Yield impact of crown rot and sowing time on winter cereal crop and variety selection – Tulloona 2015

Steven Simpfendorfer, Rick Graham and Neroli Graham

NSW DPI, Tamworth

Introduction

Crown rot, caused predominantly by *Fusarium pseudograminearum* (*Fp*), is a major constraint to winter cereal (wheat, barley and durum) production in northern NSW and southern Qld. Infection is characterised by a honey–brown discolouration at the base of infected tillers. All winter cereal crops host the crown rot (CR) fungus. Yield losses vary between winter cereal crops, with the approximate order of increasing loss being oats (least), barley, triticale, bread wheat and durum (most). Yield loss is related to the expression of whiteheads in CR infected tillers that are induced by moisture and/or temperature stress during flowering and grain-filling.

Previous NSW DPI research has demonstrated that earlier sowing can reduce CR expression by bringing the grain-filling period forward when temperatures are generally lower and less favourable to CR expression. Earlier sowing also theoretically facilitates increased root growth early in the season, which can result in deeper root exploration and improved access to soil moisture. Evapotranspiration stress during grain-filling can also be manipulated through the relative maturity of crop type and variety choice. Variety maturity interacts with the expression of CR, which depends when stress occurs within a given season and the variety's developmental stage. In the northern grains region, sowing time and variety maturity need to be balanced against the risk of excessive early vegetative growth depleting soil moisture reserves before grain-filling, and the risk of frost versus terminal heat stress during flowering and grain development.

The impact of crown rot on yield and grain quality was examined in a range of durum, bread wheat and barley varieties across two sowing times near Tulloona in north-western NSW in 2015.

Key findings

Sowing date and variety maturity choice is a balance between the risk of frost versus terminal heat stress.

Earlier sowing can increase frost risk, but also generally maximises yield potential and reduces the extent of yield loss from crown rot.

Cereal crop and variety selection can have a significant impact on yield where there are high levels of crown rot infection.

Durum wheat, barley or bread wheat varieties with increased susceptibility to crown rot, should only be grown in paddocks known to have low-risk inoculum levels based on testing (e.g. PreDicta B®).

All winter cereal varieties are susceptible to crown rot infection and will not significantly reduce inoculum levels for subsequent crops. Cereal crop and/or variety choice is not the sole solution to crown rot.

Site details

Location:	**"Myling", Tulloona**
Co-operators:	**Jack and Julia Gooderham**
Sowing dates:	**Time of sowing: TOS1–6 May 2015; TOS2–4 June 2015**
Fertiliser:	**90 kg/ha urea and 70 kg/ha Granulock® Z at sowing**
Starting N:	**137 kg/ha nitrate nitrogen (N) to 1.2 m**
Starting water:	**~209 mm (0–120 cm)**
In-crop rainfall:	**150 mm**
PreDicta B®:	**2.5 *Pratylenchus thornei*/g soil (medium risk), 2.0 log *Fusarium* DNA/g (medium risk) at sowing**

Treatments

- Twenty-four barley entries (Figure 1)
- Five durum wheat entries (Figure 1)
- Nineteen bread wheat entries (Figure 1)
- Added (plus) or no added (minus) crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Results

Sowing time effect

Yield was reduced from 5.11 t/ha with TOS1 down to 4.23 t/ha with TOS2 in the no added CR treatment when averaged across the 48 winter cereal entries. This represented a 17% (0.89 t/ha) reduction in yield potential with a delayed sowing of four weeks. In the presence of high levels of crown rot infection (added CR) average yield across entries was reduced from 4.76 t/ha with TOS1 down to 3.33 t/ha with TOS2, which represented a larger 30% (1.42 t/ha) reduction in yield potential associated with delayed sowing. This was due to a considerably higher average level of yield loss associated with increased CR infection of 21% (0.89 t/ha) with later sowing (TOS2) compared to an average of only 7% (0.35 t/ha) with TOS1.

Cereal crop and variety differences – TOS1 (6 May 2015)

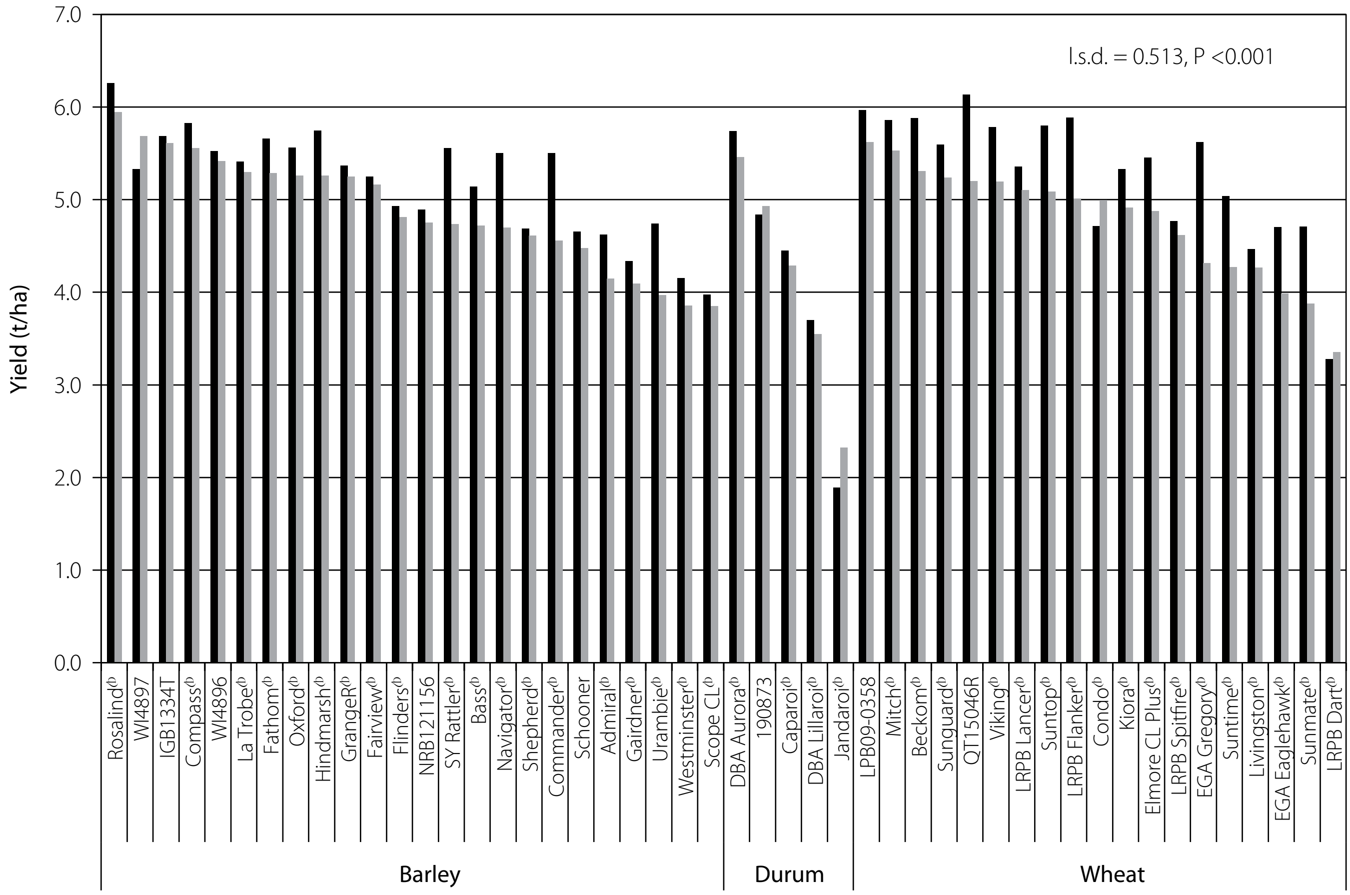

***Figure 1.** Crown rot effect on the yield of 24 barley, 5 durum and 19 bread wheat entries sown on 6 May – Tulloona 2015*

For TOS1, frost did negatively affect the quicker-maturing durum and bread wheat varieties yields (Figure 1). Frost damage was most noticable in the durum varieties Jandaroi and DBA Lillaroi, and with LRPB Dart (bread wheat). For the no added CR treatment, for barley, yield ranged from 6.26 t/ha with the recently released feed variety Rosalind down to 3.98 t/ha with Scope CL; in durum from 5.74 t/ha with DBA Aurora down to 1.89 t/ha with Jandaroi (frosted), and in bread wheat from 6.14 t/ha with the advanced breeding line QT15046R down to 3.28 t/ha with LRPB Dart (frosted) (black bars, Figure 1).

Yield loss associated with high levels of CR infection is measured as the difference between the no added CR (black bar) and added CR (grey bar) treatments (Figure 1). Added CR significantly reduced yield in only four of the barley entries at TOS1 (Figure 1):

1. 15% in Navigator (0.81 t/ha)
2. 15% in SY Rattler (0.82 t/ha)
3. 16% in Urambie (0.77 t/ha)
4. 17% in Commander (0.95 t/ha).

For the five durum varieties, yield loss from added CR at TOS1 was not significant, but remember that the yield potential of quicker-maturing varieties was frost-affected.

For TOS1, 10 of the 19 bread wheat entries (Beckom, Viking, Elmore CL Plus, Suntop, Suntime, EGA Eaglehawk, QT15406R, LRPB Flanker, Sunmate and EGA Gregory) suffered significant levels of yield loss with added CR infection, ranging from 10% (0.57 t/ha) in Beckom up to 23% (1.31 t/ha) with EGA Gregory (Figure 1).

Cereal crop and variety differences – TOS2 (4 June 2015)

No frost damage was evident in any of the winter cereal entries when sowing time was delayed to 4 June in 2015. In the no added CR treatment, barley yields ranged from from 5.04 t/ha with the advanced breeding line W14896 down to 3.31 t/ha with Gairdner; in the durum from 4.76 t/ha with DBA Aurora down to 4.21 t/ha with Caparoi; and in bread wheat from 4.80 t/ha with Livingston down to 3.40 t/ha with EGA Eagkehawk (black bars, Figure 2).

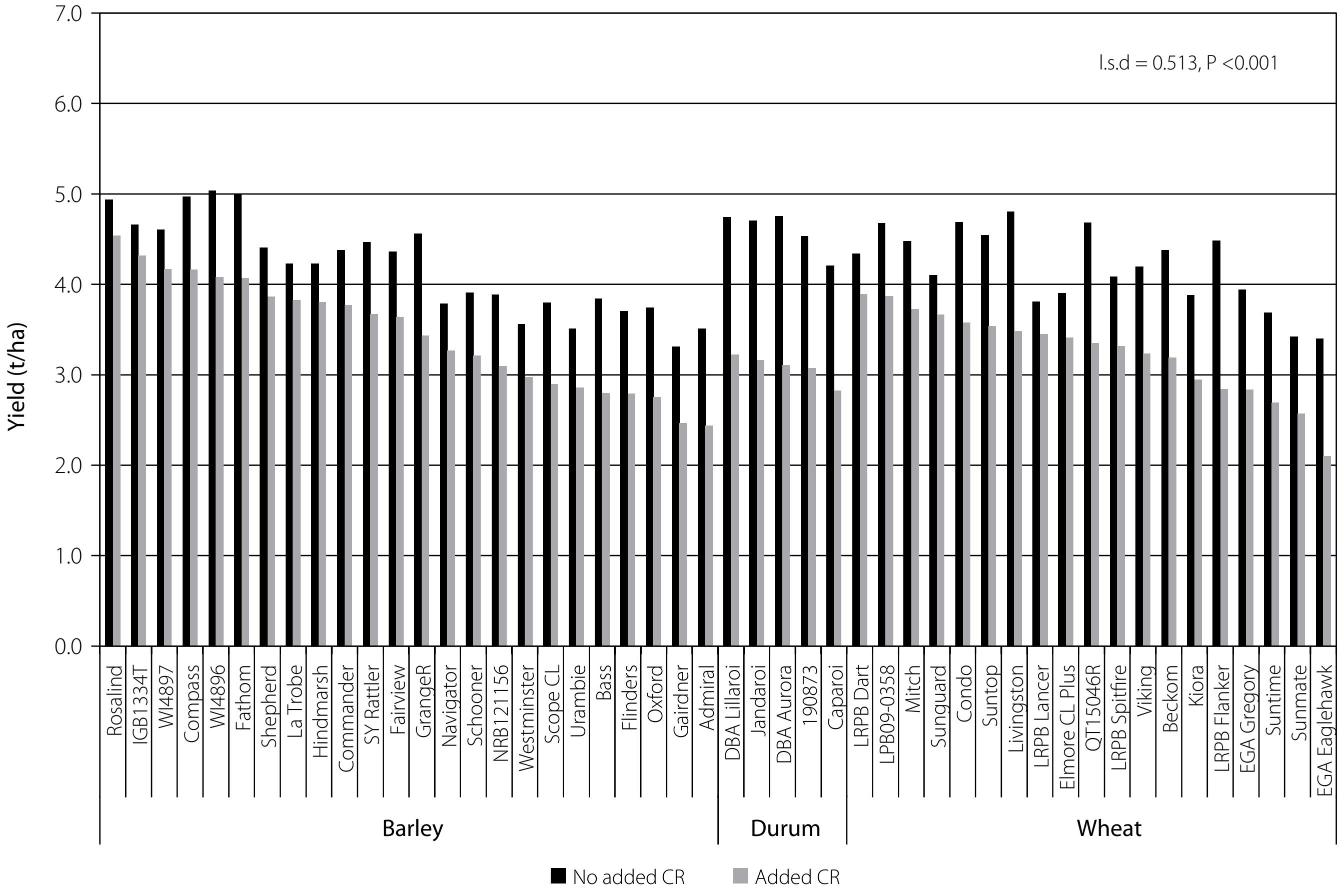

***Figure 2.** Crown rot effect on the yield of 24 barley, 5 durum and 19 bread wheat entries sown on the 4 June – Tulloona 2015*

For TOS2, added CR caused significant levels of yield loss in 19 of the 24 barley entries (except Rosalind, IGB1334T, W14897, La Trobe and Hindmarsh) and ranged from 12% in Shepherd (0.54 t/ha) up to 30% in Admiral (1.07 t/ha) (Figure 2).

Added CR caused all five durum varieties to suffer relatively high and significant levels of yield loss, with no difference between variety. Yield loss ranged from 32% in the advanced durum breeding line 190873 (1.47 t/ha) up to 35% in DBA Aurora (1.65 t/ha).

Added CR infection caused 15 of the 19 bread wheat entries (except LRPB Dart, Sunguard, LRPB Lancer and Elmore CL Plus) to suffer significant levels of yield loss. They ranged from 17% (0.75 t/ha) in Mitch up to 37% (1.64 t/ha) with LRPB Flanker (Figure 2).

Concentrating purely on the extent of yield loss associated with CR infection in the different varieties can potentially be misleading, as entries can vary markedly in their actual yield potential in a given environment and season. Amongst the bread wheat entries, Sunguard and LRPB Lancer had the lowest percentage yield loss from CR when sown on 4 June (TOS2) at Tulloona in 2015. However, in the absence of added CR (black bars) Sunguard was significantly lower yielding than Livingston (0.70 t/ha), Condo (0.59 t/ha), and the two numbered lines LPB09-0358 and QT15046R (0.58 t/ha) (Figure 2). LRPB Lancer, similarly in the no added CR treatment for TOS2, was between 0.99 t/ha to 0.53 t/ha lower yielding than the bread wheat entries Livingston, Condo, LPB09-0358, QT15046R, Suntop, Mitch, LRPB Flanker , Beckom and LRPB Dart at

Tulloona in 2015. Hence, selecting a variety on the basis of reduced yield loss to CR should not come at the expense of yield potential at the targeted sowing time.

Another option for evaluating the data is to concentrate on the absolute yield achieved under high disease pressure in the added CR treatments at each sowing time (grey bars; Figures 1 and 2). Under high CR pressure for TOS1 (6 May) only three barley varieties (Urambie, Westminster and Scope CL were lower yielding than Commander (range 0.59 to 0.71 t/ha), while 11 barley entries (Fairview to Rosalind) were higher yielding than Commander (range 0.60 to 1.39 t/ha; Figure 1).

Due largely to frost in the durum entries for TOS1, DBA Lillaroi (0.74 t/ha) and Jandaroi (1.97 t/ha) were significantly lower yielding than Caparoi, while DBA Aurora was 1.17 t/ha higher yielding than Caparoi in the added CR treatment.

With the bread wheat entries for TOS1, only the severely frost affected variety LRPB Dart was lower yielding (0.95 t/ha) than the widely grown variety EGA Gregory, while 12 entries (Elmore CL Plus to LPB09-0358) were higher yielding than EGA Gregory (range 0.57 t/ha to 1.31 t/ha; Figure 1).

The effects from high levels of CR infection on yield were considerably greater with the later sowing time of 4 June (TOS2), but significant yield benefits were still apparent with potential crop and variety selections. Under high CR pressure for TOS2, 10 barley varieties (Schooner to Admiral) were lower yielding than Commander (range 0.56 to 1.33 t/ha), while only two barley entries (IGB1334T and Rosalind) were higher yielding than Commander (range 0.55 to 0.77 t/ha; Figure 2).

The five durum entries showed no significant difference in yield under high levels of CR infection for TOS2.

For the bread wheat entries in TOS2 with added CR, only the long-season entry EGA Eaglehawk was lower yielding (0.74 t/ha) than EGA Gregory, while nine entries (Elmore CL Plus to LRPB Dart) provided a significant yield benefit over EGA Gregory (range 0.57 t/ha to 1.05 t/ha; Figure 2)

Implications

In the northern grains region, sowing date and variety maturity choice is a balance between the risk of frost versus terminal heat stress. Both can have a significant impact on grain yield as highlighted at Tulloona in 2015. Frost risk needs to be kept in perspective and sowing date matched to the relative maturity of a chosen variety. A very conservative approach to frost risk, based on recent experience, runs the risk of pushing grain-filling too far into warmer conditions. This, itself, can reduce yield, but if there is also an underlying issue with CR, then delayed sowing significantly exacerbates the expression of this disease with negative effects on both yield and grain quality.

Winter cereal crop types and varieties do differ in their extent of yield loss from CR infection. Hence, producing more susceptible cereal crop types such as durum wheat, or bread wheat varieties such as EGA Gregory, needs to be targeted at low risk paddocks based on either stubble or DNA testing such as PreDicta B®. Unfortunately, grain quality data was not available at the time of writing this paper, but should be included in any variety selection considerations.

Barley is generally considered more CR tolerant (reduced yield impact) than bread wheat as its earlier maturity tends to largely escape severe evapotranspiration stress, which exacerbates expression. However, this trial highlights that this escape mechanism depends on sowing time, with barley entries suffering an average 18% yield loss from CR at the later sowing time (4 June) relative to only 6% with the earlier sowing time (6 May). Barley is very susceptible to infection from the CR fungus and, if sown later in its planting window, will be trying to fill grain under warmer conditions, which can lead to significant yield loss from CR. This interaction is also generally more pronounced in varieties with longer maturity such as Oxford, which did not have significant yield loss at the earlier sowing date, but suffered 26% yield loss from CR infection with delayed sowing.

If forced into planting a cereal crop in a high CR risk situation, then some barley varieties could provide a yield advantage over bread wheat in that season, provided early stress does not occur and the escape mechanism is not lost through delayed sowing. Some of the newer bread wheat varieties do appear to be closing this gap to some extent. However, a key message is that this decision is only potentially maximising profit in the current season. Growing barley over bread wheat will not help to reduce CR inoculum levels, as barley is still very susceptible to infection. Significant yield loss can still occur in the best of the barley and bread wheat varieties from high CR infection. Crop and variety choice is therefore not the sole solution to CR, but rather just one element of an integrated management strategy to limit losses from this disease.

Acknowledgments

The research undertaken as part of projects DAN00175: National crown rot epidemiology and management program and DAN00167: Variety Specific Agronomy Packages for southern, central and northern NSW; is made possible by the significant contributions of growers through both trial co-operation and the support of the GRDC, the authors would like to thank them for their continued support. This project is co-funded by the NSW state government through NSW DPI who are also thanked for their support in fully funding two of our positions and for laboratory and other infrastructure costs. Soil-borne pathogen levels were determined using the DNA based soil test service PreDicta B® provided by the South Australian Research and Development Institute. Technical assistance provided by Stephen Morphett, Jim Perfrement, Jan Hosking, Mick Dal Santo, Robyn Shapland and Patrick Mortell is gratefully acknowledged. We finally thank Jack and Julia Gooderham for allowing us to conduct this trial on their property 'Myling' near Tulloona in 2015.