Managing *Pythium* and *Phytopythium* in Production Nurseries

Pythium *and* Phytopythium *are both part of a group of organisms commonly known as water moulds. They are both well known for their ability to cause damping-off during seedling production and root rot of nursery plants. Water moulds are not true fungi even though they have some fungus-like characteristics. Growing conditions in nurseries, where plants are young, richly fertilised, and often overwatered, are ideal for the development of* Pythium *and* Phytopythium. *While there are fungicides that can reduce the inoculum load of these pathogens, they are unlikely to eradicate them. Seedlings may appear to recover from an early infection, but the pathogen will still be present and may continue to infect root tips, reducing vigour and perhaps cause plant death. The most effective line of defence in a nursery is therefore to prevent the introduction and spread of these pathogens through the use of strict hygiene practices. This factsheet will cover information on how to recognise, diagnose and manage these pathogens in Australian production nurseries. It also provides a brief explanation on the relationship between* Phytopythium *(a relatively new genus) and the closely related groups* Pythium *and* Phytophthora.

Pythium root rot of parsley; the infected plant is on the left and healthy plant on the right.

INTRODUCTION

There are many species of *Pythium* and *Phytopythium*, but not all are plant pathogens. Most species are saprobes that decompose organic matter and recycle nutrients, a few are even beneficial having been used as biological control agents of plant pathogens (e.g. *Pythium oligandrum*). A number of species are primary plant pathogens that can sometimes be very aggressive. Some of the pathogenic species have a wide host range while others are more specific to particular plant species or groups of plants. Furthermore, *Pythium* can interact with other pathogens to cause disease or can be present as an opportunistic secondary invader. Distinguishing between situations in which they are acting as a saprobe and pathogen can be difficult and it is therefore recommended to use the services of a plant disease diagnostic laboratory.

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PRIMARY VS SECONDARY PATHOGENS

Sick plants may have symptoms across many parts. For example, plants with root and crown rot may also have leaf spots and tip dieback. It is often helpful to distinguish between the organisms causing disease and those that are not. The **primary pathogen** is the organism that has caused damage to the plant that has resulted in disease symptoms. **Secondary pathogens** colonise the tissue after damage has occurred from the primary pathogen and may cause further damage. **Saprobes** also arrive after primary pathogens but they only grow on dead and decaying tissue, they do not cause further damage to plants. As many pathogens can also exist as saprobes in certain circumstances, it is often difficult to distinguish between secondary pathogens and saprobes. Diagnostic laboratories use their test results, symptom development and host range to distinguish between primary pathogens, secondary pathogens and saprobes.

Poinsettias with *Botrytis* stem rot and *Phytopythium* root rot resulting in plant decline and death.

PYTHIUM

Over 120 species of *Pythium* have been identified as plant pathogens that can cause damping-off, seed decay, cutting and stem rot and sometimes even leaf blight. Germinating seeds are particularly susceptible to *Pythium* where serious losses may occur causing widespread plant death. Three of the more commonly isolated *Pythium* species detected in a wide range of Australian nursery crops include *P. dissotocum*, *P. myriotylum* and *P. irregulare*. Most *Pythium* species are more active at temperatures below 25°C, but exceptions apply.

PHYTOPYTHIUM

Until recently, species of *Phytopythium* were included in *Pythium*. They were split from *Pythium* because aspects of their biology were found to be quite distinct. They are viewed something of a hybrid between *Pythium* and *Phytophthora*, hence their name. Genetic analyses also showed that they were significantly different from *Pythium* and *Phytophthora*. To date, more than 20 species have been placed in *Phytopythium*, most of which are saprobes. However, there are pathogenic species that can cause significant economic losses to nursery crops and even some woody shrubs and trees. The most common of these are *Pp. littorale* (root rot of strawberry), *Pp. helicoides* (root and stem rot of many plants including rhododendron, Kalankoe, begonia, citrus, kiwifruit and strawberry), and *Pp. vexans* (root rot of many woody plants including kiwifruit and avocado). *Phytopythium* biology can be distinguished from *Pythium* by having higher temperature requirements for growth and infection. These organisms develop and are more aggressive pathogens at temperatures over 25°C, making them more of a problem in warmer climates.

Dieback caused by *Phytopythium* on Rosemary.

SYMPTOMS

It is impossible to distinguish between plants infected with *Pythium* and *Phytopythium* by examining the symptoms. As such they are treated together in this section. *Pythium* and *Phytopythium* infections are generally restricted to young tissue rich in carbohydrates. This is present in young roots and stems of seedlings and in feeder roots of older plants. They are a common cause of pre-and post-emergent damping-off in seedlings and dieback of older plants. With pre-emergent damping-off, seed fails to germinate or the radicle is attacked as it emerges. Post-emergent damping-off refers to the collapse of seedlings resulting from an attack at the soil line or from an infection that starts at the root tip and moves up the root. In some instances, roots may be heavily infected with *Pythium* and cause severe lack of vigour and nutrient deficiency symptoms without producing obvious root rot symptoms, i.e. they may appear relatively healthy or only slightly off colour. This is relatively common in parsley crops. Rarely, *Pythium* can cause a foliar blight or stem rot, similar to *Phytophthora*.

Plants that survive an early infection or older plants with feeder root infections may become stunted with yellowing of leaves or nutrient deficiency symptoms. This is because the plants cannot take up enough water and nutrients through their damaged root systems. These water moulds can also cause a progressive soft decay of cuttings.

Under wet, humid conditions, *Pythium* often forms a smothering mycelial mat over seedlings. In older plants the *Pythium* and *Phytopythium* are limited to rootlet invasion resulting in the loss of fine roots and root hairs (often referred to as root nibbling), this is particularly true of *Pp. vexans* infections. These roots often appear water-soaked and the root cortical tissue will often easily slough off, leaving a white strand of vascular tissue (the stele).

IDENTIFICATION

Accurate diagnosis is essential as *Pythium* and *Phytopythium* root rot symptoms can look the same as root rots caused by other pathogens such as *Phytophthora*, *Rhizoctonia*, *Chalara*, *Calonectria* (previously *Cylindrocladium*), Fusarium and others. It is therefore recommended to send samples to a diagnostic lab for an accurate identification of the primary pathogen(s) responsible for disease symptoms.

Management and control of the disease will differ depending on the pathogen or cause of disease. In the vast majority of cases knowing the genus (i.e. *Pythium*/*Phytopythium*) is

Pythium root rot on Westringia (top) and *Homalonema* (below). Note healthy roots only at the top of the westringia indicates that anoxia may be interacting with *Pythium* to produce root rot symptoms.

sufficient to guide remedial actions, but there may be some instances where DNA sequence ID to species level may be needed to determine if the isolate is a known pathogen of the specific crop. Most state governments provide a plant disease diagnostic service for their local agricultural industries (Grow Help QLD, DPI NSW, Agriculture Victoria, Biosecurity Tasmania, DDLS WA, NT Government, PIRSA). In addition, all commercial production nurseries throughout Australia receive six free samples per year from Grow Help until the end of 2025 and much reduced fees for additional samples submitted in the same year. This service is funded by a Hort. Innovation, nursery levy and Queensland Government funded project. When sending samples for a suspect *Pythium* or *Phytopythium* infection we recommend submitting whole plants in growing media. Do not treat plants with fungicides for two weeks prior to submission; fungicides can reduce the ability of tests to detect pathogens (though symptoms can still develop). Refer to your diagnostic provider for additional guidelines on submitting samples.

LIFE CYCLE

In the absence of a suitable host *Pythium* and *Phytopythium* can survive in the soil as thick walled, resistant resting spores (oospores and chlamydospores) for decades. These resting structures become activated by the presence of water and a food base such as the chemical exudate from a germinating seed or a plant root. The water mould then enters a sustained period of pathogenic development. This involves the production of numerous minute swimming spores (zoospores) that can actively swim in water and water films through soil and over surfaces towards roots that they can infect. The disease is thus more severe during an extended period of high soil moisture, or in hydroponic growing systems, as zoospores move more easily through the available water to infect healthy plant tissue. As nutrients from the infected plant become depleted, or as the soil starts to dry, the pathogen returns to the resting stage. The cycle continues when favourable wet conditions for infection return.

SPREAD

These pathogens spread throughout a nursery via the movement of infested soil, growing media, infested plant fragments, infested tools and equipment and contaminated water.

Long lived resting spores can be released from decaying plant material and can contaminate most parts of a nursery including benches, floors, flats and pots, equipment, and footwear. When plants are set close together and the humidity is high *Pythium* and *Phytopythium* can spread as mycelium fragments and form a smothering mat. Fungus gnats and shore flies that feed on roots provide a site of entry for the water mould and can spread spores between plants or trays. In addition, some *Pythium* and *Phytopythium* species can be aerially dispersed with dust.

Swimming spores are dispersed by surface water, run-off of water from infected areas, splashing water and in contaminated irrigation water. These motile spores may be present in dam and reservoir water and spread throughout the nursery when water is used that is not disinfested (or insufficiently disinfested).

Pythium root rot of poinsettia wilting next to healthy plants. Photo by Emma Lookabaugh, bugwood.org

DISEASE MANAGEMENT

Once a plant is infected with *Pythium* or *Phytopythium* it cannot be cured. While fungicide treatment will suppress or reduce disease (i.e. the symptoms), the pathogen will likely still be present in plant tissue and in the growing media. If the plant is sold it will spread the pathogen. It is therefore recommended to only sell plants that are healthy and free of plant pathogens. Fungicides in the nursery situation should only be used to protect healthy plants from becoming infected (refer to the factsheet and webinar on sustainable fungicide use in production nurseries).

The best management for these diseases is to keep them out of the nursery and this is achieved with the following strict hygiene practices.

- Water management is critical
  - Improve drainage of plants and do not over water.
  - Avoid water pooling between pots.
  - Excess water also creates ideal conditions for fungus gnats and shore flies which are effective vectors of the pathogen.
  - Ensure irrigation water is free from pathogens, i.e. that the water is appropriately disinfested or otherwise clean (town water). Refer to the factsheet comparing water disinfestation systems and numerous resources available on the Australian Plant Production Standard website).
- Ensure growing media parameters are optimal for plant growth, e.g. pH, air-filled porosity etc.
  - Do not over-fertilize or apply excessive nitrogen. High nitrogen levels suppress natural defence systems in plants.
  - Accumulation of salts in the growing medium can damage roots and make it easier for the pathogen to infect and cause disease. Similarly, low oxygen environments can damage plant roots favouring disease development if the pathogen is present.
- Disinfect benches, tools, equipment and growing areas between crops to help break the lifecycle of a wide range of pathogens.
- If you reuse flats/pots disinfest appropriately. Ensure that all organic matter is removed prior to disinfestation and use heat 60°C for 30 minutes. Use of chlorine is not recommended as any infested organic matter that remains in the pot (e.g. root fragments and growing media) is unlikely to be disinfested.
- Take cuttings from healthy, vigorous, disease-free stock. Ensure foliage and stems are dry when taken and as far as practical above the soil line. Refer to the factsheets on high health grafting and budding and preventing diseases in propagation areas for more information.
- Ensure seed is healthy and free of pathogens
- Manage and store growing media optimally.
  - Cover growing media to stop contamination with organic matter and weed seed.
  - Store on concrete that prevents contamination from soil and water pooling.
  - Use sterilised or pasteurised soil, perhaps augmented with beneficial microbes.

If you have had an infestation diagnosed in which *Pythium* or *Phytopythium* are considered **primary pathogens** the following remedial actions are recommended:

- Ensure that water disinfestation system is functioning optimally. This is particularly important if water is recycled.
- Put in place other preventative actions above.
- For damping-off symptoms in trays and flats, dispose of entire trays ensuring that the leading edge is disposed. Even small amounts of mycelium that remain in the growing area can spread to healthy plants.
- For consignments of container stock that have a low level of infestation:
  - Remove all containers with symptoms
  - Apply an appropriate fungicide on remaining plants to protect healthy plants. Note that it is not recommended to apply sequential applications to healthy stock. See minor use permits available against *Pythium*.
  - Hold remaining plants in an area away from other stock plants for a period of 2–4 weeks (ideally) to ensure symptoms do not develop in plants that are thought to be healthy.
- For consignments with a high level of infestation (i.e. a high percentage of plants are infested), consider discarding the entire consignment.
- Manage discarded plants appropriately. Dispose by deep burial.
- Do not add plants with disease symptoms to a compost heap. This will increase the inoculum load of the pathogen in the nursery.

Pythium root rot of seedling impatiens. Photo by the Department of Plant Pathology Archive, North Carolina State University, bugwood.org.

Where an infestation is suspected to be secondary to a non-pathogenic factor it is recommended to hold plants in a 'quarantine area' to prevent spread to healthy stock; the organism could be a primary pathogen to other stock lines. Provide optimal growing conditions as per the recommendations to prevent *Pythium*. Evaluate plant health to ensure that symptom development has ceased after the suspected causal factor was removed. It is recommended to sell healthy plants only.

ADDITIONAL RESOURCES:

Comparison of water disinfestation systems

Disinfesting growing areas

Fungicides, resistance and their management in production nurseries

Growing media nursery paper

Managing Disease transmission into Production Nurseries fact sheet

Preventing diseases in production nursery propagation areas fact sheet

Soil borne diseases management plan

This factsheet was updated by Sarah Dodd and Andrew Manners (Queensland Government Department of Agriculture and Fisheries – DAF) as part of the Hort Innovation, Nursery Levy and DAF funded project Resourcing, supporting, and assessing biosecurity in nursery production (NY20000) in 2021. It was originally written in 2014 as part of NY11001.