CROWN ROT – SOUTHERN FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN
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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 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
- **INOCULUM LEVELS.** Maintaining crown rot inoculum at low levels is the most effective way to reduce yield loss
- **ROTATE CROPS.** Rotate at-risk paddocks to non-host crops. This is the most effective management option. A grass-free break from winter cereals is the best way to lower crown rot inoculum levels
- **RESISTANCE.** Choose cereal crops carefully. Sow winter cereals, particularly durum, into paddocks where the risk is lowest. Selecting more resistant cereal types and varieties can help but still needs to be combined with other management options
- **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

PHOTO: NSW DPI

FIGURE 1: Crown rot can appear as whiteheads (right); however, growers are urged to also inspect for basal browning.

Crown rot is an important stubble-borne fungal disease of cereals that is common in Victorian and South Australian crops. During seasons with below-average rainfall it causes whiteheads to develop in wheat crops resulting in yield losses from about five per cent to more than 20 per cent. Yield losses in durum wheat are much greater than in bread wheat and can be more than 50 per cent.

The first step in controlling crown rot is to identify paddocks at risk. This can be done using a PREDICTA® B test before sowing or through inspection of stem bases for symptoms. In paddocks with a high crown rot risk, rotation to non-cereals can reduce inoculum levels. In paddocks with medium crown rot risk, avoiding durum and bread wheats can prevent large losses. There are several strategies presented in this fact sheet that can contribute to reducing losses associated with crown rot.

Symptoms

An obvious symptom of crown rot in bread and durum wheat is the presence of whiteheads in the crop during early grain fill (Figures 1 and 2). These heads mature early and contain shrivelled or no grain. Whitehead expression is more common in seasons with a dry spring. To confirm that whiteheads are caused by crown rot, inspect stem bases for browning (Figure 3). Note that an absence of whiteheads does not mean a crop is not infected by crown rot and that whiteheads may be also caused by other factors. For more details on crown rot identification see Box 1.

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Seasonal conditions

Losses from crown rot are strongly influenced by how a season finishes, with losses greater in seasons with a dry finish than in seasons with a wet finish (Figure 4). The fungus grows quicker in the base of an infected cereal plant at low water levels and blocks water movement up the stem to the head, causing whiteheads. Water stress later in the season, and therefore crown rot symptoms, can be worse where nitrogen inputs have been high early in the season.

Life cycle

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 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.

A new crop becomes infected when infected crop residues are in close contact with new cereal plants. The closer that infected stubble pieces are to a new plant, the higher the likelihood that infection will occur. Infection is favoured by moderate soil moisture at any time during the season. Infections occur 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 5).

Management

Crown rot management relies on:

1. identification of paddocks at risk;
2. reducing crown rot inoculum; and
3. strategies that minimise losses when cereals are grown.

Identification of paddocks at risk

The risk of crown rot in a paddock can be identified before planting, giving the opportunity to avoid losses from the disease. Research has clearly shown that higher inoculum levels in a paddock before planting result in greater yield losses in seasons conducive for crown rot expression. Before planting, a PREDICTA® B test can identify crown rot risk, enabling management strategies to be implemented. Stem bases can be inspected for symptoms to determine likely crown rot risk. See Box 2 for more information on assessing crown rot risk.

Reducing crown rot inoculum

In paddocks at risk of crown rot, rotation to break crops and stubble management can reduce crown rot risk and the threat to a subsequent cereal crop.

ROTATIONS

A grass-free break from cereals decreases crown rot inoculum (Figure 8). The type of break (for example, oilseed, pasture, legume, fallow) does not make a large difference, so select a break crop most suited to the farming system and

PHOTO: SARDI

FIGURE 2: Whiteheads caused by crown rot are generally uniformly scattered across a paddock or may be present around tree lines. Note that other factors (mice, insect damage and frost) can cause whiteheads and it is always best to inspect stem bases for characteristic stem browning. INSET: A wheat stem showing the pink growth that can be observed with crown rot.

BOX 1: CROWN ROT IDENTIFICATION

Crown rot usually first becomes obvious in a crop after flowering, when scattered whiteheads develop (Figure 2). These whiteheads are caused by the early death of individual tillers, or if severe, the whole plant. Whiteheads are more common in seasons with a dry finish. Whiteheads caused by crown rot are usually scattered across a crop and are more common around trees or other areas of the paddock prone to water stress. It is important to note that crown rot-infected crops do not always show whiteheads, so inspection of stem bases is the best way to identify an infection.

Crown rot-infected stem bases have a honey-brown discolouration on the lower leaf sheaths, stem bases and sub-crown internode. It is best to pull back the leaf sheaths when inspecting the base of the stem for the characteristic browning caused by crown rot (Figure 3). If blackening of the stem base, crown and roots is observed, then take-all is a more likely cause of the problem.

Another diagnostic feature of crown rot is the presence of a pink fungal growth on the lower stem, observed when the sheath is pulled back (Figure 2). This is not always observed, but if present it is a clear indication of this disease. It is typically present when humidity levels are high.

Whiteheads in a crop may also be caused by the fungal disease take-all. Take-all causes whiteheads on all tillers and the disease usually occurs in patches. In contrast, crown rot often infects single tillers on a plant and is scattered across a crop. It is important to note that whiteheads can also be caused by drought, frost, insect or mouse damage to stems, and sometimes by nutrient deficiencies or toxicities.

with the best economic return. The length of break required between cereal crops varies, depending on crown rot levels and the rate of stubble breakdown. Typically, a two to four-year break will be required, if inoculum levels are high, to reduce disease risk to a low level, particularly if there is low rainfall.

Good rainfall increases the effectiveness of a break, as the cereal residues harbouring the pathogen are more readily decomposed by microbes in moist soils. 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 therefore reduced inoculum levels.

MANAGING STUBBLE

Since crown rot is stubble borne, any strategies that accelerate the breakdown of stubble will also reduce the risk from crown rot. Within the plant, the inoculum is more concentrated in the crown and the bottom seven centimetres of the stem (Figure 5).

Stubble management practices such as cultivating, spreading straw, slashing and grazing can increase the rate of stubble decomposition in the medium to long term. However, in the short term these practices can increase crown rot risk as they can increase the number of infected stubble pieces that can contact new crop plants and increase infection rates.

Fragments of stubble may be hard to see with the human eye, but even small pieces can carry the disease. A PREDICTA® B test is the most accurate way to determine crown rot risk, even when small stubble fragments are infected.

Before cultivating or burning to accelerate stubble breakdown, also consider the implications for nutrient loss, erosion and degradation of soil structure.

Baling and removing straw or hay are not instant solutions for crown rot. Much of the crown rot inoculum is below the cutting level for straw and hay (Figure 5). Stubble burning is also not a quick-fix for high inoculum levels. Even where a good burn can be achieved, burning will not remove inoculum from below-ground. Depending on the timing of the burn, soil water can be lost through a lack of stubble cover during the fallow period and increase wind erosion. This water loss can exacerbate crown rot expression late in the season.

Strategies to reduce yield loss in cereal crops

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

Cereal crops differ in their yield losses due to crown rot (Figure 4). Therefore, if a cereal is to be grown in a paddock with a crown rot risk, yield losses will be less if barley or oats are grown in preference to bread wheat or durum wheat.

Note that even though barley and oats have reduced yield loss compared with wheat, they still increase inoculum levels (Figure 8), which will increase the crown rot risk in that paddock for a following cereal crop. To reduce crown rot levels and avoid losses it is best to rotate to a non-cereal break. Barley most likely escapes yield loss due to its early maturity, enabling it to finish grain filling before there is water stress at the end of the season.

PHOTO: NSW DPI

FIGURE 3: Characteristic basal browning associated with crown rot (right) compared with unaffected plants (left).

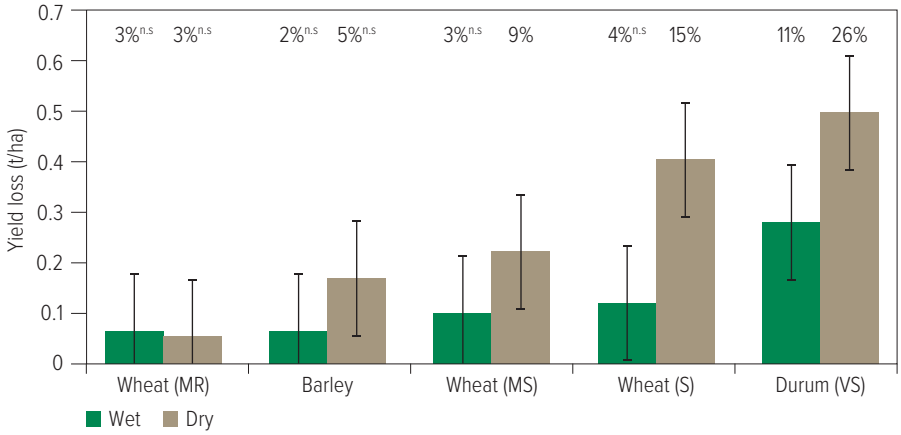

FIGURE 4: Yield loss in cereals based on an analysis of 43 field experiments conducted in Victoria and South Australia in both wet (above-average combined September and October rainfall) and dry seasons (below-average combined September and October rainfall), 1998 to 2015.

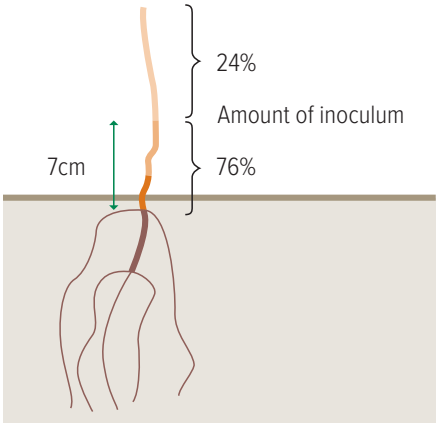

FIGURE 5: Crown rot distribution in infected cereal stubble.

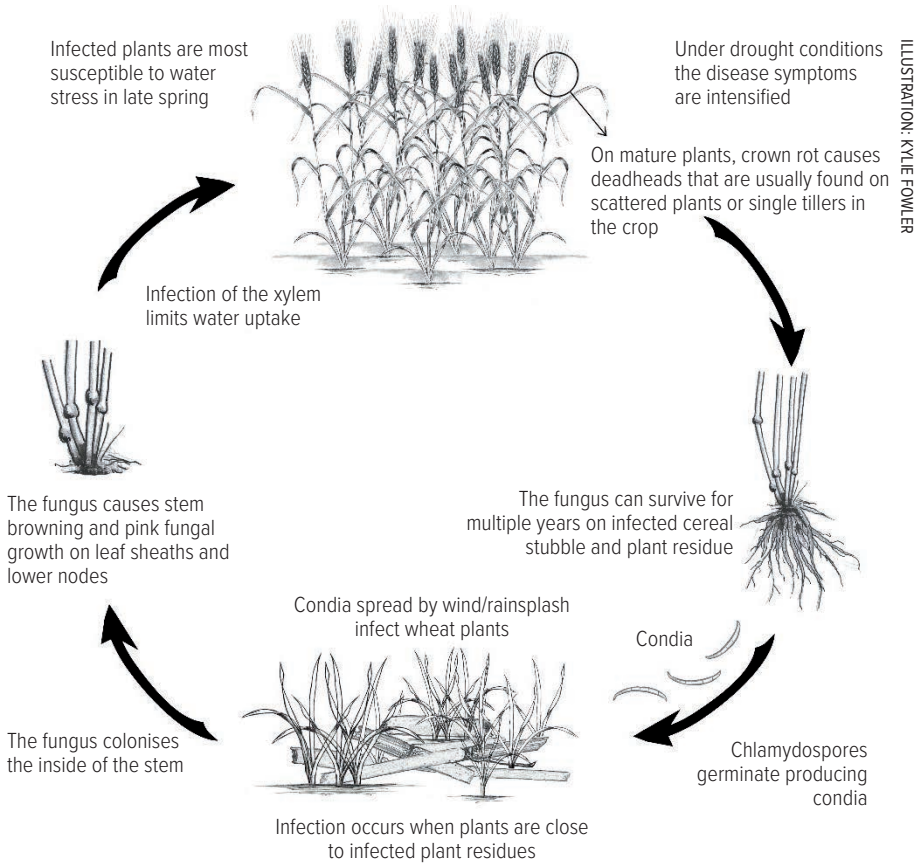

ILLUSTRATION: KYLIE FOWLER

FIGURE 6: Life cycle of crown rot.

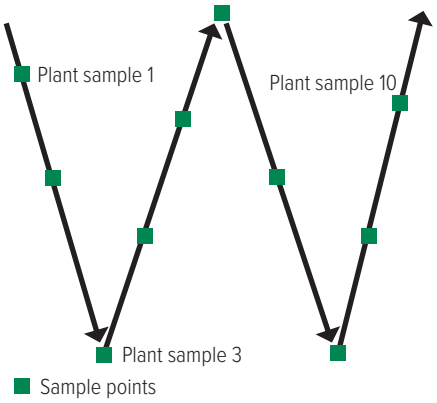

FIGURE 7: Sampling pattern within a paddock when collecting plants for assessment of stem browning caused by crown rot.

BOX 3: CROWN ROT MANAGEMENT FOR DURUM GROWERS

Yield losses due to crown rot are much greater and more common in durum than bread wheat. Therefore, durum growers are encouraged to test (see Box 2) all paddocks planned for durum wheat and only plant durum wheat into paddocks with no or low crown rot detected. In paddocks with medium crown rot levels yield losses of 20 to 50 per cent are common if there is a dry end to the season.

BOX 2: 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 cause 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 before sowing. This requires a dedicated sampling strategy and is not a simple add-on to a soil nutrition test.
- Soil cores should target 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 can consult SARDI for the latest recommended sampling strategy for your region.
- It is important to follow the recommended sampling protocols.

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 each of 10 locations (Figure 7). Examine each plant for basal browning, record what percentage of plants show symptoms (refer to Box 1) and then put in place appropriate measures for next year if the crown rot levels are medium or high.

In general, the risk of crown rot for the next season will be:

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

Within wheat cultivars there is some variation in the extent of yield loss; selecting more tolerant cultivars can reduce some of the yield loss. Consult an up-to-date cereal disease guide for crown rot ratings (see Useful resources). GRDC is supporting pre-breeding research to develop wheat cultivars with improved resistance to crown rot that will reduce yield losses.

INTER-ROW SEEDING

If cereals are to be planted into an at-risk paddock, the extent of the loss can be reduced by inter-row sowing. Since most of the crown rot inoculum is in the stem bases of the previous cereal crop (Figure 5), planting in the inter-row increases the distance between the new crop and the old infected plants, therefore decreasing the level of infection in the new crop.

Studies in the southern and northern regions have shown that planting in the inter-row can decrease the number of infected plants by about 50 per cent, which provides a small reduction in the extent of yield loss.

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.

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.

SEED-APPLIED FUNGICIDES

There are no in-crop fungicide control options for crown rot. However, there are some seed treatments that may provide partial suppression of crown rot. These may be an advantage when used in conjunction with other management options.

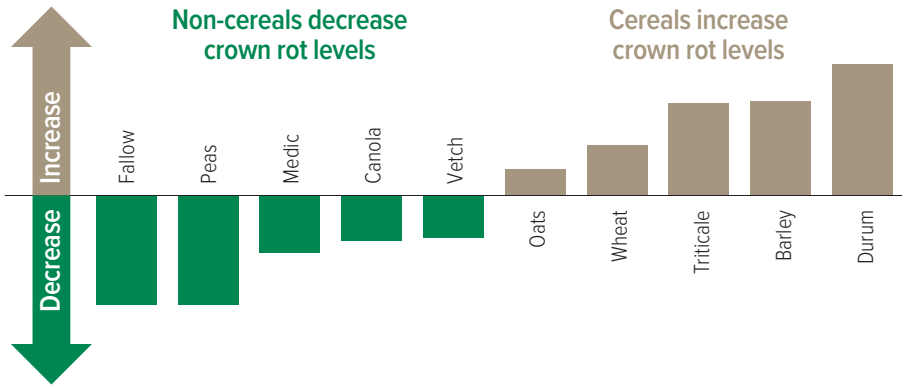

FIGURE 8: Rotation effects on crown rot levels in the soil in the following year (summary of six trials in South Australia and Victoria).

PHOTO: NSW DPI

FIGURE 9: Whiteheads are more prevalent with moisture stress. Checking around tree lines can be a better indicator in wetter or milder years.

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.

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?

No, 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.

Should I sow durum into a paddock if I do not know the crown rot risk?

Yield losses due to crown rot are much greater and more common in durum than bread wheat. Therefore, durum growers are encouraged to test all paddocks planned for durum wheat and only plant durum wheat into paddocks with no or low crown rot detected. In paddocks with medium crown rot levels yield losses of 20 to 50 per cent are common if there is a dry end to the season.

USEFUL RESOURCES

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. See the SARDI website, pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

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

State Crop Variety Guides: https://grdc.com.au/resources-and-publications/all-publications/crop-variety-guides

National Variety Trials, www.nvtonline.com.au

MORE INFORMATION

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