Phytophthora Capsici

Wednesday afternoon 2:00 pm

Where: Grand Gallery (main level) Room E & F
MI Recertification credits: 2 (1B, COMM CORE, PRIV CORE)
OH Recertification credits: 2 (presentations as marked)
CCA Credits: PM(2.0)
Moderator: Doug Higgins, Plant, Soils and Microbial Sciences Dept., MSU

2:00 pm	Pathogen Biology and Cultural Management (OH: 2B, 1 hr) • Mary Hausbeck, Plant, Soils and Microbial Sciences Dept., MSU
3:00 pm	Fungicide Management Programs (OH: 2B, 1 hr) -- Integrating cultural controls, plant resistance, and fungicides into a Phytophthora management program. • Charles Krasnow, Plant, Soils and Microbial Sciences Dept., MSU
4:00 pm	Session Ends

Phytophthora capsici: Pathogen Biology and Management Strategies

Charles S. Krasnow and Mary K. Hausbeck (517-355-4534)
Michigan State University, Department of Plant, Soil and Microbial Sciences

Phytophthora blight annually threatens vegetable production in Michigan. Many growers have been negatively impacted by losses resulting from *Phytophthora* and the pathogen continues to spread throughout the state. Limiting losses due to Phytophthora blight requires an integrated approach that includes prevention, cultural control strategies, plant resistance, and fungicides.

Biology. *Phytophthora* is a fungal-like organism that is sometimes referred to as a "water mold" due to its close relation to algae. The pathogen persists in fields long-term as an overwintering structure (oospore) that resists degradation. When conditions favor plant growth the oospore germinates and infects crops. Annual spores (sporangia and zoospores) produced on infected plants are responsible for the spread of the pathogen during the season. Zoospores can move in surface water and runoff, and heavy rain and irrigation favor *Phytophthora* dispersal and plant infection. Blighted plants are often first observed in sections of fields with poor drainage. Crops including cucumber, squash, zucchini, watermelon, cantaloupe, pepper, tomato, and snap bean can become infected by the *Phytophthora* pathogen. Multiple-year rotations to non-susceptible crops can help to reduce the levels of *Phytophthora* in a field, but rotation alone has not been adequate to significantly reduce the risk from this pathogen.

Cultural controls. Cultural control strategies include limiting the time that the soil is saturated. Raised plant beds with black plastic and trickle irrigation are widely used in vegetable production and have reduced losses from *Phytophthora* root rot. This system not only permits the application of fungicides via the drip irrigation lines, but raised beds improve soil drainage and may prevent infested soil splash onto stems and fruit. One of the drawbacks of this mode of production, however, is its cost, and reusing the same beds to grow vegetables for more than one year may increase *Phytophthora* pressure in the field. Tiling and subsoiling fields are recommended to improve drainage especially where raised plant beds are not used. *Phytophthora* has been isolated from surface water sources used for irrigation, such as ditches, culverts, streams, rivers, and holding ponds. Irrigating crops with well water or water filtered through a carbon-based filter can reduce the chances of introducing *Phytophthora* into fields.

Crop resistance. Growing *Phytophthora*-resistant crops has been considered an optimal method to increase yields and reduce fungicide use. *Phytophthora*-resistant pepper cultivars are available that perform well in Michigan. In recent MSU pepper *Phytophthora* trials, 'Paladin,' 'Turnpike' and 'Archimedes' produced high yields and had high levels of resistance to root rot. *Phytophthora* resistance is not widely available in cucurbit crops; however, partial resistance to root rot is observed in butternut, green zucchini, cousa, and spaghetti squash. Acorn, delicious, and yellow squash are susceptible to root rot. Partial resistance to root rot does not necessarily indicate resistance of the fruit. Pickling cucumber vines and roots are partially resistant to *Phytophthora*, while the fruit are highly susceptible. Many winter squash and pumpkins display "age related resistance" to fruit rot (Table 1). The squash and pumpkins are susceptible to fruit rot when young and immature and then become more resistant as they age. Mature fruit are not immune, and fruit rot can occur if the fruit are injured and when environmental conditions are conducive for disease. Fruit with 'latent' infections from the field or harvested from diseased vines, may develop rot post-harvest. In MSU research trials, fruit rot did not spread among butternut squash in post-harvest storage; only fruit with pre-existing lesions from the field developed rot. However, if healthy fruit are exposed to diseased fruit via a common dunk tank or other post-harvest washing system, pathogen spread is likely with increased fruit rot incidence. Avoiding harvesting from areas of a field infested with *Phytophthora* can help to limit the introduction of infected squash into storage and is recommended.

Table 1. Resistance of squash and pumpkin to Phytophthora root, crown and fruit rot.

Squash type	Phytophthora resistance level[x]	
	Fruit	Roots and crowns
Cousa (summer)	+	+++
Zucchini (summer)	-	++
Yellow (summer)	-	-
Acorn (winter)	++	+
Spaghetti (winter)	+++	+++
Butternut (winter)	++	+++
Hubbard (winter)	++	++
Jack o lantern (pumpkin)	+/++	+
Delicious (processing)	-	-
Cheese (processing)	+++	+++

[x]All squash and pumpkin fruit are susceptible when immature.
- = no resistance, + = low, ++ = moderate, +++ = high resistance.

Fungicide programs. Most *Phytophthora* susceptible vegetable crops require an intensive fungicide program. In Michigan, root, crown, and fruit rot occur on susceptible vegetables. Soil drenches at transplant followed by fungicide applications through the drip lines have significantly reduced root rot on susceptible crops. The drip tape should be placed 1-3 inches from the plant to improve fungicide uptake, as some fungicides have limited soil mobility. Fungicides should be applied early in the season to control root rot on vegetables grown on flat ground. An in-furrow spray of Orondis Gold at seeding effectively reduces root rot of direct seeded winter squash and banded sprays to seedlings can also be effective to protect the developing seedling; however, the early applications cannot provide long-lasting control. Fruit rot of winter squash and pumpkin has been difficult to control and was observed frequently in the 2016 season. Foliar fungicide sprays should be initiated before fruit rot symptoms develop in fields with a history of *Phytophthora*. For cucumber, foliar sprays with an air blast sprayer can improve fungicide movement into the canopy. Fungicide applications to winter squash and pumpkin could be made with a boom sprayer at over 40 GPA to better penetrate the foliage to protect the fruit from *Phytophthora* rot. Using a reduced amount of water per acre to apply fungicides will not provide enough coverage of the fruit. Although the fungicide mefenoxam (Ridomil Gold) may not be effective in all regions of the state due to pathogen resistance, new systemic fungicides such as Orondis Gold, Revus SC, and Presidio SC are effective. Fungicides with different FRAC codes should be alternated to delay the onset of pathogen resistance.

Table 2. Disease incidence (%) in Phytophthora root rot fungicide trials.

Treatment, rate/A, and (*application method*)	Disease incidence (%)
2014 *Phytophthora* trial 'Howden' pumpkin	
Untreated	47.5
Ranman SC 2.75 fl oz + Silwett L-77 SL 2 fl oz (*foliar*)	15.0
Omega F 16 fl oz (*foliar*)	15.0
Omega F 16 fl oz *-alt-* Revus SC 8 fl oz + Activator 90 SL 16 fl oz (*foliar*)	25.0
2016 *Phytophthora* trial 'Cougar' yellow squash	
Untreated	100.0
Orondis Gold 13.7 fl oz (*transplant drench*) Revus SC 8 fl oz + Kocide 3000 DF 1 lb + Act. 90 1 pt *-alt-* Ridomil Gold Copper WP 1 lb (*foliar*)	33.8

Treatment, rate/A, and (*application method*)	Disease incidence (%)
Orondis Gold 13.7 fl oz (*transplant drip*) Revus SC 8 fl oz + Kocide 3000 DF 1 lb + Act. 90 1 pt *-alt-* Ridomil Gold Copper WP 1 lb (*foliar*)	85.0
Revus SC 8 fl oz + Kocide 3000 DF 0.75 lb + Act. 90 1 pt *-alt-* Ridomil Gold Copper WP 1 lb (*foliar*)	87.5
Presidio SC 4 fl oz (*drip*)	97.9

* *-alt-* = alternate

***Phytophthora* fruit rot trial.** A trial was established at the Michigan State University Plant Pathology Farm in Lansing, MI on a *Phytophthora*-infested field site. 'Golden Delicious' processing squash was direct seeded in late May. Fungicides were applied as a heavy spray at fruit set and 11 days later using a backpack sprayer with a three-nozzle (TeeJet XR8008) spray boom with 8 inch drop-legs delivering 50 GPA at 30 psi. This provided thorough coverage of the fruit. Ridomil Gold SL (1 pt) and Orondis Gold (9.6 fl oz) were the most effective treatments in both years of the trial, reducing fruit rot of 'Golden Delicious' to less than 30% compared to more than 70% for the unsprayed control.

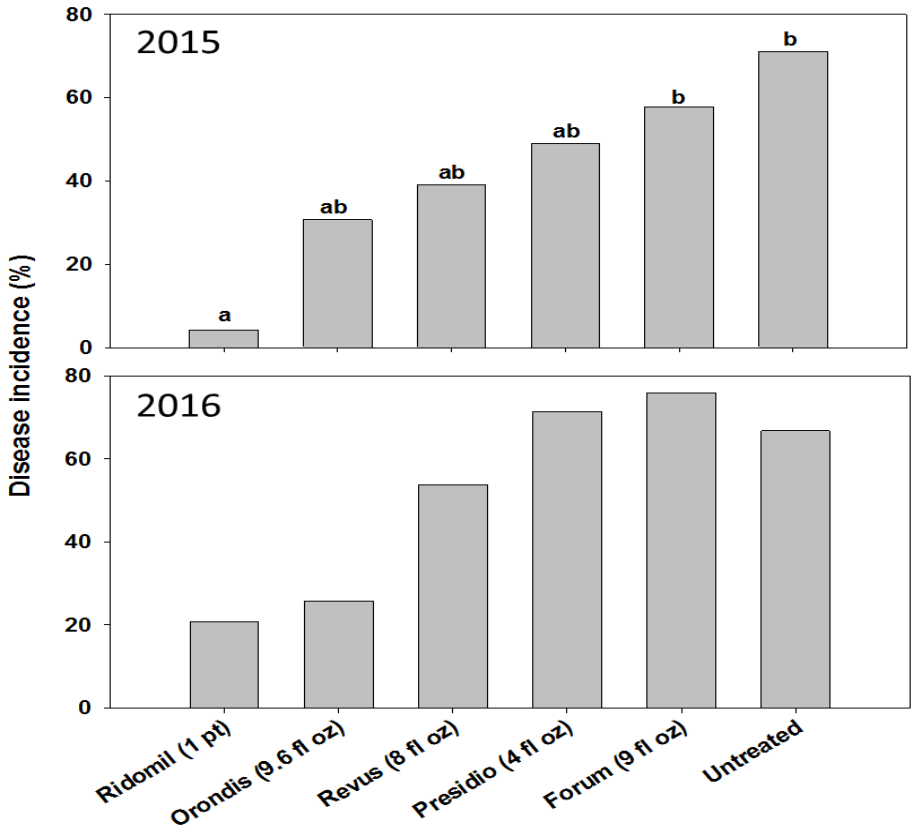

Figure 1. Effect of fungicides on Phytophthora fruit rot of 'Golden Delicious' processing squash.

Based on trials conducted at MSU, a fungicide program to control Phytophthora root and fruit rot of squash and pumpkin could include:

- Orondis Gold, Presidio SC, Revus SC, or Ridomil Gold at transplant as a soil drench, via drip irrigation, or in-furrow (direct seeded).
- Drip applications of Orondis Gold, Presidio SC, or Ridomil Gold on a 21-day interval.
- Foliar sprays of Orondis Gold, Presidio SC, Revus SC, Ridomil Gold, or Zampro SC at >40 GPA (winter squash and pumpkin) or with an air-blast sprayer (summer squash) to protect against fruit rot.

Acknowledgments. This research was supported by partial funding from a Specialty Crop Block Grant administered by the Michigan Vegetable Council and a grant from the National Institute of Food and Agriculture, U.S. Department of Agriculture award number 2015-51181-24285.