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**Introduction**

*Macrophominaphaseolina* (Tassi) Goid. asoilborne fungus causes charcoal rot.  The fungus can infect the root and lower stem of over 500 [plant species](https://projects.ncsu.edu/cals/course/pp728/Macrophomina/host.htm) . Charcoal rot is an important disease during hot, dry weather or when unfavorable environmental conditions stress the plant.  *M. phaseolina*causes disease on soybean, peanut, and corn.  Charcoal rot causes a stalk rot during hot, dry conditions in maize.

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**Host Range and Distribution**

     *M. phaseolina*infects over 500 [plant species](https://projects.ncsu.edu/cals/course/pp728/Macrophomina/host.htm) and has a wide geographic distribution.  Major cultivated hosts include: *Arachishypogaea* (peanut), *Beta vulgarius, Brassica oleracea* (Cabbage)*, Capsicum annuum*(pepper)*, Cicerarietinum* (chick pea)*, Citrus*spp. *Corchorus*sp., *Cucumis* spp., *Fargaria*sp., *Glycine Max* (soybean), *Gossypium*sp., *Helianthus annuus* (sunflower)*, Ipomoea batatas* (sweet potato)*, Medicago sativa* (alfalfa)*, Phaseolus*spp., *Pinus*spp., *Prunus*spp., *Sesamumindicum* (sesame), *Solanumtuberosum* (potato), *Sorghum bicolor*(sorghum)*, Vignaunguiculata* (bean)*,*and *Zea mays*(corn).

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**Isolation**

When microsclerotia are visible on host tissue isolation on culture media is easily accomplished using a dissecting scope.  If microsclerotia are not evident, isolation should be attempted from the areas of the plant likely infected.  Surface disinfestations of the tissue with 0.525% NaOCl solution for 1-3 minutes will enhance successful isolation. Standard solid culture media such as potato dextrose agar (PDA), cornmeal agar (CMA), lima bean agar (LBA), or water agar (WA) can be used and incubation at 28 to 35 C for 3-5 days will promote rapid growth of the fungus and exclusion of other microorganisms.

The microsclerotia density of *M. phaseolina* can be determined in soil using selective media (3).  A 5 g-subsample is first washed in 10% bleach and then rinsed over a 325 μm sieve.  The subsample is then added to 100 ml of molten PDA amended with rifampicin (100 ml/L) and tergitol (1 ml/L) and distributed evenly over 10 plates. Colonies of *M. phaseolina* can be enumerated with an unaided eye by morphology after incubation at 28 C in darkness for 3 to 5 days.

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**Identification**

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|   | *M. phaseolina* (Tassi) Goid.  (syns.*M.*phaseolina (Maubl.)Ashby, *Rhizoctoniabataticola* (Taub.) Briton-Jones, Sclerotiumbataticola Taub., and *Botryodiplodiaphaseoli* (Maubl.) Thrium.), is a soilborne plant pathogen belonging to the phylum Deuteromycetes and class Coelomycetes. It is highly variable, with isolates differing in microsclerotial size and presence or absence of pycnidia. The pycnidial stage is not common on soybean, but is on peanut. [Pycnida](https://projects.ncsu.edu/cals/course/pp728/Macrophomina/structures.htm) are initially immersed in host tissue, then erumpent at maturity. They are 100-200 μm in diameter; dark to grayish, becoming black with age; globose or flattened globose; membranous to subcarbonaceous with an inconspicuous or definite truncate ostiole.  The pycnida bear simple, rod-shaped conidiophores, 10-15 μm long. [Conidia](https://projects.ncsu.edu/cals/course/pp728/Macrophomina/structures.htm) (14-33 x 6-12 μm) are single celled, hyaline, and elliptic or oval. | https://projects.ncsu.edu/cals/course/pp728/Macrophomina/macrophominia_phaseolinia_files/image012.gif |
|   | Microsclerotia of*M. phaseolina* are jet black in color and appear smooth and round to oblong or irregular.  Across isolates, microsclerotia vary on size and shape and on different substrates.  [Microsclerotia](https://projects.ncsu.edu/cals/course/pp728/Macrophomina/structures.htm) are formed from aggregates of hyphal cells joined by a melanin material with 50 to 200 individual cells composing an individual microsclerotia. | **Colony of *M. phaseolina* on PDA**. |

Colonies in culture range in color from white to brown or gray and darken with age. Hyphal branches generally form at right angles to parent hyphae, but branching is also common at acute angles. Aerial mycelium with completely or partially appressed growth may or may not be produce in culture. Some isolates may form concentric growth rings.

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**Symptoms**

**Corn**- Charcoal rot in corn produces symptoms similar to other fungal stalk rots.  The characteristic sign of charcoal rot is the production of black microsclerotia in the vascular tissue and inside the rind of the stalk.  The stalk will appear gray to black in color. Infection of corn occurs during drought conditions when the corn stalks begin to senesce. This leads to widespread disease incidence in corn during hot and dry years (7).

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|   |   **Charcoal rot in corn stalk.** |   |  **Charcoal rot and microsclerotia in corn stalk.** |

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|   Images taken from Compendium of Corn Diseases 3rd Edition. D. G. White ed. APS Press. St. Paul, MN. |

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**Disease Cycle and Epidemiology**

*M. phaseolina*survives as microsclerotia in the soil and on infected plant debris. The microsclerotia serve as the primary source of inoculum and have been found to persist within the soil up to three years (4).  The microsclerotia are black, spherical to oblong structures that are produced in the host tissue and released in to the soil as the infected plant decays.  These multi-celled structures allow the persistence of the fungus under adverse conditions such as low soil nutrient levels and temperature above 30 C. Microsclerotial survival is greatly reduced in wet soils surviving no more than 7 to 8 weeks and mycelium no more than 7 days.  Seeds may also carry the fungus in the seed coat. Infected seed do not germinate or produce seedlings that die soon after emergence.

Germination of the microsclerotia occurs throughout the growing season when temperatures are between 28 and 35 C.  Microsclerotia germinate on the root surface, germ tubes form appresoria that penetrate the host epidermal cell walls by mechanical pressure and enzymatic digestion or through natural openings (2).  The hyphae grow first intercellularly in the cortex and then intracellularly through the xylem colonizing the vascular tissue.  Once in the vascular tissue *M. phaseolina* spreads through the taproot and lower stem of the plant producing microsclerotia that plug the vessels (8).  The rate of infection increases with higher soil temperatures and low soil moisture will further enhance disease severity.

     Hot, dry weather promotes infection and development of charcoal rot (8). In soybean charcoal rot is a greater problem after anthesis and often occurs when the plant is under drought stress (4).  *M. phaseolina*can grow and produce large amounts of microsclerotia under relatively low water potentials allowing this disease to be recognized as favoring drought (6).  The mechanical plugging of the xylem vessels by microsclerotia, toxin production, enzymatic action, and mechanical pressure during penetration lead to disease development.  The population of *M. phaseolina*in soil will increase when susceptible hosts are cropped in successive years and can be redistributed by tillage practices (8).

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**Management**

Cultural management methods must be implemented to minimize charcoal rot damage since there are no fungicides available for effective disease control.

Crop rotation out of a susceptible host is effective in some crop production systems.  Rotation out of soybeans for three years may effectively reduce microsclerotia numbers and is useful for managing charcoal rot (7).  Corn is also a host for *M. phaseolina* but isolates appear to be specific to each crop (soybean and corn) though all isolates can infect both crops.  Corn is not as good of a host to *M. phaseolina* as soybean so rotation with corn for three years may help reduce populations but not eliminate the pathogen from the soil.  Rotation with a poor host such as cotton may only require one or two years to reduce inoculum levels in soil. For peanuts rotation with cotton or rice for two to three years may help reduce soilborne inoculum.

Early Planting will aid in earlier canopy closure that will help reduce soil temperatures and therefore reduce the competitive ability of *M. phaseolina*.

Avoid high plant populations. High plant populations can contribute to increase plant stress and competition for water increasing charcoal rot potential.

Fertility. Adequate levels of available P and K will reduce nutrient stress and encourage health plant growth.

Soil Moisture. Tillage practices which reduce soil moisture stress may reduce disease potential.  Maintaining good soil moisture with irrigation from planting to pod fill may reduce disease potential.