Nursery levy at work: **Nursery Production Plant Health & Biosecurity Project**

# Pythium species

## A constant threat to nursery production

### Background

*Pythium* species, which are commonly referred to as water moulds, are well known for their ability to cause damping-off during seedling production. Water moulds also include the genera *Phytophthora* and *Aphanomyces* and are not true fungi, though have some fungus-like characteristics. Seedlings are extremely susceptible to *Pythium*, and where environmental conditions are favourable, the potential for serious losses is constant. Nursery hygiene measures provide the most fundamental line of defence against the introduction and spread of *Pythium*. Several species of *Pythium* can cause damping-off, seed decay, cutting and stem rot, as well as top (aerial) rot. In recent years, certain *Pythium* species have also been shown to be responsible for death of established plant species, e.g. blueberries.

### Introduction

There are many species of *Pythium*, not all are plant pathogens. Most species are saprophytes that decompose organic matter and recycle nutrients, a few are beneficial as biological control agents, while some are plant pathogens (these are also saprophytes and opportunistic invaders). Some of the pathogenic species have a wide host range while others have a limited host range.

**Fig. 1.** *Pythium* root rot of seedling impatiens. Photo by the Department of Plant Pathology Archive, North Carolina State University, bugwood.org.

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Growing conditions in nurseries, where plants are young, richly fertilised and often overwatered, are ideal for the development of *Pythium* spp. Losses from *Pythium* are not confined to the nursery. The pathogen is present in most cropping systems in the field where it attacks young plant tissue such as root tips. They nibble away at the roots and reduce vigour and yield potential of the crop, but rarely cause mortality. For example in pineapple fields they are reported to reduce yields by some eight percent in an exceptionally wet year and one percent in a normal season. In a nursery situation seedlings may recover from an early infection but once planted in the field the pathogen will still be present and will continue to infect root tips in older plants.

## Recognition and Detection

Accurate diagnosis is essential as *Pythium* root rot is often confused with root rots caused by fungi such as *Phytophthora*, *Rhizoctonia*, *Chalara*, *Cylindrocladium*, *Fusarium* and *Aphanomyces*. Identifying which species of *Pythium* is present is also important as they vary in their host range and temperature requirements.

The mycelium growing on roots is very fine and colourless and does not hold soil particles as *Rhizoctonia* does. It may be difficult to see with a hand lens. Diagnosis ideally requires microscope examination and isolation from infected tissue onto

### Key facts

- *Pythium* spp. are water moulds, present in most cultivated soils. Growing conditions in nurseries are often ideal their development.
- Not all species are plant pathogens.
- They can survive in soil and plant debris for many years.
- They can attack all plant parts but generally immature tissue such as root tips. They rarely cause mortality in older plants.
- Managing disease requires an integrated disease management approach.
- They can spread in irrigation water, contaminated soil, equipment and footwear. Spread can occur by moving infected plants. Some species can be aerially dispersed with dust.
- Cleanliness in the entire nursery and training of staff is essential.
- Symptoms appear virtually identical to many root diseases, including *Phytophthora*, *Cylindrocladium*, *Fusarium*, *Rhizoctonia* and others.
- Improve drainage of growing medium, do not overwater or apply excessive fertilizer.
- Fungicides are most effective when used as protectants.
- Fungicides applied after infection rarely are curative and disease will reoccur after plants leave the nursery.

**Fig. 2.** *Pythium* root rot of *Homalonema* (left) and westringia (right). Note healthy roots only at the top of the westringia indicates that anoxia may be interacting with *Pythium* to produce root rot symptoms.

selective artificial media (such media which reduces growth of true fungi and allows water moulds to grow and be isolated more readily). When examined under the microscope the fine vegetative threads of *Pythium* will be seen to be without cross walls (septa). Also thick-walled oospores will be clearly visible in infected root cells.

Rapid serological-based field kits are available for the detection of *Pythium*. However, it is important to remember that the presence of *Pythium* does not necessarily indicate that it is the primary cause of symptoms. *Pythium* often infects dead and decaying plant tissue following infection by other pathogens, e.g. *Phytophthora* or *Chalara*. Therefore, plants should still be sent to a devoted diagnostic laboratory even after a positive result from field based kits.

## Life Cycle

In the absence of a suitable host *Pythium* survives in the soil in a state of rest. It survives by producing long-lived resting spores (oospores and chlamydospores) or as mycelial fragments. These resting structures become activated by the presence of water and a food base (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 sporangia which release many minute swimming spores (zoospores). The disease is thus more severe during an extended period of high soil moisture, or in hydroponic growing systems, as zoospores

**Fig. 3.** *Pythium* root rot of parsley (above) and watermelon seedlings (below). In both cases, the infected plant is on the left and healthy plant on the right. Watermelon photo by Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

move through the 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 conditions for infection return.

## Symptoms

*Pythium* invasion is 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 (Fig. 1-4). It is a common cause of pre-and post-emergent damping-off in seedlings (Fig. 1 and 5). With pre-emergent damping-off, seed fail 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 to the soil line.

Plants that survive an early infection may become stunted with yellowing of leaves (Fig. 4). This is because the seedling cannot take up enough water and nutrients through its damaged root system. The water mould can also cause a progressive soft decay of cuttings.

Under wet, humid conditions, *Pythium* often forms a smothering mycelial mat over seedlings (Fig. 5). In older plants the pathogen is limited to rootlet invasion resulting in the loss of fine roots and root hairs (often referred to as root nibbling). Examination of the roots of an affected plant will reveal that the cortical tissue sloughs off leaving a white strand of vascular tissue (stele).

## Spread

To understand the ability of *Pythium* to cause disease we need to know how zoospores, chlamydospores, oospores, and mycelial fragments are disseminated. *Pythium* does not have an airborne phase; spread depends on scattering infested soil and plant fragments and dispersal in contaminated water.

Zoospores are dispersed by surface water, run-off of water from infected areas, splashing water and in irrigation water. These motile spores may form in standing water in dams and reservoirs and spread by using such infested water in the nursery.

Chlamydospores and oospores are released from decaying plant material and can contaminate most parts of a nursery including benches, floors, flats and pots, equipment and footwear. Spread is also aided by movement of infested soil. When plants are set close together and the humidity is high *Pythium* can spread as mycelium and form a smothering mat. Fungus gnats and shore flies will feed on roots and provide a site of entry for *Pythium* and may spread *Pythium* between plants or trays. In addition, some *Pythium* species can be aerially dispersed with dust.

**Fig. 4.** *Pythium* root rot of poinsettia showing root symptoms (above) and wilting plants next to healthy plants (below). Photos by Emma Lookabaugh, bugwood.org

## Disease Management

A strict hygiene system to exclude the pathogen from the nursery is essential. This involves using pathogen-free potting mix, pathogen-free propagating material and sound cultural practices. These cultural practices must include an effective disease control program. Pythium diseases are difficult to manage after root infection has occurred.

- Grow seedlings in soil-less potting mix or in sterilised or pasteurised soil.
- Promptly dispose of *Pythium* infected plants and do not carry over old nursery stock.
- Water management is important - improve drainage and do not over water. Avoid overhead irrigation where aerial *Pythium* is a problem. Excess water also creates ideal conditions for fungus gnats and shore flies which are effective vectors of the pathogen.
- Do not over-fertilize or apply excessive nitrogen. High nitrogen levels suppress natural defence systems in plants. Accumulation of salts in the growing medium will damage roots and make it easier for Pythium to infect.
- Ensure irrigation water is free from Pythium.
- Disinfect flats and pots which are to be reused.
- Take cuttings when plants are dry and as far as practical above the soil line.
- Fungicides are best used as preventatives or as a spot treatment to confine a limited disease outbreak. If applied after infection has occurred, fungicides rarely function as a curative treatment and the disease will reappear once plants leave the nursery. Accurate diagnosis of the disease is essential when using fungicides. Chemicals which control soil-borne diseases caused by fungi may not be effective against a disease caused by a water mould.

## Biosecurity

Nursery crops should be regularly monitored for wilted or chlorotic seedlings. As it can be difficult to accurately diagnose *Pythium* root rot, representative plant samples should be sent to a reputable plant diagnostic laboratory. As *Pythium* species vary in their host range and temperature requirements, it may be necessary for disease management to identify the *Pythium* species involved in the disease outbreak.

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**Fig. 5.** Damping off of seedlings caused by *Pythium*.