CROWN ROT – NORTHERN FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

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

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 unaffected plants close by. Do not rely solely on whiteheads as an indicator of crown rot. Other factors (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.

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. Choose cereal crops carefully. Selecting more resistant varieties can help but still needs to be combined with other management options. Sow winter cereals, particularly durum, into paddocks where the risk is lowest
- PADDOCK MANAGEMENT. Within-paddock management decisions can affect crown rot inoculum levels. Decisions such as time of sowing, crop choice, inter-row spacing 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

Crown rot is a widespread stubble-borne fungal disease in the northern grain-growing region. Recent research has demonstrated that yield loss from crown rot can be up to 25 per cent in wheat and barley in southern NSW. Across 33 field experiments conducted from 2013 to 2015 in northern NSW and southern Queensland, losses averaged nine to 17 per cent in barley, 13 to 29 per cent in bread wheat and 25 to 34 per cent in durum varieties.

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 across the crop, whereas whiteheads caused by the root disease take-all appear in distinct patches. Sometimes patches can be soil-type specific; for example, areas with a subsoil constraint such as sodicity show the disease first because of their lower ability to store or hold moisture.

Whiteheads may first appear in wheel tracks, old weed patches or around trees where crop-available soil 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. Yield losses can still be significant

P Level 4, 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604
T +61 2 6166 4500 F +61 2 6166 4599 E grdc@grdc.com.au

and equal to those in wheat, especially in barley crops that become stressed during the vegetative stages. 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. The 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.

This symptom may not appear on all stems of an infected plant and is often difficult to see in oats. 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.

PHOTO: SARDI

FIGURE 2: Crown rot can appear as whiteheads (right), but growers should also inspect for basal browning.

Importance of seasonal conditions

The expression of crown rot infection as whiteheads is strongly associated with dry conditions during flowering and grain-filling. Collaborative research conducted between Northern Grower Alliance and NSW DPI established that yield loss in bread wheat (average of five varieties) under high levels of crown rot infection was only 5 per cent when moisture stress was limited late in the season by applying supplementary irrigation.

Yield loss progressively increased up to 55 per cent at sites where the extent of moisture stress was high due to decreased stored soil water at sowing and reduced in-crop rainfall. Yield loss associated with crown rot infection increases as the extent of moisture and/or heat stress increases during grain filling.

Therefore, yield loss from crown rot in the northern region is minimal in seasons with adequate rainfall and mild temperatures during grain filling (for example, 2016). However, the expression of crown rot through whiteheads and therefore yield loss can be severe in seasons with reduced rainfall and hotter temperatures during grain filling (for example, 2017).

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 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,

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 crown rot inoculum.
- Accredited agronomists should consult SARDI for the latest recommended sampling strategy for your region.

STEM BROWNING ASSESSMENT

Check cereal crops for crown rot symptoms on stem bases 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 10). Examine each plant for basal browning, record what percentage shows the symptom and then put in place appropriate measures for next year if the crown rot levels are medium or high.

In general, 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.

crown rot infection can occur. Even small 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 7).

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 per cent in durum and 40 per cent in bread wheat and barley with associated increases in screenings.

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.

PHOTO: NSW DPI

FIGURE 3: Whiteheads are more prevalent with moisture stress. Checking around tree lines can be a better indicator in wetter or milder years.

Identifying paddocks at risk

There are several ways for growers to identify paddocks at risk of crown rot before sowing. These vary in their detail and accuracy in determining the actual level of risk.

1. Rotation history – a 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. Type of winter cereal grown – inoculum levels from highest to lowest tend to be after durum, barley, bread wheat and oats. However, all winter cereals still increase inoculum levels compared with growing a break crop.

4. 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.

5. 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.

6. 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.

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.

Crop rotations

All winter cereals increase crown rot inoculum, with durum wheat and barley increasing the levels most. Planting of winter pulses and oilseeds should be considered as a break crop. Summer legumes (such as mungbeans), oilseeds (for example, sunflower) and cereals (sorghum and maize) are also valuable rotation options in the northern region.

Breaks from winter cereals decrease inoculum and will be most effective if free of grass weeds and volunteer cereals. Inoculum declines are greatest after denser canopy break crops (for example, canola, faba beans, peas and lupins), where infected stubble is more rapidly broken down. Chickpeas are less effective at decomposing cereal stubble due to their slower canopy development but are still better than a fallow.

Good in-crop 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 enough for durum wheat.

Stubble management

CULTIVATION

Incorporating infected plant residues into the soil by cultivating (Figure 8) can increase decomposition rates. However, decay may take a few years as it is also influenced by biological activity, soil moisture and nutrient availability.

Unfortunately, cultivation also spreads infected plant residues. This may increase the proportion of plants infected in a paddock, counteracting any benefits from increased rates of residue breakdown. The main infection sites are in the bottom seven centimetres of the stem and below ground; therefore, cultivation can provide greater distribution of infected residue throughout this zone, which can then contact and infect plants.

Cultivation also results in a loss of soil moisture and reduced infiltration rates, which may also increase the expression of crown rot late in the season.

Before deciding to cultivate specifically for crown rot management, consider the implications for nutrient loss, erosion and degradation of soil structure.

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.

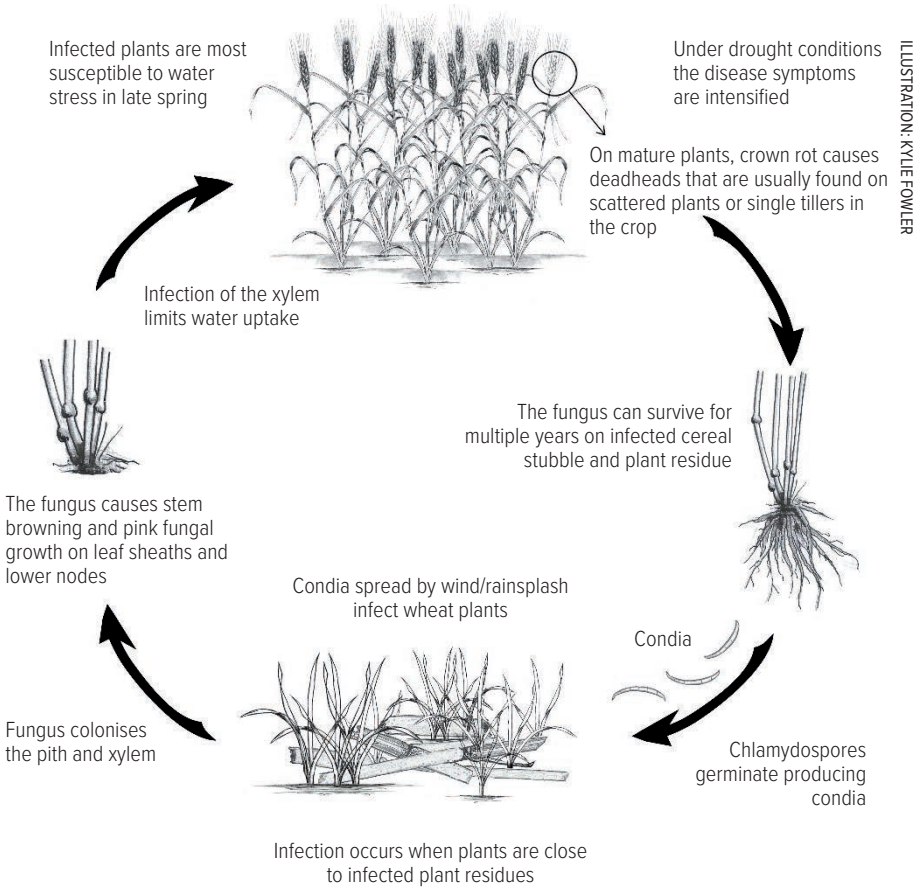


ILLUSTRATION: KYLIE FOWLER

FIGURE 6: Crown rot life cycle.

STUBBLE BURNING

Stubble burning is not a quick-fix for a high level of crown rot as burning does not remove inoculum from below ground. Depending on the timing of the burn, significant levels of soil moisture 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.

Strategies to reduce yield loss

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 durum wheat that are prone to high yield loss) can reduce losses and strategies such as inter-row sowing and time of sowing can contribute to reducing losses.

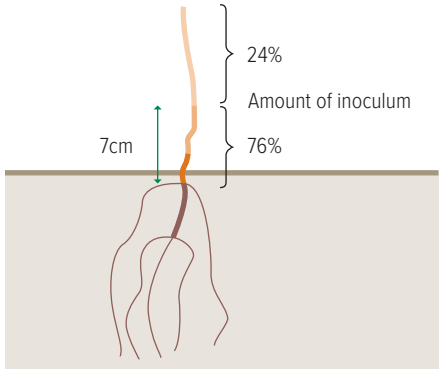
CEREAL TYPE

All winter cereals host crown rot and barley and bread wheats have varying levels of susceptibility. Yield losses vary with cereal type, variety and seasonal conditions. Barley is very susceptible to crown rot infection and will increase inoculum, but it generates higher yield compared with wheat because barley matures faster. Late-planted barley is likely to suffer significant yield losses similar to wheat.

VARIETAL RESISTANCE

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

All durum wheat varieties are very susceptible and should be avoided in medium and high-risk situations. Barley has varying levels of susceptibility and some newer varieties have a measurable improvement in their yield performance under crown rot infection.



SOURCE: SARDI

FIGURE 7: Crown rot distribution in infected cereal stubble.

Bread wheat varieties appear to differ significantly in their levels of yield loss, with newer varieties in the northern region (Sunguard$^{\Phi}$, Suntop$^{\Phi}$, LRPB Spitfire$^{\Phi}$, LRPB Gauntlet$^{\Phi}$, LRPB Lancer$^{\Phi}$, LRPB Mustang$^{\Phi}$ and Mitch$^{\Phi}$) appearing to suffer less yield impact compared with the previously widely grown variety EGA Gregory$^{\Phi}$. NSW DPI trials from 51 sites conducted between 2013 and 2017 across northern NSW and southern Queensland indicate that this can represent a yield benefit of around 0.5 to 0.7 tonnes per hectare in the presence of high levels of crown rot infection over more susceptible varieties.

However, variety choice alone is not a solution to crown rot. Even the best bread wheat or barley variety suffers up to 40 per cent yield loss under high infection levels and a dry/hot seasonal finish.

TIME OF SOWING

Sowing a variety early in its optimum sowing window will help minimise the detrimental effects of crown rot infection by bringing the grain-filling period forward into slightly reduced water stress conditions at the end of the season. However, this should be balanced against any increase in the risk of frost damage in your area.

INTER-ROW SEEDING

If cereals are to be planted into an at-risk paddock, infection rates can be reduced by sowing between intact rows of previous standing cereal stubble (Figure 9). In the north, inter-row sowing using accurate ±2 centimetre differential GPS autosteer has been shown to decrease the number of infected plants by around 50 per cent, resulting in a five 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 nutritional inputs to expected yields and available stored water. 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.

PHOTO: GRDC

FIGURE 8: Cultivation is likely to increase infection in the next cereal crop by breaking up and spreading the infected residues.

PHOTO: GRDC

FIGURE 9: Crown rot infection rates can be reduced by sowing between intact rows of previous standing cereal stubble.

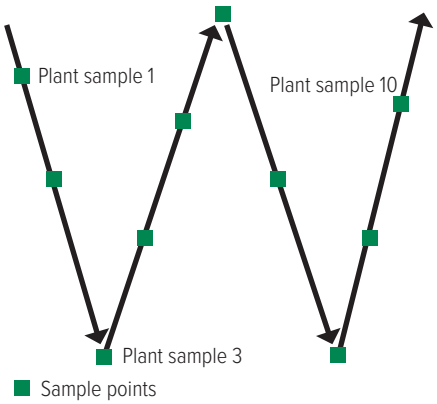


FIGURE 10: Pattern for plant samples in-crop. SOURCE: SARDI

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 seasons not particularly suited to the expression of crown rot.

Cereals differ in their tolerance to the different species of *Pratylenchus* (nematode) found in soils across the northern region. *Pratylenchus thornei* is the dominant species in the north of the region. *P. neglectus* is more prevalent in the southern part of the northern region.

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 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.

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 the 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 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

PREDICTA® B – 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 russell.burns@sa.gov.au. See the SARDI website, pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

Crown Analytical Services,
PO Box 911, Moree, NSW 2400
0437 996 678
lab@crownanalytical.com.au
www.crownanalytical.com.au

National Variety Trials,
www.nvtonline.com.au

Northern Grower Alliance,
www.nga.org.au

Cereal Disease Guides produced by each state: www.extensionaus.com.au/field-crop-diseases/cereal-disease-guides

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

GRDC Know more series, Parts 1 and 2, Managing crown rot – www.youtube.com/watch?v=ClXWTRblMrY and https://www.youtube.com/watch?v=k9ykmx4-WSw

MORE INFORMATION

Steven Simpfendorfer, NSW DPI,
0439 581 672,
steven.simpfendorfer@dpi.nsw.gov.au

Andrew Milgate, NSW DPI, 02 6938 1990,
andrew.milgate@dpi.nsw.gov.au

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