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# Fusarium crown rot of wheat – do not stress!

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## Key findings

Crown rot infection restricts a plants ability to extract plant available water (PAW) from the soil profile, especially at depths below 80 cm.

Crown rot infection reduced the extraction of PAW by 24 mm at Garah in 2013 and 49 mm at Rowena in 2013 in the durum variety Caparoi(ϕ).

This resulted in yield losses of 55% at Garah in 2013 and 64% at Rowena in 2013.

## Introduction

Crown rot, caused predominantly by *Fusarium pseudograminearum (Fp)*, is a major disease of wheat and barley crops in the northern grains region of Australia, costing growers around $97m annually. *Infection* is characterised by a honey-brown discolouration at the base of infected tillers. Proliferation of hyphal growth in the base of infected tillers is triggered by moisture and/or evaporative stress which restricts water movement through the plant. This results in the *expression* of whiteheads during flowering and grain fill, which contain no grain or shrivelled grain depending on the timing of stress relative to crop development. This study aimed to determine the actual impact of crown rot infection on soil water use through the season.

## Site details

| | | | |
|---|---|---|---|
| Locations: | **Walgett** | **Rowena** | **Garah** |
| Property: | **'Wattle Plains'** | **'Woolondoon'** | **'Miroobil'** |
| Co-operator: | **Dave Denyer** | **David & Tim Cameron** | **Andrew & Bill Yates** |
| Sowing date: | **28 May 2012** | **30 May 2013** | **31 May 2013** |

## Treatments

- One bread wheat (LRPB Spitfire(ϕ)), one barley (Commander(ϕ)) and one durum variety (Caparoi(ϕ))
- Three row spacings of 30 cm, 40 cm and 50 cm
- Added (plus) or no added (minus) crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp* at a rate of 2 g/m of row.

Neutron probe access tubes were installed in each of the three replicate plots of all treatments to 1.8 m in each season. Soil moisture was measured in 0–30, 30–60, 60–90, 90–120 cm depth intervals at stem elongation (~GS30), flowering (~GS61), grain filling (~GS80) and physiological maturity (~GS92). The upper and lower soil water limits were characterised at each location through a 'wet-up' and 'rain exclusion' site adjacent to the trial area. This data was used to calculate the plant available water (PAW) at incremental depths down the soil profile for each plot at the different growth stages. Only the average soil water usage across the three row spacings of the durum variety cv. Caparoi(ϕ) with plus or minus added crown rot is presented in this current paper to simplify interpretation.

## Results

In 2012 at Walgett, due to a good starting soil moisture profile, average March to September rainfall, and generally average to below average in-crop monthly maximum temperatures, moisture stress occurred relatively late in the season. Due to the late onset of moisture stress, there was no significant difference in water extraction in terms of PAW remaining in the profile of infected versus uninfected durum plots averaged across all treatments (Figure 2a). The presence of crown rot infection did not cause a significant ($P<0.05$) yield loss in barley and only a slight reduction of ~3.7% for bread wheat, when averaged across all treatments (data not shown). In contrast, the durum cv. Caparoi(ϕ) experienced a yield loss of 17.8% in the presence of *Fp* infection with yield decreasing from 3.78 t/ha to 3.11 t/ha (Figure 1a). Importantly,

screenings (grain below the 2.0 mm screen) increased from 6.4% to 13.2% (Table 1), which would have resulted in a downgrading from ADR3 to feed grade and therefore both a yield and grain quality penalty was associated with crown rot infection even in a season with relatively moderate and late season moisture/temperature stress.
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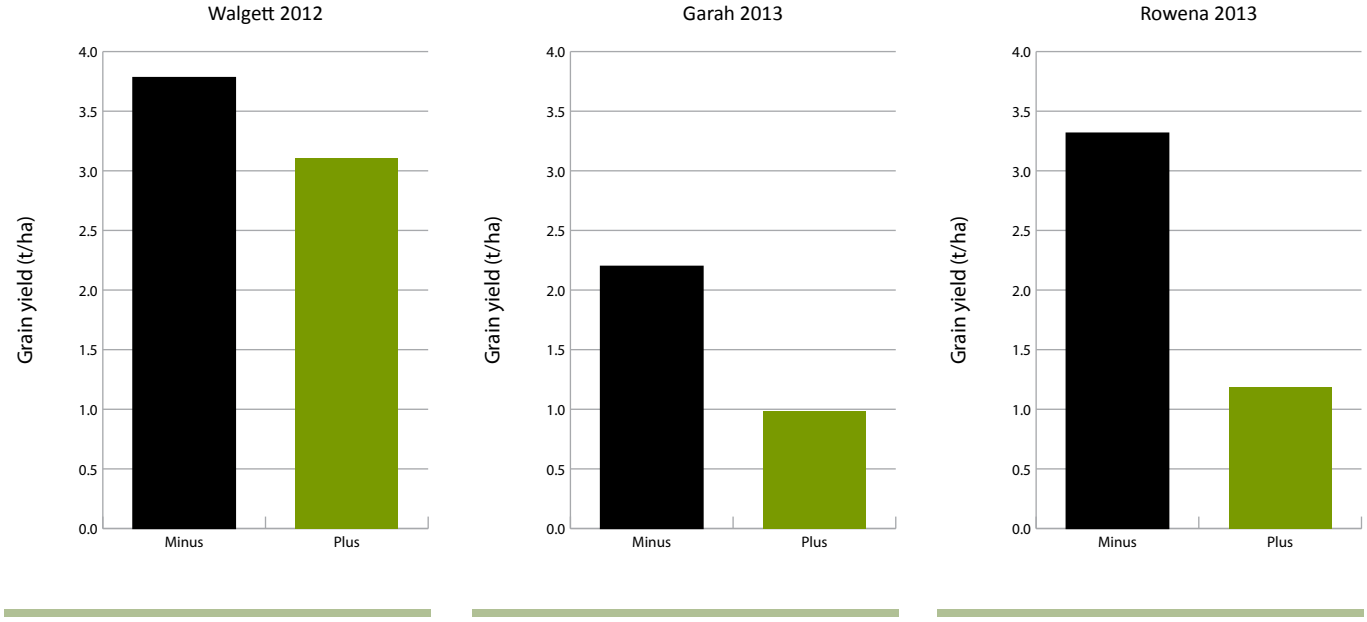


***Figure 1**. Grain yield (t/ha) for the durum wheat cv. Caparoi$^{(\phi)}$ plus and minus Fp infection, average across row spacing and plant populations at Walgett in 2012 (a), Garah in 2013 (b), and Rowena (c) in 2013. Bars represent L.S.D. (P=0.05).*

In contrast to the 2012 Walgett trial, moisture stress occurred in early August (~GS39) at both Garah (Figure 2b) and Rowena (Figure 2c) in 2013. Monthly rainfall at Garah and Rowena was below average in July, August and October 2013 with the mean maximum temperatures for July to October above average and or equivalent to the long-term highest mean monthly maximum temperatures. The difference in water extraction at Garah in terms of PAW remaining in the soil profile of *Fp* infected versus uninoculated plots was 10.3 mm at GS39 increasing to 24 mm at physiological maturity ~GS92 (Figure 2b). At Rowena the difference in unextracted PAW between plus and minus *Fp* infected plots was 23 mm at GS39, increasing to 49 mm at physiological maturity. These results demonstrate the potential for crown rot infection to restrict the ability of crops to extract PAW, which has a significant impact on grain yield and quality.

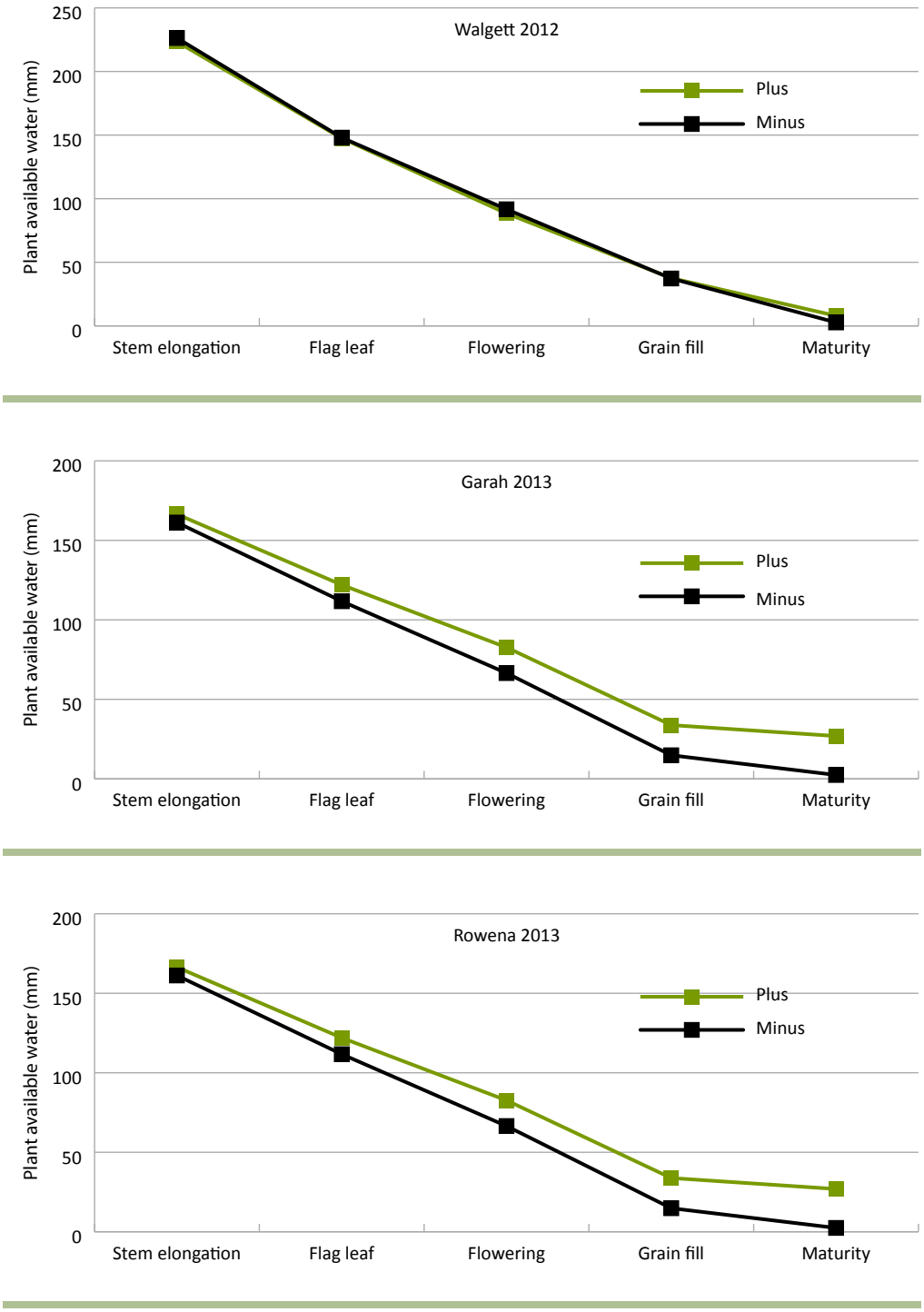


***Figure 2**. Impact of crown rot (plus and minus Fp infection) on soil water use of the durum wheat cv. Caparoi$^{(\Phi)}$ (0–150 cm) – Walgett 2012 (a), Garah 2013 (b), Rowena 2013 (c). Bars represent L.S.D. (P=0.05).*

Crown rot infection reduced yield by 55.3% (2.20 t/ha down to 0.98 t/ha) at Garah, and by 64.3% (3.32 t/ha down to 1.18 t/ha) at Rowena in 2013 (Figure 1b and c). Apart from grain yield, crown rot also impacted on grain quality parameters. Test weights at Garah decreased by 7.11 kg/hL, from 82.61 for uninfected plots to 75.54 kg/hL in *Fp* infected plots (Table 1). Similarly, screenings increased from 6.62% to 19.54% for *Fp* infected plots at Rowena with thousand grain weight (TWG) also decreasing in the presence of *Fp* infection (Table 1). It was also noted that grain protein concentration decreased at both Garah and Rowena in *Fp* infected treatments indicating that crown rot infection also appears to impact on the extraction, translocation and/or redistribution of nitrogen (N) within the plant.

***Table 1**. Grain quality parameters measured at each location for the durum cv. Caparoi(ϕ) plus and minus Fp infection.*

| Location | Grain quality | Minus | Plus | 5% L.S.D. |
|---|---|---|---|---|
| Walgett 2012 | Protein (%) | 11.76 | 12.65 | 0.27 |
| | Screening (%) | 6.36 | 13.21 | 0.16 |
| | Test weight (kg/hL) | 83.25 | 78.62 | 0.48 |
| | TGW (g) | 32.77 | 27.49 | 0.76 |
| Garah 2013 | Protein (%) | 13.86 | 13.55 | 0.23 |
| | Test weight (kg/hL) | 82.61 | 75.54 | 1.13 |
| Rowena 2013 | Protein (%) | 14.11 | 12.81 | 0.19 |
| | Screening (%) | 6.62 | 19.54 | 1.23 |
| | TGW (g) | 28.76 | 23.66 | 1.11 |



## Conclusions

Yield loss associated with crown rot infection, is largely related to the expression of whiteheads, which is influenced by moisture and/or temperature stress during flowering and grain filling. Crown rot infection was shown to restrict the plants ability to extract PAW, its impact on grain yield and quality, being dependant on the timing of stress relative to crop development. Results showed that even with only relatively moderate late seasonal moisture/temperature stress, such as experienced at Walgett in 2012, that the durum cv. Caparoi(ϕ) still experienced a yield loss of 17.8% in the presence of *Fp* infection, with screening levels also increasing from 6.36% to 13.21%. At Garah and Rowena, with stress occurring earlier in the season from GS39 onwards the presence of *Fp* infection resulted in a significant decrease in the extraction of PAW. This resulted in significant reductions in both yield and grain quality. Yield decreased by 55.3% at Garah and by 64.3% at Rowena, grain quality parameters (screenings/test weight) were also impacted, resulting in quality downgrades. These results reinforce the susceptibility of durum to crown rot infection and highlight the need to avoid planting, where there is an increased potential risk of infection and or increased likelihood of early onset of moisture stress particularly during anthesis and grain fill.

## Acknowledgements

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