Limited increasing incidence of _Pythium_ root diseases could lift grain yields by at least 10–15 per cent, particularly in higher rainfall areas, according to recent paddock trial results.

Take-all disease (Gaeumannomyces graminis) and Rhizoctonia (bare patch) cause annual wheat yield losses of $30 million and $30 million respectively in southern Australia.

But the effects of the lesser known root disease _Pythium_ on cereal and legume crop productivity are often underestimated.

Research in Australia and overseas indicates that _Pythium_ species are an important component of root disease complexes and are responsible for declining crop yields across a range of environments.

_Pythium_ is fast growing and infects roots in their early growth stages. As a result, these damaged roots are more susceptible to infection by other pathogens and may increase the severity of other diseases such as take-all.

A collaborative project involving CSIRO Land and Water and Wesfarmers Landmark is developing an integrated management package using fungicide applications, crop rotation and tillage systems to achieve long-term sustainable control of _Pythium_.

**Poor crop growth**

_Pythium_ causes seedling damping-off, poor early growth and root rot in a wide range of cereal, legume and canola crops, which all lack genetic resistance to the disease.

_Pythium_ inoculum (mainly spores) can build up over phases of the crop rotation causing significant yield declines. Three main _Pythium_ species that limit crop growth in southern Australia are _P. irregulare_, _P. ultimum_ and _P. echinulatum_.

Its ability to carry-over reduces the effectiveness of legume and canola crops as disease breaks for subsequent cereal crops.

For example, recent reports from South Australia, New South Wales and Western Australia indicate incorporation of canola, as a bio-fumigant to control take-all and Rhizoctonia in following wheat crops, caused significant increases in _Pythium_ inoculum and root rot, leading to reduced wheat yields.

Information available from two field sites in SA and NSW showed that soil-borne _Pythium_ populations from the canola phase of the rotation were generally double those from the cereal phase, indicating canola may shift the microbial soil balance to favour increased numbers of _Pythium_ species.

In addition _Pythium_ may interact with residual take-all inoculum which survived the legume or canola phase, resulting in higher than expected levels of take-all in the following year’s cereal crop.

_Pythium_ root rots are likely to be more frequent and severe in higher rainfall areas (more than 350 millimetres annual rainfall) where environmental conditions are more suitable for disease development.

Areas incorporating cereal-legume cropping on land previously used for pastures are likely to be at high risk, as these soils often contain high levels of _Pythium_ inoculum and species which are highly pathogenic to cereal crops.

**Minimum tillage systems**

Research in Australia by CSIRO and in the United States by the US Department of Agriculture indicates there are generally higher levels of _Pythium_ inoculum under reduced tillage systems (see Figure 1).

This is associated with increased levels of soil moisture and organic matter (from retained crop residues and weed remnants killed before sowing) in relatively undisturbed direct-drill (reduced tillage) systems. These conditions are known to be more suitable for the growth and disease activity of _Pythium_.

If left unchecked, _Pythium_ root diseases may be a significant barrier to the continued adoption of conservation farming practices.

**At a glance**

- Research in Australia and overseas indicates the lesser known root disease _Pythium_ has a significant impact on cereal and legume crop productivity, particularly in higher rainfall areas.
- Recent paddock trials using a _Pythium_-selective fungicide increased crop yields by up to 38 per cent.
- Researchers are aiming to develop an integrated management package using fungicide applications, crop rotation and tillage systems to limit the incidence of _Pythium_.

![New research shows _Pythium_ root diseases can cause significant crop yield losses, particularly in higher rainfall areas.](Image 1)
Pythium populations

Previous CSIRO research using de-oxyribonucleic acid (DNA) tests showed soil populations of Pythium and take-all consisted of a mixture of different genetic types (genotypes) and that similar genotypes appeared to infect the same crop species preferentially.

For example, Pythium genotypes infecting wheat crops on different farms were found to be genetically similar to each other, while genotypes from different crops (for example, wheat and medic pasture) in adjacent paddocks were different.

By comparing different paddocks with the same cropping histories, the research showed similar shifts in the genetic make-up of Pythium and take-all populations. This implies that different crops may be selecting out host-adapted genotypes of these fungi from their broader soil populations.

Disease tests also showed that individual Pythium genotypes varied in their disease severity on different crop plants.

Some strains were highly damaging to wheat but only caused mild disease on medic, while other Pythium strains did not significantly damage wheat but caused severe disease on medic plants.

These tests provide supporting evidence that some Pythium strains are better adapted to infecting certain crop hosts and different crops select out genetically related host-adapted groups of Pythium from soils.

Genetic analysis of Pythium and take-all populations show there is limited dispersal of strains among different farms.

About 98% of Pythium and take-all strains analysed were restricted to individual locations. This has important implications for assessing long-term disease control methods (for example, crop rotation and fungicide applications) as there would be limited opportunities for the spread of host-adapted or fungicide-resistant strains between paddocks. It may be possible for farmers to manage Pythium diseases on an individual paddock basis.

Being able to detect and measure Pythium levels in cropping soils, combined with knowledge of what crops they are most likely to affect and how their populations will change in response to disease management, will help develop targeted crop rotations to minimise yield losses.

Trial results

Pythium mainly infects the fine feeder roots and root hairs of plants and has been shown to reduce nutrient uptake in annual crops significantly. Recent paddock research in southern Australia using Pythium-selective fungicides has shown significant yield increases in canola (5–38%), pulses (5–35%) and cereals (4–18%) across a range of climatic and soil conditions (see Figures 2 and 3).

Similarly, research in the US using a Pythium-selective fungicide in naturally infested soil produced 20–30% more wheat tillers and contained 30% more phosphorus in the leaves, boosting overall yields by 10–20%.

These sub-lethal Pythium infections clearly have significant effects on nutrition and overall yields but the disease may go unnoticed due to a lack of any seedling damping off.

The yield responses were achieved through seed coating with the fungicide, probably indicating the responses are obtained from better crop establishment and improved early vigour. But seed coating may not offer long-term protection against Pythium and may have potential resistance problems through reliance on a single fungicide.

Laboratory tests have been carried out to determine if Pythium populations showed resistance to the Pythium-selective fungicide. All the strains screened were highly susceptible and showed no resistance to the fungicide. But previous research has shown Pythium populations can rapidly develop resistance after repeated applications.

Researchers are aiming to develop a targeted fungicide application and crop selection package to achieve long-term Pythium control through the growing season and into the next rotation phase.

Future research

CSIRO Land and Water and Wesfarmers Landmark are currently seeking funding from the Grains Research and Development Corporation for a new four-year study aimed at managing Pythium root disease complexes in crop rotations.

The research will identify and measure the levels and effects of Pythium and take-all in cropping soils in higher rainfall areas (more than 350mm) of southern Australia.

Existing DNA markers will be used to determine how phases of the rotation cycle affect the abundance, distribution and disease severity of the fungi. Researchers also hope to gain a better understanding of the pathogenic interactions between root diseases.

This information can then be used to develop on-farm management practices to limit the incidence of severe root diseases in cereal, legume and canola crop rotations.

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For more information contact Paul Harvey, CSIRO Land and Water, by email on paul.harvey@csiro.au, phone (08) 8303 8589 or fax (08) 8303 8684.