CROWN ROT – WESTERN
FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

WESTERN
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Pre-sowing strategies can help reduce losses from crown rot

KEY POINTS FOR MANAGEMENT OF CROWN ROT

- TEST. Know your paddocks' crown rot risk level. A pre-sowing PREDICTA® B soil test will identify paddocks at risk
- INSPECT. Observe previous cereal crops for symptoms. Check plants for browning at the base of infected tillers as this is the most reliable indicator of crown rot. Do not rely solely on whiteheads as an indicator
- ROTATE CROPS. Rotate at-risk paddocks to non-host crops. This is the most important management option. A grass-free break from winter cereals is the best way to lower crown rot inoculum levels
- RESISTANT VARIETIES. Choosing more resistant crop varieties or those shown to have lower levels of yield loss can help but still needs to be combined with other management strategies
- PADDOCK MANAGEMENT. Within-paddock management decisions can affect crown rot inoculum levels. Decisions such as time of sowing, crop choice, inter-row sowing and crop nutrition affect the impact of crown rot on yield and grain quality
- INOCULUM LEVELS. Maintaining crown rot inoculum at low levels is the most effective way to reduce yield loss

PHOTO: SARDI

FIGURE 1: Plants affected by crown rot have whiteheads and awns that tend to stick out compared with the normal green heads of the unaffected plants close by. Do not rely solely on whiteheads as an indicator of crown rot. Other factors (take-all, mice, insect damage and frost) can cause whiteheads. A whitehead caused by crown rot will always have a characteristic browning at the base of the infected tiller.

Crown rot is a widespread stubble-borne fungal disease in the western grain-growing region. Recent research at Merredin and Wongan Hills has demonstrated that high levels of crown rot can cause average yield losses of 19 per cent in bread wheats and 18 per cent in barley. In four recent WA trials, yield losses to crown rot of seven milling oats averaged four per cent. Some oat varieties had no yield loss.

Symptoms

Whiteheads

An obvious symptom of crown rot in wheat is the presence of whiteheads in the crop during early grain fill. These heads mature early and contain shrivelled or no grain. Whiteheads caused by crown rot are usually scattered through the crop, whereas whiteheads caused by the root disease take-all appear in distinct patches.

Sometimes patches can be soil-type specific; for example, scalded hard-setting soils show the disease first because of their lower ability to store or hold moisture. Whiteheads are favoured by moisture stress during grain filling and contribute to yield loss.

Whiteheads may first appear in wheel tracks, old weed patches or around trees where crop-available soil

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moisture is more limited (Figures 1 to 3). However, whiteheads may not appear on all stems of an infected plant. Barley generally does not produce whiteheads because it matures earlier than wheat, which helps it escape late-season moisture stress. But yield losses can still be significant and equal to those in wheat. Oats rarely exhibit this symptom. In seasons with good spring rain whiteheads may not occur, even in infected crops. The expression of whiteheads is closely related to the extent of yield loss.

Stem browning

A brown stem base is the most reliable indicator of crown rot infection. This symptom becomes more pronounced from mid to late grain filling through to harvest (Figures 4 and 5). In wetter or milder years, checking plants around tree lines can be a better indicator of crown rot infection levels.

To inspect for the honey/dark brown discolouration, pull back the leaf sheaths at the stem base. This symptom may not appear on all stems of an infected plant and is often difficult to see in oats. This browning may also be seen in combination with white/pink fungal growth that can be on either the outside of the lower stems underneath the leaf sheaths or visible if the stem is cut open. The pink fungal growth only occurs when moisture is still available late in the season and should not be used as the definitive symptom of crown rot infection.

Importance of seasonal conditions

The expression of crown rot infection as whiteheads is strongly associated with conditions during flowering and grain filling. Yield loss increases as the extent of moisture and/or heat stress increases. The growth of the fungus in the base of the cereal plant blocks water movement up the stem to the head, causing the formation of whiteheads. Therefore, yield loss from crown rot in the western region is minimal in seasons with adequate rainfall and mild temperatures during grain filling. However, yield losses can be severe in seasons with reduced rainfall and hotter temperatures during grain filling.

Life cycle and spread of infection

Crown rot is caused by the fungal pathogens *Fusarium pseudograminearum* and/or *F. culmorum*. Its host range is confined to cereals and grasses. Therefore, crown rot is worse in paddocks with tight cereal rotations (particularly of susceptible varieties) or where grass weeds are not controlled. Stubble retention and reduced tillage practices also support carry-over of crown rot inoculum.

The life cycle of crown rot is shown in Figure 6. Its inoculum survives from one season to the next in stem bases and crowns. Until the stubble is completely

PHOTO: NSW DPI

FIGURE 2: Whiteheads are more prevalent with moisture stress. In wetter or milder years, checking around tree lines can be a better indicator.

BOX 1: ASSESSING THE CROWN ROT RISK

ASSESSING RISK WITH PREDICTA® B

PREDICTA® B is a DNA-based soil test that detects levels of a range of cereal pathogens, including the main *Fusarium* species that causes crown rot.

- It is commercially available to growers using accredited agronomists who submit samples through the South Australian Research and Development Institute (SARDI).
- The test identifies the level of risk for crown rot and other soil-borne pathogens before sowing. It requires a dedicated sampling strategy and is not a simple add-on to a soil nutrition test.
- Collection of soil cores should be done on the previous winter cereal rows, if possible, and any stubble fragments should be retained.
- Short pieces of stubble (one to two from each PREDICTA® B soil sampling location) from previous winter cereal crops and/or grass weed residues should be added to the soil sample to enhance detection of the crown rot inoculum.
- Accredited agronomists should consult SARDI for the latest recommended sampling strategy for your region.

PLANT DISEASE DIAGNOSIS

A commercial plant disease diagnosis service is available through DDLS Plant Laboratories (DPRID) for crown rot and other pathogens (see Useful resources).

STEM BROWNING ASSESSMENT

Check cereal crops for crown rot between grain filling and harvest. Collect plant samples from within the paddock by walking in a large 'W' pattern, collecting five plants at 10 different locations (Figure 7). Examine each plant for basal browning, record what percentage shows the symptom and then put in place appropriate measures for next year.

Generally, the level of risk for crown rot infection for the following season relates to current season infection rates:

- **LOW** – less than 10 per cent of plants infected;
- **MEDIUM** – 11 to 24 per cent of plants infected; and
- **HIGH** – more than 25 per cent of plants infected.

broken down the inoculum can survive within the stubble, meaning that it may survive for several seasons.

When growing cereal plants come in contact with infected plant residues, crown rot infection can occur. Even minute pieces of residue can infect plants and a paddock with little visible stubble may still have a crown rot risk. Infection is favoured by moderate soil moisture at any time during the season.

Infection occurs through the coleoptile, sub-crown internode, crown and/or outer leaf sheaths at the tiller bases. The fungus spreads up the stem during the season, with most inoculum being concentrated near the base of the plant (Figure 8).

Disease management

Managing crown rot in a cropping operation relies on:

- identification of paddocks at risk before planting;
- crop rotations to reduce inoculum levels;
- stubble management to reduce inoculum levels; and
- strategies that minimise yield losses when cereals are grown.

Identifying paddocks at risk

The first step in reducing yield loss is to identify paddocks at risk (see Box 1, Assessing the disease risk). This can be done by visually assessing crown rot levels in the previous cereal crop and by having soil/stubble samples analysed by PREDICTA® B testing.

If crown rot is identified as a risk, there are many ways to minimise that risk for the coming season. However, actual yield loss will be determined by seasonal conditions. For example, a paddock may have high inoculum load, but the cereal crop may only suffer small yield losses if there is good spring rainfall or adequate stored moisture with mild temperatures.

The type of paddock history that points to high crown rot risk includes factors such as:

1. Rotation history – the higher frequency of winter cereals within the rotation increases risk.
2. Time since last winter cereal crop – inoculum levels decline over time and will be highest in cereal-on-cereal rotations, lower following one break crop and even lower after two break crops.
3. Grass weed control – any blow-out in control has the potential to increase inoculum levels in those patches and reduce fallow soil water storage, which can exacerbate whitehead expression.
4. Crown rot observed in the previous season – whiteheads are only a good indicator of infection levels in seasons with drier spring conditions. Assessing the incidence of basal browning is a better indicator of actual infection levels.
5. PREDICTA® B testing – this provides the most accurate assessment of risk levels if the recommended sampling protocol is followed. It also has the added benefit of determining levels of other common pathogens such as root lesion nematodes from the same sample. See Box 1 for more information on using PREDICTA® B.

Crop rotations

All winter cereals increase crown rot inoculum, with durum wheat and barley increasing the levels most. Breaks from winter cereals decrease inoculum and will be most effective if free of grass weeds and volunteer cereals. Inoculum declines after break crops such as canola and lupins.

For break crops, early canopy closure and warm, damp conditions under the canopy will result in the fastest decomposition of crown rot-infected plant residues and reduction of inoculum levels.

Good rainfall increases the effectiveness of the break, because cereal residues harbouring the pathogen are more readily decomposed by microbes in moist conditions. Where disease levels are high and rainfall is low, it may take two to four years for infected plant residues to decompose to the point where inoculum levels are low.

PHOTO: GRANT STAINER, DPIRD

FIGURE 3: Crown rot can appear as whiteheads (right). Growers are advised to also inspect for basal stem browning.

PHOTO: NSW DPI

FIGURE 4: White tillers (on left) uninfected by crown rot with tillers (on right) showing characteristic basal browning associated with crown rot infection.

Stubble management

CULTIVATION

Crown rot inoculum is most concentrated below ground and in the bottom seven centimetres of the stem (Figure 8). Stubble management practices such as cultivation, spreading and slashing through cultivation can increase the rate of stubble decomposition, but can also spread the infected residues across the paddock. Decay may take multiple years as it is also influenced by biological activity, soil moisture and nutrient availability.

Where there is insufficient moisture or adequate time to allow stubble breakdown, these cultivation practices can increase infection rates in the next winter cereal crop. Grazing cereal stubble can also spread inoculum through physical movement of infected residues by stock.

PHOTO: DPIRD

FIGURE 5: Brown stem bases are a sure sign of crown rot in wheat. The labels (a to d) outline the level of infection: a) no infection, b) mild infection, c) moderate infection and d) severe infection.

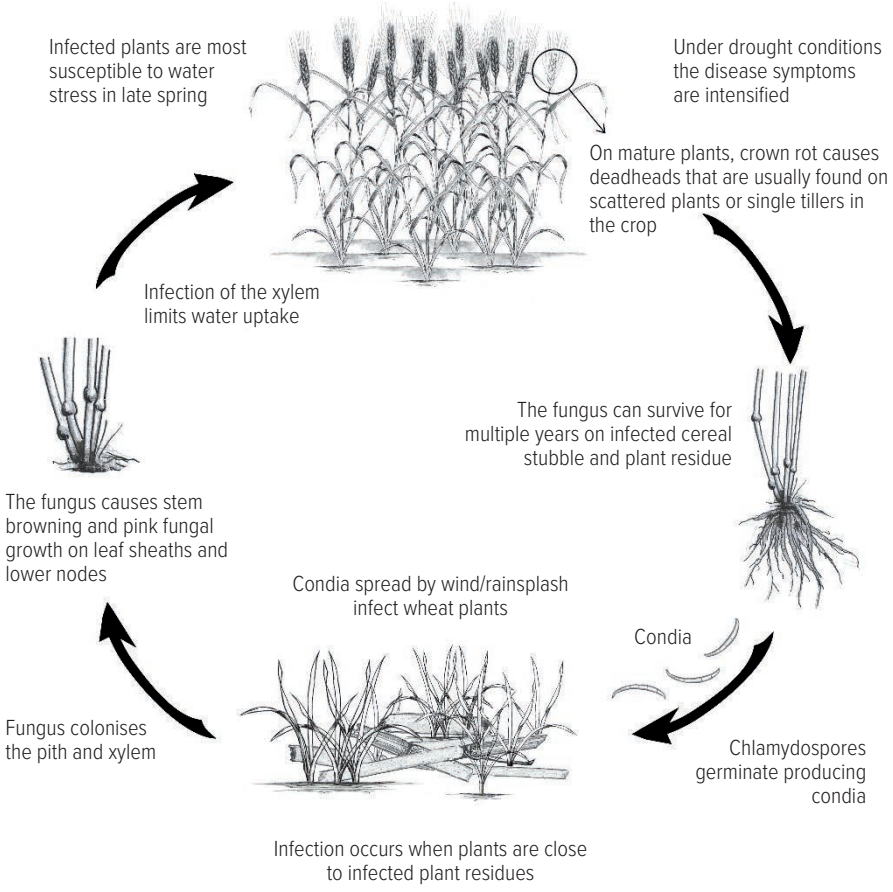

ILLUSTRATION: KYLIE FOWLER

FIGURE 6: Disease cycle of crown rot in cereals.

BALING AND BURNING

Baling and removing straw or hay are not instant solutions. This is because much of the crown rot inoculum is below the cutting level for straw and hay and stubble with high levels of infection is a common occurrence in WA (Figure 9). For the same reason, stubble burning is not a quick-fix. Even where a good burn can be achieved, burning will not remove inoculum from below ground. Before baling or burning specifically to manage crown rot, consider the implications for nutrient loss, erosion and degradation of soil structure.

Strategies to minimise yield losses

If a cereal must be sown in a paddock with an identified risk for crown rot, there are a range of strategies that can be adopted to minimise losses. No single strategy will prevent losses, but improved control will be achieved when multiple strategies are implemented. Crop selection (for example, avoiding cereal crops such as bread wheat that are prone to high yield loss) can reduce losses and strategies such as inter-row sowing and time of sowing can also help.

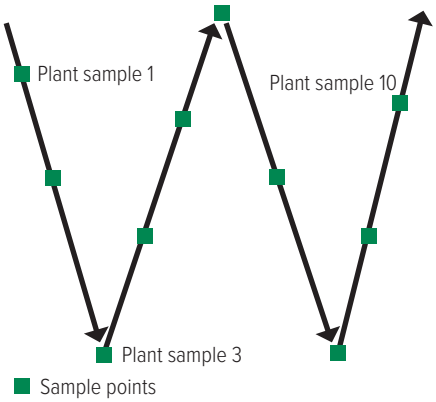

FIGURE 7: Pattern for collecting plant samples from a paddock to determine level of crown rot infection.

CEREAL TYPE

All winter cereals host crown rot and oats, barley and bread wheats have varying levels of susceptibility. Yield loss due to infection varies with cereal type, variety and seasonal conditions. Barley is susceptible to infection and will build up inoculum, but it matures faster than bread wheats and can often escape some of the heavy yield losses suffered by wheat. Late-planted barley is likely to suffer significant yield losses similar to wheat. Data from WA trials conducted by DPIRD suggests oats may be a better economic choice than some bread wheat as yield loss averaged four per cent.

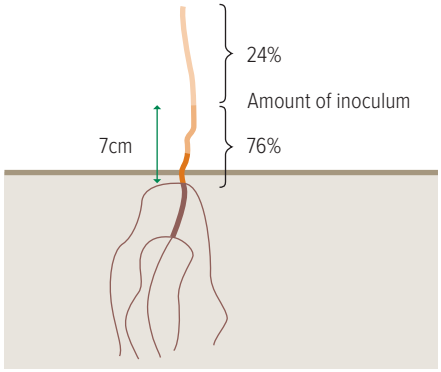

FIGURE 8: Crown rot distribution in infected cereal stubble.

VARIETAL RESISTANCE

No cereal crop or variety is fully resistant to crown rot, but some varieties have partial resistance genes that limit the rate of pathogen development, which can help to retain yield when seasonal conditions are good (no water or heat stress).

Some new barley and wheat varieties have a measurable improvement in their yield performance when infected with crown rot. Wheat and barley trials conducted at Merredin and Wongan Hills from 2014 to 2016 found that all varieties had reduced yield in inoculated plots. However, Emu Rock$^{\Phi}$ was consistently the least affected by crown rot. Other varieties were less robust; for example, Justica CL Plus consistently had the greatest reduction in yield.

In the barley trials, Litmus$^{\Phi}$ and La Trobe$^{\Phi}$ had consistently higher yields than most other barley varieties in the presence of crown rot infection, while Bass$^{\Phi}$, Baudin$^{\Phi}$ and Granger$^{\Phi}$ consistently had the greatest yield reduction in the presence of this disease.

Variety choice is not a solution to crown rot as even the best bread wheat or barley variety can suffer up to 40 per cent yield loss under high infection levels and a dry/hot seasonal finish.

Wheat and barley variety disease guides and the National Variety Trials website provide crown rot ratings, which are largely based on the evaluation of resistance (see Useful resources). The latest information on the relative yield of varieties in the presence of crown rot can be found on GRDC's website.

TIME OF SOWING

Time of sowing has little impact on the incidence of crown rot infection. However, disease severity (as measured by basal browning) and yield loss increases with later sowing. Planting date should be determined by the presence of adequate soil moisture, the type of variety sown and the management of frost risk. Sowing a variety early in its sowing window will help minimise the detrimental effects of any crown rot infection by bringing the grain-filling period forward into slightly reduced evaporative stress conditions.

INTER-ROW SEEDING

Infection rates can be reduced by sowing between intact rows of previous standing cereal stubble (Figure 10). In the western region, inter-row sowing using accurate ±2 centimetre differential GPS autosteer has been shown to decrease the number of infected plants by about 50 per cent, resulting in a 5 to 10 per cent yield advantage in the presence of crown rot.

CROP NUTRITION

As crown rot is more severe when a crop suffers from water stress late in the season, it is important to match nitrogen rates and timing to stored soil moisture and targeted potential yield. Excessive early crop growth (bulky crops following excessive nitrogen inputs) can deplete stored soil water, increasing the risk of water stress during grain fill particularly in seasons where water is more limiting.

Ensure crops have adequate zinc nutrition. Whitehead expression can be more severe in zinc-deficient crops. Applying zinc above recommended rates will not provide further protection from crown rot.

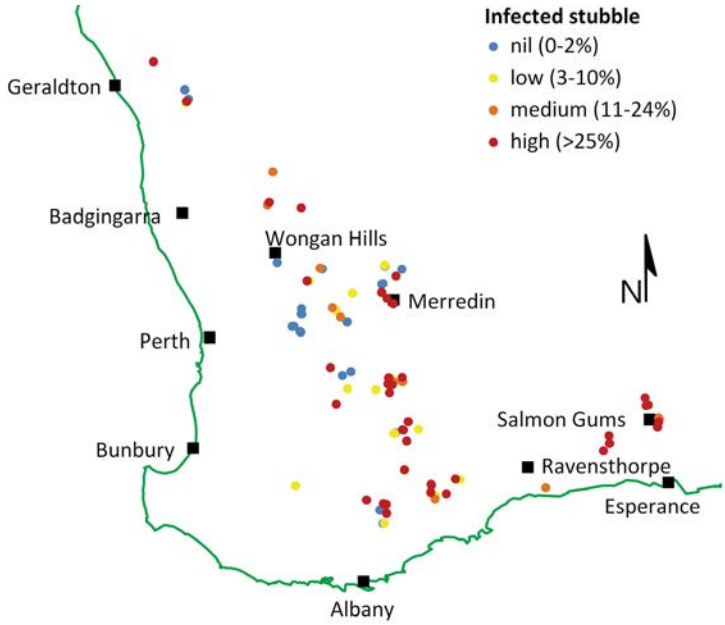

FIGURE 9: Crown rot incidence in Western Australia based on two-year stubble survey (2013-14) conducted by DPIRD. SOURCE: DANIEL HÜBERLI, DPIRD

PHOTO: DPIRD

FIGURE 10: Crown rot infection rates can be reduced by sowing between intact rows of previous standing cereal stubble.

Interaction between crown rot and root lesion nematode

Root lesion nematodes (RLNs) feed inside root systems, reducing the ability of plants to access moisture and nutrients. The presence of RLNs appears to exacerbate yield loss from crown rot infection even in seasons not particularly suited to the expression of crown rot. Cereals differ in their tolerance to nematodes and this tolerance can vary for the different *Pratylenchus* species found in WA soils.

FREQUENTLY ASKED QUESTIONS

Can I spray in-crop to control crown rot?

No. There are no fungicide options registered for in-crop control of crown rot. The fungus is protected inside plant material with infection concentrated at the base of tillers.

What about fungicide seed or in-furrow treatments to control crown rot?

Rancona® Dimension is registered for the suppression of crown rot. It has been found to reduce fungal DNA early in the season but on its own does not appear to provide season-long protection. It should only be considered as one component of an integrated disease management strategy. There are no 'magic bullets' for controlling crown rot.

Do any soils suppress crown rot?

There is little current paddock evidence for this, but soils that hold less moisture or restrict root growth, such as compacted soils, can exacerbate expression of this disease.

I have taken a standard soil nutrition test between the previous rows and to depth. Can I just split some of that off and get a PREDICTA® B test done for crown rot?

A nutrition soil sample is unlikely to be representative of the true crown rot inoculum load in a paddock, especially in no-till situations. The crown rot fungus is stubble-borne from previous winter cereal or grass weed residues. PREDICTA® B sampling needs to target incorporation of these residues in the soil sample if present. The dedicated sampling strategy recommended for PREDICTA® B should be followed.

USEFUL RESOURCES

DPIRD Diagnostic Laboratory Services – Plant Pathology, (08) 9368 3351, DDLS@dpird.wa.gov.au

PREDICTA® B: a soil analysis service delivered by accredited agronomists. Contact your local agronomist or to locate your nearest supplier, email your contact details and location to nigel.percy@sa.gov.au or russel.burns@sardi.com.au. See the SARDI website, pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

National Variety Trials, www.nvtonline.com.au

Cereal Variety Disease Guides produced by DPIRD, see www.agric.wa.gov.au

Cereal Variety Disease Guides can also be found at http://extensionaus.com.au/field-crop-diseases/crown-rot-winter-cereals

For more information on the interactions between specific crops and crown rot, see **GRDC's GrowNotes™** at www.grdc.com.au/GrowNotes

Hüberli D, Gajda K, Connor M and Van Burgel A (2017), **Choosing the best yielding wheat and barley variety under high crown rot.** In: 2017 Grains Research Updates, Perth, Western Australia, 27-28 February. http://researchrepository.murdoch.edu.au/id/eprint/35682

GRDC Know More series – Strategies to control crown rot, https://youtu.be/2X3wE4QmAgI

MORE INFORMATION

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