or even virus symptoms. The pathogen is an obligate parasite, requiring living cucurbit plants to remain viable. The pathogen cannot overwinter in the soil on its own, as production of persistent soilborne spores (oospores) have not been found here in Wisconsin.

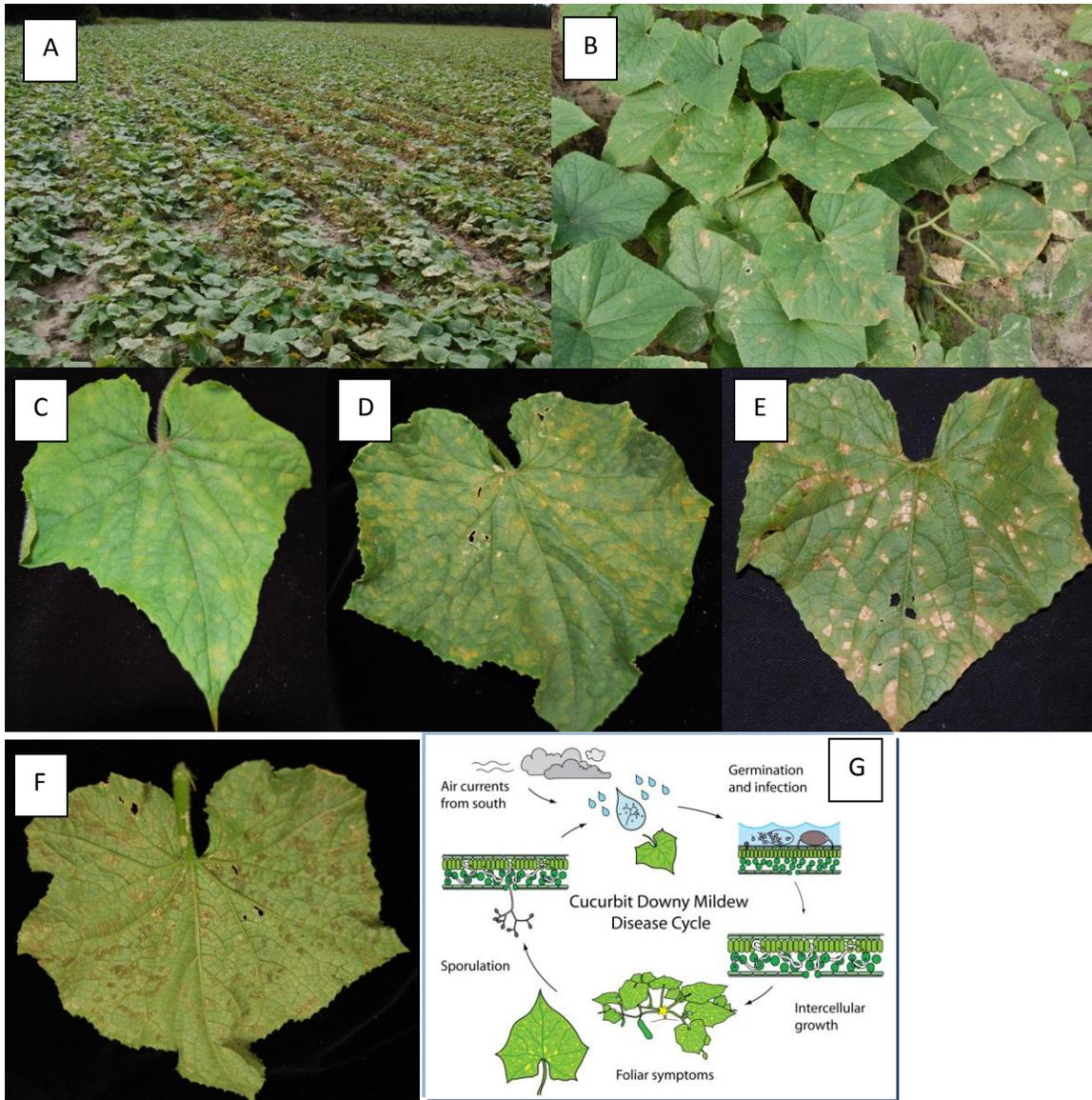
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- A. Pickling cucumber field with downy mildew. Note symptoms of dead foliage at center.
- B. Symptoms of downy mildew on pickling cucumber. Note tan to brown angular lesions.
- C. Early symptoms of downy mildew on cucumber leaf. Pale green to yellow small lesions. Early infection is often misdiagnosed as fertility deficiency, angular leaf spot, or virus.
- D. Advanced downy mildew symptoms on cucumber leaf. Yellow angular lesions over entire leaf surface. Pathogen sporulation is very abundant on leaf underside.
- E. Mature downy mildew lesions on cucumber leaf. Angular lesions have turned necrotic. Pathogen sporulation begins to shut down on leaf once necrosis sets in. Depending upon weather and use of fungicides, lesions can produce more spores and create new lesions.
- F. Signs of downy mildew on cucumber leaf underside. Note dark brown, fuzzy pathogen sporulation in angular patches which correlate to yellowing on surface.
- G. Cucurbit downy mildew disease cycle. Created by Rosemary Clark, formerly of UW-Vegetable Pathology.