SOY AUSTRALIA LTD
Australian Soybeans
Soybean Fact Sheet
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Charcoal rot of soybean

Background

Charcoal rot of soybean is caused by the soilborne fungus *Macrophomina phaseolina*. This pathogen has a very wide host range, including all summer crops but particularly soybean, sorghum, sunflower, mungbean, maize and cotton, many horticultural crops and trees, and also weeds. Overseas more than 500 plant species have been recorded as hosts of *M. phaseolina*, while in Australia over 80 plants have been identified as hosts.

The fungus is widespread in Australia, having been found in all mainland states and territories, with most records in the eastern farming systems from Victoria to central Queensland.

Charcoal rot is regarded as the most common disease of soybean in Australia, and under the right weather conditions it can cause the premature death of entire soybean crops.

Figure 1: Early symptoms of charcoal rot infection of a soybean plant.

Photo: Dr M Ryley

Figure 2: Grey 'staining' of inside of soybean stem base affected by charcoal rot.

Photo: Dr N Moore, NSW DPI

Biology and epidemiology

The infection process of *M. phaseolina* in soybean is reasonably well understood. When roots of seedlings grow very near microsclerotes of *M. phaseolina*, their exudates stimulate the microsclerotes to germinate, and fungal strands grow towards and ultimately into the roots.

Evidence suggests that infection occurs when the seedlings are growing actively and that the pathogen remains latent inside roots until the plants are stressed.

The combination of the plant physiological stresses associated with flowering and an external stress, most frequently caused by high temperatures (>35°C) and/or low soil moisture, stimulates the pathogen into activity. Stress from waterlogging followed by hot weather, and perhaps stem insect injury, can also predispose plants to charcoal rot.

During this stage, *M. phaseolina* produces a plant toxin which together with a plugging of the water conducting tissue causes rapid wilting and ultimately plant death. As infected plants die microsclerotes are produced in abundance in the roots and lower stems.

Rarely, small flask-shaped structures called pycnidia, containing spores that ooze out through an opening at the top of the structure during moist weather, develop on the stems. The role of these spores in the life cycle of *M. phaseolina* is not well understood, but they may be involved in the aerial infection of pods and seeds.

Symptoms

Charcoal rot symptoms appear on soybean plants usually at and after flowering, although hot, dry weather immediately after emergence can kill seedlings.

From flowering onwards, individual plants scattered across a paddock suddenly wilt, with leaves dying rapidly but remaining attached to the petioles. In furrow-irrigated crops plants at the head ditch end often wilt before plants across the rest of the paddock, and in paddocks with several different soil types plants growing in lighter soil tend to wilt first.

Figure 3: Later symptoms of charcoal rot infection of a soybean plant.

Photo: Dr M Ryley

The stems of infected plants turn from green to a light yellow-tan colour, later becoming brown. On occasion, infected plants will display a dark brown lesion extending from ground level up the stem, ending in a gradation in colour from dark brown to yellow into the green stem above the lesion.

This symptom can be confused with that caused by phytophthora root and stem rot (PRR; *Phytophthora sojae*), but the stem lesions of PRR are sunken and often bordered by a red-black margin, with the boundary between the lesion and the green stem above being very distinct and with no colour gradation.

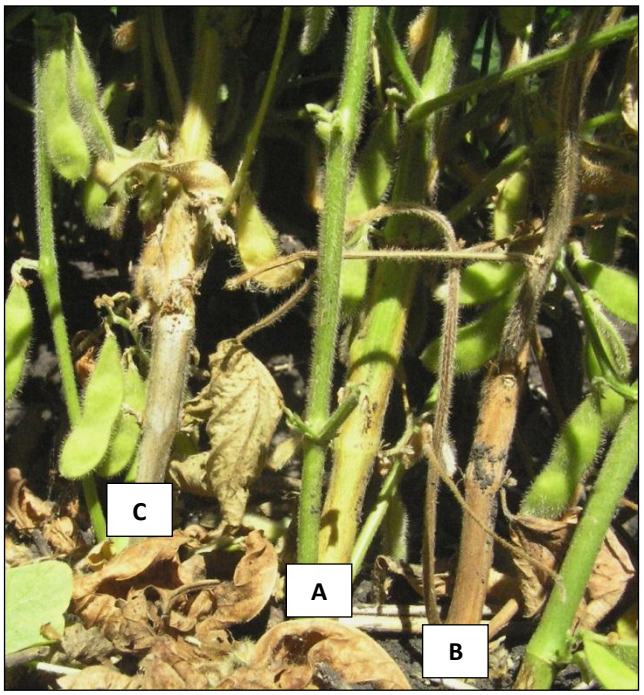

Figure 4: Symptom development on lower stems of soybean plants affected by charcoal rot from early symptoms to later symptoms (A) yellow-light tan, (B) brown, (C) ashen grey.

Photo: Dr M Ryley

Figure 5: Dark brown charcoal rot lesion extending up a soybean stem. Note the gradation from brown to yellow then into the green part of the stem as the lesion borders.

Photo: L Gaynor, NSW DPI

A diagnostic symptom of charcoal rot in the early stages of development is an orange discoloration of the tissue just below the surface of the stem, commonly called “orange bark disorder”. The rapid onset of wilting and the orange stem tissue discoloration is caused by a plant toxin produced by *M. phaseolina*.

Figure 6: Orange discoloration just below the stem surface of soybean plant infected by charcoal rot (orange bark disorder).

Photo: Photo: Dr M Ryley

Charcoal rot-infected plants almost always die before maturity, and after death the stems usually turn an ashen grey colour with minute black specks on the surface, giving the stems a peppery appearance. When the dead tap roots and basal stems are split this pepper symptom is also readily apparent, with the minute black specks contrasting sharply with the white stem pith.

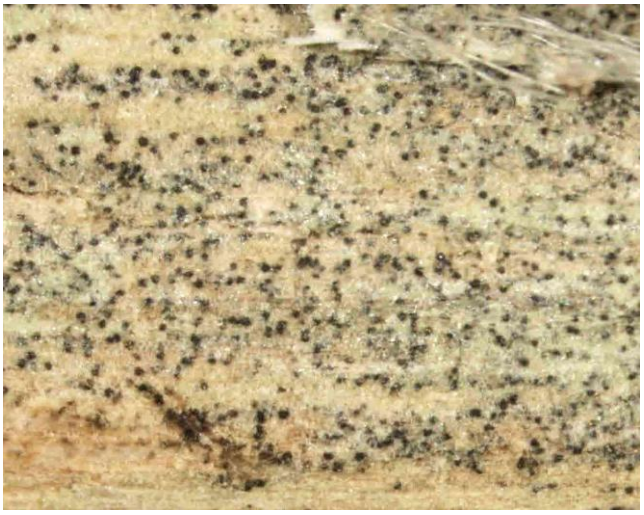

Figure 7: Close-up of black microsclerotes of *M. phaseolina* on the surface of an infected stem.

Photo: Photo: Dr M Ryley

The minute black specks referred to above are the survival structures of *M. phaseolina.* They are called microsclerotes, and are composed of tightly compacted fungal strands that form a hard rind at the surface, enabling them to survive for many years in the soil

Figure 8: Close-up of black microsclerotes of *M. phaseolina* inside a charcoal rot infected stem.

Photo: Photo: Dr M Ryley

Management options

Management of charcoal rot of soybean is challenging for several reasons – the pathogen is widespread in all agricultural soils in Australia, the microsclerotes are long lived in soil and infected plant residues, and *M. phaseolina* has a wide host range.

Despite this, charcoal rot does not devastate many crops, the incidence and severity of the disease being determined mostly by weather conditions which cause stress at and after flowering. More commonly, the disease causes premature plant death resulting in the production of undersized and wrinkled seed.

Options for Integrated Disease Management of charcoal rot are;

- **Paddock selection** - do not sow soybean into a paddock in which a previous crop (including other hosts such as sorghum, maize and mungbean) experienced a severe outbreak of charcoal rot within the past 2 years
- **Variety selection** - all Australian soybean varieties are susceptible to infection by *M. phaseolina*
- **Seed and in-crop fungicides** - no fungicides have been demonstrated to be economically viable for control of the pathogen
- **Fallow weed management** - research in Australia has shown that many weeds are infected by *M. phaseolina* but do not display symptoms, so effective weed control in fallows is essential
- **Plant population** - ensure that recommended planting rates are used to minimise stress, particularly in dryland crops
- **Irrigation** - ensure that irrigation is timed well to minimise moisture stress, particularly after flowering
- **Tillage** - overseas research indicates that *Macrophomina* microsclerotes survive better inside infected stem residues than in the soil, and that those in surface residues survive for longer than those in buried stubble; however, the interactions between soil moisture levels, stress and infection by *M. phaseolina* under different tillage systems has not been studied in Australia.

For additional information contact

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Further reading

Mungbean and Soybean Disorders: The Ute Guide. The Grains Research & Developent Corporation, Queensland Department of Primary Industries.

Compendium of Soybean Diseases, 4th edition (eds GL Hartman, JB Sinclair, JC Rupe). The American Phytopathological Society, St Paul MN, USA.

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