Tips and Tactics

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Crown rot in cereals

Western Region

FEBRUARY 2016

Rotations, observations and testing key to crown rot control

Three top tips to stop crown rot: rotate crops, observe plants for browning at the base of tillers and test stubble and soil.

Management strategies

Reducing the risk before planting

Reducing inoculum is vital to managing crown rot. Crop rotation is the most important management option for this disease.

Rotations

All winter cereals increase crown rot inoculum, with durum wheat and barley increasing the levels most.

Breaks from winter cereals decrease crown rot inoculum and will be most effective if free of grass weeds and volunteer cereals.

Inoculum declines after break crops such as canola and lupins.

Good rainfall increases the effectiveness of the break, because cereal residues harbouring the pathogen are more readily decomposed by microbes in moist conditions.

Figure 1: White tillers (on left) uninfected by crown rot with tillers (on right) showing characteristic basal browning associated with crown rot infection. (Image: NSW DPI)

KEY POINTS

- Rotate 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.
- Observe. Check plants for browning at the base of infected tillers as this is the most reliable indicator of crown rot. Don't rely solely on whiteheads as an indicator (Figures 1, 2, 4, 5). More detail in 'The disease', page 4.
- Test. A pre-sowing PreDicta B™ soil test will identify paddocks at risk of crown rot.
- Sow winter cereals, particularly durum, into paddocks where the risk is lowest.
- Choosing more resistant crop varieties can help but still need to be combined with effective management.
- There are many in-paddock actions that can reduce yield losses (pages 2–4).
- Keeping crown rot inoculum at low levels is the most effective way to reduce yield loss from this disease.

Figure 2: Brown stem bases are a sure sign of crown rot in wheat. The labels (a–d) outline the level of infection: a) no infection, b) mild infection, c) moderate infection and d) severe infection. (Image: DAFWA)

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.

Cultivation

Incorporating infected plant residues into the soil by cultivating (Figure 10, page 5) can increase decomposition rates. However, decay may take multiple years as it is also influenced by biological activity, soil moisture and nutrient availability.

Unfortunately cultivation spreads infected residues, which may increase plant infection rates, therefore counteracting any benefits from increased residue breakdown. The main infection sites are below-ground. Hence cultivation can distribute infected residues throughout this zone, which can then contact and infect plants.

Prior to cultivating specifically to manage crown rot, also consider the implications for nutrient loss, erosion and degradation of soil structure.

Baling and burning

Baling and removing straw or hay are not instant solutions for crown rot. 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 (Figure 3). For the same reason, stubble burning is not a quick-fix for high crown rot levels. Even where a good burn can be achieved, burning will not remove inoculum from below-ground.

Prior to baling or burning specifically to manage crown rot, consider the implications for nutrient loss, erosion and degradation of soil structure.

Assessing the disease risk

Soil sampling for future risk

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 from accredited agronomists through the South Australian Research and Development Institute (SARDI).
- The test identifies the level of risk for crown rot and other soil-borne pathogens prior to sowing. However, this requires a dedicated sampling strategy and is not a simple add-on to a soil nutrition test.
- Soil cores should be targeted from the previous winter cereal rows, if possible, and any stubble fragments should be retained.
- Short pieces of stubble (1–2 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 inoculum that causes crown rot.
- Accredited agronomists can consult SARDI for the latest recommended sampling strategy for your region.

Plant disease diagnosis

- A commercial plant disease diagnosis service is available through AGWEST Plant Laboratories (DAFWA) for crown rot and other pathogens (see Useful Resources).

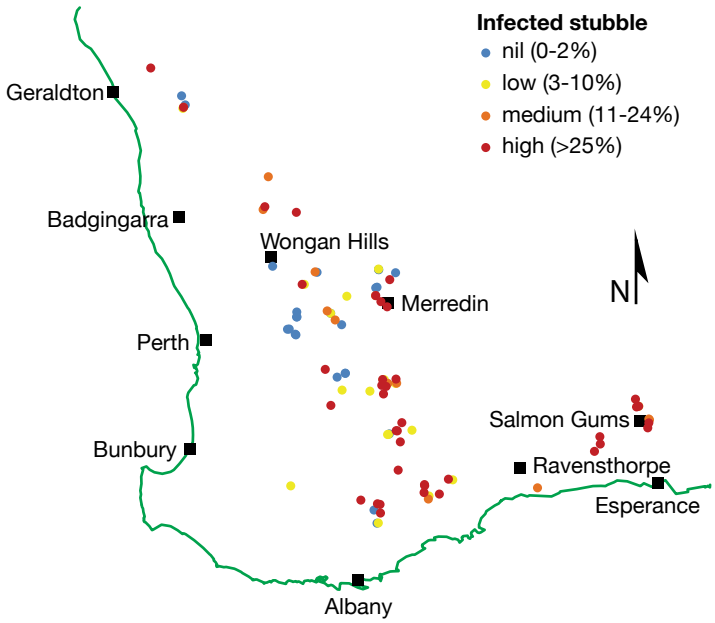


Figure 3: Crown rot incidence in Western Australia based on two-year stubble survey (2013/14).

Figure 4: Crown rot can appear as whiteheads (right), however growers are urged to also inspect for basal browning.

Figure 5: Plants affected by crown rot have whiteheads and awns that tend to stick out compared to the normal green heads of the unaffected plants close by. Do not rely solely on whiteheads as an indicator of crown rot. Other factors (mice, insect damage, frost) can cause whiteheads. A whitehead caused by crown rot will always have a characteristic browning at the base of the infected tiller. (Image: SARDI)

Reducing yield loss

The first step in reducing yield loss is to identify paddocks at risk (see section on 'Assessing the disease risk' for details). Do this by visually assessing crown rot levels in a prior cereal crop or have soil/stubble samples analysed by PreDicta B™. If crown rot has been identified as a risk in a paddock, there are a number of ways to minimise the risk for the coming season.However, actual yield loss will be determined by seasonal conditions. For example, a paddock may have a high inoculum load, but the cereal crop may only suffer small yield losses if there is good spring rainfall or stored moisture with mild temperatures.

Paddock selection

- Cereals: avoid paddocks with a high crown rot risk.
- Determine paddock risk (see section on 'Assessing the disease risk' for details) by visually assessing crown rot levels in a prior cereal crop or have soil/stubble samples analysed by PreDicta B™.

Paddock histories that point to high crown rot risk include:

- high infection levels in a winter cereal crop in the last three years
- high frequency of winter cereals in the rotation
- paddocks that have grown a susceptible variety in the previous year/s
- stubble retention with no tillage
- low rainfall during the last fallow or break crop from cereals (dry conditions may slow down the rate of residue decomposition)
- poor grass weed control
- stubble cultivated close to sowing
- paddocks with low stored soil moisture at sowing or soil types with lower water holding capacity.

As a general rule, the level of risk for crown rot infection for the following season relates to current season infection rates:

- Less than 10% of plants infected = low risk for following season
- From 11–24% of plants infected = medium risk for following season
- More than 25% of plants infected = high risk for following season.

Cereal type

- All winter cereals host crown rot and barley and bread wheats have varying levels of susceptibility. Yield loss due to infection varies with cereal type, variety and seasonal conditions.
- Barley is very susceptible to crown rot infection and will build up inoculum however, it generates higher yield compared to wheat because barley matures faster. Late-planted barley is likely to suffer significant yield losses similar to wheat. Yield losses are worse when stress occurs early during the growing season.

Varietal resistance

Varietal resistance and tolerance to crown rot exist but are not the sole solution.

Resistance: the plant's ability to limit the development of the crown rot fungus within living tissue. No cereal crop is resistant to crown rot.

Tolerance: the plant's ability to maintain yield in the presence of crown rot infection.

Relative yield loss between varieties

- Variety choice is NOT a solution to crown rot with even the best bread wheat or barley variety suffering up to 40% yield loss from crown rot under high infection levels and a dry/hot seasonal finish.
- All current durum varieties are very susceptible to crown rot and should be avoided in medium and high risk situations.
- Cereal varieties differ in their tolerance to crown rot. This can have a significant impact on the relative yield of varieties in the presence of this disease and carryover of the disease into the following year.
- Some newer wheat varieties have a measurable improvement in their tolerance to crown rot. Limited data suggest Emu Rock(Ⓟ PBR) is likely to yield better in the presence of high levels of crown rot infection, appearing to suffer less yield impact compared to Mace(Ⓟ PBR).
- Variety disease guides and the National Variety Trials website, www.nvtonline.com.au provide crown rot ratings, which are largely based on the evaluation of resistance. The latest information on the relative yield of varieties in the presence of crown rot can be found on the GRDC website, www.grdc.com.au.

If a cereal must be sown but there is a risk of yield loss from crown rot

- Select a cereal type that will have the lowest yield loss. Barley is the first choice, followed by bread wheat and triticale. Avoid durum.
- Check wheat variety guide for bread wheats with improved tolerance (See Useful resources).
- Match nitrogen nutrition to stored moisture and seasonal forecast to avoid bulky crops that run out of moisture in spring, which leaves them more susceptible to the fungus.
- Ensure zinc nutrition is adequate.
- Sow on the inter-row, if this option is available and you are not sowing into non-wetting soil.
- Avoid sowing late in the planting window.
- Fungicide(s) used as seed dressings and registered for suppression of crown rot are unlikely to provide consistent or significant yield improvements on their own. They may contribute to an advantage when used in conjunction with other management options.
- Note that by growing a cereal, particularly a susceptible variety, inoculum levels will increase for subsequent crops.

Straight from the researcher

See Daniel Hüberli talking about crown rot in Western Australia at the 2015 GRDC Updates.

Download at: https://www.youtube.com/watch?v=Wwpc6tkmRbM

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 a season not overly conducive to the expression of crown rot.
- Cereals differ in their tolerance to not only crown rot, but also to nematodes, and this tolerance can be different for the different species of nematodes.

Managing stubble

- Inoculum will be more concentrated below ground and in the bottom 7 cm of the stem (Figure 6).
- Stubble management practices such as cultivating, spreading and slashing through cultivation can increase the rate of stubble decomposition but can also spread the infected residues across the paddock.
- Where there is no stubble moisture or adequate time to accelerate stubble breakdown, these practices can increase infection rates in the next winter cereal crop.

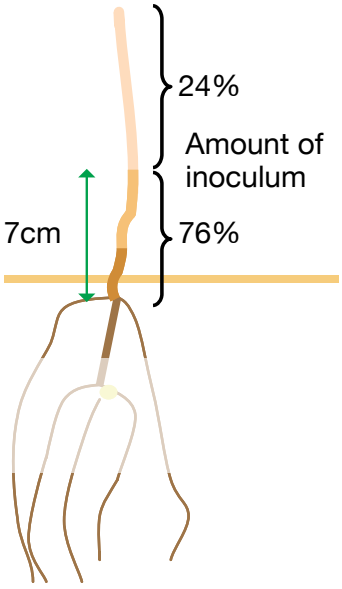


Figure 6: Crown rot distribution in infected cereal stubble.

- Grazing stubble can also spread inoculum.

Time of sowing

- There is little impact of time of sowing 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 and the type of variety sown to also manage frost risk.

Figure 7: Crown rot infection rates can be reduced by sowing between intact rows of previous standing cereal stubble. (Image: GRDC)

- 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. However, this should be balanced against any increase in the risk of frost damage in your area.

Inter-row seeding

- Infection rates can be reduced by sowing between intact rows of previous standing cereal stubble (Figure 7).
- In the western region inter-row sowing using accurate ± 2 cm differential GPS autosteer has been shown to decrease the number of infected plants by about 50%, resulting in a 5% to 10% yield advantage in the presence of crown rot.

Crop nutrition

- Bulky crops are more likely to experience greater water stress during grain filling, making them more vulnerable to yield losses from crown rot if water becomes limiting later in the season. However, these crops can have better root systems that can better access all available plant water.
- Match nitrogen rates and timing to stored soil moisture and targeted potential yield. This will avoid excessive early crop growth, which can diminish soil water reserves prior to the critical grain filling period.
- Pay attention to zinc nutrition. The expression of whiteheads in crown rot infected tillers can be more severe in zinc-deficient crops. Applying zinc above recommended rates will not provide further protection from crown rot.

The disease

- Crown rot is caused primarily by the fungus *Fusarium pseudograminearum* with another species *F. culmorum* also being important in some other regions.
- It is hosted by all cereals and many grass weeds.
- The crown rot fungus can survive for multiple years as mycelia (the vegetative part of a fungus, consisting of a network of fine white filaments called 'hyphae') inside infected plant residues.
- Cereal-on-cereal cropping programs and stubble retention can increase crown rot levels, especially where susceptible varieties have been grown.
- The impact of the disease is worse in a dry finish.
- Major yield losses occur when disease inoculum levels are high and there is moisture and/or evaporative stress during grain filling. Yield loss can be up to 90% in durum and 50% in bread wheat with increased screenings.

Infection

When infected plant residues come in contact with growing cereal plants, 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 found near the base of the plant.

Checking crops for rot

Stem browning

A brown stem base is the most reliable indicator of crown rot. This symptom becomes more pronounced from mid to late grain filling through to harvest (Figures 1 and 2). In wetter or milder years, checking plants around tree lines can be a better indicator. To see the honey/dark brown colour more easily the leaf sheaths should be pulled back. This browning may also be seen in combination with white/hot pink fungus that can either be on the outside of the lower stems or visible if the stem is cut open. This symptom may not appear on all stems of an infected plant and is difficult to see in oats.

Stem browning assessment

Check cereal crops for crown rot between grain filling to harvest. Collect plant samples from within the paddock by walking in a large 'W' pattern, collecting 5 plants at 10 different locations (Figure 8). Examine each plant for basal browning, record what percentage shows the symptom and then put in place appropriate measures for next year.

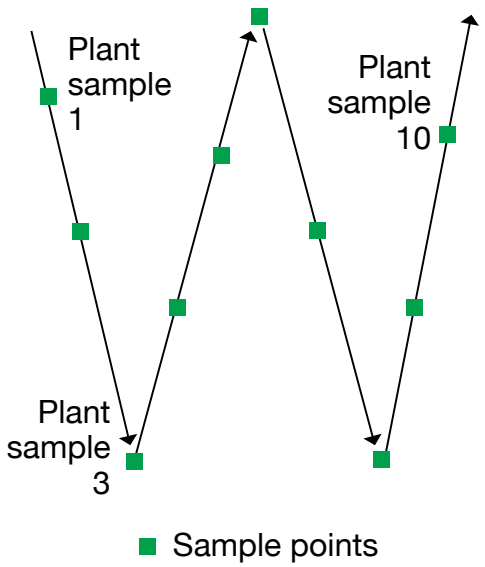
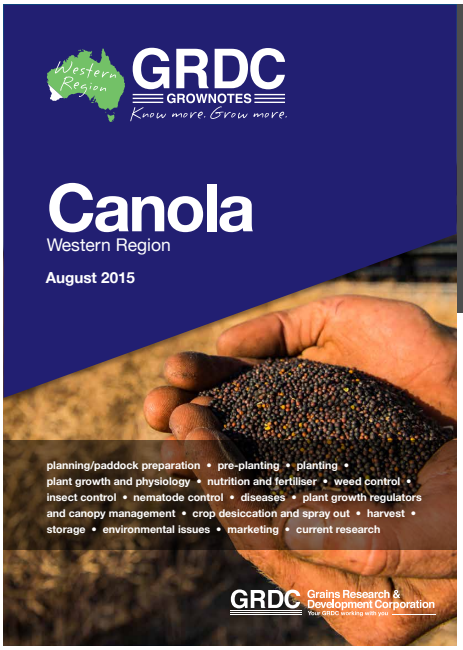


Figure 8: Pattern for plant samples.

Whiteheads

Whiteheads caused by crown rot are usually scattered through the crop and do not appear in distinct patches as seen with the root disease take-all. The patches can be soil-type specific, with scalded hard-setting soils showing up 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 moisture is more limited (Figures 5 and 9). 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, white heads may not occur, even in infected crops.

Figure 9: Whiteheads are more prevalent with moisture stress. Checking around tree lines can be a better indicator in wetter or milder years. (Image: NSW DPI)



Breakcrops such as canola and lupins are valuable for controlling crown rot inoculum. For detailed information on canola production in WA, see the GRDC GrowNotes at www.grdc.com.au/GrowNotes

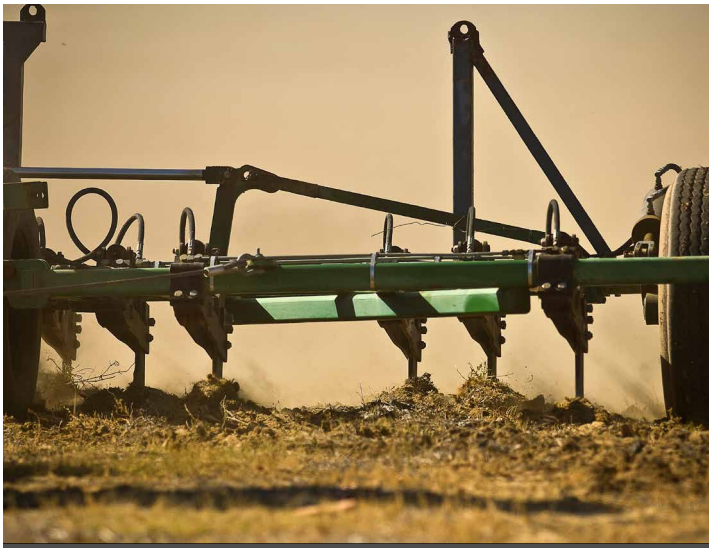


Figure 10: Cultivation is likely to increase infection rates in the next cereal crop by breaking up and spreading the infected residues. (Image: GRDC)

Frequently asked questions

Q. Can I spray in-crop to control crown rot?

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

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

A. Rancona Dimension is registered for the suppression of crown rot. It has been measured 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.

Q. Do any soils suppress crown rot?

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

Q. 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. 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 in 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.

Contacts and useful resources

- Daniel Hüberli, DAFWA (08) 9368 3836 daniel.huberli@agric.wa.gov.au
- Steven Simpfendorfer, NSW DPI 0439 581 672 steven.simpfendorfer@dpi.nsw.gov.au
- AGWEST Plant Laboratories, DAFWA (08) 9368 3721 agwestplantlabs@agric.wa.gov.au
- DAFWA Diagnosing crown rot in cereals http://www.agric.wa.gov.au/n/2131
- PreDicta B™: a soil analysis service delivered by accredited agronomists. Contact your local agronomist or to locate your nearest supplier, e-mail your contact details and location to Shawn.Rowe@sa.gov.au. See the SARDI website http://pir.sa.gov.au/
- National Variety Trials www.nvtonline.com.au
- Cereal Variety Disease Guides produced by DAFWA
- eXtensionAUS crown rot http://www.extensionaus.com.au/tag/crown-rot/
- For more information on the interactions between specific crops and crown rot, see the GRDC GrowNotes at www.grdc.com.au/GrowNotes

Further reading

D Hüberli (2014) Crown rot in winter cereals - Western region. eXtension Australia, online article, 10 November. http://www.extensionaus.com.au/crown-rot-cereals-western/

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