Crop rotation could reduce Pythium root rot

Root pathogenic Pythium species are widely distributed throughout cropping soils in the mid- to high-rainfall areas (more than 350 millimetres), infecting all major grain crop and pasture species. This article details the results of recent CSIRO and Landmark research which could provide better management options for Pythium rootrots.

by Paul Harvey, CSIRO LAND AND WATER

CSIRO research shows crops differ significantly in their susceptibility to Pythium infection and their capacity to ‘carryover’ the disease to subsequent crops.

Lupin is the most susceptible, supporting high levels of the disease, followed by canola, peas, wheat and barley.

More importantly, individual crops appear to support particular strains of Pythium, causing the genetic make-up of the soil fungal population to change depending on the rotation.

The findings are good news for Pythium control as they offer the possibility of using crop rotation to improve management of Pythium rootrots.

Fungus widespread

Pythium root disease has been described as the ‘common cold’ of cropping systems because the fungus occurs widely but is rarely considered a severe threat to productivity.

As a result, Pythium’s impact on the productivity of crop rotations often has been underestimated or overlooked completely.

Pythium can impact on crop growth early in the season by reducing crop emergence through ‘damping off’ and later in the season by causing root rot and lowering yield potential.

Pythium rapidly infects germinating seeds and seedlings of all major grain crops and pastures.

After the roots are infected, Pythium produces large numbers of spores which enable the pathogen to re-infect growing roots continuously throughout the season and across all phases of the crop rotation (see Farming Ahead No. 151, page 38).

The increasing frequency and severity of Pythium root rots across southern and Western Australia (see Farming Ahead No. 153, page 38) appear to be related to the adoption of reduced tillage systems and the switch to repetitive canola–wheat rotations.

As both of these trends are here to stay, there is an urgent need to develop pre-emptive strategies to manage this increasingly important disease.

A collaborative project, funded by the Grains Research and Development Corporation and involving CSIRO Land and Water and Landmark has been established to develop an integrated management package for Pythium through targeted use of fungicides and crop rotation strategies.

Raising Pythium awareness

To highlight the impact of Pythium on crop growth and yields, the research team established crop rotation trials in South Australia, Victoria and New South Wales during 2002 and 2003.

Crops were either treated with a Pythium-selective fungicide (metalaxyl) as a seed dressing or left untreated.

At a glance

- CSIRO research indicates crop rotation could be used to improve management of Pythium root rots.
- Researchers found crops differ in their susceptibility to Pythium infection and their capacity to ‘carryover’ the disease to subsequent crops.
- Importantly, individual crops appear to support particular strains of Pythium.
- Establishing the amount and type of Pythium strain present in the soil before sowing would enable farmers to make a crop choice based on which crops the Pythium strains are least likely to infect.

Pythium produces large numbers of spores which enable the pathogen to re-infect growing roots continually throughout the season. By determining the type and amount of Pythium strains in the soil, growers could make an appropriate crop choice based on which crops the Pythium strains are least likely to infect.
During 2002, high levels of *Pythium* were detected at all sites with an average of 185 spores per gram of soil. Fungicide decreased soil-borne spore levels by an average of 19 per cent and root infection by 29% and resulted in grain yield increases in canola (24–27%), cereals (3–14%) and pulses (9–30%).

*Pythium* levels during 2002 were almost double those detected during the 2003 drought with an average of 310 spores per gram of soil.

During 2003, the *Pythium*-selective fungicide decreased levels of soil-borne fungal spores by 28% and root infection by 16%, producing grain yield increases in canola (11%), wheat (3%) and pulses (2–26%) (see Table 1 and Figure 1).

**Fungicide of limited impact**

The CSIRO research found pre-dressing seed with metalaxyl provided only limited root rot control with *Pythium* root infections decreased by only 29% during 2002 and 16% during 2003.

Metalaxyl applied as a seed dressing is only effective for the first 4–8 weeks of crop growth. This, combined with the ability of *Pythium* to produce large numbers of infectious spores rapidly, means the pathogen population can recover quickly and exceed ‘pre-fungicide’ levels as the season progresses.

The inability of metalaxyl seed dressings to control *Pythium* root rot effectively indicates the yield benefits measured during the field trials were caused largely by improved early crop growth. This means more effective and sustained *Pythium* control throughout the growing season could lead to further improvements in grain yields.

**Crop rotation strategies**

Because all crop and pasture plants can carry *Pythium*, crop rotation previously has not been considered useful in managing *Pythium* root rots.

But the CSIRO research indicated different crops can affect the amount and type of *Pythium* present in the soil, implying individual crops can select for and increase spore levels of particular *Pythium* strains. In addition, crops grown for their second successive year support higher *Pythium* levels than crops grown in annual rotation.

Continuous wheat in particular causes *Pythium* levels to rise which probably contribute to the rapid yield declines often observed in successive wheat crops (see Figure 2).

**Pythium strains change with crop**

CSIRO researchers are using DNA markers to determine the size and genetic make-up of *Pythium* populations in cropping soils and using these tools to monitor how these change over phases of the rotation.

Genetic analysis of *Pythium* strains indicates the genetic make-up of *Pythium* populations shifts in response to different crops. This suggests individual strains of *Pythium* are better adapted at infecting some crops than others and that different crops could be selecting for these crop-adapted strains.

Consequently, *Pythium* could be managed by determining the *Pythium* strains and level in the soil and making an appropriate crop choice based on which crops the *Pythium* strains are least likely to infect.

This research provides a better understanding of the ecology of *Pythium* and will enable *Pythium* disease prediction models to be developed.

Sustainable disease control will require an integrated programme of targeted fungicide applications during highly susceptible phases of the rotation (for example, grain legumes or canola) and timing the rotation sequence to match less susceptible crop species with the particular soil-borne *Pythium* population.

This strategy will limit the pathogenic impacts of *Pythium*, thereby avoiding severe disease incidence in the current cropping phase and high levels of inoculum carry-over in subsequent years.

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**TABLE 1 Pythium fungicide (2003)**

<table>
<thead>
<tr>
<th>Soil</th>
<th>Pythium (%)</th>
<th>Root rot (%)</th>
<th>Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>–25</td>
<td>–4</td>
<td>+4</td>
</tr>
<tr>
<td>Canola</td>
<td>–19</td>
<td>–20</td>
<td>+11</td>
</tr>
<tr>
<td>Lupin</td>
<td>–33</td>
<td>–7</td>
<td>+26</td>
</tr>
<tr>
<td>Peas</td>
<td>–36</td>
<td>–22</td>
<td>+2</td>
</tr>
<tr>
<td>Wheat</td>
<td>–26</td>
<td>–28</td>
<td>+3</td>
</tr>
<tr>
<td>Average</td>
<td>–28</td>
<td>–16</td>
<td>+9</td>
</tr>
</tbody>
</table>

* Decreased soil-borne *Pythium* levels by an average of 28 per cent, reducing subsequent root rot infection by an average of 16% and leading to a 9% increase in average crop yield. The relatively small impact of the fungicide on subsequent root rot infections indicates the fungicide has a short window of effectiveness and that longer lasting controls could lead to further increases in grain yields.

Source: CSIRO Land and Water.

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* Treating canola seed with a *Pythium*-selective fungicide increased grain yields by an average of 11 per cent across four trial sites. The fungicide had limited impact on root rot infections (reduced by 20%) suggesting more effective and sustained control of *Pythium* throughout the growing season could lead to higher yields.

Source: CSIRO Land and Water.