BLACK ROOT ROT

Black root rot, caused by *Berkeleyomyces rouxiae*, can be a significant problem in cooler growing regions. Affected crops may be slow growing or stunted early in the season which can delay in the onset of flowering.

FACT SHEET

THE PATHOGEN

Black root rot is caused by the soil-borne fungal pathogen, *Berkeleyomyces rouxiae* (formerly known as *Thielaviopsis basicola*). The pathogen is capable of surviving for years in the soil by producing two distinct types of reproductive spores: i) thick-walled chlamydospores for long-term dormancy, and ii) thin-walled endoconidia for quick seasonal infection.

CONDITIONS FAVOURING DISEASE

Black root rot is favoured by cool soil temperatures during crop establishment, with disease generally most severe at 16–20°C and severity declining as soil temperatures increase above 24°C. Cooler temperatures also slow cotton seedling growth, extending the period during which young roots are susceptible to infection.

SYMPTOMS & IMPACTS

The disease primarily affects cotton during the early stages of crop development, reducing seedling vigour, which can also make plants more susceptible to infection by other seedling pathogens, including *Pythium, Rhizoctonia* and *Fusarium* spp. As a result of infection, the plant's ability to absorb water and nutrients through damaged roots is reduced, leading to slower development, stunting, and delayed flowering.

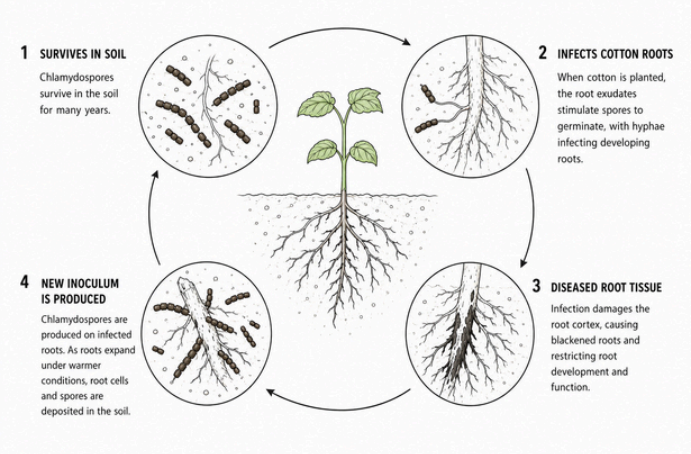
Infected seedlings exhibit external blackening of the tap and lateral roots and the below ground portion of the stem.

IMAGE (R): AI-generated schematic adapted from published black root rot life-cycle diagrams. Fungal structures are illustrative only and should not be considered morphologically accurate or to scale.

However, the vascular interior of the root usually remains white. In severe cases of infection, the black root infection can move inward from the root surface and penetrate the vascular core.

Black root rot is typically a non-lethal seedling disease, and infected seedlings usually resume more normal growth when weather conditions become more favourable. The tap root then expands rapidly, shedding the dead, blackened cells.

Black root rot occurs throughout most cotton-growing regions but is particularly important in southern New South Wales, where cooler temperatures occur during plant establishment and shorter growing seasons can affect the crop's ability to compensate from early stress and infection. In heavily affected fields, growers may need to replant or abandon crops altogether, with reports of yield loss of up to 46%. In parts of southern New South Wales, black root rot inoculum in some fields has increased to levels where cotton production is no longer economically viable.



CURRENT MANAGEMENT PRACTICES & ONGOING RESEARCH

Monitor and diagnose diseases accurately
Conduct regular disease surveys to monitor disease incidence and severity over time.

The Australian Cotton Disease Collaboration (the ACDC) is continuing to provide ongoing diagnostic support to help growers and consultants identify pathogens, building a national database on the prevalence and distribution of cotton diseases. For more information, contact the project lead, Dr Dinesh Kafle, dinesh.kafle@dpi.qld.gov.au.

Good field and bed preparation
Ensure fields and beds are well prepared to maximise crop establishment and minimise disease risk. Level fields promote uniform drainage and reduce waterlogging, which can stress plants and increase their susceptibility to disease. Prepare beds so they are high, well-shaped and firm to improve drainage, support consistent seed placement, and promote vigorous seedling establishment.

Plant into rising soil temperatures
Where possible, plant when soil temperatures are rising to encourage rapid germination and vigorous early growth. Both planting date and irrigation strategy should be considered, as they influence the soil temperatures experienced by the establishing crop.

In fields with a history of black root rot, pre-irrigation is generally preferred over watering up. Watering up after planting can lower soil temperatures around the germinating seed, slowing emergence and prolong cool conditions that favour black root rot development.

CRDC-funded research conducted by Dr Jamali and Dr Bange at ACRI in Narrabri during the 2015 - 2016 season found that cotton watered-up one day after planting experienced soil temperatures up to 2.4°C cooler than cotton planted into pre-irrigated soil. This demonstrates that irrigation strategy can influence the soil temperatures experienced by establishing cotton

Rotate with non-host crops
The inoculum of *B. rouxiae* builds up when susceptible host crops are grown. Rotating cotton with non-host crops, such as winter cereals, vetch, sunflower, sorghum, safflower, canola and maize, can help reduce inoculum levels. Rotations should be incorporated as part of a long-term strategy.

Fallows are not an effective management strategy, as the pathogen produces persistent spores that can survive in the soil for many years.

Avoid rotating to susceptible host crops (including legumes such as chickpea, faba bean, mungbean, pigeon pea and soybean) that can increase inoculum levels.

The **Australian Cotton Production Manual**'s *Potential disease implications of rotation crops (in relation to the following cotton crop)* table outlines the likelihood of inoculum levels increasing or decreasing, helping growers choose the most suitable rotation crops before cotton with respect to their disease of concern.

Practice good farm biosecurity and hygiene, including weed management
Prevention is the most effective management strategy for black root rot. Once *B. rouxiae* becomes established in a field, it is extremely difficult to eradicate due to its spores that can persist in the soil for many years.

Protect clean fields by implementing good farm biosecurity practices to minimise the introduction and spread of pathogens. Ensure all people, vehicles and machinery arriving on-farm follow Come Clean, Go Clean protocols and are free of soil and plant debris before entering production areas.

Control weeds, volunteer cotton and ratoon cotton plants, that can allow the pathogen to survive and reproduce between cotton crops.

Known weed hosts includes bellvine, burr medic, medic, common sowthistle, dead nettle, common thornapple, fierce thornapple, golden crownbeard, lucerne volunteers, redroot amaranth, shepherd's purse, wild tobacco and velvetleaf. Refer to the **Cotton Pest Management Guide**'s *Weeds as hosts of cotton pathogens* table for the current list of weed hosts of cotton pathogens.

Use biofumigant crops
Biofumigation involves growing crops with high concentrations of glucosinolates, which can suppress some soil-borne pathogens when incorporated into the soil. Biofumigant crops can be grown as part of a rotation or as a green manure crop and should be incorporated while fresh. To minimise the risk of phytotoxicity to the following cotton crop, allow at least 4–6 weeks between incorporation and planting.

CRDC-funded dield trials conducted by Dr Karen Kirkby from NSW DPIRD during 2013–2014 found that biofumigant crops (a biofumigation blend comprising doublet fodder radish, carinata, and white mustard, and doublet fodder radish alone) reduced black root rot severity in cotton compared with vetch and fallow treatments.

While these trials demonstrated that biofumigation can reduce black root rot severity, they were conducted more than 12 years ago. Since then, new biofumigation blends have become available, providing growers with additional options that were not evaluated in the original research.

The effectiveness of biofumigation depends on producing sufficient biomass, the glucosinolate concentration of the biofumigant crop, mulching and incorporation, effective sealing of the soil surface, and favourable conditions for decomposition. Adequate soil moisture is required to produce sufficient biomass and activate the biofumigation process following incorporation.
While these trials demonstrated that biofumigation can reduce black root rot severity, they were conducted more than 12 years ago. Since then, new biofumigation blends have become available, providing growers with additional options that were not evaluated in the original research. While biofumigation does not eliminate *B. rouxiae* from the soil, it can reduce disease severity and can be considered as part of an integrated disease management program.

Consider summer flooding

Summer flooding is a deliberate management tactic where fallowed fields are intentionally covered by water during the hottest months of the year. Prolonged summer flooding has been shown to reduce *B. rouxiae* populations and black root rot severity. Overseas research and limited Australian studies indicate that flooding is most effective under warm conditions (when maximum air temperatures exceed 30°C) and when maintained for a prolonged period (minimum 30 – 60 days).

However, because of water requirements and operational constraints, this tactic is generally not a practical management option for Australian cotton production systems.

The ACDC is investigating the soil, environmental and microbial factors influencing black root rot infection and severity, while strengthening cotton pathology in southern NSW. Field, glasshouse, and laboratory studies will identify and evaluate practical management strategies including biocontrol agents, biofertilisers, and plant growth regulators. For more information, contact the project lead, Dr Ben Stodart, bstodart@csu.edu.au.

Host plant resistance

Host plant resistance offers the best long-term solution for managing black root rot. Although no commercial cotton varieties currently possess resistance, research conducted through Cotton Breeding Australia, a joint venture between CSIRO and Cotton Seed Distributors, has identified a novel source of resistance in a wild cotton relative and is working to incorporate this trait into Australian upland cotton. Developing resistant varieties has proven technically challenging because this resistance originates from a genetically incompatible species which also had undesirable agronomic traits such as poor yield and fibre quality.

Recent breeding and genomic advances have produced promising new breeding lines, and further evaluation is underway. For more information, contact Dr Warwick Stiller, warwick.stiller@csiro.com.au.

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by Sharna Holman-Buckley, CottonInfo Disease and Biosecurity Technical Lead/QDPI.
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For further information
www.cottoninfo.com.au
www.unisq.edu.au/research/the-acdc

THE ACDC The Australian Cotton Disease Collaboration IS AN INITIATIVE OF CRDC IN PARTNERSHIP WITH UniSQ Queensland Government

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BEST PRACTICE