Crown Rot Management Strategies

(Northern New South Wales and Queensland)

Key issues are summarised below and additional detail is available inside.

Whiteheads in a wheat crop after moisture stress.

Photo courtesy Hugh Wallwork, SARDI

Assessment of the Level of Crown Rot

An accurate assessment of the level of crown rot in each paddock is an essential first step in developing a risk reduction strategy.

There are basically two different approaches to assessing levels of crown rot within a paddock which can then be used to broadly categorise disease risk as being high (H), medium (M) or low (L). *(See page 3)*

1. VISUAL MEASUREMENT – this can only be done in a standing cereal crop during grain development or near harvest. Assessments should be based on the prevalence of basal browning and NOT the expression of whiteheads. *(Instructions page 2)*

2. PREDICTA B is a soil based test which detects DNA levels of the crown fungus. Therefore it is highly sensitive and thus it is critical to follow the supplied sampling guidelines.

An integrated approach to disease management, using a combination of the following strategies is essential to reducing losses to crown rot.

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- **CROP ROTATION** is the most effective method to reduce crown rot. Rotations should include the strategic use of crops such as chickpea, faba bean, field pea, canola, mustard, mungbean, sunflower, sorghum or cotton.

  Break crops sown on narrow row spacings will produce denser canopies that increase the breakdown of infected cereal residue.

Irrespective of which crop is used effective control of grass weeds both during the life of the crop and in the fallow periods is critical.

- **REDUCE MOISTURE STRESS** in your wheat or barley crop through fallow management, avoiding excessively high sowing rates, matching nitrogen fertiliser inputs to available water, controlling in-crop and fallow weeds.
- **PLANTING BETWEEN THE ROWS** of the previous winter cereal crop. Crown rot fungus is stubble-borne so in a no-till system the inoculum becomes concentrated in previous winter cereal rows. Note that this relies on the previous cereal rows remaining intact as any fragmentation (e.g. cultivation, mulching, grazing etc.) redistributes inoculum into the inter-row area.
- **ENSURE ADEQUATE NUTRITION** especially zinc.
- **SOW BREAD WHEAT VARIETIES WITH IMPROVED PARTIAL RESISTANCE TO CROWN ROT.** All durum varieties are highly susceptible. Note that all current barley varieties are very susceptible and result in considerable build-up of inoculum. However, barley suffers less yield loss from crown rot due largely to its earlier maturity.
- **BURNING STUBBLE** does not guarantee freedom from crown rot. Burning only removes above ground inoculum with the crown rot fungus still surviving in crown tissue below the ground.

The publication "Northern Grain Production – a farming systems approach" summarised recent QLD DPI&F and NSW DPI rotation research plus 13 farmer case studies of farmers with long term rotations resulting in low levels of crown rot in 2005.

The Disease

Crown rot caused by the fungal pathogen *Fusarium pseudograminearum* is a major constraint to winter cereal production (wheat, barley and triticale) in Australia.

The disease is characterised by a light honey-brown to dark brown discolouration of the base of infected tillers. Initial infection is favoured by wet conditions but the fungus grows more rapidly through the plant tissues when they are stressed for moisture, resulting in the development of whiteheads (Figure 1). The disease effectively blocks the base of infected tillers, preventing water movement from the roots through the stems, producing prematurely ripened heads (whiteheads) that either contains no grain or light-weight shrivelled seed. With crown rot, the whole plant may not necessarily be affected or dead, and in fact some tillers may appear quite healthy, producing normal heads.

Yield losses from crown rot are therefore most severe in seasons with a wet start followed by a dry finish.

Basal browning characteristic of crown rot left, compared to healthy plant right.

Figure 2. Courtesy Lester Burgess, University of Sydney

However, it is important to distinguish between infection (basal browning) and whitehead expression (i.e. yield loss). Whiteheads are purely a response to infection that develops with the onset of moisture stress.

The host range of the crown rot fungus includes wheat, barley, triticale and many of the common grass weeds - phalaris, wild oats, barley grass, ryegrass and summer grasses. Some plant species, such as oats (cereal, grazing and wild oats), host the crown rot fungus but do not show visible signs of infection.

The prevalence of crown rot is influenced more by the cropping system than soil type with the frequency of cereal growth and stubble retention being the two biggest factors favouring the development of a disease problem.

Assessment

The first step in managing crown rot is to monitor and record the levels of disease in each paddock remembering that whiteheads are not expressed in years with a wet finish.

There are basically two different approaches to assessing levels of crown rot within a paddock which can be used to broadly categorise disease risk as being high (H), medium (M) or low (L).

1. VISUAL – this can only be done in a standing cereal crop during grain development or near harvest. Assessments should be based on the prevalence of basal browning and NOT the expression of whiteheads. To get an accurate assessment of crown rot levels ten plants should be pulled randomly from ten spatially separated locations within a paddock on a W sampling pattern. The leaf sheaths should be rubbed back and the first internode of all tillers visually assessed for basal browning. The number of diseased plants in 100 plants provides a percentage crown rot figure where the disease risk is L ≤ 10%, M = 11-24% and H ≥ 25% diseased plants. Assessments should be undertaken annually in paddocks with a history of crown rot particularly after a number of years of winter cereal production.

2. PREDICTA B – is a pre-sowing soil test which detects levels of the crown rot fungus using a sophisticated DNA method. Sample collection technique is important, and agronomists are trained in this and interpretation of results to ensure a valid result. Risk categories (H, M or L) presented in the report are based on the level of crown rot fungal DNA in the submitted soil sample. It is a useful tool for monitoring changes in risk levels following break crops or fallow where no other method of assessment is readily available.

Disease Management

Crop rotation, varietal selection, nutrition , grass control and planting strategies need to be integrated for effective management of crown rot.

Crop Rotation

It is important to remember that crown rot is a stubble-borne pathogen which survives as mycelium (cottony growth) inside cereal and grass weed residues. The initial starting levels of crown rot inoculum and the season in which break crops are grown will influence their effectiveness. Hence, rotation to non-host winter pulse (chickpea, faba bean, field pea, lupin) or oilseed (canola or mustard) crops or summer crops (sorghum, cotton, sunflowers, mungbean etc.) are the most crucial component of an integrated disease management system. Break crops allow natural microbial decomposition of cereal residues which harbour the crown rot fungus.

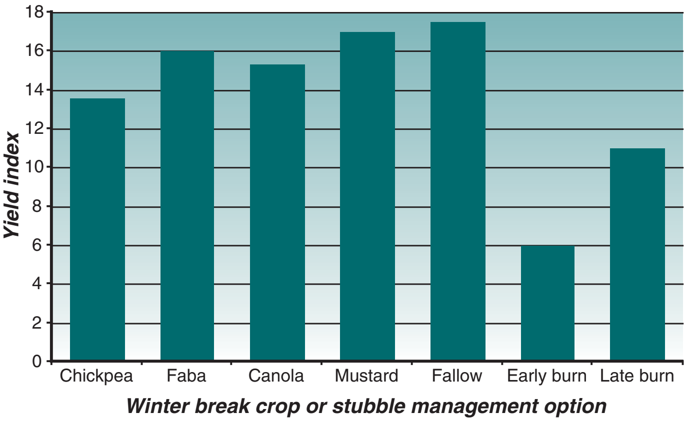
The row spacing at which break crops are sown is likely to influence their effectiveness in controlling crown rot. Research indicates that break crops grown on row spacings of 30 or 38 cm rather than 50 or 100 cm provide more ground cover and will be more effective in reducing the inoculum of the crown rot fungus.

The effectiveness of a break crop in terms of reducing yield loss to crown rot is a function of both inoculum survival (decomposition) and water use pattern of the break crop. Chickpeas and field peas tend to use less water during the season than brassicas and generally do not root as deep in the soil. Thus cereal crops growing after chickpeas or field peas may experience reduced moisture stress through this water saving and this reduces the development of whiteheads in infected tillers.

It is not the retention of cereal residues in a no-till farming system which is the problem with crown rot. It is the amount of this cereal residue containing the crown rot fungus which creates the problem. The aim is to keep inoculum levels low with an integrated approach to disease management so that crown rot does not become a major limitation to production.

Cropping options

Yield response in a following cereal crop as a result of the benefit of reducing crown rot is a function of a break crops effect on inoculum survival, soil water and nitrogen. Yield responses from NSWDPI experiments are summarised in the graph below and compared with other disease management options of a long fallow, early (December) or late (May) burning of wheat stubble.



Yield indexed to continuous wheat. Source: NSW DPI

> Long term monitoring has confirmed that crop rotation is effective for the management of crown rot.
>
> *Take home message from "Crown rot monitoring studies NW NSW - What have we learnt about the impacts of rotation": L W Burgess, P Castor, J Smith-White. Paper at the 2005 Goondiwindi GRDC Adviser Update.*
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> In one example crown rot in a Sunco crop was 94% but after a cotton - durum - chickpea rotation the following Lang wheat crop had only 2% infection.
>
> In another case Sunco wheat had an 80% infection but following a chickpea - sorghum sequence crown rot was not detected in the Sunvale crop.
>
> In the same research crown rot levels in one case increased from 8% to 32% following a break crop due to the lack of grass weed control.

Some common rotations

The rotations listed are examples of the type of rotation required to reduce the risks of losses to crown rot in subsequent wheat crops.

The publication "Northern Grain Production – a farming systems approach" contains 13 detailed farmer case studies of farmers with long term rotations and low levels of crown rot in 2005.

HIGH LEVEL OF CR INFECTION (≥25%)

- LF - Sorghum— DC Chickpeas – Wheat
- Chickpea - LF— Sorghum— LF - Wheat
- DC Mungbean – LF – Sorghum— DC Chickpea— Wheat
- LF - sorghum – LF – Wheat - Chickpeas

3 years Lucerne provided it is kept grass free

MEDIUM LEVEL OF CR INFECTION (11-24%)

- Pre plant burn – Chickpea – Wheat
- Chickpea – Pre plant burn - Wheat
- LF – Sorghum— Wheat
- DC Summer Crop – LF – Wheat

LOW LEVEL OF CR INFECTION (≤10%)

No limitation to crop choice. However, regular inclusion of break crops will prevent crown rot levels from rising.

NOTE: LF = long fallow, DC = double crop. In the examples above, faba bean, field pea, canola/mustard can substitute for chickpea and other summer crops for sorghum. Barley can be substituted for wheat.

Rotation Crops

All winter and summer break crop options provide a yield benefit in subsequent cereal crops as a direct result of reducing levels of crown rot. The selection of the appropriate break crop to suit individual situations will have the most economic impact.

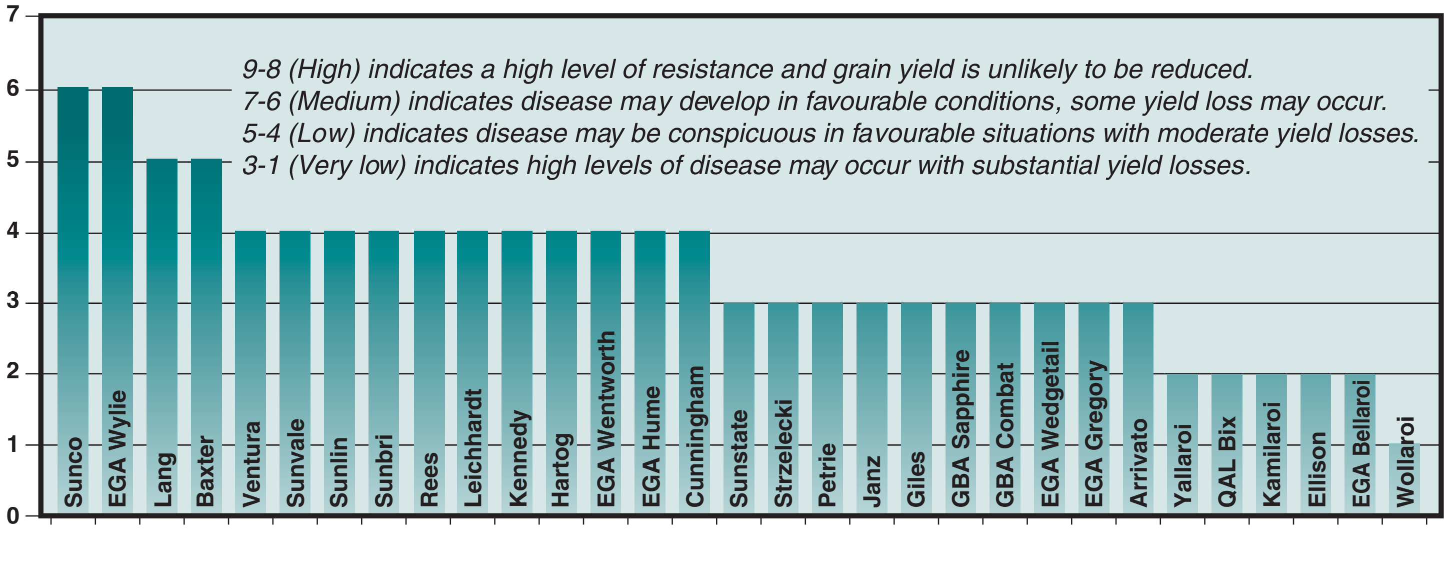
WINTER PULSE CROPS

All new pulse varieties have a Pulse Australia VMP (Variety Management Package) which provides the critical management recommendations for that variety. Both the NSW DPI and QLD DPI&F provide extensive crop guides as well.

Wheat and barley varieties

Although there are no varieties that have total resistance to crown rot on the market wheat varieties like Sunco, Baxter, Lang and EGA Wylie have useful levels of partial resistance. All current durum varieties are highly susceptible to crown rot and should only be considered in low risk situations. All barley varieties are quite susceptible to infection and can cause a build-up of inoculum. However, barley tends to suffer less yield loss than wheat due to its earlier maturity.

Partial resistance of northern wheat varieties (QLD DPI&F)



Chickpeas – by far the most popular winter broadleaf crop in the northern region due to its adaptation and proven performance. There are three new varieties, Flipper, Yorker and Kyabra will make chickpeas more attractive to most farmers. Better suited to the well drained deeper clay soils

Faba bean – With the release of Cairo the area in N/NSW and QLD border areas has increased significantly. Has the best tolerance to water logging of all pulse crops and also contributes significantly higher levels of nitrogen to the soil.

Field peas – Yarrum, the new release from Sydney University is the first field pea adapted to the northern region. Suited to a wider range of soil types, particularly lighter soils.

WINTER OILSEEDS

Canola and Mustards – canola is more suited to C/NSW and the higher rainfall areas of N/NSW and the new mustard releases appear to have potential in the NW of NSW.

SUMMER CROPS

Sorghum – in areas where sorghum is adapted it is a valuable crop in rotations to reduce levels of crown rot and in many areas is part of a successful rotation that also includes chickpeas or faba beans.

Other Summer Crops – mungbeans, sunflower, maize, cotton etc can be used instead of sorghum when appropriate.

Double crop options

With seasonal conditions resulting in significant acreage of summer crops such as sorghum in the northern cropping zone, chickpeas and field peas are good 'double crop' options for 2006 to get back into a winter rotation. Both chickpeas and field peas have low water use compared to other winter crop options and provide a further disease break for crown rot. Growers should consider narrow row spacing if specifically targeting further decomposition of winter cereal residues harbouring the crown rot fungus.

Nitrogen interactions

In northern NSW and Queensland, research has shown that nitrogen inputs need to be matched to available soil water. Nitrogen interacts with crown rot in two ways. Firstly, when excessive N is applied then vegetative growth is enhanced which uses additional soil moisture resulting in increased moisture stress producing whiteheads during grain fill.

Secondly, recent work by both UNE and NSWDPI has further shown that N by itself increases the severity of disease (extent of basal browning) in infected tillers. Of particular importance is adequately estimating the N input from the various pulse break crop options. Underestimating N inputs from pulses may result in excessive additional N being applied to the following winter cereal crop.

Zinc nutrition

Zinc nutrition certainly plays a minor role in reducing losses to crown rot. However, it appears that routine application of zinc, to ensure maintenance levels within the soil, are adequate to manage this aspect.

Grass weed control

Grass weeds can impact on crown rot in two ways. Firstly, many are alternate hosts of *F. pseudograminearum* so can facilitate increased survival over the summer fallow and in break crops. Secondly grass weeds can also reduce soil water storage over the summer fallow or compete with the cereal crop for available water. This can result in increased moisture stress and exacerbate the development of whiteheads in infected crops.

The control of grass weeds both in-crop (especially in break crops) and over the fallow period is critical.

Inter-row sowing

Crown rot inoculum remains concentrated in the previous cereal rows in a no-till farming system. Recent work by the UNE has shown that infection occurs when the plant (crown, sub-crown internode or tiller bases) comes in direct contact with a piece of residue harbouring the crown rot fungus.

Research by NSW DPI at 44 sites in 2005 showed that sowing between previous winter cereal rows decreases the severity (average 51%) and incidence (average 45%) of crown rot in following cereal crops.

However, inter-row sowing is NOT a solution to crown rot but rather a useful additional strategy.

Burning

Burning stubble only removes above ground inoculum with the crown rot fungus still surviving in crown tissue below ground. There is also no heat kill of inoculum in the soil. Growers need to be aware of potential losses in stored soil moisture as a result of burning (especially with an early burn).

A late burn in autumn is preferable to an early burn in summer as cereal residues are retained for a longer period. Soil water storage is maintained but above ground inoculum is reduced.

An additional option is to use an autumn burn prior to or after a break crop. This removes above ground inoculum and only decomposition of infected cereal crowns is needed during the rotation.

Cultivation

Soil cultivation is being considered by many no-till growers in 2006 as an option for controlling Fleabane. This practice will assist also in the reduction of crown rot inoculum but could result in decreased soil water storage over the fallow. This may cause increased moisture stress late in the winter season and a greater expression of whiteheads in plants with crown rot. Furthermore, if conditions (moisture and time) are not conducive to microbial decomposition then the increased fragmentation of infected cereal residues can increase the number of plants which get infected in the subsequent winter cereal crop.

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