Response of barley, durum and bread wheat varieties to crown rot across two sowing times – Tamworth 2014

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Introduction

Crown rot (CR), caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), is a major constraint to winter cereal (wheat, barley and durum) production in the northern grains region. Yield loss is related to the expression of whiteheads that are induced by moisture and/or temperature stress during flowering and grain-fill. Previous NSW DPI research has demonstrated that earlier sowing can reduce the expression of CR by bringing grain-fill forward a week or two to when temperatures are generally lower. Earlier sowing potentially also facilitates increased root growth early in the season, which might result in deeper root exploration and access to additional soil moisture throughout the season. However, sowing time needs to be balanced against the risk of excessive early vegetative growth depleting soil moisture reserves before grain-fill 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 22 barley, six durum and 34 bread wheat entries across two sowing times at Tamworth in northern NSW in 2014.

Key findings

Yield in the presence of crown rot was generally barley > bread wheat > durum across both sowing times, but significant differences were evident between varieties.

Barley, bread wheat and durum varieties differ in their extent of yield loss from crown rot and their actual yield and grain quality (screenings) in the presence of this disease.

However, all varieties are susceptible to crown rot infection and will not significantly reduce inoculum levels for subsequent crops. Variety choice is not a sole solution to crown rot.

Site details

Location:	**Tamworth Agricultural Institute, NSW DPI, Tamworth**
Sowing dates:	**TOS1: 20 May 2014; TOS2: 10 June 2014**
Fertiliser:	**180 kg/ha urea and 50 kg/ha Granulock® Supreme Z at sowing**
In-crop rainfall:	**225 mm (TOS1) and 192 mm (TOS2)**
PreDicta B®:	**Nil RLN and 2.6 log *Fusarium* DNA/g (high risk) at sowing**
Harvest date:	**17 November 2014**

Treatments

- Twenty-two barley; six durum wheat and 34 bread wheat entries (Table 1).
- Added (plus) or no added (minus) CR at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Results

- No frost damage was evident across entries for either sowing time.
- The average yield of all entries and CR treatments was 3.80 t/ha across TOS1 (20 May) and 2.90 t/ha across TOS2 (10 June), which represents a 24% reduction in yield with a three-week delay in sowing.
- Sowing time did not significantly affect grain protein levels averaged across treatments.
- Average screening levels increased from 13.3% with TOS1 to 18.9% with TOS2, a 43% increase (P = 0.108).
- CR had limited impact on protein resulting in a 0.3% reduction in the added CR treatment compared with the no added CR treatment, which was only significant when averaged across all entries and sowing times.
- There was only a 0.7% increase in screening levels in the added CR treatment compared with the no added CR treatment when averaged across all entries and sowing times, due to high background inoculum levels across the site.

20 May sowing (TOS1)

- For barley, yield in the no added CR (high background inoculum levels) treatment ranged from 5.53 t/ha (La Trobe) down to 4.19 t/ha (Westminster); in durum from 3.34 t/ha (Hyperno) to 2.51 t/ha (Caparoi); and in bread wheat from 4.97 t/ha (Condo) to 2.99 t/ha (Sunvale; Table 1).

CROP PROTECTION

- TOS1 for the long season wheat variety Einstein was still too late for this variety, which struggled to meet its vernalisation requirement and was significantly later to produce heads and mature than any other entry, obtaining a yield of only 0.81 t/ha.
- Yield loss (difference between no added CR and added CR treatments) ranged in barley from 0.32 t/ha (6.5%) with Fathom to 1.32 t/ha (29.8%) with Oxford; in durum from 0.71 t/ha (21.6%) with entry 290564 to 1.18 t/ha (41.1%) with DBA Aurora; and in bread wheat from 0.32 t/ha (7.8%) with Suntop to 1.24 t/ha (34.5%) with Justica CL Plus (Table 1).
- The extent of yield loss has been underestimated due to high background inoculum levels across the site. A level of CR infection had already occurred in the no added CR plots. Focusing on yield in the presence of high levels of CR infection (added CR) provides a related measure of variety tolerance.
- Yield in the added CR (high infection levels) treatment ranged in barley from 4.91 t/ha (Hindmarsh) down to 3.11 t/ha (Oxford); in durum from 2.58 t/ha (290564) down to 1.64 t/ha (Caparoi); and in bread wheat from 4.03 t/ha (Condo) down to 2.36 t/ha (Justica CL Plus; Table 1).
- Adding CR inoculum did not significantly affect grain quality in any of the entries (data not presented). Hence the average of added CR and no added CR treatments for each entry are presented (Table 1).
- Quite high grain protein levels were achieved across the site for TOS1, which ranged in barley from 16.4% (IGB1140) to 13.5% (Grout); in durum from 14.8% (Caparoi) to 13.9% (Jandaroi); and in bread wheat from 15.5% (Lancer) to 12.5% (Sunmate; Table 1).
- Screening levels with TOS1 ranged in barley from 4.8% (NRB121156) to 60.5% (Urambie); in durum from 8.0% (Jandaroi) to 23.3% (Caparoi); and in bread wheat from 6.4% (Gauntlet) to 20.9% (Lincoln; Table 1).

Table 1. *Impact of crown rot and sowing time on the yield and grain quality of barley, durum and bread wheat – Tamworth 2014*

Variety	Yield (t/ha @ 11% moisture)				Protein (%)		Screenings (%)	
	20 May		10 June		20 May	10 June	20 May	10 June
	No added CR	Added CR	No added CR	Added CR				
Barley								
Bass$^{\phi}$	4.71	4.27	3.52	2.34	15.2	15.5	8.6	16.5
Buloke$^{\phi}$	4.76	4.15	3.89	3.02	14.4	14.7	10.5	18.2
Commander$^{\phi}$	5.14	4.25	4.54	3.69	14.2	14.1	15.6	13.7
Compass$^{\phi}$	5.15	4.59	4.67	3.71	13.8	13.8	9.4	10.8
Fairview$^{\phi}$	4.91	3.74	3.46	2.79	15.0	14.7	13.8	21.6
Fathom$^{\phi}$	4.89	4.57	4.38	3.67	15.1	14.8	9.1	9.2
Flinders$^{\phi}$	4.88	3.48	3.60	3.03	15.8	15.3	12.8	31.7
Gairdner$^{\phi}$	4.55	3.70	3.52	2.86	16.3	15.6	19.5	29.7
GrangeR$^{\phi}$	5.20	4.34	4.16	3.43	14.9	15.2	8.0	13.4
Grout$^{\phi}$	4.89	3.79	4.05	3.42	13.5	14.2	12.1	18.1
Hindmarsh$^{\phi}$	5.33	4.91	5.08	4.48	14.4	14.8	10.0	9.5
IGB1140	4.62	3.82	3.99	3.11	16.4	15.1	7.7	13.1
La Trobe$^{\phi}$	5.53	4.77	4.96	4.64	13.7	14.4	11.7	12.2
Navigator$^{\phi}$	4.33	3.67	3.67	2.79	15.9	15.1	19.4	25.2
NRB121156	4.61	3.61	3.49	2.81	15.3	15.3	4.8	12.7
Oxford$^{\phi}$	4.43	3.11	3.06	2.20	15.7	14.1	16.9	33.4
Scope CL$^{\phi}$	4.72	4.03	4.09	3.41	14.9	14.8	9.9	13.9
Skipper$^{\phi}$	5.16	4.81	4.63	4.31	14.8	14.6	9.0	7.8
SY Rattler$^{\phi}$	4.47	3.45	4.09	3.16	13.9	14.2	22.1	26.1
Urambie$^{\phi}$	4.39	3.91	3.26	2.56	15.4	15.0	60.5	54.1
Westminster$^{\phi}$	4.19	3.54	3.08	2.28	14.9	14.7	18.7	23.4

Variety	Yield (t/ha @ 11% moisture)				Protein (%)		Screenings (%)	
	20 May		10 June		20 May	10 June	20 May	10 June
	No added CR	Added CR	No added CR	Added CR				
Wimmera	4.62	3.84	3.58	3.00	15.9	15.7	16.3	20.7
Durum wheat								
290564	3.29	2.58	2.21	1.44	14.4	15.2	15.1	26.0
Caparoi	2.51	1.64	1.46	0.88	14.8	15.0	23.3	39.1
DBA Lillaroi	3.02	1.90	1.94	0.97	14.5	14.9	15.4	31.2
DBA Aurora	2.87	1.69	1.79	1.22	14.3	14.5	21.9	30.6
Hyperno	3.34	2.50	2.16	1.32	14.7	15.4	22.1	35.8
Jandaroi	3.29	2.54	2.61	2.09	13.9	14.5	8.0	14.1
Bread wheat								
Baxter	4.49	3.75	3.40	2.86	13.9	15.0	7.1	7.6
Condo	4.97	4.03	3.40	2.82	12.7	14.0	10.7	15.5
Corack	4.43	3.88	3.58	3.13	12.6	13.7	10.8	10.4
Crusader	4.16	3.43	3.57	3.19	13.3	13.4	14.7	11.9
Dart	4.45	3.56	3.50	3.02	13.2	13.9	14.3	16.3
Derrimut	4.40	3.87	3.11	2.49	13.6	14.5	13.2	18.0
EGA Gregory	3.79	3.01	2.69	1.97	13.1	13.5	11.2	21.4
EGA Wylie	4.25	3.22	2.89	2.29	14.5	15.3	11.2	12.4
Einstein	0.81	0.76	0.25	0.22	16.5	16.2	9.0	9.0
Elmore CL Plus	4.04	3.65	3.20	2.39	13.8	15.1	10.3	22.1
Emu Rock	4.35	3.95	3.52	2.96	14.2	14.9	12.1	13.2
Gauntlet	3.92	2.96	3.06	2.14	13.9	14.6	6.4	10.1
Grenade CL Plus	3.87	3.19	2.97	1.91	12.6	13.7	8.2	13.8
Impala	4.18	3.51	3.52	2.80	13.2	14.0	8.6	15.8
Justica CL Plus	3.60	2.36	2.35	1.84	14.5	15.2	14.5	20.0
Kiora	3.82	3.06	2.41	1.89	14.7	15.8	14.9	30.2
Lancer	3.78	3.13	2.92	2.46	15.5	15.9	7.3	17.1
Lincoln	3.21	2.43	2.09	1.55	13.9	15.1	20.9	28.5
Livingston	4.40	3.36	3.53	2.30	13.7	14.5	11.0	17.5
LPB09-0515	4.35	3.38	3.01	2.01	14.1	15.1	17.1	24.0
Mace	4.30	3.73	3.51	2.79	12.8	13.6	11.6	15.3
Merlin	4.48	3.82	3.51	2.46	14.5	16.0	8.7	11.5
Mitch	4.20	3.32	3.15	2.60	13.2	14.4	10.8	16.8
Phantom	3.98	3.18	2.75	1.87	14.0	14.8	10.5	14.2
Spitfire	4.28	3.88	3.55	2.84	14.6	16.0	8.6	9.1
Strzelecki	3.07	2.48	1.76	1.21	14.8	15.1	16.3	30.9
Sunguard	4.07	3.60	3.26	2.90	14.1	14.3	7.9	12.1
Sunmate	4.27	3.62	3.30	2.35	12.5	13.5	10.2	11.6
Suntime	4.35	3.71	3.10	2.41	13.3	14.3	10.9	15.7
Suntop	4.17	3.84	3.37	2.62	13.5	14.4	13.7	12.6
Sunvale	2.99	2.66	2.71	2.03	15.2	15.7	11.1	21.1
Ventura	4.33	3.65	3.57	2.84	13.6	14.1	14.1	15.5
Viking	4.05	2.92	2.22	1.30	14.2	15.4	14.1	28.8
Wallup	4.52	4.01	3.56	2.89	13.9	15.2	7.7	10.3
LSD	0.388				0.81		7.65	
P value	0.119				<0.001		<0.001	
CV (%)	8.3				3.8		30.7	

10 June sowing (TOS2)

- Yield in the no added CR (high background inoculum levels) treatment ranged in barley from 5.08 t/ha (Hindmarsh) down to 3.06 t/ha (Oxford); in durum from

2.61 t/ha (Jandaroi) to 1.46 t/ha (Caparoi); and in bread wheat from 3.58 t/ha (Corack) to 1.76 t/ha (Strzelecki; Table 1).

- TOS2 for the long-season wheat variety Einstein was even later, which did not meet its vernalisation requirement and was significantly later to produce only a few heads and mature than any other entry obtaining a yield of only 0.25 t/ha.
- Yield loss (difference between no added CR and added CR treatments) ranged in barley from 0.32 t/ha (6.5%) with La Trobe to 1.18 t/ha (33.5%) with Bass; in durum from 0.52 t/ha (19.9%) with Jandaroi to 0.97 t/ha (50.2%) with DBA Lillaroi; and in bread wheat from 0.36 t/ha (11.0%) with Sunguard to 1.23 t/ha (34.8%) with Livingston (Table 1).
- Yield in the added CR (high infection levels) treatment ranged in barley from 4.64 t/ha (La Trobe) down to 2.20 t/ha (Oxford); in durum from 2.09 t/ha (Jandaroi) down to 0.88 t/ha (Caparoi); and in bread wheat from 3.19 t/ha (Crusader) down to 1.21 t/ha (Strzelecki; Table 1).
- Adding CR inoculum did not significantly affect grain quality in any of the entries (data not presented). Hence the average of added CR and no added CR treatments for each entry are presented (Table 1).
- High grain protein levels were also achieved across the site with TOS2, which ranged in barley from 15.7% (Wimmera) to 13.8% (Compass); in durum from 15.4% (Hyperno) to 14.5% (DBA Aurora and Jandaroi); and in bread wheat from 16.0% (Merlin and Spitfire) to 13.4% (Crusader; Table 1).
- Screening levels with TOS2 ranged in barley from 7.8% (Skipper) to 54.1% (Urambie); in durum from 14.1% (Jandaroi) to 39.1% (Caparoi); and in bread wheat from 7.6% (Baxter) to 30.9% (Strzelecki; Table 1).

Conclusions

Sowing date and variety maturity choice is a balance between frost risk and terminal heat stress in the northern grain region. Both can significantly affect grain yield. No frost damage was evident at this site in 2014 with either sowing time, but terminal heat stress did occur, which was more severe during grain filling with the second sowing time. A three-week delay in sowing time resulted in an average 24% reduction in yield across the winter cereal entries. Later sowing pushed grain-fill too far into hotter conditions. This can reduce yield by itself, 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.

Varieties do differ in their extent of yield loss from CR and in their relative yield in the presence of high levels of infection, which is often referred to as tolerance. This is a function of a variety's level of partial resistance to infection, but appears to also interact with its environmental adaptation and maturity relative to the timing of stress (moisture and heat), which exacerbates the expression of CR. Generally quicker maturing barley, durum and bread wheat entries were higher yielding in the presence of CR infection in this trial. This does not necessarily mean that these varieties have improved levels of resistance to CR infection, but rather their quicker maturity allowed them to minimise stress during grain filling relative to longer season entries, reducing the expression of CR.

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, as long as early stress does not occur. Some of the newer bread wheat varieties do appear to be closing this gap to some extent. Barley tends to yield better in the presence of CR infection due to its earlier maturity relative to bread wheat, providing an escape mechanism that reduces its exposure to moisture stress during the critical grain filling stage. 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 very susceptible to infection. Significant yield loss is still occurring in the best of the barley and bread wheat varieties in the presence of high CR infection.

Profit can be maximised in the current season with variety selected for yield even with CR present, although all varieties still suffer yield loss. But this strategy will not reduce inoculum levels for subsequent crops.

Winter cereal 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.

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