

## Managing a plant fungus in nursery production

### SUMMARY

- Fungi constitute the largest number of plant pathogens and are responsible for a range of serious plant diseases such as root rot, cankers and foliage blights. Pathogenic fungi damage plants by killing cells and/or causing plant stress.
- Fungal pathogens survive in soil, on plants, plant residue, and on equipment and machinery before seizing opportunities to infect. Once active, fungal diseases exploit plant weaknesses, leaving plants prone to more disease and insect pests.
- This Nursery Paper provides an overview of the symptoms, diagnosis, management and prevention of a plant fungus, using *Thielaviopsis basicola*, Black Root Rot (BRR) as an example.
- This disease can be found worldwide and has been identified as a major problem in Australian production nurseries since 1993.



*Black root rot of Viola spp. Note the lack of plant vigour, poor overall plant health and lack of roots due to root rot. Source: Bruce Watt, University of Maine, Bugwood.org*

### BACKGROUND

*Thielaviopsis basicola* is a common soil-borne fungal pathogen and is the causal agent of Black Root Rot (BRR). The fungus is commonly found in all soil types and growing media in both seedling nurseries and production fields. It will grow on decomposing plant residue of non-host plants and is a particular problem in bedding plants and some vegetables.

Recorded hosts include a wide range of fruit, vegetable, ornamental and native plants. The fungus is of economic importance, causing reduced and stunted plant growth, reduced yields in commercial crops and significant production losses in greenlife crops. The disease presents certain challenges in early detection due to frequent misdiagnoses with delayed diagnosis leading to higher crop losses and a greater cost in cleaning up (disinfecting) the production nursery. As there is no cure, nursery stock losses can be significant with all infected plants needing to be destroyed. Therefore, prevention is the best method of control and is possible with rigorous management practices.



*Thielaviopsis basicola on pansy plugs. Photo courtesy Roger Styer, Styer's Horticultural Consulting*



## Disease description

**Name:** *Thielaviopsis basicola*  
(Black Root Rot)

**Synonyms:** include *Chalara elegans*,  
*Torula basicola* and *Trichocladium*  
*basicola*

**Division:** *Ascomycota*

**Family:** *Ceratocystidaceae*

**Genus:** *Thielaviopsis*

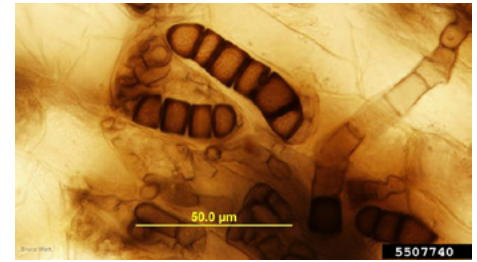
## Disease Cycle

During periods when no susceptible host plants are available the fungus survives as dormant chlamydo spores (resting spores). BRR produces two types of reproductive spores, thin-walled endospores and thick-walled chlamydo spores. Both spore types can cause plant disease. The thin-walled endospores are relatively short lived (up to seven months in soil). They are clear and rather fragile and move easily with splashing water from irrigation. These may be more difficult to detect in or on plant tissue.

The other type is a chlamydo spore and is dark brown to black in colour and forms as a long-term spore which may survive in soil for many years.



Symptoms of *Thielaviopsis basicola* on vinca plugs. Photo courtesy Roger Styer, Styer's Horticultural Consulting.



Close-up of chlamydo spores in a *Viola* spp. root. Photo by Bruce Watt, University of Maine, Bugwood.org.

Chlamydo spores stick to sides of trays, bench surfaces and other greenhouse materials. The dark colour provides protection from sunlight and they have thick walls that keep them from drying out and dying. When conditions are favourable, these spores are stimulated to germinate by compounds produced by the roots. Favourable conditions include a soil pH between 5 and 8.5 with a soil temperature between 17 and 25°C. Saturated soil can also increase disease incidence, as well as increase the overall stress on the plant leading to a higher disease susceptibility. The fungus can spread from infected roots to healthy roots if they come into contact and from reused containers or growing media of an infected plant. Spores can also be splashed from container to container when irrigating.

## Symptoms

Symptoms of BRR may include blackening of the hypocotyl, tap root and fibrous roots. Root mass is smaller and appears dark brown to black. Small lesions may be found on some roots or affect the whole root system.

In severely affected plants, root mass is greatly reduced, and in extreme cases, roots are reduced to stubs. Infected plants are slow growing, remain stunted, some may show yellowing of the lower leaves in comparison with healthy plants. Apart from the lack of vigour and general chlorosis, there may not be any specific above-ground symptoms.

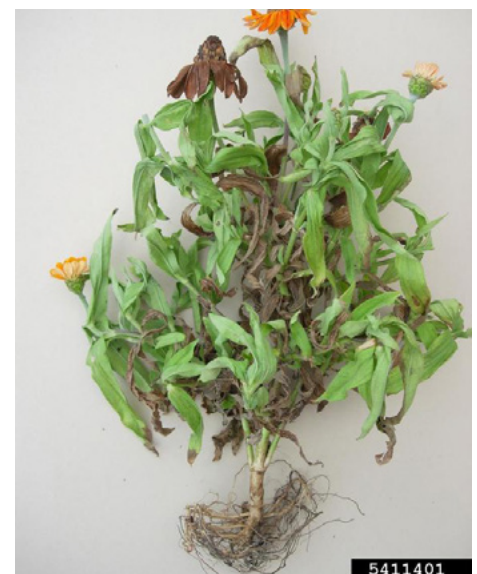
Additionally, there may be little to no symptoms on some cultivars and species, so it can easily be passed from greenhouse to greenhouse on healthy-appearing plants. However, on a highly susceptible cultivar, BRR causes serious growth reduction and crop losses.

## Host Plants

Over 100 species from at least 30 plant families have been recorded as hosts since the pathogen was first documented in England during the 1850's.

**TABLE 1. EXAMPLES OF PLANTS TYPES REPORTED AS SUSCEPTIBLE TO BLACK ROOT ROT**

Herbaceous ornamentals	Vegetable crops
Astilbe, Bacopa, Begonia	Bean, Carrot, Corn, Cucurbits
Cineraria, Cyclamen, Dianthus	Eggplant, Lettuce, Okra, Onion
Fuchsia, Gerbera, Gloxinia	Pea, Tomato
Kalanchoe, Impatiens	Woody ornamentals
Pansy/Viola,	Barberry
Pelargonium, Petunia, Phlox, Primula	Bitter lemon
Poinsettia,	Catalpa, Camellia, Citrus
Salvia, Snapdragon, Sweet Pea	English box, Euonymus
Verbena, Vinca, Zinnia	Holly, Inkberry, Lilac



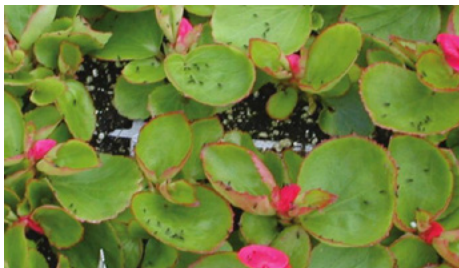
Wilted zinnia, reduced root system. Photo by Elizabeth Bush, Virginia Polytechnic Institute and State University, Bugwood.org.





BRR can occur at any stage of plant growth, from seedlings in containers to plants ready for market. The disease is frequently misdiagnosed as fertiliser injury, underfeeding, heat and cold injury, over-watering, under-watering, the fungus *Rhizoctonia*, the root-rot organism *Cylindrocladium*, *Pythium* root rot, fungus gnats and nematodes.

Despite the name, 'root rot,' signs of the disease are often noted in the plant's leaves, not its roots. By then, unfortunately, the damage has already been done.



Shorefly adults on Begonia plants. Photo courtesy Roger Styer, Styer's Horticultural Consulting.

## Identification

- Plants affected by black root rot may show above-ground symptoms that are not the only diagnostic criteria as they can be confused with other root rot diseases or general nutrient deficiencies
- Yellowing of leaves, plant stunting, wilting or even plant death
- A diagnostic feature of black root rot is the presence of black lesions on the roots, which are visibly very different from healthy white roots
- Root discoloration initially is brown and becomes dark black as abundant black-coloured spores (chlamyospores) form on and in the root system
- Lesions which occur in the middle of the root and expand to form cankers
- Sometimes black lesions can extend into the crown and on the plant stem near the soil line causing stems to be necrotic and soft and leaves to wilt
- The root discoloration is not always dramatic, consider accessing the help of a diagnostic laboratory to identify BRR. It is an easy disease to diagnose reliably, quickly and relatively cheaply in a plant pathology laboratory.

## Testing

Testing for plant pathogens such as BRR is available at specialist plant diagnostic laboratories. Please refer to the below table for information on lab services in your state

DIAGNOSTIC SERVICES FOR PLANT DISEASES	
NSW	<a href="https://www.dpi.nsw.gov.au/about-us/services/laboratory-services/plant-health">https://www.dpi.nsw.gov.au/about-us/services/laboratory-services/plant-health</a>
QLD	<a href="https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/agribusiness/grow-help-australia">https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/agribusiness/grow-help-australia</a>
VIC	<a href="http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/diagnostic-services#crop-health-services">http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/diagnostic-services#crop-health-services</a>
WA	<a href="https://www.agric.wa.gov.au/taking-samples-plant-disease-diagnostics">https://www.agric.wa.gov.au/taking-samples-plant-disease-diagnostics</a>
TAS	<a href="https://dpiw.tas.gov.au/biosecurity-tasmania/plant-biosecurity/plant-diagnostic-services/plant-pathology-laboratory">https://dpiw.tas.gov.au/biosecurity-tasmania/plant-biosecurity/plant-diagnostic-services/plant-pathology-laboratory</a>

## Disease management strategies

**Quarantine Areas:** A quarantine area should be established within the production nursery to isolate and inspect incoming stock for weeds, pests and diseases. These locations can assist in identifying and isolating plant diseases before they become a problem and need not be more than a bench set aside from other crops/ areas and signed.

If BRR infection is confirmed, dispose of infected plants and use propagation records to track individual plants or batches. Infected plants should be immediately sealed in containers/bags and removed from site.

**Crop Monitoring:** Ensure there is a monitoring procedure in place with staff trained to scout for potential pests and know the process to follow if a disease is identified.

Staff should keep a close eye on susceptible hosts, looking for any growth irregularity in the crop. For

example, if a viola or lettuce crop looks uneven, with plants stunted to various degrees and some having yellow or purple foliage, the root system should be examined.

Rinsing the root system of a stunted plant, will allow you to see areas of the roots that are stunted and blackened. In BRR, the above-ground symptoms resemble starvation, despite correct fertilisation. Plant symptoms caused by a cultural error tend to have an even effect throughout the whole cultivar or species, whereas disease symptoms present a more irregular, scattered pattern in the crop. When receiving plugs of BRR-prone crops, check the root systems to make sure they are white and healthy looking. Root discoloration is not always dramatic, so you may need the help of a diagnostic laboratory to identify BRR.

The BioSecure HACCP Guidelines has the appropriate crop monitoring procedure which can be accessed at <http://nurseryproductionfms.com.au>

**Pest ID:** Consult the Pest Identification Tool (<http://pestid.com.au>) developed for industry to assist with the identification and treatment of pest insects, diseases, disorders and weeds. It also includes information on beneficial insects as biocontrol treatments.

**Integrated Pest Management (IPM):** Regular monitoring in production nurseries when combined with Integrated Pest Management (IPM) techniques (see BioSecure HACCP Guidelines) can help reduce occurrences of many plant viruses, fungal diseases, insect pests and weeds. Refer to: <http://nurseryproductionfms.com.au> for more information on best practice.

**Sanitation:** Practice good nursery hygiene by sterilising tools, equipment, recycled containers and surfaces before use. This will reduce stock losses caused by plant pathogens and improve overall plant health within the nursery environment. Keeping accurate propagation records is recommended as nursery management best practice because it allows for patterns to be observed and traceability of infections.



The most common way BRR is spread in a production nursery is on infected propagation material (e.g. plugs) or by reusing seedling trays, tubes or pots and failing to clean growing surfaces (benches). It can also be present in soil, growing media and as a contaminant in peat based potting mixes so it is important to use soil-less media from NIASA accredited suppliers.

Inspect newly purchased plant material for symptoms, such as wilting and darkened roots, before introducing them to the cropping system. Remove and dispose of any and all infected plant material and infested growing media from cropping areas.

Young seedlings can become infected through the use of seedling trays contaminated with this pathogen. It is important to thoroughly wash trays and to decontaminate with a disinfectant solution (e.g. Quaternary ammonium). Control common plant production insects such as fungus gnats and shore flies because they can carry BRR spores. Fungus gnats are able to injure a diseased root system further and spread the pathogen within and throughout the cropping system.

**Reduce Plant Stress:** Take preventative and reactive measures to reduce plant stress. Allow saturated growing media to dry out between irrigations. Monitor nutrient levels to prevent nutrient imbalances, particularly over-fertilisation. Do not

allow plants to be exposed to extreme high or low temperatures which further add to plant stress levels.

**Growing Media pH:** BRR grows best (and is most harmful to plants) at a high growing pH, 6.2 and above. Adjusting the pH to 5.5 can reduce the impact of the pathogen. Growing media blends that drain well are desirable, as the pathogen is also favoured by saturated growing media conditions.

**Appropriate Irrigation:** Ensure that water splash is minimised to decrease spore dispersal. Also, irrigate plants thoroughly and less frequently to prevent saturated growing media. Other simple measures, such as not dropping hoses onto the ground, also help to keep BRR out of the crop.

**Fungicide Management:** It is important to remember that plants already infected with BRR cannot be cured and at best a fungicide will suppress the infection for a time. If BRR is suspected, get a professional diagnosis and start addressing the problem as soon as possible. There are some fungicides that have been shown to be effective against BRR, however they must be applied preventatively or at first detection of the disease for maximum effect. Fungicides can not compensate for poor sanitation or environmental controls. Fungicide control alone will not stop the disease, so if necessary, use in combination with the cultural practices listed above.

**Fungicides:** The number of fungicides registered to specifically control BRR are limited. The active ingredients in Banrot 400WP and Banrot 80G are a combination of THIOPHANATE-METHYL and ETRIDIAZOLE, being broad spectrum systemic fungicides which can provide protection for up to 8 weeks. Although Banrot 400WP can be used as a growing media drench anytime throughout the crop cycle, it is especially important to apply at the time of initial planting. Banrot 80G (Granules) is applied directly into the growing medium as a pre-plant growing media-mix additive functioning as a preventative or as a post-plant broadcast treatment.

Both formulations have been tested and shown to be safe on a wide range of plants when used as directed. However, it is not practical to test all plant types and varieties that may be treated with Banrot therefore when other plants not listed are being treated, a small test should be conducted first before treating large areas or plant numbers. Over-dosing may result in toxicity to sensitive plants.

Research continues overseas and more fungicides may become available over time. For an updated list of available fungicides that may be right for your particular situation, check the APVMA website. Greenlife Industry Australia manages the Minor Use Permit (MUP) program on behalf of the nursery industry and has acquired MUP's for use in nursery stock. See MUPs listed at: <https://nurseryproductionfms.com.au>

## FURTHER INFORMATION

To purchase or view the latest edition of the NIASA BMP Guidelines: <http://nurseryproductionfms.com.au/product-category/niasa>

To purchase or view the latest edition of the BioSecure HACCP Guidelines: <https://nurseryproductionfms.com.au/biosecure-haccp-certification>

Hints for Diagnosing Diseases: <https://pestid.com.au/disease>

Integrated Pest Management Information: <http://nurseryproductionfms.com.au>

Use the Australian Pesticides and Veterinary Medicines Authority's (APVMA) website to search for registered chemical products (PubCRIS): <https://apvma.gov.au>

Minor Use Permits for pesticides: <https://nurseryproductionfms.com.au/minor-use-permits-mups-for-pesticides>

PAST EDITIONS OF NURSERY PAPERS ARE AVAILABLE ONLINE on the Greenlife Industry Australia website: [https://www.greenlifeindustry.com.au/Section?Action=View&Section\\_id=46](https://www.greenlifeindustry.com.au/Section?Action=View&Section_id=46)