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Charcoal Rot of Strawberry Caused by *Macrophomina phaseolina*[1]

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Introduction

Charcoal rot is caused by the fungus *Macrophomina phaseolina* and has become more prevalent in Florida strawberry fields since methyl bromide was phased out. This disease was first observed in December 2001, when collapsed and dying strawberry plants from a commercial field were submitted to our diagnostic clinic (Figure 1). Since then, samples have been received in our diagnostic clinic every season.

Figure 1. Strawberry field affected by charcoal rot during the 2015–2016 season.
Credit: Al Herndon

Causal Agent and Symptoms

Macrophomina phaseolina is distributed worldwide and has a wide host range. The fungus produces resistant, long-lived structures called sclerotia that survive in the soil and on strawberry debris. These microsclerotia are usually the primary source of new infections. Their numbers increase in the soil when susceptible hosts are grown continuously for several seasons.

Symptoms caused by *Macrophomina phaseolina* are similar to those caused by other crown-rot pathogens, such as *Colletotrichum* and *Phytophthora* species. Plants initially show signs of water stress and eventually collapse (Figure 2). Cutting the crowns of affected plants reveals reddish-brown necrotic areas along the margins and in the woody vascular ring (Figure 3). To confirm charcoal rot, a sample should be submitted to a diagnostic clinic, and the pathogen must be isolated from the diseased crowns and identified.

Figure 2. Strawberry plant wilting and collapsing due to charcoal rot.
Credit: UF/IFAS

Figure 3. Internal symptoms of charcoal rot, including reddish-brown necrotic areas on the margins and woody vascular ring of the crown.

Disease Development and Spread

M. phaseolina is a common soilborne pathogen in many warm areas of the world. Many vegetable crops planted as second crops after strawberry, such as squash, cantaloupe, peppers, and legumes used as cover crops, are susceptible to the pathogen. However, our research indicates that the strains that affect strawberry do not affect other crops and vice versa. In general, high temperatures (~30°C [86ºF]), sandy soils, and low soil moisture favor infection and disease development. Soil is usually the primary source of inoculum, but there is evidence that the fungus can survive on crop residue, especially strawberry crowns that are incorporated into the soil or thrown between beds when the plastic is reused the following season.

Control

Management of *M. phaseolina* involves a combination of cultural practices and chemical methods. Cultivars differ in their susceptibility to charcoal rot. Among currently grown cultivars, 'Florida Medallion' is highly susceptible, 'Florida Brilliance' and 'Florida Encore' are moderately susceptible, and Sweet Sensation® 'Florida 127' and 'Florida Ember' are moderately resistant. Pre-plant soil fumigation is the standard method employed by growers to reduce inoculum levels and control charcoal rot. Methyl bromide was highly effective in controlling the pathogen. Since its phase-out, strawberry growers have transitioned to alternative broad-spectrum fumigants. Studies performed at the UF/IFAS Gulf Coast Research and Education Center (UF/IFAS GCREC) in Wimauma, FL, at the Florida Strawberry Growers Association in Dover, and on commercial farms demonstrated that Telone®, K-pam®, Vapam®, Paladin®, and Dominus® applied through shank or drip tapes were effective in reducing inoculum of *M. phaseolina* placed at the center of the beds, but PicClor60 was less effective. However, these products may not always effectively reduce inoculum on the sides of the beds due to their limited movement through the soil. The type of plastic used (VIF, TIF, or LDPE) may also influence the efficacy of the fumigant and, therefore, the control of the inoculum. In studies performed in Dover, Telone® applied under VIF plastic showed better results than when applied under LDPE plastic.

Plant losses to charcoal rot can be somewhat reduced by chemigation or application of fungicides through the drip system. In chemigation experiments at UF/IFAS GCREC, Kenja, Rhyme™, Topsin, Velum Prime and Howler suppressed charcoal rot when drip applied, but results were not always consistent. Of these, Rhyme™, Velum Prime and Howler are currently labeled for drip application to strawberry. Several important points related to chemigation should be considered: 1) multiple drip applications may not perform as well as a properly applied pre-plant soil fumigation; 2) drip applications should outperform spray applications because *M. phaseolina* is a soil-borne pathogen; 3) applications made in the fall (when soil temperatures are high and plants are most susceptible) are the most effective; and 4) double drip tapes should perform better than single tapes when used as the conduit for fungicides or fumigants. Chemigation trials at UF/IFAS GCREC are continuing the search for more effective products and the development of proper labeling.

Table 1. Fungicides recommended in Florida for management of charcoal rot caused by *Macrophomina phaseolina*.

Product name (active ingredient)	Fungicide Group[a]	Maximum Rate Per Acre		Min. Days to Harvest	Remarks
		Per Application	Per Season		
Rhyme (flutriafol)	3	7 fl oz	28 fl oz	0	Apply through drip irrigation. Recommended initial application at transplanting. For spring and fall planting, a second application is required approximately 30 days later. For fall planting, additional applications may be required at 30-day intervals.
Velum Prime (fluopyram)	7	6.84 fl oz	13.7 fl oz	0	DO NOT make more than 2 sequential applications of VELUM PRIME or any Group 7-containing fungicide before rotating with a fungicide from a different group.
Howler EVO	BM02	120 oz	—	0	Use higher rate and shorter intervals when disease pressure is high. Use lower rates when used in tank mixes and/or rotations with other effective fungicides.

[a]Fungicide group (FRAC Code): Numbers (1–37) and letters (BM) are used to distinguish the fungicide mode of action groups. All fungicides within the same group (with the same numbers or letter) indicate same active ingredient or similar mode of action. This information must be considered for the fungicide resistance management decisions; M = Multi-site inhibitors, fungicide resistance risk low. Source: FRAC Code List 2017; http:s//www.frac.info/ (FRAC = Fungicide Resistance Action Committee). n.a.: not applicable

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