Dr. M.K. Hausbeck, Michigan State University, Department of Plant Pathology,
East Lansing, MI 48819 (517-355-4534, hausbec1@msu.edu)

Crown, root and fruit rot caused by *Phytophthora capsici* may initially occur in the low areas of a field where water accumulates. Under warm, wet conditions, root and crown infection of pepper, zucchini, squash, and pumpkin typically causes wilt and plant death. Plants often have brown to black discolored roots and/or crowns. In contrast, infected cucumber and tomato plants may show only limited root rot and plant stunting. Disease symptoms on snap beans include water-soaking on the leaves, stem browning, and overall decline. Table 1 lists susceptible crops.

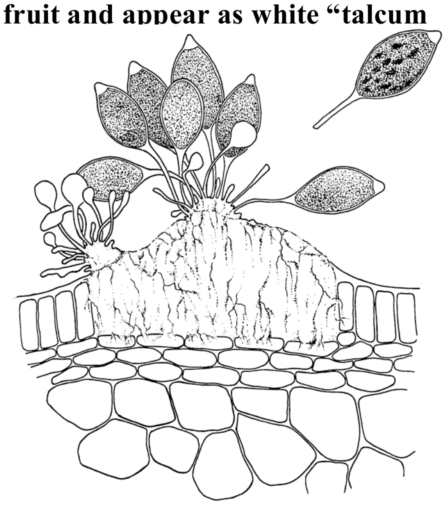
Table 1. Crops susceptible to *Phytophthora capsici* under field conditions.

Cucurbitaceae		Solanaceae	Fabaceae
cantaloupe	summer squash	bell pepper	snap bean
cucumber	watermelon	hot pepper	lima bean
gourd	winter squash	eggplant	wax bean
pumpkin	zucchini	tomato	
muskmelon			

While plant death is always a concern, fruit rot seems to be especially troublesome for the vine crops. In general, infected cucurbit fruit initially exhibit dark, water-soaking, followed by a white ‘powdered-sugar’ layer of spores on the surface of the fruit 2 to 3 days later. In Michigan, fields of healthy-appearing cucumber vines with mature fruit have been abandoned in the field at harvest, or semi-truck loads of fruit rejected at the processing facility, due to rot. Fruit can become infected while in the field with the disease progressing during storage and transit with fruit rot occurring after delivery to the processor or retailer.

***Phytophthora capsici* reproduces via spores called sporangia that develop on infected plants and fruit and appear as white “talcum**

Spores create field epidemics. *Phytophthora capsici* has the potential for rapid disease spread. Mature spores (sporangia) are easily dislodged by rain and irrigation and can directly germinate or, when immersed in water, release 20 to 40 swimming spores (zoospores) that travel with water in fields. The number of spores (sporangia) on a single infected spaghetti squash fruit was estimated to be 44 million, with the potential to release 840 million swimming spores (zoospores). As *P. capsici* has



Sporangia are lemon-shaped spores that must be magnified 400 times to be seen individually.

spread to more acreage devoted to vegetables, producing vulnerable crops has become a challenge.

Rotate crops. While crop rotation is important, the long-term survival of spores (oospores) is a problem. Even long rotations (> 5 years) to non-susceptible hosts are not enough. The availability of noninfested land is becoming increasingly scarce. The development of agriculture land for urban use and the relatively low value of some field crops have forced many vegetable producers to reduce their crop rotation to only 1 or 2 years.

Today, many vegetable producers recognize that cucurbit (cucumbers, pumpkins, squash, zucchini, melons) and solanaceous (tomatoes, peppers, eggplant) crops are at risk for *P. capsici* infection and rotate these crops with other vegetables (i.e., carrots, beans, onions, asparagus are examples from Michigan) or agronomic crops (soybeans, alfalfa, small grains). However, recent reports of commercial losses in lima beans and snap beans from this pathogen and susceptibility of soybeans and other commonly grown vegetables under laboratory conditions suggest that guidelines for crop rotation should be reevaluated.

Keep *Phytophthora* out. Runoff water from infested fields can transport the pathogen from diseased plants to nearby water sources used for irrigation. We began testing aboveground water sources in Michigan for contamination with *P. capsici* during 2001 and recovered the pathogen from irrigation ponds on two farms. Additional irrigation water sources were monitored for *P. capsici* in 2002 through 2007, and the pathogen was frequently detected in a river, creek, and a naturally-fed pond. All of these water sources were located near crops infected with *P. capsici*. Prior to this research, the presence of *P. capsici* in Michigan irrigation sources had not been reported. Another potential source of *P. capsici*-contaminated water may be from vegetable processing facilities that apply their waste water to nearby vegetable production sites. Using water that may be contaminated with *P. capsici* to irrigate healthy crops must be avoided to limit pathogen spread.

Identifying factors contributing to the spread of *P. capsici* to new locations can be challenging. Producers are warned against dumping *P. capsici*-infected produce on or near their farms. Once *P. capsici* is established in a field, tillage and cultivation distribute diseased plant material and spread spores (oospores) throughout the field and soil profile. It is possible that *P. capsici* may be disseminated to new fields via equipment even when no remnants of diseased plant material are visible.

Manage water. Plant into well-drained fields and into raised beds whenever possible. Excess moisture is the single most important component to the initial infection and spread of *P. capsici*. When a field is infested with *P. capsici*, narrow spacing enhances disease spread and development by increasing relative humidity in the microclimate, and lengthening the duration of soil surface and fruit wetness after a rain or irrigation. Preliminary studies have been conducted at Michigan State University to integrate cultural control methods of controlling *P. capsici* on zucchini, methods including soil amendments, protective mulches, and water management. Raised beds, flat beds, and raised beds with black plastic + straw and/or compost were compared. Although the treatment with raised beds, plastic, straw, and compost was significantly better than flat beds for stand count, numbers, and weight of healthy fruit both years, disease still occurred. While cultural strategies offer reasonably effective protection for fresh-market zucchini or similar bush-type cucurbit varieties, these management tools are too costly and impractical for growers of cucurbits for the processing industry where the profit margin is relatively small.

Apply tested fungicides. While fungicides cannot be relied upon alone to prevent disease, they have provided Michigan growers with an extra degree of protection, especially when used in combination with crop rotation, raised beds, and water management. Some fungicides are available and have been tested for combating *P. capsici*, especially when the pathogen is resistant to mefenoxam (Ridomil Gold is an example), but none have proven wholly effective when the weather favors disease. The fungicides Acrobat 50WP, Gavel 75DF, and Tanos 50WG limit disease and have been tested in replicated large-scale pickling cucumber field trials. Mixing a full rate of copper hydroxide with a *Phytophthora* fungicide may be helpful, and is recommended. Seed treatment with either Apron XL LS or Allegiance FL may be helpful during seed germination to limit pre- and post-damping off caused by *P. capsici*. Alternate fungicides and avoid relying on a single fungicide to delay development of fungicide resistance in *P. capsici*. A new fungicide Presidio, will soon be available and is highly recommended for use against Phytophthora crown, root, and fruit rot.

Good coverage of the plant and fruit with fungicide is essential for maximum protection, but can be difficult when fruit are shielded by dense foliage. Plant spacing has been increased by some growers to improve fungicide coverage. Early and frequent fungicide applications are required, but increase the cost of production. In Michigan, a fungicide spray may be needed every 5 to 7 days when the weather is wet and rainy. However, the pre-harvest interval required for Gavel ($\geq$ 4 days) makes it difficult to use this fungicide in some production systems.

Can fumigation help? The long-term persistence of the spores (oospore) in agricultural soils poses a continual threat to the successful commercial production of host crops. Both registered and experimental fumigants have been tested in Michigan in conjunction with commercial producers at known *P. capsici*-infested sites. Recent MSU studies at a site infested with *P. capsici* showed that Vapam and Telone C-35 were helpful in limiting disease when used in a raised bed, plastic mulch system.

Table 2. Recommended control strategies for blight caused by *P. capsici*.

Preplant
• Use a seed treatment. • Consider a pre-plant banded fungicide application for infested fields. • Plant susceptible hosts in well-drained fields. • Utilize raised beds (15-20 cm minimum) whenever possible. • Do not plant in low-lying areas of the field.
Production
• Monitor fields for disease, including damping off, plant stunting, root and crown rot. • Do not irrigate a field with water that contains runoff from fields with a history of *Phytophthora* disease. • Irrigate conservatively and, if possible, do not irrigate prior to harvest. • Plow under portions of the field with diseased plants, including healthy plants that border diseased areas. • Remove diseased fruit from the field.
Production (continued)
• Never dump culls or diseased fruit from other fields or farms into production fields. Once *Phytophthora capsici* is introduced, it may remain indefinitely. • Apply fungicide preventively and frequently, especially for known problem fields. • Rotate the types of fungicides used.
Postharvest
• Harvest fruit as soon as possible from problem fields and plow under crop residue immediately. • Keep harvested fruit dry and cool.

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No-Till Pumpkins