ROOT DISEASE

FACT SHEET

GRDC Grains Research & Development Corporation

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Pythium root rot

The impact of Pythium can be felt throughout the growing season, not just at crop emergence, resulting in yield reductions in cereal, brassica and pulse crops and in pastures. Research has now identified that crop rotation can have a big influence on the pathogen and disease expression.

KEY POINTS

- The root pathogen Pythium is widely spread across cropping soils and is more prevalent in areas with an annual rainfall above 350mm.
- Incidence is greater in acid-neutral soils with higher levels of organic matter and under reduced tillage systems.
- All major grain crops and pastures in Australia host Pythium, reducing productivity directly or in combination with other common root diseases.
- Rotations can be used to manage soil-borne inoculum levels and disease.
- Integrated management using targeted rotations and disease suppressive treatments provides longer-term control and yield benefits.
- Often misdiagnosed as other cereal root diseases

Damage from Pythium often goes unnoticed as it can be uniformly spread in the paddock. In trials, canola treated with a Pythium-selective seed dressing (right) yielded up to 35 per cent more than untreated seed (left) with only partial disease control.

Pythium causes seedling damping-off and root rot and has been found to be widely spread across cropping soils, generally being more prevalent in the areas with annual rainfall greater than 350mm. Disease incidence tends to be greater in reduced tillage systems in higher organic matter soils with acidic-neutral rather than alkaline pH.

In the field Pythium is frequently misdiagnosed as Rhizoctonia.

New research has found that high rainfall or cold waterlogged soils are not a prerequisite for Pythium infection. High incidences of root rot were recorded in periods of drought, conditions not previously considered conducive to development of Pythium diseases.

Traditionally, Pythium has been considered a ‘damping-off’ disease of seedlings. However, its ability to re-infect continually throughout the growing season and cause root rot has been found to reduce crop production significantly, often in the absence of damping-off symptoms.

Crop species, and to a lesser extent varieties, show significant differences in their susceptibility to damage by Pythium and in their ability to ‘carry over’ inoculum. This makes crop rotation an important control method. In future, variety-based information on Pythium suppression will be available.

While at least eight species of Pythium have been identified under rotations including canola, cereals and pulses, *Pythium irregulare* and its close relatives were found to be the dominant species. The balance of the species was found to change under different crop rotations.

In trials carried out in four states over four years using a Pythium-selective seed dressing at greater concentrations than commercial products, yield increases of two to 12 per cent were recorded in cereals, five to 25 per cent in canola and five to 35 per cent in pulses.

These yield improvements were achieved with only partial disease control. Chemicals, on average, decrease soil inoculum and root infection by only 25 per cent. The scale of the response depended on the season and previous cropping history, but if left untreated demonstrated the type of losses Pythium can cause.

Identification

Infection

- All major crop and pasture species grown across Australia can host and be infected by Pythium.
- The plant parasite infects germinating seeds, root tips and strips away fine rootlets and root hairs.
- Pythium species survive in soils as thick-walled spores, remaining dormant during dry periods and in the absence of a plant host.
- Chemicals released from germinating seeds and emerging roots trigger Pythium to grow and attract it to the host, infection occurred as early as 24 to 48 hours after sowing into moist soil.
- Pythium grows rapidly, producing large numbers of spores on growing plant tissues and on fresh plant material added to soil, such as stubble and weeds killed by herbicides or tillage.
- These spores enable Pythium to re-infect growing roots rapidly and continuously.
- Consequently, crops can experience repeated 'waves' of Pythium infection throughout the growing season. This contrasts to the slower inoculum build-up attributed to other fungal root diseases such as take-all and Rhizoctonia.
- The weakened plant is then more vulnerable to infection by these other fungal pathogens.
- Plants may recover from early infection, especially where nutrition is adequate, but slowing plant development results in crop yield potential being significantly reduced.

PHOTO: CSIRO

Above-ground symptoms are generally nonspecific as all plants may fail to thrive. Therefore It is only when direct comparisons are made between untreated (left) and treated (right) plants that the effects of low to moderate Pythium incidence are noted.

Symptoms

Seedling damping-off, failure to thrive and yield decline are all symptoms or potential results from Pythium infection. Infected seedlings appear spindly and stunted, and in cereals the first true leaf is often short, twisted and cupped.

Pythium is often distributed relatively evenly in soils. This means that in the absence of a protective treatment all plants are affected by Pythium to a similar extent and that unless severe, infection goes undetected.

Consequently, diagnosis of Pythium root rot based on above-ground symptoms is difficult and when the disease is moderate to severe, is often misdiagnosed as Rhizoctonia damage. The effects of Pythium root rot are therefore often underestimated.

Pythium-infected root systems appear stunted with few lateral roots. They show soft, yellow to light brown colouration in infected areas especially near the tips. Finer 'feeder roots' are often lost, the outer layers rotting away and exposing the central vascular tissues to give the appearance of Rhizoctonia-like 'spear points'.

Cereals are less susceptible to Pythium than canola and grain legumes. However, Pythium has been found to contribute to yield decline in continuous cereal systems. Significant increases in Pythium inoculum and root infection were observed with consecutive wheat and barley crops compared with these cereals grown in rotation with pulses.

Pythium populations appear to rapidly adapt to crops and vary in abundance depending on crop rotation. Increased damage has been recorded in less diverse rotations, for example repetitive canola-wheat, long-term pastures or where the same crop is grown repeatedly.

Testing

It is important to know which root diseases are present in a paddock's soil and the overall levels of inoculum. This will assist with decisions on when to use disease-suppressive chemicals and inoculants to achieve maximum effect against Pythium.

Pre-sowing DNA soil tests are available for other common root pathogens, including Rhizoctonia, take-all and Fusarium. A parallel test for Pythium species is in the final stages of development by SA Research and Development Institute and CSIRO.

PHOTO: CSIRO

Below ground symptoms – carefully extracted and washed roots infected with Pythium show browning, evidence of root loss and rotting of the outer layers to give Rhizoctonia-like spear points.

Management

Advances in knowledge and understanding of Pythium, and in chemical and disease suppressive biological products (inoculants) are providing growers with the tools to manage Pythium. Crop rotations offer a method of minimising inoculum build-up, while fungicides and inoculants provide protection for germinating seed and the growing crop.

Agronomy

Sowing undamaged, robust seeds at the correct depth and with adequate nutrition are fundamental agronomy practices for healthy plant growth. The value of using fresh (i.e. previous season's seed) is particularly important for limiting the effects of Pythium damage. As the seed ages cells die, reducing seedling vigour and increasing susceptibility to pathogen attack. In addition, when planted in soil the dead seed cells act as attractants and readily accessible nutrients for Pythium. Placement of fertiliser in close proximity to the germinating seed is also important, as roots damaged by Pythium have fewer laterals and hairs to access the nutrients.

Rotations

Pythium is found in all Australia's crop environments and all crop and pasture species are susceptible to infection. Generally, such a wide host range suggests that crop rotations will not result in disease control. However, research has shown that crop choice and frequency play a pivotal role in the build-up and decline of Pythium inoculum. Grain and pasture legumes and canola crops have been found to support larger populations of Pythium than cereals, with barley being the least susceptible (Figure 1).

Disease incidence was found to be significantly greater after long-term pastures (legumes or mixed) and in less diverse rotations. For example, in a repetitive canola-wheat rotation, Pythium inoculum levels reduced under the wheat phase but this decline was smaller than the inoculum increase under the canola. Consequently, year-on-year inoculum levels were rising.

In a more diverse rotation, especially those that included two non-consecutive cereals, the increase in soil inoculum and root infection across the rotation was lower (Figure 1). Differences in the rate of inoculum change at these two sites relate to the types of Pythium species present and the varieties grown. Despite the contrasting soil pH and rainfall between the sites, the effects on Pythium levels were very similar, indicating that crop type was driving these changes.

Chemical control

Extensive field trials using a Pythium-selective seed dressing resulted in yield increases, especially in canola and pulses. These yield increases generally occurred in the absence of any improved crop emergence and with only partial (25 per cent reduction) in Pythium. Pythium-selective chemicals were more effective in the higher-diversity rotations, probably being related to the lower overall inoculum levels and disease pressures.

Due to their relatively short window of activity (four to eight weeks), chemical seed treatments do not protect against on-going Pythium root attack. The pathogen's ability to rapidly produce large numbers of infective spores means that Pythium numbers can quickly recover as the season progresses. Based on this, yield benefits achieved with chemical seed dressings are primarily associated with improved seedling vigour and early crop growth. More effective, sustained disease control throughout the growing season can lead to further improvements in grain yields.

Potential new products

Researchers are in the process of commercialising microbial inoculants as seed dressings and in-furrow treatments to suppress Pythium and other root diseases such as Rhizoctonia. At least one inoculant has been found to be as effective as a registered chemical seed dressing at reducing root infection by Pythium (Figure 2a). At some trials sites the use of this inoculant resulted in a significant increase in grain yields (Figure 2b).

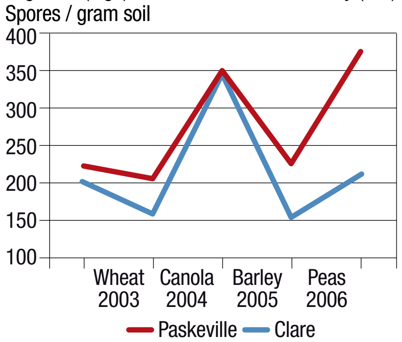
While both disease-suppressive treatments reduced Pythium incidence to the same extent eight weeks after emergence, only the inoculant significantly increased yield. This implies that the inoculant is providing extended disease protection during the season, because of its close persistence and association with the growing plant. Using a combination of the biological and chemical as an integrated treatment further reduced Pythium disease incidence and increased wheat yields.

Integrated management

Genetic studies of Pythium communities have shown that once fully developed, integrated Pythium disease management strategies are likely to be effective for extended periods.

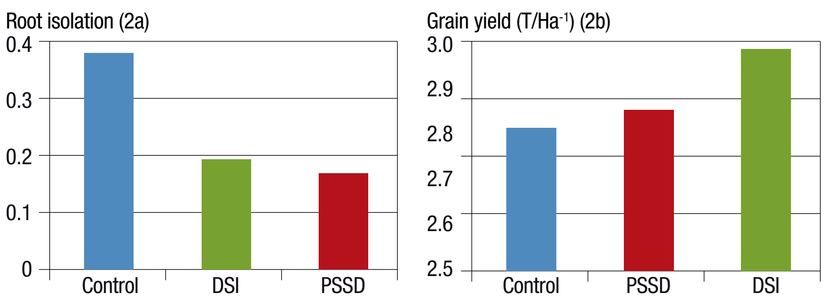
FIGURE 1 Changes in Pythium inoculum by rotation crop at two sites.

Legumes (high)→Canola→Wheat→Barley (low)



SOURCE: CSIRO, *Managing soil microbes for grains industry*

FIGURE 2 Changes in Pythium root infection and yield in wheat treated with an in-furrow disease-suppressive inoculant (DSI) or a Pythium-suppressive seed dressing (PSSD).



Registration of these products is currently being explored.
SOURCE: CSIRO, *Managing soil microbes for grains industry*

PHOTO: CSIRO

The damage in this barley crop is caused by Pythium. When the Pythium disease is moderate to severe it is often misdiagnosed as Rhizoctonia damage.

Frequently asked questions

What are the symptoms of Pythium infection?
Crops experiencing reduced early vigour and consecutive yield declines, even in the absence of obvious above-ground symptoms, are likely to be suffering Pythium root rot. When disease is moderate to severe, crop symptoms include patches of very poor growth that are often misdiagnosed as Rhizoctonia. Pythium-infected root systems show yellow to light brown discolouration and appear stunted with few lateral and fine feeder roots. As the infection progresses the softer outer root layers rot away, exposing the central core and appearing as Rhizoctonia-like 'spear points'.

If all crops are susceptible, how can rotation be used to manage Pythium?
Crop species and in some cases varieties show significant differences in their susceptibilities to infection by Pythium and their capacities to build-up and 'carry over' soil-borne inoculum. As the total inoculum levels change in response to crop rotation, the genetic make-up of pathogen populations also shifts. Pythium populations consist of a complex of crop-adapted variants that vary in abundance depending on the rotation sequence.

What are the most effective rotation strategies?
Where feasible, a diverse crop rotation should be used to manage Pythium root rot. Less diverse cropping rotations such as repetitive wheat-canola are at significantly higher disease risk than more diverse three-to-four-year rotation cycles. In trials, rotations with a four-year cycle that included two cereal phases (wheat and barley) had the lowest incidence of Pythium root rot.

As cereals are the least susceptible, can I manage Pythium with consecutive cereal crops?
Continuous cereal cropping needs to be considered with caution, as Pythium contributes to yield declines reported in repetitive wheat cropping. Significant increases in Pythium inoculum and root infection were observed when growing consecutive cereals, compared with growing in rotation. This strategy will also increase the risk of Pythium interacting with other cereal root diseases (Rhizoctonia, take-all), thereby increasing severity.

Are pre-sowing soil testing options available for Pythium?
DNA-based quantitative diagnostic tests for key pathogenic Pythium species are in the final stages of development by SARDI and CSIRO. Non-quantitative, enzyme-linked assays are available to indicate the presence of Pythium in soils. Research is being carried out to improve interpretive capability of the diagnostics. This will assist decision making to better target rotation sequences and integrate chemical and biological crop protectants to suppress Pythium root disease complexes.

Useful resources:

- **Predicta B – www.sardi.sa.gov.au/products__and__services/entomology/diagnostic_service/predicta_b**
- **Crop Ute Guide series – various titles – Ground Cover Direct http://www.grdc.com.au/bookshop, free phone 1800 11 00 44, ground-cover-direct@canprint.com.au**
- **Pestgenie – search Pythium – www.pestgenie.com.au**

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