Tips and Tactics

GRDC GROWNOTES® Southern Region

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Crown rot in winter cereals

Southern 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 levels 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 (Figure 1).

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

The type of break (for example, oilseed, pasture, legume, fallow) does not make a large difference. Choose the break most suited to the farming system and with the best economic return.

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

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.

Where disease levels are high and there is low rainfall, it may take around 2–4 years for infected plant residues to decompose to reduce disease risk to a low enough level to sow durum wheat.

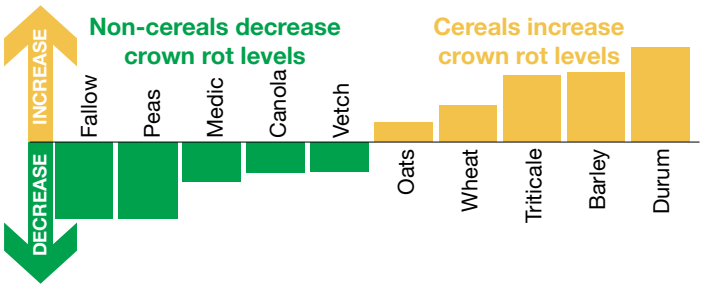

Figure 1: Rotation effects on crown rot levels in the soil in the following year (summary from six trials in South Australia and Victoria)

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 2, 3, 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: White tillers (on left) uninfected by crown rot with tillers (on right) showing characteristic basal browning associated with crown rot infection. (Image: NSW DPI)

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Cultivation

Incorporating infected plant residues into the soil by cultivating (Figure 10, page 5) can increase decomposition rates. This reduces inoculum levels in the medium to long term. However, cultivation is likely to increase infection rates in the next cereal crop by breaking up and spreading the infected residues.

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

Baling and burning stubble

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. 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.

Depending on the timing of the burn, significant levels of soil moisture storage can be lost through the lack of stubble cover during the fallow period. This can have a big effect on the expression of crown rot late in the season.

Figure 3: Brown stem bases are a sure sign of crown rot in wheat. (Image: DAFWA)

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.

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 with mild temperatures.

Paddock selection

- Durum wheat: select paddocks with a low risk of crown rot.
- Other cereals: avoid paddocks with a high crown rot risk.

Paddock histories that point to high crown rot risk include:

- high levels of infection 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
- durum wheat in the past one to three years
- stubble retention with no tillage
- low rainfall during the last break from cereal (dry conditions may slow down the rate of residue decomposition)
- stubble cultivated close to sowing (increases the chance of infection)
- poor grass weed control
- paddocks with low stored soil water at grain filling and 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

- While all winter cereals host the crown rot fungus, yield loss due to infection varies with cereal type. The approximate order of increasing yield loss is cereal rye, oats, barley, bread wheat, triticale and durum wheat.
- Barley will build-up inoculum levels similar to wheat but generally shows less yield loss than bread wheat due to its earlier maturity relative to wheat.

Varietal resistance

Varietal resistance to crown rot exists, but this resistance only plays a part in a combined strategy to control the disease.

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, with the best level of resistance currently available in the southern region being 'moderately susceptible'.

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

Durum wheat	all varieties are very susceptible.
Barley	varying levels of susceptibility.
Bread wheats	some cultivars are rated as moderately resistant-moderately susceptible.

Relative yield loss between varieties

- Variety choice is NOT a solution to crown rot. Even the best bread wheat or barley variety can still suffer 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 resistance to crown rot. This can have a significant impact on the relative yield of varieties in the presence of this disease.
- Some newer wheat varieties have a measurable improvement in their resistance to crown rot. Limited data suggest that Emu Rock(D) is likely to yield better in the presence of high levels of crown rot infection, appearing to suffer less yield impacts compared to many common wheats.
- 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.
- Select a bread wheat or barley variety with improved tolerance.
- 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.
- 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 Alan McKay discussing Predicta B sampling after the 2015 GRDC Update in Ballarat.

Download at: https://www.youtube.com/watch?v=ePYJAlmyU5Y

Interaction between crown rot and root lesion nematodes

- 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.
- *Practylenchus neglectus* is the dominant RLN species in the southern region and *P. thornei* is more prevalent in the northern region.
- PreDicta B™ soil tests also detect RLNs.

Time of sowing

- Research has found little impact from the time of sowing on the incidence of crown rot infections. However, disease severity as measured by basal browning and yield loss increases with later sowing.
- 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 for your area.

Managing stubble

- Inoculum will be more concentrated below ground and in the bottom seven centimetres of the stem (Figure 6).
- By harvest, the crown rot fungus may have colonised from the crown to around 20 cm above soil level.
- Stubble management practices such as cultivating, spreading, slashing and grazing can increase the rate of stubble decomposition in the medium to long term. In the short term, however, these practices can increase infection rates in the next cereal crop, as broken up pieces of infected residues can come into contact with new crop plants and cause infection.

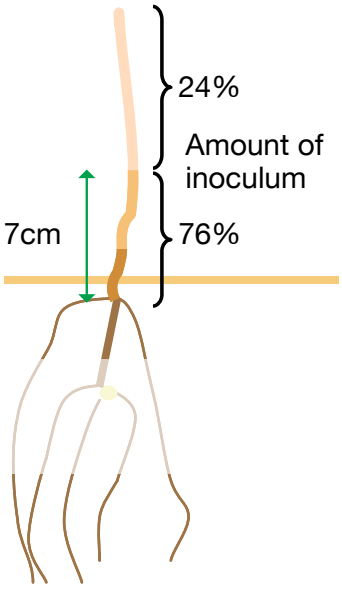

Figure 6: Crown rot distribution in infected cereal stubble.

- Fragments of stubble may be hard to see with the human eye, but even small fragments can carry the disease. Predicta B™ testing is the most accurate way to determine these levels.
- If stubble is still present, the disease will still be present. Grazing stubble can also spread inoculum.

Inter-row seeding

- Infection rates can be reduced by sowing between intact rows of previous standing cereal stubble (Figure 7).
- In the south, inter-row sowing using accurate ±2 cm differential GPS autosteer has been shown to decrease the number of infected plants by around 20%, resulting in a 10% yield advantage in the presence of crown rot.

The disease

- Crown rot is caused primarily by the fungi *Fusarium pseudograminearum* and/or *F. culmorum*.
- It is hosted by all winter cereals and many grass weeds.
- The crown rot fungi can survive for many 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.
- 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 or barley 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 but early infection is most likely to cause yield loss. 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.

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

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 available stored soil water 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 against crown rot.

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 (Figure 4). 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 rarely seen in oats.

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 5 plants at 10 different locations (Figure 8). Examine each plant for basal browning, record what percentage of the plant shows the symptom and then put in place appropriate measures for next year.

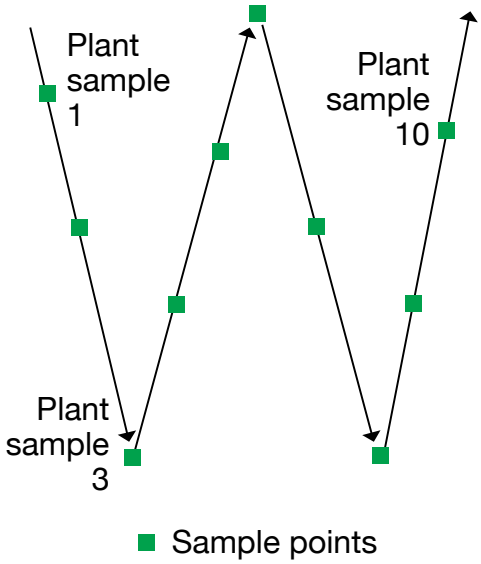

Figure 8: Pattern for plant samples.

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 may not appear on all stems of an infected plant. Whiteheads are favoured by moisture and/or water 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). 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.

More information

Birchip Cropping Group trials co-ordinator, Claire Browne, demonstrates a useful decision support tool designed by CSIRO to help grain growers decide on what break crops to sow and their end use.

See more at: http://www.grdc.com.au/Resources/Tools/Break-Crops-Decision-Support-Tool

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)

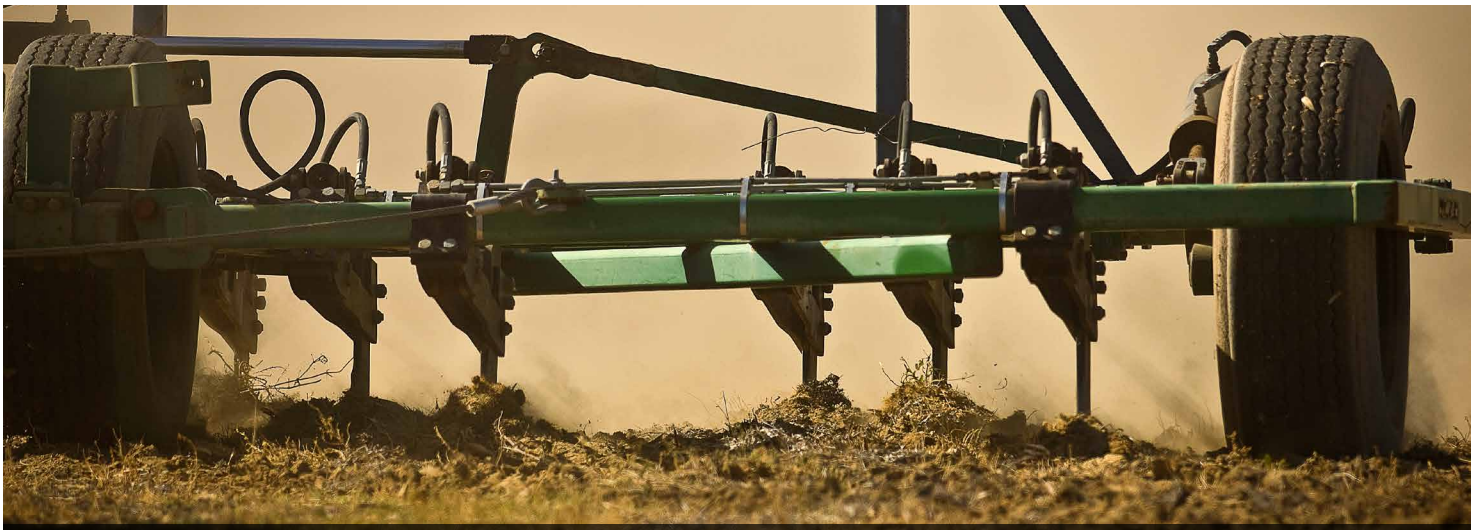

Figure 10: Cultivation is likely to increase infection rates in the next cereal crop by breaking up and spreading the infected residues. (Image: GRDC)

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 want to grow durum wheat, but what about crown rot?

A. Despite losses to crown rot, some growers report durum wheat on average gives better gross margins than bread wheat. Their approaches to minimising crown rot include:

- choosing paddocks with low crown rot inoculum (if unsure test using PreDicta B™)
- not sowing durum after a certain date
- choosing soil types with better soil moisture storage
- limiting early nitrogen application
- inter-row sowing if previous cereal residue is still standing.

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.

Useful resources

- Grant Hollaway,
  DEDJTR Victoria 03 5362 2111
  Grant.Hollaway@ecodev.vic.gov.au
- Margaret Evans,
  SARDI 08 8303 9379
  Email marg.evans@sa.gov.au
- 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/research
- National Variety Trials
  www.nvtonline.com.au
- Cereal Variety Disease Guides produced by each state
- For more information on the interactions between specific crops and crown rot, see the GRDC GrowNotes at
  www.grdc.com.au/GrowNotes
- 2016 SA Sowing Guide
  http://grdc.com.au/Research-and-Development/National-Variety-Trials/Crop-Variety-Guides
- 2016 Victorian Winter Crop Summary
  http://grdc.com.au/Research-and-Development/National-Variety-Trials/Crop-Variety-Guides

Further reading

Crown rot in winter cereals (2014). eXtension Australia, online article.
http://www.extensionaus.com.au/crown-rot-in-winter-cereals/

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