Department of Primary Industries

Northern grains region trial results Autumn 2015

RESEARCH & EXTENSION – INDEPENDENT RESEARCH FOR INDUSTRY

Editors: Loretta Serafin, Steven Simpfendorfer,
Mike Sissons, Andrew Verrell & Guy McMullen

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Editing and compilation

This report has been compiled by Loretta Serafin, Steven Simpfendorfer, Mike Sissons, Andrew Verrell and Guy McMullen, all from NSW DPI, Tamworth, on behalf of the authors.

Front cover photo: Mungbean Field, Leigh Jenkins, NSW DPI, Trangie.
Rear cover photo: Soybean Field, Natalie Moore, NSW DPI, Grafton.

Foreword

NSW Department of Primary Industries (NSW DPI) is a major source of applied Research & Development (R&D) for cropping systems in central and northern NSW especially in collaboration with our major funding partner the GRDC. The NSW DPI R&D teams based across the region; at Trangie, Tamworth, Narrabri and Grafton, conduct a range of on-farm research trials across plant breeding, agronomy, physiology, nutrition and crop protection.

This is the sixth edition of the Northern Grains Region Trials Book and it has continued to evolve each season since the first edition. The 2015 volume includes 49 papers reporting on trials from across the northern grains region from Dubbo and into southern Queensland. These short papers have been written to improve the awareness and accessibility of the results from NSW DPI run research trials in the region. The papers are based on scientifically sound, independent research but need to be taken in the context of the situation and season that the work has been conducted. Most of the papers report on an individual trial in one location over one season. In order to make best use of all research data, the results from several sites and seasons should be used. In many cases the research that is reported will prompt questions and we encourage you to contact the authors to discuss any of these queries.

The work that is reported is only possible through the cooperation of the many growers, advisors and consultants who our research teams work with throughout the year and these contributions are acknowledged within each paper. We also collaborate with other research organisations including grower groups such as Grains Orana Alliance and Northern Grower Alliance, agribusinesses, universities and other state based research providers.

Finally, we would like to thank the authors and editorial team for all their work compiling and reviewing the diverse range of papers in this year's edition.

We hope that you find the papers informative and of value to your business and we would also welcome any feedback that you might have that would help us to continue to make our research program and the Northern Grains Region Trials Book a valuable resource into the future.

The Research & Development Team,

Northern Cropping Systems

NSW Department of Primary Industries

Contents

Contents

Cereal variety x weed competition – Trangie 2014

Greg Brooke[1], Leigh Jenkins[1], Rick Graham[2] and Guy McMullen[2]
[1] NSW DPI, Trangie [2] NSW DPI, Tamworth

Key findings

The barley varieties Compass$^{\Phi}$, La Trobe$^{\Phi}$ and Scope CL$^{\Phi}$ were the highest yielding varieties in this trial in the presence and absence of weed pressure.

Increasing the plant population of La Trobe$^{\Phi}$, and Scope CL$^{\Phi}$ improved their relative yield where weeds were also present by 15% and 6%, respectively and further reduced weed seed-set.

La Trobe$^{\Phi}$, Scope CL$^{\Phi}$ and Compass$^{\Phi}$ were the most competitive varieties and provided greatest suppression of weeds.

Barley was generally more competitive with the mimic weed than wheat but large differences were apparent between varieties.

Introduction

Herbicide resistance has led to a greater need for Integrated Weed Management (IWM). Growers are seeking non-herbicide options to help reduce weed competitiveness and seed-set. Crop competition is an important management tool in helping suppress weed growth in-crop. However, crop types and varieties differ in their competitive ability. In this trial a range of barley, wheat and triticale varieties were tested for their competitive ability against a known population of weeds (oats).

Site details

Location:	**Trangie**
Co-operator:	**Agricultural Research Station**
2013 crop:	**Field peas**
Soil type:	**Brown chromosol**
P (Colwell):	**35 mg/kg**
Total N:	**175 kg/ha (0–120 cm)**
PAW:	**~36 mm (0–120 cm in April)**
In-crop rainfall:	**142 mm from 1 May to 31 October**
Sowing date:	**12 June**
Fertiliser at sowing:	**70 kg/ha Granulock Supreme Z treated with 500 g/L of flutriafol**
Fertiliser post sowing:	**77 L/ha Easy N in July**
Harvest date:	**7 November**
Herbicides:	**Precept® at 1 L/ha (150 EC)**

Treatments

- 11 cereal varieties: All varieties sown to establish target plant populations of 100 plants/m^2 (100) and two varieties were also sown at a target of 200 plants/m^2 (200)
- All varieties were sown both with and without weeds (+/- treatments) aiming to establish 50 weed plants/m^2
- The varieties used were:
    - Barley: Buloke$^{\Phi}$, Commander$^{\Phi}$, Compass$^{\Phi}$, Gairdner$^{\Phi}$, GrangeR$^{\Phi}$, Scope CL$^{\Phi}$ (100 and 200), La Trobe$^{\Phi}$ (100 and 200), Urambie$^{\Phi}$
    - Wheat: Sunvale$^{\Phi}$, LRPB Spitfire$^{\Phi}$
    - Triticale: Canobolas$^{\Phi}$
- Weed: Yarran oats @ 50 plants/m^2 sown inter-row as a mimic weed

Results

- The barley varieties Scope CL$^{\Phi}$ and La Trobe$^{\Phi}$ suppressed weed seed-set down to around 100 kg/ha compared to the least competitive varieties (e.g. Urambie$^{\Phi}$) which allowed 500 kg/ha of weed seed-set.
- In this trial varieties such as Sunvale$^{\Phi}$ with less competitive ability lost up to 29% of their potential yield due to the presence of weeds (Oats @ 50 plants/m^2).

- Doubling the seed rate of two of the barley varieties; Scope CL$^{\phi}$ and La Trobe$^{\phi}$ (from 100 to 200 seeds/m^2) provided increased weed competition and improved the relative yield of the crop.
- The variety La Trobe$^{\phi}$ responded well to increased target plant population. La Trobe$^{\phi}$ yielded an additional 15% by increasing the plant stand from 100 to 200 plants/m^2 in the presence of weed competition. At 200 plants/m^2 La Trobe$^{\phi}$ suffered only 8% yield loss from weed competition compared with 23% at 100 plants/m^2.

Summary

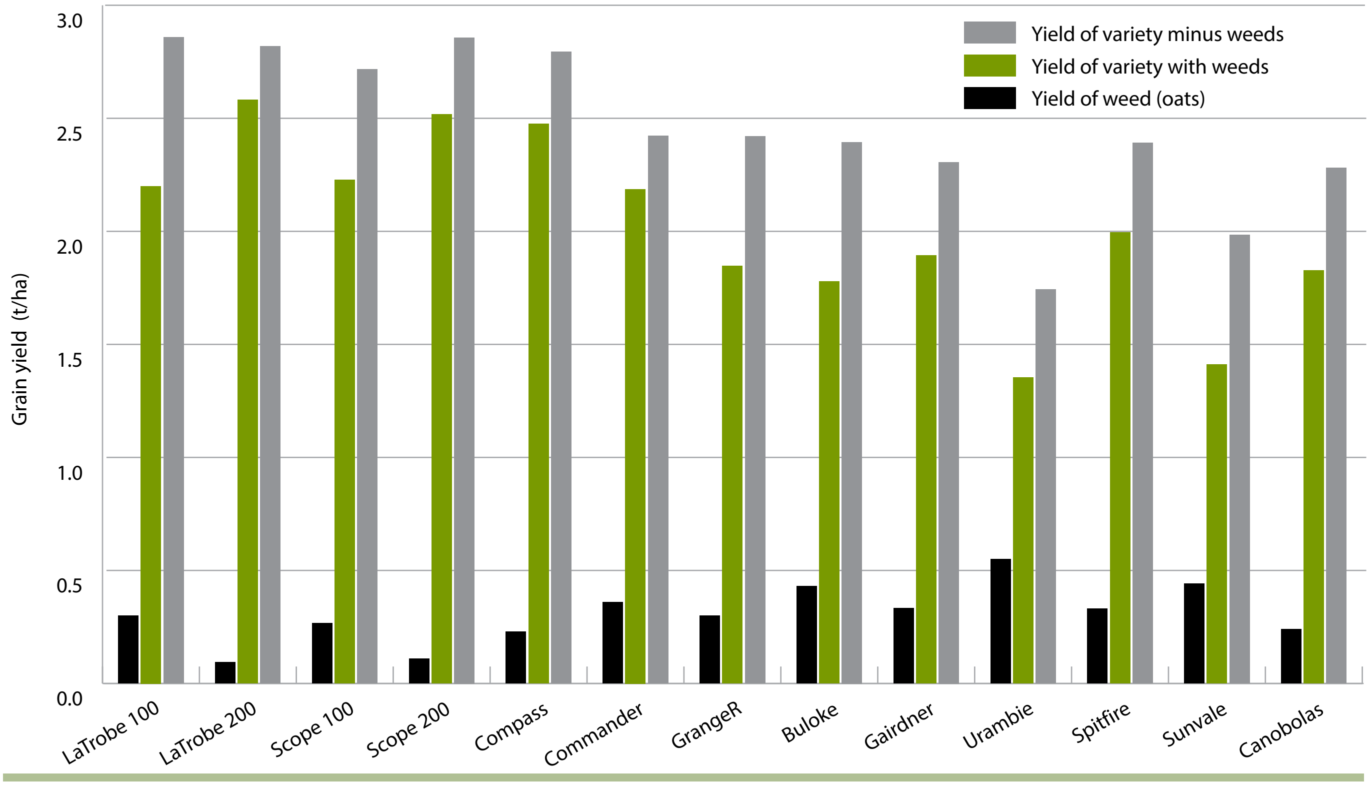

Figure 1. *Yield of variety with/without weeds, yield of weed (oats), L.S.D = 0.23 t/ha variety; 0.13 t/ha weeds=0.12 t/ha*

Variety selection can play an important role in Integrated Weed Management (IWM) strategies. Some varieties appear to have the capacity for high yield and increased weed competition. Weeds if left unchecked can produce significant quantities of seed which is returned to the seed bank for subsequent seasons as well as reducing the current crop yield.

Barley is generally more competitive than wheat but among barley varieties there are significant differences in their relative competitiveness with Compass$^{\phi}$, La Trobe$^{\phi}$ and Scope CL$^{\phi}$ appearing better in this trial. Some wheat varieties e.g LRPB Spitfire$^{\phi}$ out-yielded some barley varieties e.g. Urambie$^{\phi}$ and also provided better weed suppression. The triticale variety Canobolas$^{\phi}$, although sown later than ideal out-yielded some barley varieties and also provided better weed suppression. Canobolas$^{\phi}$ has a quick erect growth features that assist in early weed competition. It was also the tallest variety at maturity reaching a greater height than the weeds.

Increasing plant population of the cereal crop both reduced the weed seed set and increased the crop yield in the presence of weed competition.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00167). Thanks to Gavin Melville, Trangie (NSW DPI) for biometrical support. Jayne Jenkins, Scott Richards, Paddy Steele, Liz Jenkins, Lizzie Smith and Sally Wright (all NSW DPI) are thanked for their technical assistance.

Sowing time response of 21 wheat varieties – Trangie 2014

Greg Brooke[1], Leigh Jenkins[1] and Guy McMullen[2]
[1] NSW DPI, Trangie [2] NSW DPI, Tamworth

Introduction

The appropriate sowing time for a variety is a critical factor in achieving maximum water use efficiency and yield potential. Sowing a variety too early relative to its maturity predisposes it to frost damage whilst sowing too late frequently results in reduced grain yields and quality due to heat stress during the flowering and grain filling period. The performance of 21 wheat varieties across three sowing times was examined in replicated field trials at Trangie in central-west NSW in 2014. These experiments are a continuation of co-funded research between NSW DPI and GRDC under the VSAP program since 2009 which have been reported annually in the Northern Grains Region Trial Results book.

Site details

Location:	**Trangie Agricultural Research Station**
2013 crop:	**Field peas**
Soil type:	**Brown chromosol**
PreDicta B®:	**0.3 *Pratylenchus thornei*/g soil (low risk), nil crown rot at sowing (0–30 cm)**
P (Colwell):	**35 mg/kg (0–10cm)**
Total N:	**175 kg/ha (0–120 cm)**
PAW:	**36 mm (0–120 cm) at 1 April (estimated PAW at 12 June – 62 mm (assumed 25% fallow efficiency of rainfall received))**
In-crop rainfall:	**142 mm from 1 May to 31 October**
Fertiliser:	**70 kg/ha Granulock Z Extra treated with 2.5 L Sapphire (i.e. Intake® – flutriafol treated);** **77 L/ha Easy N in July at ~Z32**

Treatments

Time of sowing 1 (TOS 1) – 15 April Time of sowing 2 (TOS 2) – 29 April Time of sowing 3 (TOS 3) – 14 May
Twenty one wheat varieties sown at target population of 100 plants/m^2 : LRPB Crusaderᶲ, LRPB Dartᶲ, EGA Eaglehawkᶲ, Elmore CL Plusᶲ, LRPB Gauntletᶲ, EGA Gregoryᶲ, LRPB Impalaᶲ, LRPB Lancerᶲ, Livingstonᶲ, LRPB Vikingᶲ, LPB09-0515, Mitchᶲ (QT14381), LRPB Spitfireᶲ, Sunmateᶲ (SUN595I), SUN663A, Sunguardᶲ, Suntopᶲ, Sunvaleᶲ, Sunzellᶲ, Condoᶲ (VX1634), EGA Wedgetailᶲ
Three varieties were also sown at a target plant population of 200 plants/m^2. EGA Gregoryᶲ, LRPB Lancerᶲ, LRPB Dartᶲ

Key findings

Sowing time had a large influence on yield. The average yield of the 21 wheat varieties was 4.29 t/ha when sown on 15 April; 4.06 t/ha when sown on 29 April and 3.27 t/ha when sown on 14 May in 2014.

The longer season variety EGA Eaglehawkᶲ averaged the highest yield across the three sowing times largely due to its exceptional yield of 5.71 t/ha in TOS 1.

The longer season varieties Sunzellᶲ, EGA Eaglehawkᶲ and EGA Wedgetailᶲ all delayed flowering until early September with the earliest time of sowing (15 April) avoiding the worst frost risk window.

However, EGA Gregoryᶲ and LRPB Lancerᶲ flowered around 20 days earlier than these varieties when sown on 15 April.

Suntopᶲ was around 20 days earlier to flower than EGA Gregoryᶲ with 15 April sowing but both varieties had equivalent flowering times with the later two sowing times.

True longer season varieties such as Sunzellᶲ, EGA Eaglehawkᶲ or EGA Wedgetailᶲ should be considered if early sowing opportunities arise to minimise frost risk but quicker maturing varieties are preferred with later sowing times in May to maximise yield.

Results

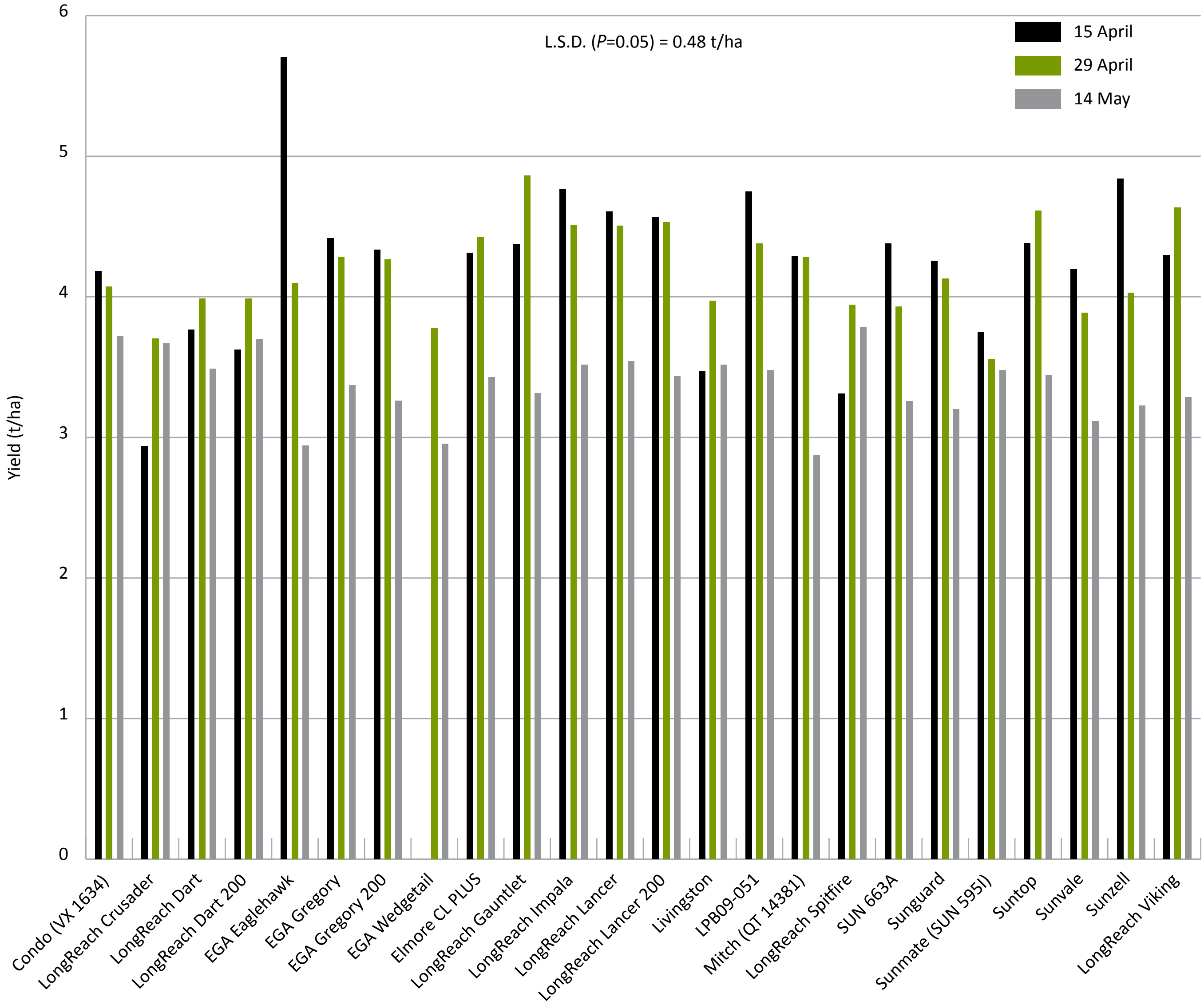

***Figure 1**. Effect of three sowing times on wheat yield – Trangie 2014*

(NB. EGA Wedgetail$^{\text{⦶}}$ is not included in TOS 1 treatment as it was not ready for harvest.)

- The three highest yielding varieties with TOS 1 (15 April) were EGA Eaglehawk$^{\text{⦶}}$ (5.71 t/ha), Sunzell$^{\text{⦶}}$ (4.84 t/ha) and LRPB Impala$^{\text{⦶}}$ (4.77 t/ha)(Figure 1).
- The three highest yielding varieties with TOS 2 (29 April) were LRPB Gauntlet$^{\text{⦶}}$ (4.86 t/ha), LRPB Viking$^{\text{⦶}}$ (4.64 t/ha) and Suntop$^{\text{⦶}}$ (4.62 t/ha)(Figure 1).
- The three highest yielding varieties with TOS 3 (14 May) were LRPB Spitfire$^{\text{⦶}}$ (3.79 t/ha), Condo$^{\text{⦶}}$ (3.72 t/ha) and LRPB Dart$^{\text{⦶}}$ (3.70 t/ha)(Figure 1).
- EGA Eaglehawk$^{\text{⦶}}$ was the highest yielding variety averaged across the three sowing times due mostly to its exceptional yield of 5.71 t/ha with TOS 1.
- EGA Eaglehawk$^{\text{⦶}}$ and Sunzell$^{\text{⦶}}$ displayed the greatest drops in yield as they were sown past their optimum early April window.
- The quicker maturing varieties LRPB Spitfire$^{\text{⦶}}$, LRPB Dart$^{\text{⦶}}$, LRPB Crusader$^{\text{⦶}}$ and Condo$^{\text{⦶}}$ performed better than longer maturing types from the last sowing time on 14 May (Figure 1).

- LRPB Crusader$^{\phi}$, LRPB Spitfire$^{\phi}$ and LRPB Viking$^{\phi}$ all showed symptoms of frost damage with the earliest sowing date which reduced their yield performance compared to the other two sowing dates but damage was not evident in LRPB Dart$^{\phi}$ or Condo$^{\phi}$ which flowered before the main frost events in late July/early August.
- Increasing the target plant population from 100 to 200 plants/m^2 did not significantly impact on yield of any of the three varieties at any of the three sowing dates.

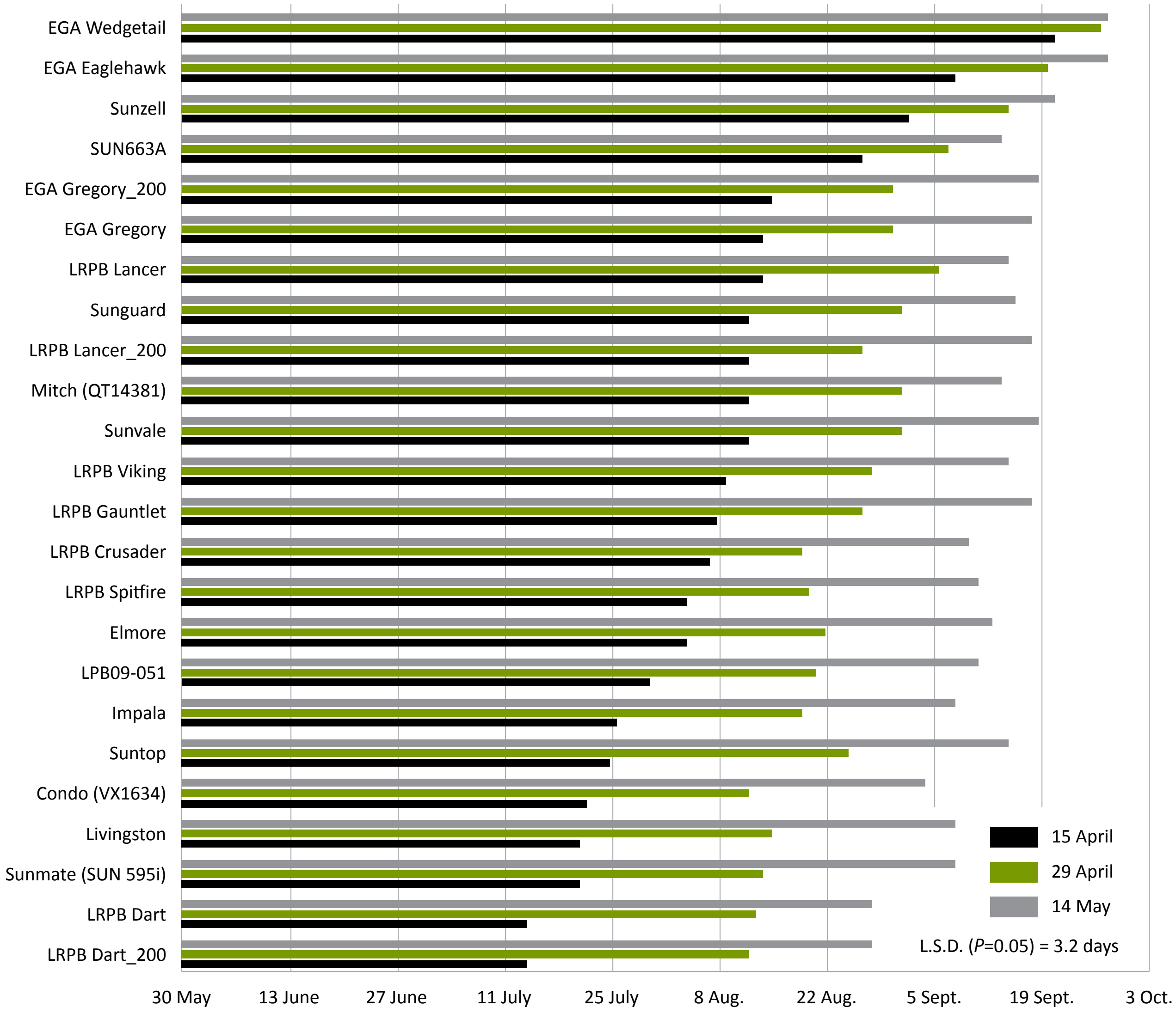

***Figure 2**. Flowering time of 21 wheat varieties across three sowing dates – Trangie 2014*

- Sunzell$^{\phi}$, EGA Eaglehawk$^{\phi}$ and EGA Wedgetail$^{\phi}$ all delayed flowering until early September with the earliest time of sowing (15 April), avoiding the worst frost risk window but EGA Wedgetail$^{\phi}$ was even substantially later reaching maturity in TOS 1 and yield data was not obtained.
- Early sowing with TOS 1 (15 April) resulted in the quicker maturity varieties LRPB Dart$^{\phi}$, Livingston$^{\phi}$, Condo$^{\phi}$ Suntop$^{\phi}$, LRPB Impala$^{\phi}$ Sunmate$^{\phi}$ and LPB09-0515 all flowering by the 2nd to 3rd week of July putting them at major risk of frost damage.
- LRPB Lancer$^{\phi}$ and EGA Gregory$^{\phi}$ were not significantly different in flowering time for TOS 1 and 3, but LRPB Lancer$^{\phi}$ was one week slower with TOS 2 (29 April)(Figure 2).

- The flowering time of Suntop$^{\phi}$ was significantly quicker with the first sowing time being around 20 days earlier than EGA Gregory$^{\phi}$ whilst the flowering time of these two varieties were roughly equivalent with the later two sowing dates.
- Target plant population had no impact on flowering date in any of the three varieties over the three sowing dates.

Summary

The varieties EGA Eaglehawk$^{\phi}$ and Sunzell$^{\phi}$ performed well from TOS 1 (15 April) and on par with the average yield of other wheat varieties in TOS 2 (29 April). However, by TOS 3 (14 May) these two varieties were significantly lower yielding than the quicker maturing varieties. Consideration should be given to sowing one of these true longer season lines when an early sowing opportunity arises. However, with more traditional main season sowing times in early-mid May progressively quicker maturing lines are preferable to maximise yield.

Acknowledgements

This research is co-funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00167). Thanks to Gavin Melville, Biometrician Trangie and to Jayne Jenkins, Scott Richards, Paddy Steele, Liz Jenkins, Lizzie Smith and Sally Wright (all NSW DPI) for technical assistance.

Yield and grain quality response of barley cultivars to four sowing dates – Narrabri 2014

Rick Graham and Guy McMullen
NSW DPI, Tamworth

Introduction

Variety response to sowing time trials help to determine how new varieties compare in yield, grain quality and maturity with benchmark varieties across the sowing window at a regional level, assisting growers to better match variety with sowing time. This trial series is particularly relevant, as the Australian barley industry is currently going through a period of transition as breeding companies bring on line their next generation of malting and or feed varieties. Since 2012, eleven new malting varieties have been accredited by Barley Australia. In addition, dedicated feed varieties such as Fathom$^{\phi}$ have been released.

The combination of variety and sowing date determines the probable timing of environmental stresses (frost and heat) at key developmental stages, such as anthesis and during the critical post-flowering grain fill period. The optimum flowering window is considered an agronomic compromise between avoiding excessive grain yield (GY) loss due to frost and ensuring that flowering occurs early enough to allow a long grain fill period before heat and moisture stress reduce GY and grain quality parameters.

A replicated trial was conducted at the IA Watson Grain Research Centre at Narrabri, in 2014 to determine the GY and quality response of a range of commercially available and advanced barley breeding lines across four different sowing times. Phenology information was also collected throughout the season to aid in sowing time recommendations.

Site details

Location:	**IA Watson Grain Research Centre, Narrabri**
Co-operator:	**Richard Heath**
Previous crop:	**Faba beans**
Soil type:	**Black vertosol**
Fertiliser:	**Supreme Z extra @ 60 kg/ha at sowing**
Starting N:	**300 kg N/ha (0–120 cm)**
Phosphorus:	**49 mg/kg (Colwell P), 645 mg/kg (BSES P) (0–10 cm)**
Starting water:	**~170 mm PAW to 120 cm**
In-crop rainfall:	**155 mm (plus irrigation ~ 25mm on 6 May)**

Treatments

There were 24 barley entries both commercially available and advanced breeder lines, with varying maturities and agronomic characteristics included in the trial. The trial was sown at four separate sowing dates in 2014 being 23 April, 15 May, 12 June and 4 July, in a split plot design with three replicates.

Key findings

This time of sowing trial highlighted the ability of some of the newer barley varieties namely Compass$^{\phi}$ and Fathom$^{\phi}$ to maintain grain yield (GY) and grain quality parameters across a relatively wide sowing window.

Results illustrated the benefit of sowing in the early part of the sowing window, particularly for the longer season varieties Navigator$^{\phi}$ and Oxford$^{\phi}$, which showed significant decreases in GY and quality (increased screenings/ decreased retentions) with delayed sowings.

GrangeR$^{\phi}$ and Compass$^{\phi}$, showed improved grain retentions and grain stability in comparison to Gairdner$^{\phi}$ and Commander$^{\phi}$ respectively, highlighting the breeding improvements in terms of GY and quality, of the newer malt and or potential malt varieties.

NRB121156, an advanced breeders line, showed good grain stability and displayed excellent straw strength across sowing dates.

Results

- GY results illustrate the yield potential of some of the newer barley varieties across sowing times (Table 1).
- Compassᶲ, a prospective Commanderᶲ replacement currently undergoing malt accreditation, demonstrated a good ability to maintain GY across the sowing window.
- The new malt accredited variety GrangeRᶲ achieved good GY in the early to main season sowing window opportunities (23 April and 15 May) as did Navigatorᶲ a longer season domestic malt quality variety from an early sowing date (23 April).
- The early maturing barley varieties Fathomᶲ a dedicated feed variety, and the recently accredited malt varieties, La Trobeᶲ and Scope CLᶲ did not appear to suffer any significant GY penalties from the earliest sowing date (April 23).

Table 1. *Grain yield of seventeen barley varieties sown at four sowing times – Narrabri 2014*

	Grain yield (t/ha)			
Variety	**23 April**	**15 May**	**12 June**	**4 July**
Bassᶲ*	5.88	5.96	4.11	3.13
Commanderᶲ*	5.97	5.42	4.41	3.64
Compassᶲ	6.33	6.01	5.00	3.80
Fairview*	5.75	5.93	4.58	3.41
Fathomᶲ	6.00	5.80	5.22	4.50
Flinders*	5.11	5.61	3.83	3.10
Gairdnerᶲ*	4.52	5.29	3.31	2.62
GrangeRᶲ*	6.25	5.67	4.21	3.43
Groutᶲ	5.26	5.18	4.43	4.18
La Trobeᶲ*	5.68	5.83	4.18	3.17
Navigatorᶲ*	5.75	4.10	3.41	3.49
NRB12115	5.20	5.17	4.48	3.15
Oxfordᶲ	6.08	5.17	4.30	3.17
Scope CLᶲ*	5.12	5.26	4.12	3.45
Skipperᶲ	5.43	5.27	4.25	3.72
Wimmeraᶲ*	5.22	4.75	4.03	2.71
L.S.D. (P=0.05) (TOS × Var)		0.64		

**Denotes malt accredited variety*

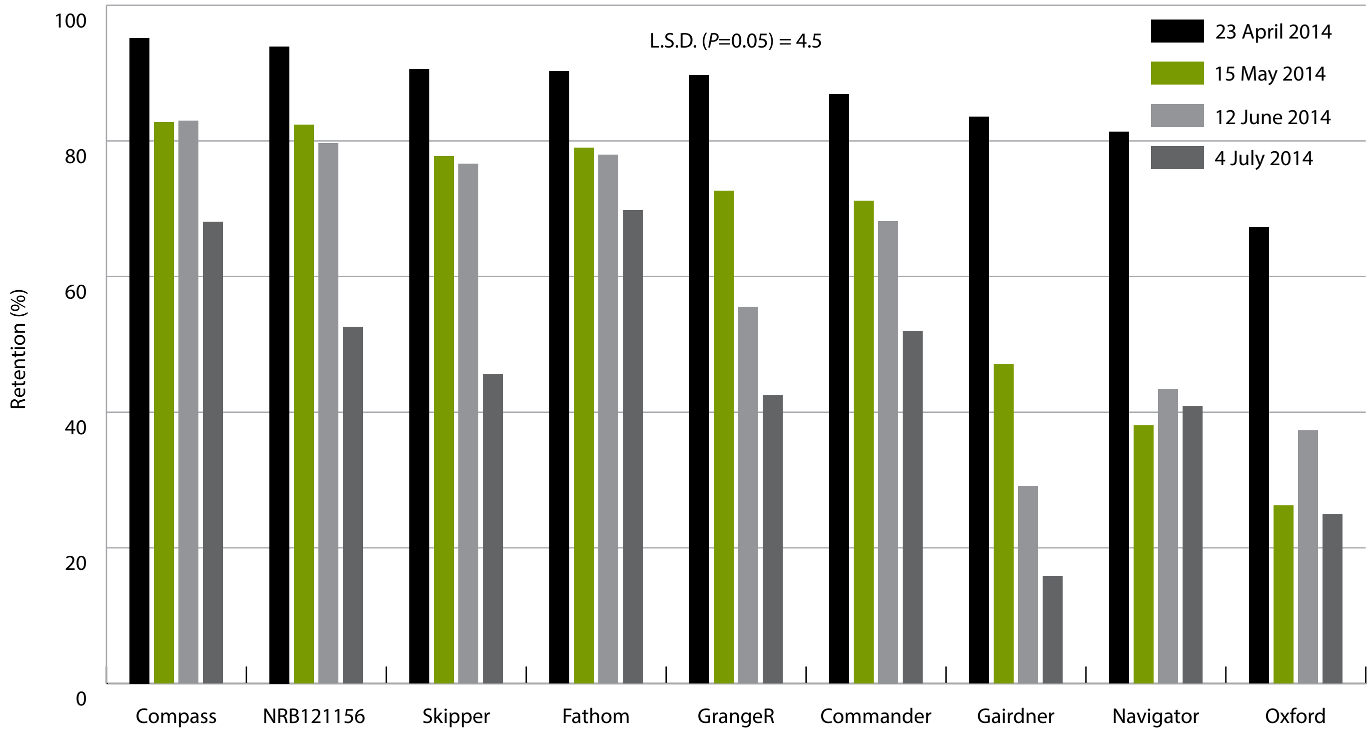

***Figure 1**. Retention (%) for nine barley varieties over four sowing dates – Narrabri 2014*

- Apart from GY responses, the effect of delayed sowing on grain quality parameters and in this case retentions (a measure of grain plumpness), defined as material retained above a 2.5 mm screen, was also significantly ($P<0.001$) affected, with a variety and a sowing time response evident. Malt grade barley needs to achieve a minimum retention level of 70%.
- A number of the newer cultivars such as Compass$^{\phi}$, Skipper$^{\phi}$ and Fathom$^{\phi}$ were able to maintain good grain stability across most of the sowing window (Figure 1). NRB121156 an advanced breeder's line from the former Queensland DPI breeding program also showed good grain plumpness and displayed excellent straw strength and standability across sowing dates (data not shown).
- Compass$^{\phi}$ showed improved grain retentions in comparison to Commander$^{\phi}$, achieving the minimum 70% retentions malt receival standard for 3 of the 4 sowing dates. In contrast, Commander$^{\phi}$ had difficulties achieving minimum retention receival standards with later sowing dates.
- Similarly, GrangeR$^{\phi}$, a Gairdner$^{\phi}$ type replacement, showed improved grain retentions and grain stability in comparison to Gairdner$^{\phi}$, highlighting the breeding improvements in terms of GY and quality, of the newer malt and or potential malt varieties.

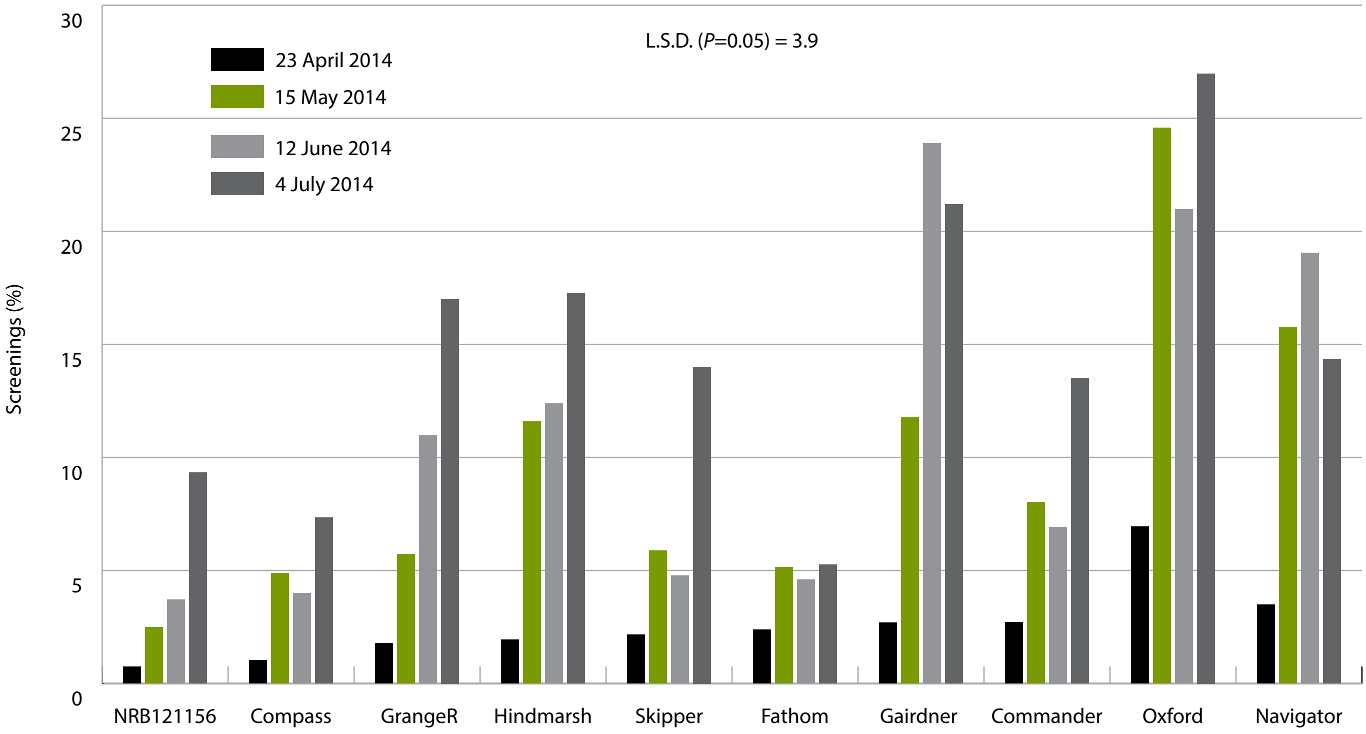

***Figure 2**. Screenings (%) for ten barley varieties over four sowing dates – Narrabri 2014*

- Varietal response to sowing time in terms of screenings (grain below a 2.2 mm screen) were measured with a 7% maximum for malting and 15% maximum for feed grade barley. The trial results clearly demonstrate the negative impact of both variety choice and delayed sowing on grain screenings (Figure 2).
- The longer maturing varieties Navigator⁽ᵖ⁾ and Oxford⁽ᵖ⁾ were clearly impacted by delayed sowing, particularly given the high starting N and warm dry finish to the season, further emphasising both the significance of sowing date and variety selection.
- Compass⁽ᵖ⁾ had good grain stability across the sowing window, as reflected by its low percentage of screenings. Likewise the feed variety Fathom⁽ᵖ⁾ displayed excellent grain size/stability. Gairdner⁽ᵖ⁾ as noted in previous trials has issues with increased screening levels with delayed sowings and hard finishes, in comparison GrangeR⁽ᵖ⁾ demonstrated reduced screenings relative to Gairdner⁽ᵖ⁾ across sowing dates. However, screenings levels in GrangeR⁽ᵖ⁾ were still above malt specifications on 12 June sowing and above feed specifications on 4 July sowing (Figure 2).
- Hindmarsh⁽ᵖ⁾appeared to have some problems achieving screening specifications with delayed sowing this was also evident with its sister line La Trobe⁽ᵖ⁾ at the 4 July sowing (data not shown). Interestingly, the early maturing variety Skipper⁽ᵖ⁾ was able to maintain low levels of screenings, achieving malt specifications for the first three sowing dates and feed quality standards for the last sowing date.

Summary

These results highlight the ability of some of the newer barley varieties such as Compass$^{(\phi)}$ and Fathom$^{(\phi)}$ to maintain GY and grain quality parameters across a relatively wide sowing window. Importantly, the findings illustrated the GY benefit of planting varieties in the early part of their optimum sowing window, particularly the longer season varieties Navigator$^{(\phi)}$ and Oxford$^{(\phi)}$, which showed significant decreases in GY and quality (increased screenings/decreased retentions) with delayed sowing dates. A number of the newer malting and potential malt varieties such as GrangeR$^{(\phi)}$ and Compass$^{(\phi)}$, depending on market demand and accreditation respectively, appeared to offer significant GY and quality advantages over benchmark malting varieties, namely Gairdner$^{(\phi)}$ and Commander$^{(\phi)}$. La Trobe$^{(\phi)}$ a 2015 malt accredited variety and Skipper$^{(\phi)}$ a variety currently undergoing accreditation are considered early maturing options for the northern grains region. However, growers should be aware that Skipper$^{(\phi)}$ does appear to have issues around straw strength and increased lodging risk in higher yielding environments. Whilst La Trobe$^{(\phi)}$ did have difficulty achieving malt receival retention specifications with delayed sowing dates, this may however have been related to the high starting N and warm dry finish to the season. Finally, NRB121156, an advanced breeder's line from the former Queensland DPI breeding program being evaluated by Heritage Seeds, demonstrated good grain stability (low screening/high retention) and displayed excellent straw strength/standability across sowing dates.

Acknowledgements

This trial was co-funded by NSW DPI and GRDC under the Variety Specific Agronomy Project (DAN00167). Technical assistance provided by Stephen Morphett, Jim Perfrement, Peter Formann, Jim Keir, Jan Hosking, Rod Bambach, and Richard Morphett (all NSW DPI) are gratefully acknowledged.

Response of current and potential wheat varieties to four sowing dates – Narrabri 2014

Rick Graham, Stephen Morphett and Guy McMullen
NSW DPI, Tamworth

Key findings

Grain yield (GY) results highlight the importance of sowing varieties in their recommended sowing window.

Early sowing of short season varieties resulted in significant GY penalties, with Dartᶲ for example experiencing a 2.4 t/ha (42%) yield penalty from a TOS 1 (April 23) versus a main season TOS 2 (May 15) sowing date, due principally to frost induced sterility.

Delayed sowing of longer season varieties such as EGA Eaglehawkᶲ TOS 1 to TOS 2, resulted in a 1.2 t/ha (22%) GY loss.

Lancerᶲ and Suntopᶲ performed well in both TOS 1 and TOS 2 and would appear good varietal choices for this sowing window and environment.

Mitchᶲ and Spitfireᶲ maintained yield and ranking with a main season (TOS 2) and a delayed TOS 3 (June 12) sowing date. Sunmateᶲ was able to maintain yield ranking from delayed sowings in TOS 3 and TOS 4 (July 4).

Averaged across varieties there was a negative effect of delays in sowing on yield with a reduction of 1.27 t/ha from TOS 2 to TOS 3, with a further reduction of 1.23 t/ha at TOS 4, associated with increased temperature and moisture stress during the critical grain fill period .

Introduction

The autumn break and subsequent sowing window in NSW can occur anywhere between March and June, with the reliability of the break being more inconsistent in northern NSW in comparison to southern NSW. There are also wheat varieties with a wide range of maturities available to growers in NSW and Queensland, which coupled with no till farming systems, has increased the length of sowing date opportunities.

Variety response to sowing time trials help to determine how new varieties compare in maturity and yield with existing varieties across the sowing window at a regional level. This provides data to better inform growers about varietal response to sowing window options and therefore to better match variety with sowing time. Overtime, these trials provide greater confidence in varietal performance estimates and flowering behaviour.

The combination of variety and sowing date determines the probable timing of environmental stresses (frost and heat) at key developmental stages, such as anthesis and during the critical post-flowering and grain fill period. The optimum flowering window is considered an agronomic compromise between avoiding excessive grain yield (GY) loss due to frost and ensuring that flowering occurs early enough to allow a long grain fill period before heat and moisture stress reduce GY and grain quality parameters.

A replicated trial was conducted at the IA Watson Grains Research Centre at Narrabri in 2014 to determine the GY and grain quality response of a range of commercially available and advanced wheat lines across four different sowing times. Phenology information was also collected throughout the season to aid sowing time recommendations.

Site details

Location:	**IA Watson Grains Research Centre, Narrabri**
Co-operator:	**Richard Heath**
Previous crop:	**Faba beans**
Soil type:	**Black vertosol**
Fertiliser:	**Supreme Z extra @ 60 kg/ha at sowing**
Starting N:	**300 kg N/ha (0–120 cm)**
Phosphorus:	**49 mg/kg (Colwell P), 645 mg/kg (BSES P) (0–10 cm)**
Starting water:	**~170 mm PAW to 120 cm**
In-crop rainfall:	**155 mm (plus irrigation ~ 25mm on 6 May)**

Treatments

There were 24 wheat entries both commercially available and advanced breeding lines, with varying maturities and agronomic characteristics included in the trial. The wheat time of sowing (TOS) trial included 19 bread wheat and 5 durum lines. The trial was sown at four separate sowing dates in 2014 being 23 April, 15 May, 12 June and 4 July, in a split plot design with three replicates.

Results

Yield results highlight the importance of sowing maturity types in the correct sowing window, with yield penalties associated with either early and or delayed sowings. The effect of maturity type and time of sowing on GY for an early (Spitfire⁽ᴰ⁾), main (Suntop⁽ᴰ⁾) and long season variety (EGA Eaglehawk⁽ᴰ⁾) at Narrabri in 2014 is illustrated in Figure 1.

Early maturing varieties (e.g. Spitfire⁽ᴰ⁾) sown before their recommended 'sowing window' predisposed them to increased risk of frost. On the other hand, delayed sowing of mid to late maturing varieties (e.g. EGA Eaglehawk⁽ᴰ⁾) resulted in increased heat and moisture stress during the critical grain fill period reducing GY potential and adversely affecting grain quality parameters.

- Sowing Dart⁽ᴰ⁾ and Spitfire⁽ᴰ⁾, both early maturing lines on April 23, well before their recommended sowing windows, resulted in significant yield reductions of 2.4 (42%) and 1.6 t/ha (28%) respectively compared to a May 15 sowing (Table 1). The durum variety Hyperno⁽ᴰ⁾ also suffered a significant yield reduction from this early sowing window (1.48 vs 4.43 t/ha, or a 67% yield reduction). Yield reductions associated with the early sowing of early maturing varieties was most likely due to frost induced sterility. There was a -3.3°C frost event on August 12 (Figure 2), which would have corresponded with head emergence and or early anthesis for a number of early maturing varieties.
- Conversely, these results emphasize the importance of sowing the correct variety in the earlier part of the optimum sowing window. The effect of delayed sowing, on the long season variety EGA Eaglehawk⁽ᴰ⁾ for example, with a 15 May versus an 23 April sowing, was a 1.2 t/ha yield reduction (Table 1). Similarly, the main season varieties EGA Gregory⁽ᴰ⁾, Lancer⁽ᴰ⁾, and Suntop⁽ᴰ⁾ achieved yield benefits when sown in the their correct sowing windows, with significant yield reductions from 12 June sowing versus 23 April or 15 May sowing date.

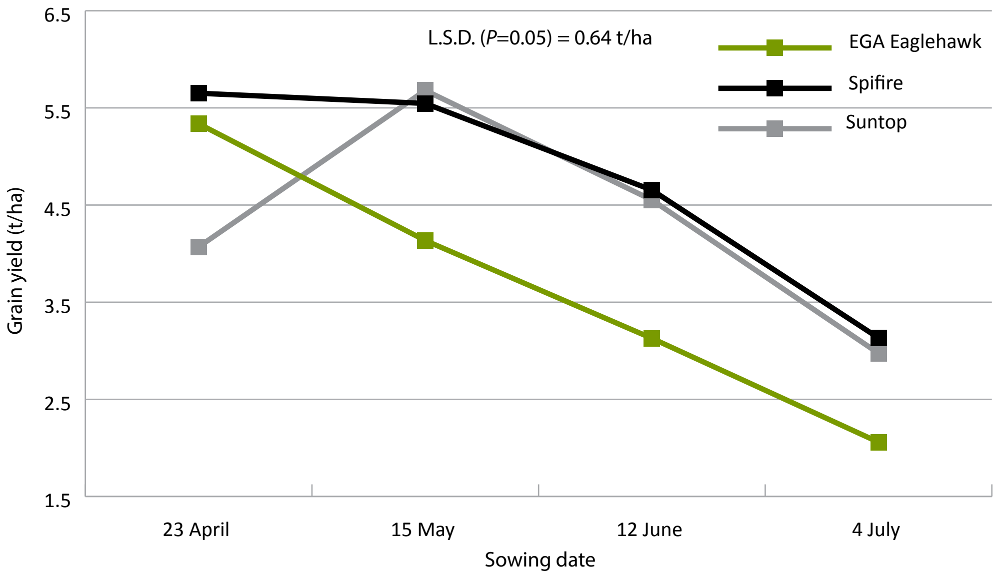

***Figure 1**. Grain yield response for an early (Spitfire⁽ᴰ⁾), main (Suntop⁽ᴰ⁾) and long season bread wheat variety (EGA Eaglehawk⁽ᴰ⁾) across four sowing dates – Narrabri 2014*

***Table 1**. Grain yield (t/ha) and rankings for 5 durum and 19 bread wheat varieties across four sowing times and mean overall grain yield for individual sow times within a trial – Narrabri 2014*

	Yield (t/ha) and rank within sow time							
Variety	**23 April**		**15 May**		**12 June**		**4 July**	
TD241046	2.17	23	5.53	13	4.05	17	3.01	9
TD290564	2.82	22	5.52	14	4.39	6	2.73	22
Caparoi$^{ⓓ}$	4.47	16	5.48	16	3.88	20	2.81	17
DBA Aurora$^{ⓓ}$ (UAD0951096)	3.99	20	5.36	18	3.96	18	2.57	23
Hyperno$^{ⓓ}$	1.48	24	4.43	23	4.30	8	2.97	12
EGA Eaglehawk$^{ⓓ}$	5.34	10	4.14	24	3.13	24	2.06	24
EGA Gregory$^{ⓓ}$	5.68	5	5.10	21	4.07	16	2.74	21
Elmore CL Plus$^{ⓓ}$	5.66	6	5.51	15	3.93	19	2.93	14
HRZ03.0056	5.45	8	5.65	9	4.57	4	2.97	11
Kiora (VX2485)	5.20	11	5.41	17	4.09	15	2.75	20
Livingston$^{ⓓ}$	4.40	17	5.78	2	4.11	14	3.17	4
LPB09-0515	5.92	2	5.77	3	4.29	9	3.30	2
LRPB Crusader$^{ⓓ}$	4.08	18	5.57	11	4.80	1	3.26	3
LRPB Dart$^{ⓓ}$	3.31	21	5.68	8	4.23	10	3.12	6
LRPB Gauntlet$^{ⓓ}$	5.35	9	5.90	1	3.86	21	3.05	8
LRPB Lancer$^{ⓓ}$	5.86	3	5.71	4	4.18	13	2.79	19
LRPB Viking$^{ⓓ}$ (LPB08-0079)	5.07	14	5.34	19	3.76	23	2.80	18
Mitch$^{ⓓ}$ (QT14381)	5.11	13	5.68	7	4.39	7	2.85	15
LRPB Spitfire$^{ⓓ}$	4.07	19	5.68	6	4.55	5	2.97	10
SUN663A	5.79	4	5.70	5	4.22	11	2.95	13
Sunguard$^{ⓓ}$	5.94	1	5.32	20	4.19	12	3.07	7
Sunmate (SUN595I)	4.56	15	5.63	10	4.58	3	3.42	1
Suntop$^{ⓓ}$	5.65	7	5.55	12	4.65	2	3.13	5
Sunvale$^{ⓓ}$	5.18	12	4.91	22	3.79	22	2.82	16
L.S.D. (P=0.05) G × TOS	0.68							
TOS average (t/ha)	4.69		5.43		4.16		2.93	
L.S.D. (P=0.05) TOS	0.52							

- All varieties experienced significant yield penalties with the latest sowing date of July 4. A synopsis of GY variety responses for early and delayed time of sowings at Narrabri in 2014 is outlined in Figure 3. The yield loss from TOS 2 to TOS 3, was 1.27 t/ha, with a further yield reduction of 1.23 t/ha from TOS 3 to TOS 4. Decreases in yield potential from delayed sowings were associated with increased temperature and moisture stress during the critical grain fill period. The mean estimated anthesis date of 26 September for TOS 3, was coupled with temperatures increasing to ~30˚C, whilst the mean estimated anthesis date of 5 October for TOS 4, coincided with temperatures rising to in excess of 35°C (Figure 2).
- A number of the durum varieties also showed good yield potential and followed the mean GY TOS response (Figure 3). The experimental durum line TD241046 showed both good GY and grain quality in terms of grain stability (low screenings) and good grain protein concentration (data not shown).
- Apart from GY response, delayed sowing influenced grain quality parameters, namely screenings (data not shown). This would have been related to high starting soil N and a warm dry finish to the season, emphasising both the significance of sowing date and variety selection.

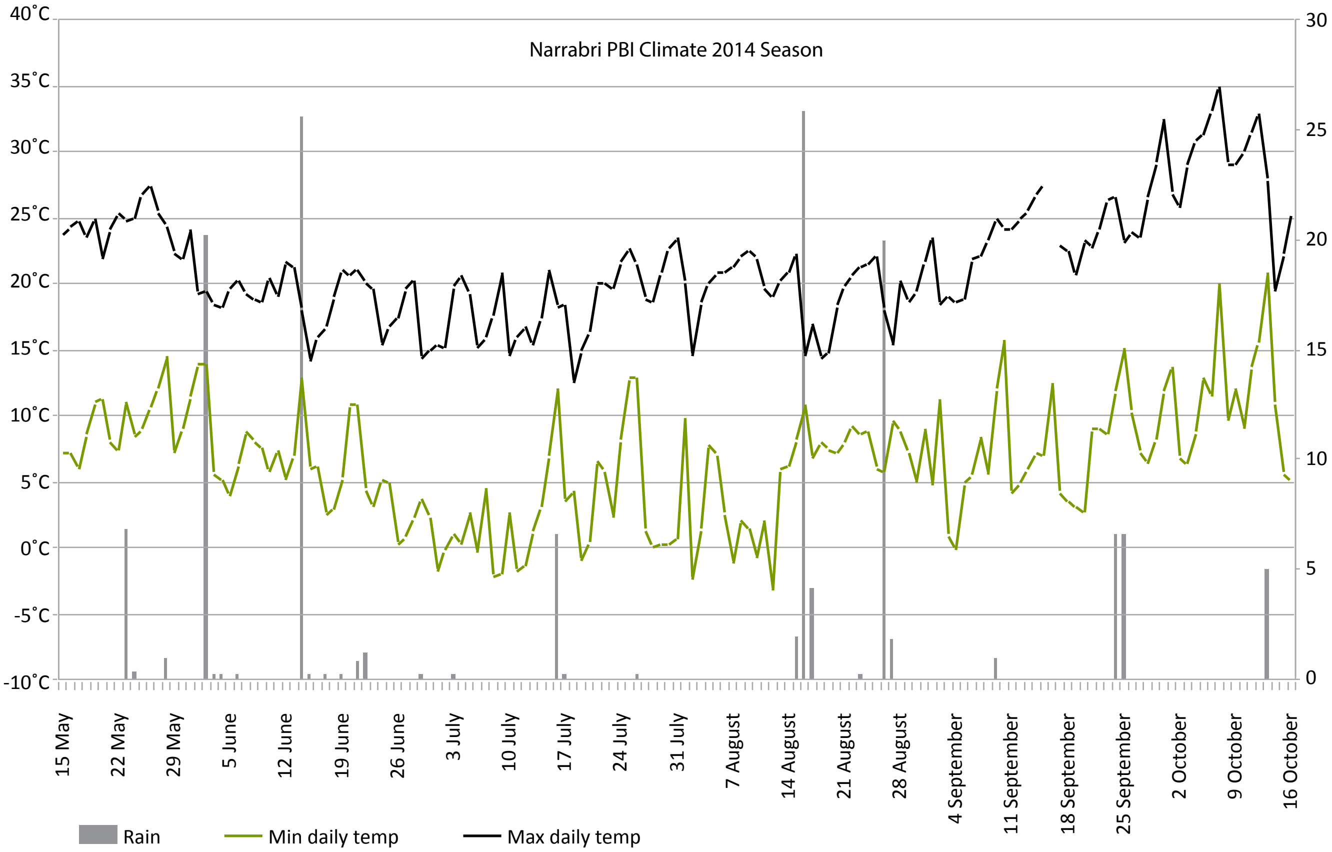

***Figure 2**. Temperature and growing season rainfall – Narrabri 2014*

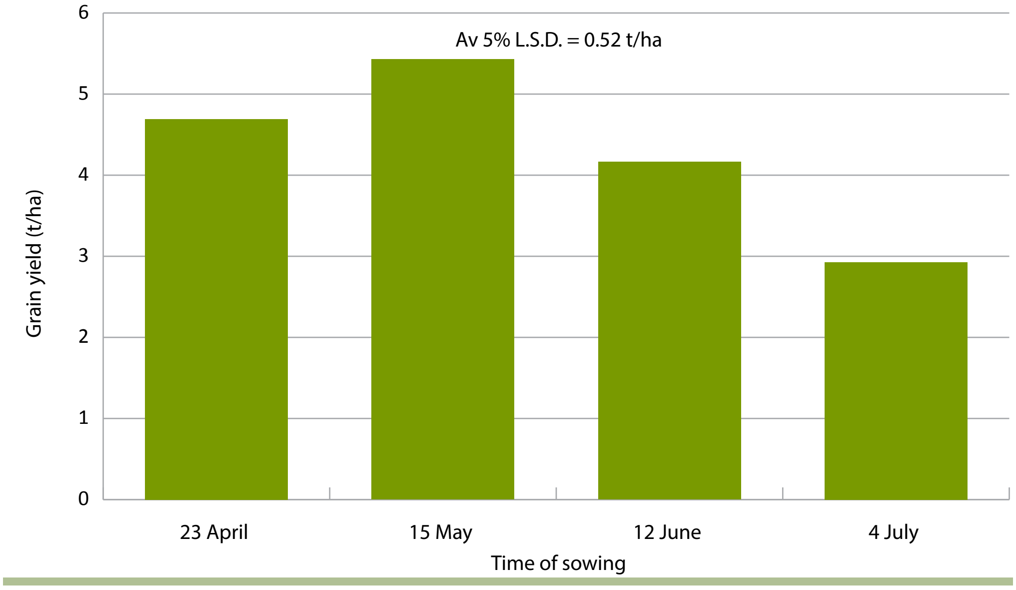

***Figure 3**. Mean varietal grain yield across four times of sowing - Narrabri 2014*

Summary

This trial illustrates the importance of sowing varieties in their recommended sowing window, and highlighted the associated risk of planting varieties outside this sowing window. Early sowing of short season varieties resulted in significant GY penalties, with Dart⍉ for example experiencing a 2.4 t/ha (42%) yield penalty and the durum variety Hyperno⍉ experiencing a 2.95 t/ha (67%) yield reduction from a TOS 1 versus a TOS 2 sowing date. A number of the durum varieties showed good yield potential and followed the mean GY TOS response of the bread wheat varieties. Conversely, delayed sowing of longer season varieties such as EGA Eaglehawk⍉ from TOS 1 to TOS 2, resulted in a 1.2 t/ha (22%) yield reduction. When looking at main season varieties, Lancer⍉ and Suntop⍉ performed well from both TOS 1 and TOS 2 and would appear good varietal choices for this sowing window, with Suntop⍉ maintaining its yield ranking across later sowing times. Mitch⍉ and Spitfire⍉ showed that they were able to maintain yield and ranking from a main season (TOS 2) and a delayed (TOS 3) sowing date. Other varieties such as Sunmate⍉ were able to maintain their yield ranking from delayed sowings (TOS 3 and 4). Importantly however, when looking at the overall meaned GY response, there was a negative effect on yield with delays in sowing with a yield reduction of 1.27 t/ha from TOS 2 to TOS 3, with a further reduction of 1.23 t/ha at TOS 4. Decreases in yield potential from delayed sowings at Narrabri were associated with increased temperature and moisture stress during the critical grain fill period, with all varieties showing significant yield reductions at TOS 4.

Acknowledgements

This trial was co-funded by NSW DPI and GRDC under the Variety Specific Agronomy Project (DAN00167). Technical assistance provided by Jim Perfrement, Peter Formann, Jim Keir, Jan Hosking, Rod Bambach and Richard Morphett (all NSW DPI) are gratefully acknowledged. The management and staff at the University of Sydney, IA Watson Grains Research Centre at Narrabri are also acknowledged for their assistance in the conduct of this trial.

Evaluation of new and potential malt barley varieties – Spring Ridge 2014

Rick Graham, Stephen Morphett, Jim Perfrement and Guy McMullen
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Introduction

The Australian barley industry is going through a period of transition, as breeding companies bring online their next generation of malting varieties. Since 2012, eleven new barley varieties have received malting accreditation through Barley Australia, with a further four potential releases in the next two year. This commercial accreditation process typically takes three years to complete, details of the process and lines undergoing evaluation can be found at **www.barleyaustralia.com.au**

When making a decision to adopt a new variety, growers need to consider agronomic advantage and market potential, as successful uptake of a variety will ultimately depend on both its agronomic performance and market demand. The agronomic response of a variety to management inputs (e.g. time of sowing, nitrogen fertiliser and seeding rate) particularly in terms of probability of achieving malt specifications, will obviously affect likely adoption.

In 2012, a collaborative trial series involving the three GRDC funded barley agronomy projects operating in the Northern, Southern and Western grains region was initiated to compare yield and quality responses of potential malt varieties likely to be grown nationally under a range of management practices. Results from a northern region trial conducted at Spring Ridge on the Liverpool Plains in 2014, are outlined in this trial report.

Key findings

Commander$^{\phi}$ was the highest yielding malt accredited variety in this trial. Compass$^{\phi}$ a potential malt variety, is agronomically similar to Commander$^{\phi}$, but appears to have improved yield potential and grain quality parameters.

Compass$^{\phi}$ maintained its yield potential while achieving malting grain protein concentration and physical grain quality specifications across a range of N rates and plant populations.

La Trobe$^{\phi}$, a sister line to Hindmarsh$^{\phi}$, accredited as a malt variety by Barley Australia in March 2015 and GrangeR$^{\phi}$ a 2013 accredited variety, both exhibited good yield potential and grain quality parameters and offer viable options as early and mid maturing sowing alternatives, respectively.

Site details

Location:	**'Nowley' Spring Ridge**
Co-operator:	**Noel Ticehurst**
Previous crop:	**Canola**
Soil type:	**Black vertosol**
Sowing date:	**22 May 2014**
Fertiliser:	**60 kg/ha Granulock Z extra at sowing**
Starting N:	**123 kg N/ha (0–120 cm)**
Starting water:	**~130 mm PAW to 120 cm**
In-crop rainfall:	**174 mm**

Treatments

Eight varieties were trialled: Bass$^{\phi}$, Commander$^{\phi}$, Compass$^{\phi}$, GrangeR$^{\phi}$, La Trobe$^{\phi}$, Skipper$^{\phi}$, Wimmera$^{\phi}$ and Buloke$^{\phi}$. Varieties were sown with target populations of 75, 150 and 300 plants/m^2, in a factorial trial design with four nitrogen (N) rates of 0, 30, 90 and 150 kg N/ha, all applied as urea. Nitrogen treatments were side banded at sowing, with no further N applications made throughout the season.

Results

- There was a curvilinear yield response for N applications averaged across all Treatments, with a significant increase in grain yield up to 90 kg N/ha (5.71, 5.91 and 6.03 t/ha for 0, 30 and 90 kg N/ha, respectively), with a yield decline (5.90 t/ha) at the higher 150 kg N/ha rate. This response is not surprising, given the high starting soil N level of ~120 kg N/ha (0–120 cm) at this site in 2014.

- There was also a variety by N rate response for grain yield, although most varieties followed the overall N response curve, Bassᶲ and Bulokeᶲ were responsive at the low N rate (30 kg N/ha), whilst Wimmeraᶲ showed no grain yield response to N rates, compared to the 0 N rate (data not shown) possibly due to increased biomass production pre-anthesis.
- Averaged across all treatments (N rate and population), Compassᶲ was the highest yielding variety, achieving a grain yield of 6.49 t/ha, followed by Commanderᶲ at 6.12 t/ha, GrangeRᶲ 5.97 t/ha and La Trobeᶲ at 5.92 t/ha (Table 1a).
- Increasing plant population resulted in improved grain yield (Table 1b) with no variety by seed rate interactions evident.
- There was also a variety by N rate response for grain yield, although most varieties followed the overall N response curve, Bassᶲ and Bulokeᶲ were responsive at the low N rate (30 kg/ha), whilst Wimmeraᶲ showed no grain yield response to N rates (data not shown) possibly due to increased biomass production pre-anthesis.

***Table 1a and 1b**. Effect of variety choice and plant population (plants/m^2) on grain yield (t/ha) – Spring Ridge in 2014*

Variety	**Grain yield (t/ha)**
Bassᶲ	5.87
Bulokeᶲ	5.58
Commanderᶲ	6.12
Compassᶲ	6.49
GrangeRᶲ	5.97
La Trobeᶲ	5.92
Skipperᶲ	5.87
Wimmeraᶲ	5.30
L.S.D. (*P*=0.05)	0.12

Plant population (plants/m^2)	**Grain yield (t/ha)**
75	5.66
150	5.96
300	6.04
L.S.D. (*P*=0.05)	0.07

- In contrast to yield, grain protein concentration (GPC) showed a linear trend with increasing N rates, with no varietal interactions apparent. Increasing plant population resulted in a decrease in GPC which is consistent with a yield dilution effect as higher plant populations also improved yield in this trial (data not shown).
- Averaged across all Treatments (N rate and population), Compassᶲ, Commanderᶲ and La Trobeᶲ, achieved significantly lower GPC than the other barley varieties, indicating that these varieties were able to maintain lower GPC across a range of N and seed rates (Table 2).

- The indicative varietal differences in grain quality also provide a good overview of varietal performance, with high GPC in Bass$^{\phi}$ and both high screenings and low retention levels in Wimmera$^{\phi}$ indicating that they may be more prone to issues around meeting malt receival specifications (Table 2).

***Table 2**. Average grain quality for eight barley varieties grown across four N application rates (0,30, 90 and 150 kg N/ha) and at three plant populations – Spring Ridge 2014*

Variety	GPC (%)	Screenings (%)	Retention (%)	Test weight (kg/hL)
Bass$^{\phi}$	12.1	1.9	88.5	75.6
Buloke$^{\phi}$	11.4	3.5	79.9	74.6
Commander$^{\phi}$	10.8	2.6	87.5	74.3
Compass$^{\phi}$	10.5	1.5	92.8	73.5
GrangeR$^{\phi}$	11.3	2.9	83.7	74.3
La Trobe$^{\phi}$	10.7	3.6	82.3	75.7
Skipper$^{\phi}$	11.3	1.9	90.8	75.6
Wimmera$^{\phi}$	11.4	5.8	67.1	68.8
L.S.D. (*P*=0.05)	0.2	1.1	1.7	0.3

- Varietal GPC results trended towards the established yield dilution response (increasing yield = decreasing protein), with the exception of Bass$^{\phi}$. Bass$^{\phi}$ was more grain protein responsive at comparable yields to Skipper$^{\phi}$, GrangeR$^{\phi}$ and La Trobe$^{\phi}$ (Figure 1).

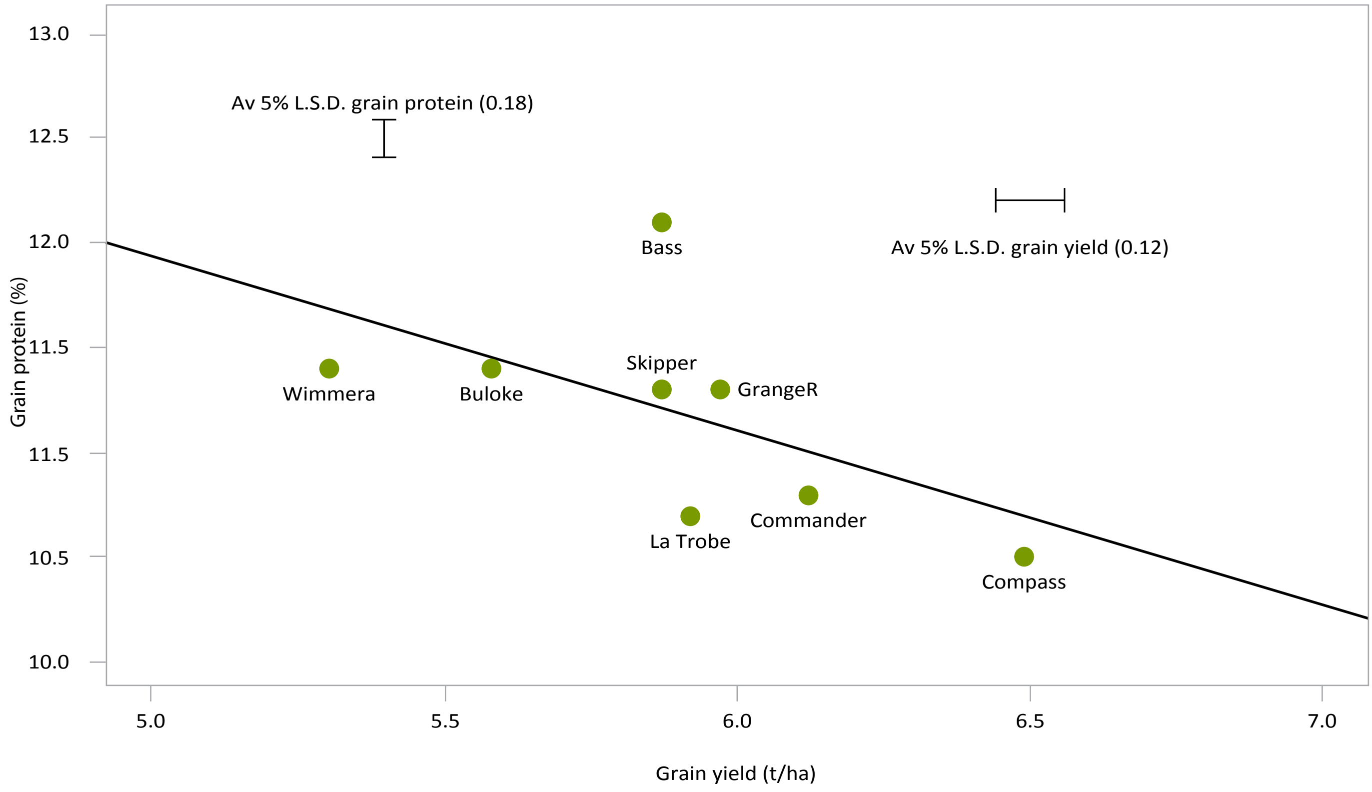

***Figure 1**. Linear relationship between grain yield (t/ha) and grain protein concentration (%) for barley varieties sown at Spring Ridge in 2014*

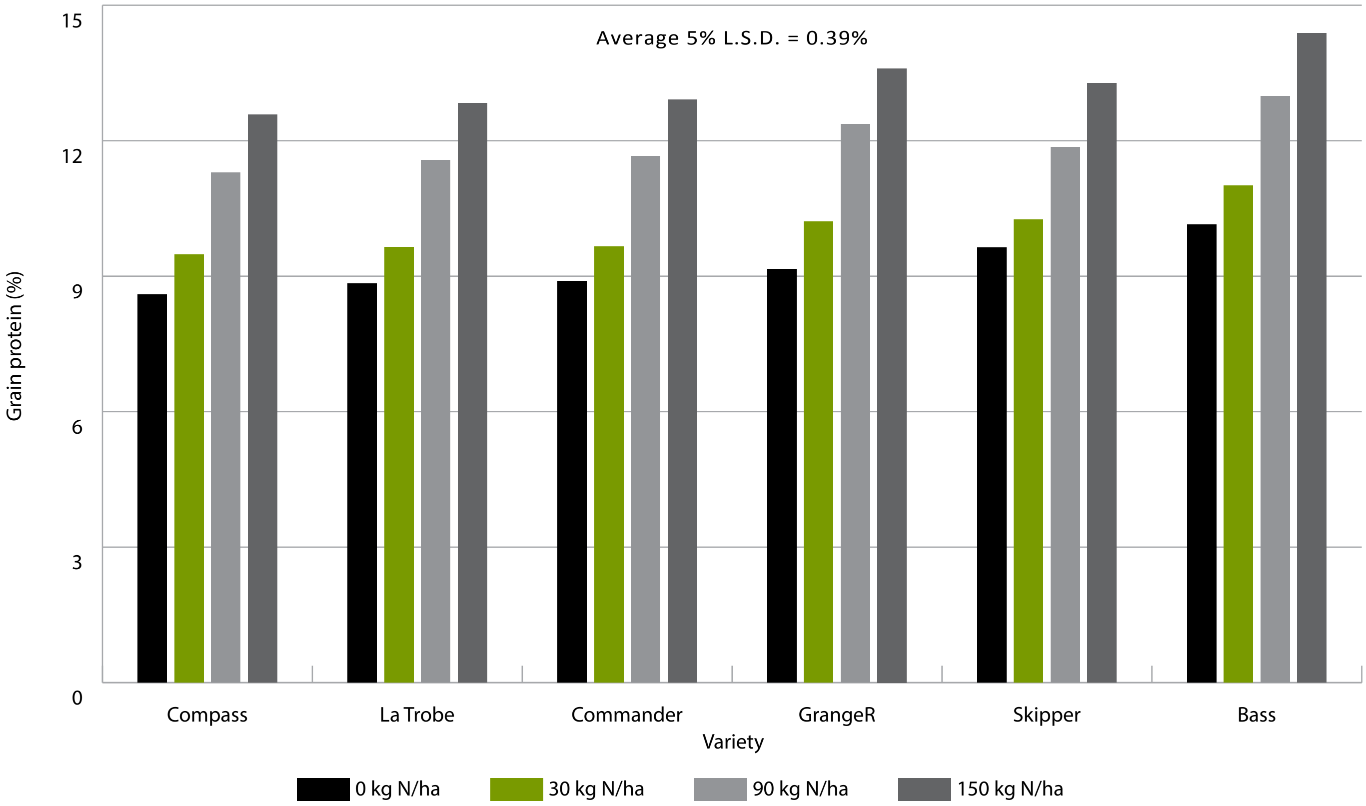

***Figure 2**. Effect of N rate on grain protein (%) for selected barley varieties – Spring Ridge 2014*

- Varieties such as Commander⊕, La Trobe⊕ and Compass⊕ could have issues achieving minimum GPC requirements of 9% under low to moderate N application rates in high yielding environments (Figure 2).
- Grain quality parameters in terms of malt receival standards (screenings and retentions) were generally good, with only Wimmera⊕ exceeding the 7% screening level at the higher 90 and 150 kg N/ha rates. Buloke⊕ at 69% was below the minimum 70% retentions level at the 150 kg N/ha application rate, with Wimmera⊕ also experiencing issues around retentions at 62 and 60% respectively, at the 90 and 150 kg N/ha rates (data not shown).
- Test weights although varying between varieties and treatments, were all above the malt grade specification of 65 kg/hL across all treatments.
- Skipper⊕ under moderate to high N rates and in high yielding (>5 t/ha) environment showed an increased potential to lodge. Results also indicated that susceptibility to lodging in this environment was comparable between Compass⊕ and Commander⊕ under high starting N application rates.

Summary

There are a number of new potential high yielding malting varieties currently undergoing accreditation that appear to show promise in the northern grains region. Compass$^{\phi}$ demonstrated good adaptability and was able to maintain yield potential and GPC specifications across a range of N application rates. Compass$^{\phi}$ is agronomically similar to Commander$^{\phi}$, but has improved yield potential and grain stability (e.g. increased retentions). However, Commander$^{\phi}$ was still the highest yielding current malt accredited variety in this trial. La Trobe$^{\phi}$ which was accredited as a malt variety by Barley Australia in March 2015 and GrangeR$^{\phi}$ a 2013 accredited variety, both exhibited good yield potential and grain quality parameters and offer viable options as early and mid maturing sowing alternatives, respectively. Skipper$^{\phi}$, an early maturing variety that is not going to be commercialised as a malt variety, did appear to have issues around straw strength and increased lodging risk in a higher yielding environment such as Spring Ridge in 2014. The sensitivity and or responsiveness of varieties to management inputs outlined in this trial will help to develop variety specific management guidelines, increasing the likelihood of variety uptake and probability of a new variety achieving malt specifications. It is important to note however, that unless there is an established niche or defined market, the expectation should be to deliver newly accredited and or potential malting varieties as feed until there are clear segregation, market demand and pricing signals.

Acknowledgements

The research was co-funded by NSW DPI and GRDC through the Variety Specific Agronomy Project (DAN00167). Thanks to Noel Ticehurst at 'Nowley' for his assistance and Richard Heath from the University of Sydney (PBI Narrabri) for providing the trial site. The trials and data collection were managed by Peter Formann, Jim Keir, Jan Hosking and Rod Bambach (all NSW DPI).

Mungbean variety comparison – Liverpool Plains 2013–14

Kathi Hertel[1], Craig Chapman[1] and Steven Harden[2]
[1] NSW DPI, Narrabri [2] NSW DPI, Tamworth

Key findings

Jade-AU$^{⊕}$ released in 2013, has demonstrated equal or significant improvements over the now outclassed Crystal$^{⊕}$ in areas of yield, seed size and plant architectural attributes in this experiment.

Celera II-AU$^{⊕}$ released in 2014 has extended the range of varietal maturities available, being the quickest to flower and reach physiological maturity. Practical management considerations in this experiment resulted in a long delay to harvest. This impacted negatively on yield performance and does **not** represent a true indication of its yield potential.

Differences in yield were established between varieties, however results should be treated with caution due to a coefficient of variation of 21% in this trial.

Biomass production is central to nitrogen fixation and is integral to quantifying the contribution of summer pulse crops to northern farming systems over the longer term. These experimental results contribute to a collaborative relationship with the GRDC funded Project DAQ00181: *Optimising nitrogen fixation in grain legumes – northern region*, led by Dr Nikki Seymour at DAFF in Queensland.

Introduction

Improving the yield potential and reliability of pulses in Northern Grains Region farming systems is a major focus of the Northern Pulse Agronomy Initiative project. Benefits of pulse crops include:

- improving the productivity of subsequent crops
- reducing the impacts of disease and weeds
- increasing soil fertility
- enhancing farm income
- increasing crop diversity and economic risk
- producing a protein food source, increasingly in demand by a global population.

This experiment is one of a number of research studies into summer pulses, specifically soybean and mungbean, conducted by NSW DPI researchers at Grafton, the Australian Cotton Research Institute (Narrabri) and the Trangie Agricultural Institute. Additional sites are also located on farms located throughout the Northern Grains Region.

One of the aims of the project is to investigate agronomic constraints to achieving yield potential of summer pulses. Data from experiments will be used to develop variety specific agronomy recommendations for newer varieties as well as general pulse agronomy recommendations. This experiment includes older varieties as well as newer varieties to assess gains in yields and improvements in desirable agronomic traits of recently released varieties.

Site details

Location:	**'Windy Station' Pine Ridge**
Co-operator:	**Romani Pastoral Company, Peter Winton (Crop Manager)**
Planting date:	**12 December 2013**
Fallow rainfall:	**295 mm (125 mm in November)**
In-crop rainfall:	**265 mm (planting to physiological maturity)**
Harvest date:	**6 May (144 DAS)**
Comments:	**The experiment was sown into marginal seedbed moisture, however 18.4 mm of rainfall fell** **5 days after sowing. In-crop rainfall (planting to physiological maturity) totalled 265.1 mm**

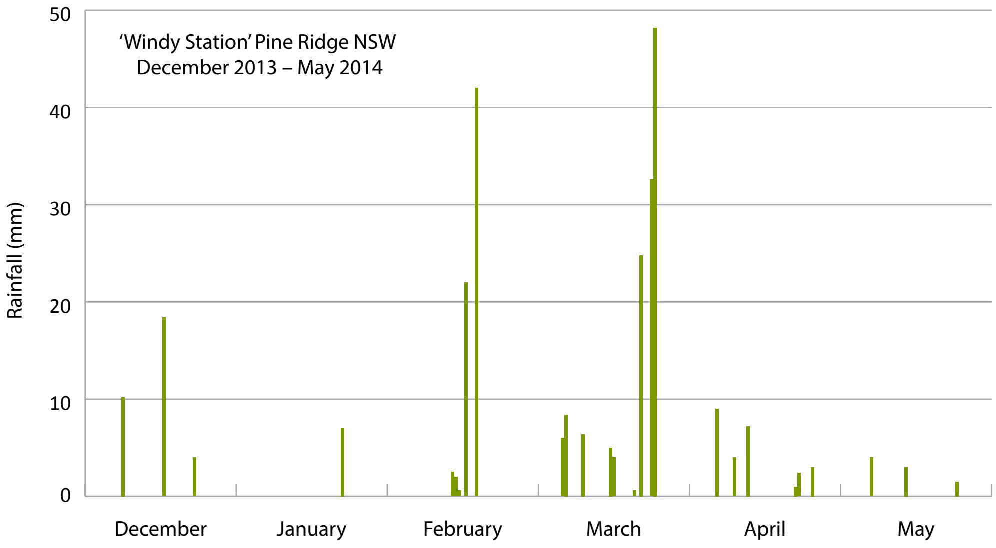

__Figure 1__. Daily rainfall events at 'Windy Station' Pine Ridge in 2013–14

__Table 1__. Site temperature (°C)

	December	January	February	March	April
Minimum	11.7	8.8	9.3	5.3	-0.4
Minimum (mean)	16	15.2	15.4	13.1	9.4
Maximum	39.6	45.1	37.8	31.7	29.4
Maximum (mean)	34.1	35.1	31.3	27.3	24.8
Overall mean	25.1	25.1	23.4	20.3	17.1

Treatments

- Seven varieties were evaluated: Jade-AU⦶, Crystal⦶, Satin II⦶, Regur, Berken, Green Diamond⦶, Celera-II⦶.
- Jade-AU⦶, a large seeded bright green mungbean was released in 2013 to replace Crystal⦶. It has the best available combined suite of resistance to the major diseases affecting mungbean (powdery mildew, tan spot and halo blight).
- Crystal⦶ was released in 2008. At the time it had the most widespread adaptation, suitable for both spring and summer plantings and also the best combined resistance to major mungbean diseases. It has now been outclassed by Jade-AU⦶.
- Celera II-AU⦶ is a small seeded variety released in 2014 to replace Celera⦶ and Green Diamond⦶. Celera II-AU⦶ is the first mungbean variety with improved resistance to halo blight (MR).
- Satin II⦶ is a dull-seeded mungbean released in 2008 to replace Satin.
- Berken is the favoured variety for sprouting segregation.
- Regur is a black seeded mungbean variety.

Results

Plant growth and development

Observations on 6 January (24 DAS) recorded all mungbean varieties with two fully expanded trifoliate leaves (V3). The seasonal conditions during the mid-vegetative growth stages of the trial were characterised by temperatures reaching 40 °C in early January and again in mid-January.

Flowering commenced in late January for most varieties. Data from other experiments would support the appearance of the first flowers in the variety Celera II-AUᶲ. The crucial reproductive phase occurred during February, a month characterised by below average temperatures, ranging between 15.3 °C and 31.6 °C; and 69 mm of rainfall over a 5 day period.

By the end of the first week in March, most varieties were beginning to reach physiological maturity, indicated by green pods turning brown. Regur was the exception; its pods were still lengthening with only the first signs of seed development evident (R3).

Establishment

- The experiment was sown on 90 cm row spacing into marginal seedbed moisture. Crop establishment was measured 26 days after sowing. The crop establishment at the site averaged only 67%. There were no significant differences in plant establishment between varieties.

Yield

- Overall mean site yield was 1.16 t/ha (Table 3). There was no significant difference between Jade-AUᶲ, Crystalᶲ, Satin IIᶲ and Berken. Of the small seeded varieties, there was no significant difference in yield (L.S.D. 0.43). Jade-AUᶲ recorded the highest yield of 1.45 t/ha. This was 25% above the site average and 2% greater than Crystalᶲ. Differences in yield were established between varieties; however results should be treated with caution due to a coefficient of variation of 21% in this trial (Table 3).
- Celera II-AUᶲ was disadvantaged in this experiment due to it very early maturity. The long delay to harvest resulted in harvest losses. **Celera II-AUᶲ results should be regarded with caution**.
- Regur is a variety of black gram (*Vigna mungo*). This species have an indeterminate growth habit, continuing to grow new leaves after the start of flowering. This effectively delays its maturity, particularly where seasonal conditions favour growth. At this site continuing rainfall events and average daily temperatures around 20 °C throughout March and April favoured continued flowering and vegetative growth until the site was desiccated in late April. These growth characteristics are reflected in Regur's comparative yield in this experiment to the other varieties that are all *Vigna radiata* mungbeans with a determinate growth pattern.

Table 3. Mungbean grain results at 'Windy Station' Pine Ridge in 2013–14

Variety	Yield (t/ha)	Yield as % site mean	Yield as % Crystal$^{\phi}$	100 seed weight (g)	Seed protein (%) DM basis
Jade-AU$^{\phi}$	1.44a	125	102	6.97	27.63
Crystal$^{\phi}$	1.42ab	122	100	6.73	27.73
Satin II$^{\phi}$	1.31ab	113	93	6.52	27.37
Regur	0.77c	66	54	5.54	25.10
Berken	1.12abc	96	79	6.72	26.30
Green Diamond$^{\phi}$	0.99bc	86	70	3.94	27.73
Celera II-AU$^{\phi}$	0.78c	67	55	3.27	27.60
Site mean	1.16			5.83	27.14
L.S.D. (P=0.05)	0.43			0.65	0.60

Seed size

- Seed size (100 seed weight) differences were consistent within varieties. Celera II-AU$^{\phi}$ and Green Diamond$^{\phi}$ are small-seed varieties whilst the remaining varieties that were tested are large-seeded genotypes. Jade-AU$^{\phi}$ recorded the largest seed size (Table 2).

Protein

- There was no significant difference in seed protein content between Jade-AU$^{\phi}$, Crystal$^{\phi}$, Satin II$^{\phi}$, Celera II-AU$^{\phi}$ and Green Diamond$^{\phi}$ (Table 2). However these were all significantly greater than Berken (26.3%) and Regur which measured the lowest seed protein content of 25.1% (L.S.D. 0.60).

Biomass

- Above ground dry matter was cut at flowering to measure peak biomass. There was no significant difference in biomass production between varieties in this experiment. Overall site mean was 3.27 t DM /ha.

Crop height and harvestability

- Jade-AU$^{\phi}$ was the tallest variety overall at 44.4 cm (Figure 2). Its lowest pods were at 29.2 cm above ground level. These attributes improve crop harvestability and reduce risks of downgrading due to soil staining and contamination. Regur was consistent with its well-known inherent characteristic of setting pods low in the plant canopy, just 17.2 cm above ground level. Its 23.4 cm depth of pods represents more than half of the overall crop height.

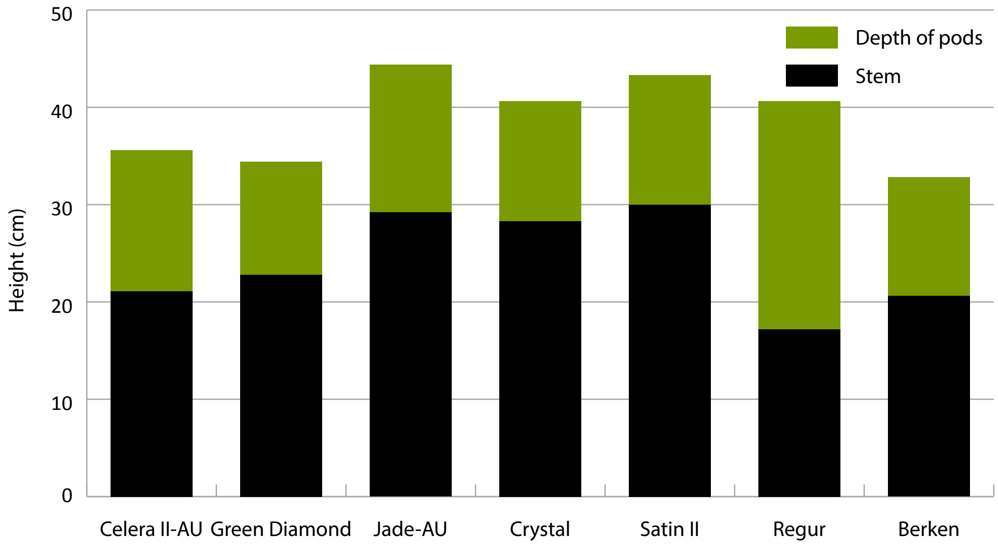

***Figure 2**. Harvestability characteristics in mungbean varieties at 'Windy Station' Pine Ridge in 2013–14*

Summary

- This experiment includes the most recently released elite genotypes, namely Jade-AUᶲ and Celera II-AUᶲ from the collaborative mungbean breeding program involving GRDC, DAFF and the Australian Mungbean Association. Results show differences in agronomic characteristics, grain quality and yield performance between current industry genotypes.
- Jade-AUᶲ, released in 2013, has demonstrated improvement over the now outclassed Crystalᶲ in areas of yield, seed size and plant morphology in this experiment. With its superior combined suite of disease resistance it is currently the most functional variety available to the industry.
- Celera II-AUᶲ released in 2014 to replace Celeraᶲ and Green Diamondᶲ in the niche small seed market, was disadvantaged in this experiment due to it very early maturity. A long delay to harvest resulted in harvest losses. Results do not show a true reflection of genetic potential and should be treated with caution. It remains the industry standard, rated moderately resistant (MR) to halo blight.
- In conjunction with the biomass results and collected samples, further results are pending from the collaborative work with the GRDC funded Project DAQ00181: Optimising nitrogen fixation in grain legumes – northern region, led by Dr Nikki Seymour at DAFF in Queensland. These experimental results and others in this project represent early data that aims to quantify the nitrogen benefit to northern farming systems over the longer term.

Acknowledgements

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Quality testing conducted by Futari Grain Technology Services – Narrabri.

Mungbean variety comparison – Breeza, Liverpool Plains 2013–14

Kathi Hertel[1], Craig Chapman[1] and Steven Harden[2]
[1] NSW DPI, Narrabri [2] NSW DPI, Tamworth

Introduction

Improving the yield potential and reliability of pulses in Northern Grains Region farming systems is a major focus of the Northern Pulse Agronomy Initiative. Benefits of pulse crops include: improving the productivity of subsequent crops, reducing the impacts of disease and weeds, increasing soil fertility, enhancing farm income, increasing crop diversity and economic risk and producing a protein food source for the increase in demand of a global population

This experiment is one of a number of research studies into summer pulses, specifically soybean and mungbean, conducted by NSW DPI researchers at Grafton, the Australian Cotton Research Institute (Narrabri) and the Trangie Agricultural Institute. Additional sites are also located on farms throughout the Northern Grains Region.

One of the aims of this project is to investigate agronomic constraints to achieving the yield potential of summer pulses. Data from experiments will be used to develop variety specific agronomy recommendations for new varieties as well as general pulse agronomy recommendations. This experiment includes older varieties as well as newer varieties to assess gains in yields and improvements in desirable agronomic traits of recently released varieties.

Site details

Location:	**NSW DPI Liverpool Plains Field Station, Breeza**
Planting date:	**6 December 2013**
Row spacing:	**90 cm (on 2 m beds)**
Soil type:	**Black vertosol**
Soil test:	

***Table 1**. Starting soil nutrition – Breeza 2013–14*

Depth cm)	Nitrate (mg/kg)	Colwell P (mg/kg)	BSES P	Sulphur (mg/kg)	Organic carbon (%)	pH Level $(CaCl_2)$
0–10	13	26	717.04	5.5	1.0	7.9
10–30	9	16	711.45	10.8	0.79	7.9
30–60	7	11	-	8.1	0.64	8.0
60–90	5	18	-	9.6	0.53	8.1
90–120	6	25	-	9.3	0.44	8.2

Fertiliser:	**110 kg/ha Granulock Zn**
Irrigation:	**14 November 2013 (pre-water), 8 January 2014, 23 January 2014**
Harvest date:	**16 April (130 DAS)**

Key findings

Experiment results show differences in agronomic characteristics and grain quality between current industry genotypes. Yields were adversely affected by brief periods of waterlogging during the growing season, impacting on the performance of all varieties; mungbeans are well known for their sensitivity to 'wet feet'.

Celera II-AU$^{\phi}$ released in 2014 has extended the range of varietal maturities available, being the quickest to flower and reach physiological maturity. Practical management considerations in this experiment have severely impacted on its growth and development. Results do not represent a true indication of its genetic potential and should be treated with caution. Celera II-AU$^{\phi}$ remains the industry standard for halo blight resistance, rated moderately resistant (MR).

Jade-AU$^{\phi}$, released in 2013, has demonstrated differences over the now outclassed Crystal$^{\phi}$ in plant morphology in this experiment. With its superior combined suite of disease resistance it is currently the most functional variety available to the industry.

***Table 2**. Site rainfall 2013–14 (mm)*

December	January	February	March	April	Total
28 (5)	0	56 (4)	163 (9)	19 (3)	266

*[1] In-crop rainfall: 142 mm * Number of wet days in brackets*
[1] NOTE: In-crop rainfall refers to the sum of rainfall events from planting date to physiological maturity.

***Table 3**. Site temperature (°C)*

	December	January	February	March	April
Minimum	4.6	13	12.2	9.9	2.3
Minimum (mean)	*15.8*	*17.5*	*17*	*15*	*11.5*
Maximum	41.3	45.2	37.5	32	31.1
Maximum (mean)	*33.7*	*34.7*	*32.1*	*28.5*	*26.3*
Overall mean	26.7	26.1	24.6	21.8	18.9

Treatments

- Seven varieties were evaluated: Jade-AU$^{\oplus}$, Crystal$^{\oplus}$, Satin II$^{\oplus}$, Regur, Berken, Green Diamond$^{\oplus}$ and Celera II-AU$^{\oplus}$.
- Jade-AU$^{\oplus}$, a large seeded bright green mungbean was released in 2013 to replace Crystal$^{\oplus}$. It has the best available combined suite of resistance to the major diseases affecting mungbean (powdery mildew, tan spot and halo blight).
- Crystal$^{\oplus}$ was released in 2008. At the time it had the most widespread adaptation, suitable for both spring and summer plantings and also the best combined resistance to major mungbean diseases. It has now been outclassed by Jade-AU$^{\oplus}$.
- Celera II-AU$^{\oplus}$ is a small seeded variety released in 2014 to replace Celera$^{\oplus}$ and Green Diamond$^{\oplus}$. Celera II-AU$^{\oplus}$ is the first mungbean variety with an improved resistance to halo blight (MR).
- Satin II$^{\oplus}$ is a dull-seeded mungbean released in 2008 to replace Satin.
- Berken is the favoured variety for sprouting segregation.
- Regur is a black seeded mungbean variety.

Comments

Irrigation

- The site was pre-watered on 14 November 2013 before sowing on 6 December 2013. A second irrigation was applied 8 January 2014 (32 DAS) when varieties were at the late vegetative growth stage.
- The second in-crop irrigation applied 23 January 2014 (47 DAS) resulted in waterlogging for the following 7 days. This was a major stress for all varieties and **adversely affected yields in all varieties in this experiment**.
- Observations recorded 2 days before this irrigation recorded all varieties at some stage of flowering, for example Satin II$^{\oplus}$ just beginning to open its first flowers on some plants and Jade-AU$^{\oplus}$ was estimated to reach 50% flowering stage (F50) on 22 January (46 DAS). Most advanced at this time were Celera II-AU$^{\oplus}$ and Green Diamond$^{\oplus}$, both at 100% flowering and already with pod development. Celera II-AU$^{\oplus}$ was the quickest with seeds forming within pods.

Plant growth and development

- The experiment was sown on 6 December into suitable seedbed moisture with the soil temperature measured at 9:00 am recording 19 °C at 10 cm soil depth.
- The following 6 weeks after sowing, daily maximum temperatures exceeded 30 °C, with a peak temperature of 45 °C on 29 January. This time period included the whole vegetative growth period. Jade-AU$^{\phi}$ reached 50% flowering around 22 January (46 DAS) followed an estimated day later by Crystal$^{\phi}$. Celera II-AU$^{\phi}$ was already at 100% flowering and GS R2/R3 by 21 January 2014.
- Observations recorded on the 30 January 2014 (54 DAS) showed Celera II-AU$^{\phi}$ beginning to show signs of constriction around fully formed seeds in pods (R4). This was in contrast to most other varieties in the experiment that were still at R3 – i.e seed development within the pod is still at the early stages and pods at the top main stem nodes were just reaching maximum length. Notable was Regur which was at the early stages of pod development (R2). These observations coincided with the end of the week long period of waterlogging.
- Temperatures during the pod fill stage of most of the varieties during February remained mostly below 30 °C, averaging around between 20 and 24 °C most days.
- Observations on 3 February (58 DAS) recorded Celera II-AU$^{\phi}$ to be the most advanced with pods on the main stem beginning to change colour from green to brown (R5). All varieties with the exception of Regur had ceased to flower.

Results

***Table 4**. Mungbean Yield results at Liverpool Plains Field Station, Breeza in 2013–14*

Variety	Yield (t/ha)	Yield as % site mean	Yield as % Crystal$^{\phi}$	100 seed weight (g)
Jade-AU$^{\phi}$	0.92a	110	94	6.15
Crystal$^{\phi}$	0.98a	117	100	6.11
Satin II$^{\phi}$	0.94a	112	96	6.04
Regur	0.84a	100	86	4.92
Berken	0.81a	97	82	5.83
Celera II-AU$^{\phi}$	0.45b	54	46	3.72
Site mean (t/ha)	0.84			5.38
% CV	17.8			2.4
L.S.D. (P < 0.05) (P <*0.1)	*0.23			0.23

Yield

- This experiment was harvested 16 April 2014, 130 days after sowing. Overall mean site yield was 0.84 t/ha. Analysis showed no significant yield difference between all large seeded genotypes. The coefficient of variation of 17.8% indicates the variability of yield results **and should be treated with caution**. Celera II-AU$^{\phi}$ was harvested later than would be advised in a commercial situation due to the delays in harvest for the longer season varieties in this experiment. Because of this there were some shattering losses. These were measured and added to the harvested yield. Observations recorded 15 February (70 DAS) showed all plots of Celera II-AU$^{\phi}$ at physiological maturity, ie at 90% black pod (R7).
- A miscalculation during trial preparation resulted in Green Diamond$^{\phi}$ seed sown at twice its intended seeding rate. This yield data was excluded from the analysis.

Seed size

- The varieties in this experiment are distinct in their inherent characteristic seed size. Jade-AU$^{\phi}$, Crystal$^{\phi}$ and Satin II$^{\phi}$ are similar large seeded types. Celera II-AU$^{\phi}$ and Green Diamond$^{\phi}$ are small seeded varieties. The results in this experiment are consistent with known varietal differences.

Crop height

- Figure 1 shows the relative differences between varieties of plant height and podding characteristics. There was no significant difference in-crop height between Jade-AU$^{\phi}$, Crystal$^{\phi}$, Satin II$^{\phi}$ and Green Diamond$^{\phi}$. Celera II-AU$^{\phi}$ and Berken were the shortest, averaging 35 and 45.6 cm respectively.

Height to lowest pod

- This measurement gives an indication of crop harvestability. Figure 1 shows the depth of pods of each variety with Regur showing a podding depth of 30 cm from the top of the plant. Regur is well known to set its pods lower, in this experiment measuring 19 cm above ground level. There was no significant difference in the height above ground of the lowest pod in Jade-AU$^{\phi}$, Crystal$^{\phi}$ and Satin II$^{\phi}$.

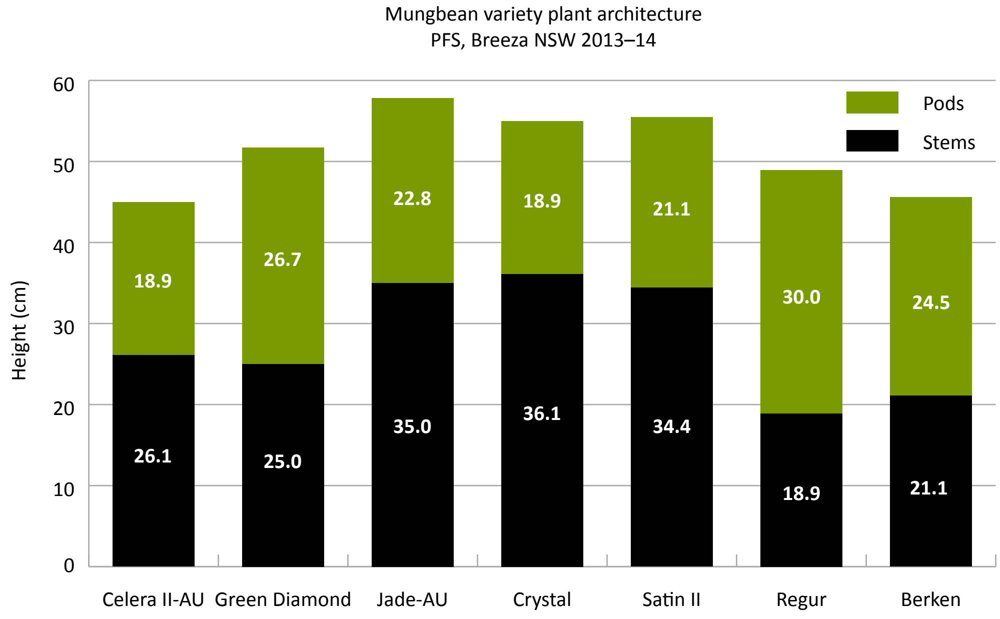

***Figure 1**. Comparison of plant architecture in mungbean varieties at Breeza in 2013–14*

Summary

- This experiment includes the most recently released elite genotypes, namely Jade-AU$^{\phi}$ and Celera II-AU$^{\phi}$ from the collaborative mungbean breeding program involving GRDC, DAFF and the Australian Mungbean Association. Results show differences in agronomic characteristics, grain quality and yield performance between current industry genotypes.
- Yields in this experiment were adversely affected by waterlogging during the growing season as revealed by capacitance probe measurements. Mungbeans are well known for their sensitivity to ‘wet feet’. Of particular note was the poor performance of Celera II-AU$^{\phi}$. Celera II-AU$^{\phi}$ was most severely affected by waterlogging during the critical pod fill growth phase when irrigation was timed to coincide with the start of flowering in other varieties. Its yield was further compounded by the long delay to harvest, as the trial was only harvested when the longer season varieties were ready.

- Jade-AU$^{\phi}$, released in 2013, has demonstrated differences over the now outclassed Crystal$^{\phi}$ in plant morphology in this experiment. With its superior combined suite of disease resistance it is currently the most functional variety available to the industry.
- Celera II-AU$^{\phi}$ released in 2014 to replace Celera$^{\phi}$ and Green Diamond$^{\phi}$ in the niche small seed market, was disadvantaged in this experiment due to it very early maturity. This resulted in harvest losses. **Results do not show a true reflection of genetic potential and should be treated with caution**. It remains the industry standard for halo blight resistance, rated moderately resistant (MR).

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Technical support: Joe Morphew, Rod Jackson, Scott Goodworth, Rosie Holcombe, Jim Murphy, Joel Hargreaves and Dave Eglington.

Quality testing conducted by Futari Grain Technology Services – Narrabri.

Mungbean variety response to irrigation regime – Narrabri 2013–14

Kathi Hertel[1], Craig Chapman[1], Rod Jackson[1] and Steven Harden[2]
[1] NSW DPI, Narrabri [2] NSW DPI, Tamworth

Key findings

Results show differences in agronomic characteristics and grain quality between current industry genotypes. Difficulties with irrigation and harvest timing have compromised results. **Yields in particular in this experiment do not demonstrate a true reflection of the genetic potential of varieties in this experiment**.

In other studies, Jade-AU$^{(d)}$ (released in 2013), has demonstrated improvement over the now outclassed Crystal$^{(d)}$ in the areas of yield, seed size and plant morphology in this experiment. With its superior combined suite of disease resistance it is currently the most functional variety available to the industry.

Celera II-AU$^{(d)}$ released in 2014 has extended the range of varietal maturities available, being the quickest to flower and reach physiological maturity. It remains the industry standard, rated moderately resistant (MR) to halo blight. Of all varieties in this experiment, it was the most negatively impacted. **Results do not show a true reflection of its genetic potential**.

Introduction

Improving the yield potential and reliability of pulses in Northern Grains Region farming systems is a major focus of the Northern Pulse Agronomy Initiative project. Benefits of pulse crops include improving the productivity of subsequent crops, reducing the impacts of disease and weeds, increasing soil fertility, enhancing farm income, increasing crop diversity and economic risk and producing a protein food source for the increasing demand by a global population.

One of the aims of the project is to investigate agronomic constraints to achieving yield potential of summer pulses. Data from experiments will be used to develop variety specific agronomic recommendations for newer varieties as well as general pulse agronomy recommendations. This experiment includes older varieties as well as newer varieties to assess gains in yields and improvements in desirable agronomic traits of recently released varieties.

This experiment is one of a number of research studies into summer pulses, specifically soybean and mungbean, conducted by NSW DPI researchers at Grafton, the Australian Cotton Research Institute (Narrabri) and the Trangie Agricultural Institute. Additional sites are also located on farms located throughout the Northern Grains Region.

The experiment aimed to represent a dryland crop situation with a full soil water profile at sowing compared to irrigated crops, with an irrigation applied during the vegetative growth stage and two in-crop irrigations applied at both vegetative mid-vegetative and early flowering growth stages.

Site details

Location: **Australian Cotton Research Institute, Narrabri**

Planting date: **3 December 2013**

Target population: **35 plants/m^2**

Layout: **60 cm rows on 2.0 m wide raised bed**

Harvest date: **3 May (120 DAS)**

Comments:

The experiment was sown into excellent seedbed conditions after 56 mm rainfall in the 10 day period prior to planting and with soil temperatures recorded at 23.7 °C (taken at 9:00 am at 10 cm depth). The day before emergence 7.2 mm rain fell. Crop emergence (50%) was 3 days after sowing. Soil temperatures in the 5 day period following sowing during which seed was germinating, recorded maximum soil temperatures of between 27.5 and 32.7 °C at 10 cm depth.

During the 6 weeks following sowing, all but 17 days recorded daily maximum air temperatures of 35 °C or more. Only 2 of 17 days recorded daily maximum temperatures below 30 °C. On 4 January 2014 (28 DAS) temperatures peaked at 47 °C.

__Table 1__. Site temperature (°C)

	December	January	February	March	April
Minimum	6.8	12.6	14.1	10.6	6.2
Minimum (mean)	*16.8*	*19.3*	*19.7*	*16.5*	*13.7*
Maximum	41.9	47.0	41.4	35.3	33.5
Maximum (mean)	*34.7*	*36.8*	*35.4*	*30.7*	*28.3*
Overall mean	23.6	28	27.6	23.6	21

Treatments

Four varieties were evaluated: Jade-AU$^{\phi}$, Crystal$^{\phi}$, Satin II$^{\phi}$ and Celera II-AU$^{\phi}$.

- Jade-AU$^{\phi}$, a large seeded bright green mungbean was released in 2013 to replace Crystal$^{\phi}$. It has demonstrated consistent yield improvements over Crystal$^{\phi}$ in northern NSW. It has the best available combined suite of resistance to the major diseases affecting mungbean (powdery mildew, tan spot and halo blight).
- Crystal$^{\phi}$ was released in 2008. At the time it had the most widespread adaptation, suitable for both spring and summer plantings and also the best combined resistance to major mungbean diseases. It has now been outclassed by Jade-AU$^{\phi}$.
- Celera II-AU$^{\phi}$ is a small seeded variety released in 2014 to replace Celera$^{\phi}$ and Green Diamond$^{\phi}$. Celera II-AU$^{\phi}$ is the first mungbean variety with an improved resistance to halo blight (MR).
- Satin II$^{\phi}$ is a dull-seeded mungbean released in 2008 to replace Satin.

Three irrigation regimes were:

- Treatment 1: Irrigated 1 [pre-water only] 7 November 2013 (26 DAS)
- Treatment 2: Irrigated 2 [pre-water + in-crop irrigation] 15 January 2014 (42 DAS)
- Treatment 3: Irrigated 3 [pre-water + in-crop irrigation] 20 December 2013 (16 DAS) +15 January 2014 (42 DAS)

A capacitance probe was installed at the field to monitor irrigation. Problems with the bed subbing up evenly to the middle crop row meant irrigations were longer than desirable and the experiment suffered periods of waterlogging after irrigation. This impacted on all varieties and is the main reason attributed to the low yields in this experiment in all varieties.

The timing of the *first in-crop irrigation* 16 DAS (20 December 2013) in Treatment 3 in this experiment coincided with all varieties during the vegetative growth stage.

Observations recorded 22 January, 7 days after the *second in-crop irrigation* (Treatments 2 and 3 – 49 DAS) showed Celera II-AU$^{\phi}$ to be the most advanced, showing constriction around the seeds (GS R4) in the pre-water treatment only. In the two in-crop irrigation treatment, Celera II-AU$^{\phi}$ development was averaging growth stage R3, showing the beginnings of early seed development as pods lengthened to around 5 cm. Jade-AU$^{\phi}$ and Crystal$^{\phi}$ were flowering, with pods at around 1 – 2 cm in length. Satin II$^{\phi}$ was observed to be in the early stages of flowering, with some plants yet to flower and others only just showing the very first hints of pod development.

Results

Yield

- Overall mean site yield was 0.84 t/ha (Table 2). There was no significant difference in yield between the newly released variety Jade-AU$^{\phi}$ to either Satin II$^{\phi}$ or Crystal$^{\phi}$ (L.S.D. 0.10). There was no significant effect of irrigation regime on any variety.
- Celera II-AU$^{\phi}$ yields were significantly lower than other varieties in this experiment. *These results do not give a true representation of its yield potential.* Practical management of Celera II-AU$^{\phi}$ planted with other longer season varieties compromised its growth and development, with the timing of irrigations, periods of waterlogging at critical development phases and late harvest all compounding to adversely affect its performance.

***Table 2**. Effect of irrigation regime on mungbean yield Narrabri in 2013–14*

Variety	**Yield (t/ha)**			**Yield as % site mean**			**Yield as % Crystal$^{\phi}$**		
	Irr. 1	**Irr. 2**	**Irr. 3**	**Irr. 1**	**Irr. 2**	**Irr. 3**	**Irr. 1**	**Irr. 2**	**Irr. 3**
Jade-AU$^{\phi}$	0.46	0.99	1.14	98	102	106	98	103	114
Crystal$^{\phi}$	0.47	0.96	1.01	101	99	93	100	100	100
Satin II$^{\phi}$	0.52	1.08	1.13	113	111	105	112	112	113
Celera II-AU$^{\phi}$	*0.41	*0.84	*1.03	*88	*87	*95	*87	*88	*102
Site mean	0.46	0.97	1.08						
L.S.D. (P=0.05)	0.17								

**Due to the practical timing of trial harvest operations, Celera II-AU$^{\phi}$ was harvested later than would be recommended. Physiological maturity (R7) was recorded 52 days earlier. Shattering losses were measured and added to the harvested yield to give a true indication of variety performance.*

Seed size

- There was no significant interaction of varieties with irrigation regime on seed size. The significant differences measured between varieties are due to their inherent genetic makeup (Table 3). Celera II-AU$^{\phi}$ is a small seeded variety, targeted at a specific market. Its 100 seed weight averaged 3.78 g in this experiment. The remaining varieties are large seeded types. In this experiment, there was no significant difference in seed size between Crystal$^{\phi}$ at 7.12 g/100 seeds, Jade-AU$^{\phi}$ or Satin II$^{\phi}$.

Seed protein

- There was a significant difference in the seed protein content between varieties (L.S.D. 0.36) and varieties within irrigation treatments (L.S.D. 0.95) (Table 3). Satin II$^{\phi}$ recorded the highest protein content, significantly greater than all other varieties.
- There was no significant difference between Jade-AU$^{\phi}$ and Crystal$^{\phi}$. Celera II-AU$^{\phi}$ measured the lowest protein content at 25.94%. There was no consistent pattern in response to irrigation treatments. Treatment 1 (pre-water only) measured the highest average protein (27.06%).

***Table 3**. Effect of irrigation regime on mungbean seed quality at Narrabri in 2013–14*

Variety	100 seed weight (g)			*Seed protein (%)		
	Irr. 1	**Irr. 2**	**Irr. 3**	**Irr. 1**	**Irr. 2**	**Irr. 3**
Jade-AU$^{\phi}$	7.10	7.18	6.91	26.43	26.53	26.2
Crystal$^{\phi}$	7.44	6.80	7.12	26.8	25.40	26.63
Satin II$^{\phi}$	7.52	6.91	6.75	26.63	25.17	26.03
Celera II-AU$^{\phi}$	3.87	3.74	3.49	28.37	27.30	28.17
Site mean	6.48	6.16	6.13	27.06	26.10	26.76
L.S.D. *(P=0.05)*	N.S.D.			0.95		

**Expressed as dry matter basis*

Height of lowest pod

- Figure 1 shows the effect of irrigation regime on the height of the lowest pod and overall plant height of individual varieties. It shows the depth of podding and indicates the potential effects on harvestability and risks of downgrading from staining and soil contamination. The height of the lowest pod on plants averaged 36.71 cm across the whole experiment. The height of the lowest pod in Celera II-AU$^{\phi}$ was significantly lower than all other varieties. There was no significant difference in height of lowest pod between the remaining large seeded varieties under the different irrigation regimes.

Crop height

- Crop height at maturity across the site averaged 49.17 cm. There were significant differences in-crop height at maturity between varieties. Celera II-AU$^{\phi}$ was significantly shorter than other varieties, averaging 45.37 cm. There was no significant difference in-crop height between the remaining varieties. Irrigation regime had significant effects on crop height of all varieties (Figure 1), averaging an increase in overall crop height of 39% between the pre-water only regime and the full irrigation regime.

Days to physiological maturity

- Celera II-AU$^{\phi}$ reached physiological maturity (90% black pods) 63–66 DAS. This was earlier than all other varieties in the experiment which reached physiological maturity 72–74 DAS. There was no significant difference in timing to physiological maturity between Jade-AU$^{\phi}$, Crystal$^{\phi}$ and Satin II$^{\phi}$. The time to reach physiological maturity for each variety was unaffected by irrigation regime.

Summary

- This experiment includes the most recently released elite genotypes, namely Jade-AU$^{\phi}$ and Celera II-AU$^{\phi}$ from the collaborative mungbean breeding program involving GRDC, DAFF and the Australian Mungbean Association. Results show differences in agronomic characteristics and grain quality between current industry genotypes. *Yields in this experiment do not demonstrate a true reflection of the potential of these varieties.*
- In other studies, Jade-AU$^{\phi}$ (released in 2013), has demonstrated improvement over the now outclassed Crystal$^{\phi}$ in areas of yield, seed size and plant morphology. *With its superior combined suite of disease resistance it is currently the most functional variety available to the industry.*

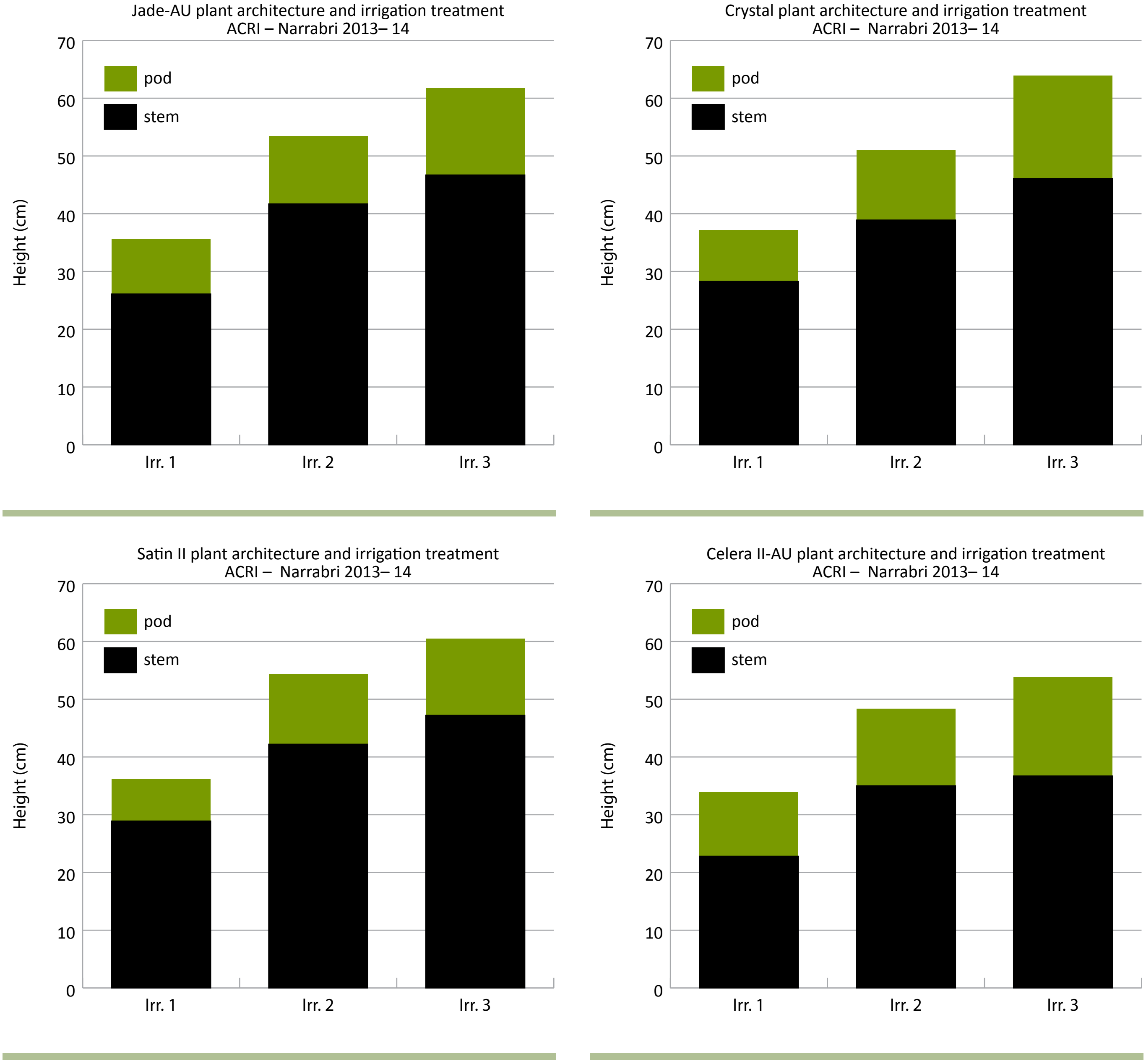

***Figure 1**. Effect of irrigation regime on harvestability characteristics in mungbean varieties at Narrabri in 2013–14*

- Celera II-AU$^{\phi}$ released in 2014 to replace Celera$^{\phi}$ and Green Diamond$^{\phi}$ in the niche small seed market. It remains the industry standard, rated moderately resistant (MR) to halo blight. Of all varieties in this experiment, it was the most negatively impacted. *Results do not show a true reflection of its genetic potential.*

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Technical support: Joe Morphew, Des Magann and Rosie Holcombe.

Quality testing conducted by Futari Grain Technology Services – Narrabri.

Managing dryland sorghum for maximum yield potential – Breeza 2013–14

Loretta Serafin, Guy McMullen, Nicole Carrigan and Peter Perfrement
NSW DPI, Tamworth

Introduction

NSW DPI and GRDC have commenced a three-year joint funded project targeted at identifying key management practices which can help growers to close the yield gap between potential and actual yields achieved in sorghum and wheat in the northern grains region.

The project aims to quantify the individual contribution to grain yield of a range of agronomic factors and identify any interactions between them. Defining the contribution of these agronomic factors to grain yield will allow for economic comparison and provide direction for growers on which are the most important drivers for closing the gap between potential and achieved grain yield. Not all interactions have been investigated, as the size of the trials would be prohibitive and statistical analysis would be compromised.

This season's sorghum trials include varying a range of management practices such as sowing date, row spacing, plant population, hybrid selection, nitrogen and phosphorus application rates. Two sites were planted in the 2013–14 season, Breeza which included a dryland and an irrigated trial and Pine Ridge, which had a dryland site only.

Site details

Location:	**Liverpool Plains Field Station, Breeza (Field 4)**
Co-operator:	**NSW DPI**
Planter:	**Monosem Precision planter on 90 cm row spacing or twin rows with 4 rows per bed on 1.8 m raised beds**
Starting soil water:	**187 mm PAW for sorghum to 1.2 m when cored pre-sowing (TOS1)**
Starting nutrition:	**Starting soil nutrition is outlined in Table 1. The available soil nitrate N was calculated as 47 kg/ha (0–120 cm)**

Table 1*. Starting soil nutrition*

Depth (cm)	Nitrate (mg/kg)	Colwell P (mg/kg)	Colwell K (mg/kg)	Sulphur (mg/kg)	Organic carbon (%)	Conductivity (dS/m)	pH level ($CaCl_2$)
0–10	10	26	415	5.5	1.00	0.179	7.9
10–30	6	16	309	10.8	0.78	0.186	7.9
30–60	3	11	211	8.1	0.64	0.238	8.0
60–90	2	18	226	9.6	0.53	0.347	8.1
90–120	1	25	234	9.3	0.44	0.324	8.2

Key findings

Time of sowing 1 (30/31 Oct) yielded more than time of sowing 2 (9/10 Dec) in this season, but only by 0.25 t/ha.

Varying hybrid selection had minimal impact on yield at this site in this season.

The 90 cm row spacing yielded more than the twin row configuration in both TOS 1 and TOS 2 across all three target plant populations.

Increasing plant population from 50 to 75,000 plants/ha improved yield from 3.01 t/ha to 4.10 t/ha in TOS 1 only.

Increasing nitrogen rate improved yields in both times of sowing. In TOS 1 the yield response to applying 200 kg N/ha at sowing compared to the nil treatment was 1.81 t/ha. In TOS 2 the yield response was still significant but lower at a 0.85 t/ha yield increase.

The application of 10 kg phosphorus (P) alone did not provide a yield response over nil P, however in combination with nitrogen significant yield responses were gained at both the 10 and 20 kg of P/ha rates.

Treatments

A series of 24 treatment combinations were investigated in a partially factorial experiment with three replicates. The treatments were designed similar to an omission trial, with the 'top' treatment designed to offer the perceived optimum combination of factors and a 'bottom' treatment including the base set of agronomic factors.

Table 2. *Treatment details*

Treatment	Details
Two times of sowing (TOS)	TOS 1 – 30 and 31 October 2013 TOS 2 – 9 and 10 December 2013
3 Hybrids	MR Buster$^{\phi}$, MR Scorpio$^{\phi}$, 85G33
3 Plant populations	50, 75 and 100,000 plants/ha
2 Row spacings	90 cm solid (2 rows on raised beds) Twin rows (4 rows on raised beds, outside rows 90 cm apart with a twin row planted 7.5 cm inside each of these)
3 Nitrogen rates	0, 100 or 200 kg N/ha applied as urea at sowing
3 Phosphorus rates	0, 10 or 20 kg P applied as triple super at sowing

Results

Sowing time

Time of sowing 1 (TOS 1) had higher yields than TOS 2. On average TOS 1 yielded 0.25 t/ha more than TOS 2 in this dryland site with average site yields of 3.38 t/ha and 3.14 t/ha, respectively.

Hybrid selection

Three hybrids were selected for the trials; a commercial hybrid, MR Buster$^{\phi}$, which was used to benchmark against the genetic gain possible for growers changing to newer hybrids, in this case MR Scorpio$^{\phi}$ and 85G33.

In this dryland trial this season there was no significant difference in the yield of the three hybrids when sown at 90 cm row spacing's with a population of 50,000 plants/ha, 100 kg N/ha and 10 kg P/ha applied at sowing.

Yield differences due to hybrid selection were small but much larger differences were obtained from varying other agronomic factors.

Two row configurations were used, a 90 cm solid plant with two rows sown on top of the bed and a twin row configuration where 4 rows were sown, with the outside rows being 90 cm apart and then a twin row sown 7.5 cm inside each of these rows. The row spacing's were compared using the hybrid MR Scorpio$^{\phi}$ across three plant populations, 50, 75 and 100, 000 plants/ha using a base rate of 100 kg N/ha and 10 kg P/ha.

The 90 cm row spacing at 75 and 100,000 plants/ha yielded the same as the twin row configuration at 100,000 plants/ha in TOS 1. In TOS2 there was no significant difference between the 90 and twin row configurations, with the exception of the 75,000 population twin rows which yielded significantly less.

Plant population

There was a significant increase in yield of over 1.0 t/ha in TOS 1 only as plant population increased from 50 to 75,000 plants/ha (Table 3). There was no difference in yield between the 75 and 100,000 plants/ha treatment. There was no significant response to varying population in TOS 2.

***Table 3**. Impact of time of sowing and plant population on yield of dryland grain sorghum – Breeza 2013–14*

					Yield (t/ha)	
Variety	**Population ('000/ha)**	**N (kg/ha)**	**P (kg/ha)**	**Row spacing (cm)**	**TOS 1**	**TOS 2**
MR Scorpio$^{\phi}$	50	100	10	90	3.01b	3.38 b
MR Scorpio$^{\phi}$	75	100	10	90	4.10 a	3.05 b
MR Scorpio$^{\phi}$	100	100	10	90	4.17 a	3.37 b
				5% L.S.D.	0.73	

Nutrition

In these trials only two aspects of crop nutrition were investigated, nitrogen and phosphorus. Both nutrients were applied at sowing.

There was a significant response to nitrogen (Figure 1). In TOS 1, yield improved as nitrogen rate increased with a significant response with each rate increase. Yield increased by 0.76 t/ha from applying 100 kg N/ha compared to the nil treatment, and then by an additional 1.05 t/ha with the application of the 200 kg N/ha treatment (an additional 100 kg). As such there was close to a 2 t/ha response from the application of 200 kg N/ha. In TOS 2, the response to nitrogen was not as great, with no difference between the 100 and 200 kg N/ha treatments, but the 200 kg N/ha treatment yielding 0.85 t/ha more than the nil treatment (Figure 1).

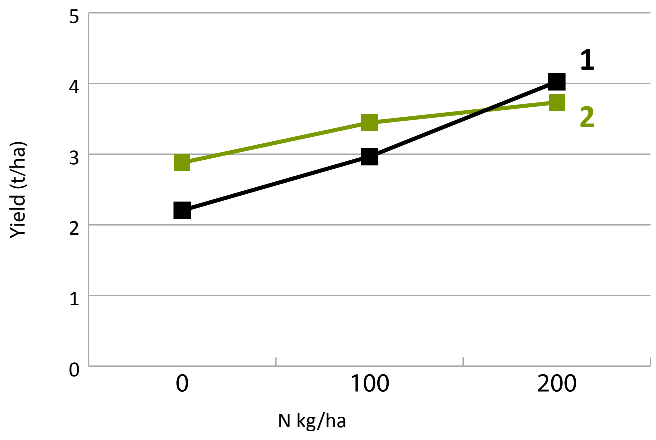

***Figure 1**. Impact of nitrogen rate and time of sowing on dryland grain sorghum yield – Breeza 2013–14*

Responses to phosphorus were not as clear cut as with the application of nitrogen. TOS 2 yielded better than TOS 1, and while there was a trend for increased yields when both nitrogen and phosphorus were added they were not always significant (Table 4).

***Table 4**. Impact of varying phosphorus and nitrogen rates on grain yield of dryland sorghum – Breeza 2013–14*

					Yield (t/ha)	
Variety	**Population (m^2)**	**N (kg/ha)**	**P (kg/ha)**	**Row spacing (cm)**	**TOS 1**	**TOS 2**
MR Scorpio$^{(|)}$	5	0	0	90	2.21c	2.88 b
MR Scorpio$^{(|)}$	5	100	0	90	2.97 b	3.45 ab
MR Scorpio$^{(|)}$	5	0	10	90	2.35 c	2.87 b
MR Scorpio$^{(|)}$	5	100	10	90	3.01 b	3.38 ab
MR Scorpio$^{(|)}$	5	100	20	90	2.85 b	3.87 a
				5% L.S.D.	0.73	

Summary

The results from this trial conducted under dryland conditions at Breeza in the 2013–14 summer cropping season suggest that significant yield gains can be achieved by varying agronomic management practices. The preliminary results from this trial suggest that growers and agronomists should address nutritional issues; in particular ensuring nitrogen supply is sufficient as yield benefits of around 2.0 t/ha were gained from the application of 200 kg N/ha. There was also a significant yield response to increasing plant population from 50 to 75,000 plants/ha of over 1.0 t/ha. In comparison the yield responses from varying hybrid choice were only relatively minor at both times of sowing in this season.

In order to fully evaluate potential financial returns from adopting such higher input cost strategies, growers should complete their own gross margin to compare potential returns in their individual circumstances.

Acknowledgements

Technical assistance provided by Angus Hombsch, Jim Perfrement, Peter Formann, Scott Goodworth and Steve Gengos, is gratefully acknowledged. This research was co-funded by NSW DPI and GRDC under the Northern Region High Yielding Cereal Agronomy Project (DAN 00181). Thanks to Pioneer Hi-Bred and Pacific Seeds for supply of trial seed.

Managing irrigated sorghum for maximum yield potential – Breeza 2013–14

Loretta Serafin, Guy McMullen, Nicole Carrigan and Peter Perfrement
NSW DPI, Tamworth

Introduction

NSW DPI and GRDC are conducting a three-year joint funded project targeted at identifying key management practices which can help growers to close the yield gap between potential and actual yields achieved in sorghum and wheat in the northern grains region.

The project aims to quantify the individual contribution to grain yield of a range of agronomic factors and identify any interactions between them. Defining the contribution of these agronomic factors to grain yield will allow for economic comparison and provide direction for growers on which are the most important drivers for closing the gap between potential and achieved grain yield. Not all interactions have been investigated, as the size of the trials would be prohibitive and statistical analysis would be compromised.

This season's sorghum trials include varying a range of management practices such as sowing date, row spacing, plant population, hybrid selection, nitrogen and phosphorus application rates. Two sites were planted in the 2013–14 season, Breeza which included a dryland and an irrigated trial and Pine Ridge, which had a dryland site only.

Site details

Location:	**Liverpool Plains Field Station, Breeza (Field 4)**
Co-operator:	**NSW DPI**
Planter:	**Monosem Precision planter on 90 cm row spacing or twin rows with 4 rows per bed on 1.8 m raised beds**
Starting soil water:	**187 mm PAW for sorghum to 1.2 m when cored pre-sowing (TOS1)**
Irrigations:	**7 January 2014 (Irrigated trial TOS 1 and 2)**
	3 February 2014 (Irrigated trial TOS 1 and 2)
Starting nutrition:	**Starting soil nutrition is outlined in Table 1. The available soil nitrate N was calculated as 47 kg/ha (0–120 cm)**

***Table 1**. Starting soil nutrition – Breeza 2013–14*

Depth (cm)	Nitrate (mg/kg)	Colwell P (mg/kg)	Colwell K (mg/kg)	Sulphur (mg/kg)	Organic carbon (%)	Conductivity (dS/m)	pH level ($CaCl_2$)
0–10	10	26	415	5.5	1.00	0.179	7.9
10–30	6	16	309	10.8	0.78	0.186	7.9
30–60	3	11	211	8.1	0.64	0.238	8.0
60–90	2	18	226	9.6	0.53	0.347	8.1
90–120	1	25	234	9.3	0.44	0.324	8.2

Key findings

Time of sowing 1 (TOS 1) yielded more than time of sowing 2 (TOS 2) in this season, but only by 0.35 t/ha.

Varying hybrid selection had no significant impact on yield at this site in this season.

The 90 cm row spacing in TOS1 and TOS 2 yielded the same as the twin row spacing in TOS1. However, the twin row configuration was lower yielding in TOS 2.

There were no significant yield response associated with varying plant populations under irrigation, with an average site yield of 5.42 t/ha.

In TOS 1 there was a 2.9 t/ha yield benefit from applying 200 kg N/ha compared to the Nil N treatment. In TOS 2 the response was similar to TOS 1 but there was no significant difference between the 100 and 200 N/ha treatments, which were 2.0 and 2.3 t/ha higher yielding than the nil treatment, respectively.

Responses to phosphorus were evident at both sowing times, however the response was only significant when it was coupled with the application of nitrogen.

Treatments

A series of 24 treatment combinations were investigated in a partially factorial experiment with three replicates. The treatments were designed similar to an omission trial, with the 'top' treatment designed to offer the perceived optimum combination of factors and a 'bottom' treatment including the base set of agronomic factors.

***Table 2**. Treatment details*

Treatment	Details
Two times of sowing (TOS)	TOS 1 – 30 and 31 October 2013 TOS 2 – 9 and 10 December 2013
3 Hybrids	MR Buster,$^{\phi}$ MR Scorpio$^{\phi}$, 85G33
3 Plant populations	50, 75 and 100,000 plants/ha
2 Row spacings	90 cm solid (2 rows on raised beds) Twin rows (4 rows on raised beds, outside rows 90 cm apart with a twin row planted 7.5 cm inside each of these).
3 Nitrogen rates	0, 100 or 200 kg N/ha applied as urea at sowing.
3 Phosphorus rates	0, 10 or 20 kg P applied as triple super at sowing.

Results

Sowing time

The earlier time of sowing produced higher yields with TOS 1 yielding 0.35 t/ha more than TOS 2 in the irrigated trial. TOS 1 was also higher yielding than TOS 2 in the dryland trial at this site in 2013–14 with the an average yield of 5.60 t/ha in the irrigated trial and 5.23 t/ha in the dryland trial.

Hybrid selection

Three hybrids were selected for the trials; a commercial hybrid, MR Buster$^{\phi}$, which was used to benchmark against the genetic gain possible for growers changing to using newer hybrids, in this case MR Scorpio$^{\phi}$ and 85G33.

In this irrigated trial this season there was no significant difference in the yield of the three hybrids when sown at 90 cm row spacing's with a population of 50,000 plants/ha, 100 kg N/ha and 10 kg P/ha applied at sowing (Figure 1).

Yield differences due to hybrid selection were small but much larger differences were obtained from varying other agronomic factors.

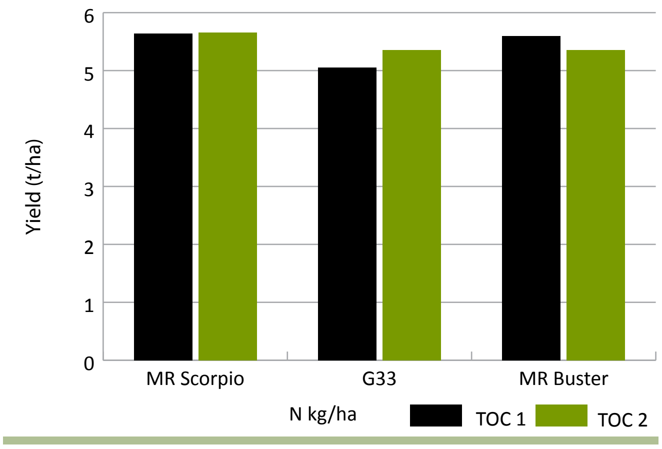

Figure 1. *Impact of varying hybrid selection on irrigated grain sorghum yield across two sowing times – Breeza 2013–14*

Row Configuration

Two row configurations were used, a 90 cm solid plant with two rows sown on top of the bed and a twin row configuration where 4 rows were sown, with the outside rows being 90 cm apart and then a twin row sown 7.5 cm inside each of these rows. The row spacing's were compared using the hybrid MR Scorpio⁽ᴾ⁾ across three plant populations, 50, 75 and 100, 000 plants/ha using a base rate of 100 kg N/ha and 10 kg P/ha.

In this irrigated trial the 90 cm row spacing produced equivalent yield across TOS 1 and TOS 2 at the three plant populations as the twin row spacing in TOS 1. However, the twin rows were lower yielding at all three plant populations in TOS 2 (Figure 2).

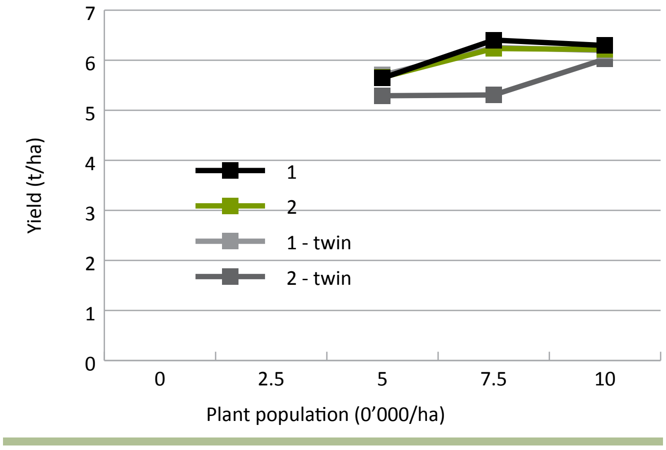

Figure 2. *Impact of varying row configuration and plant population on yield of irrigated grain sorghum – Breeza 2013–14*

Plant population

In this irrigated trial yield appeared to increase as plant population increased from 50 to 75,000 plants/ha and then plateau. However, the differences were not significant between populations or across the two sowing times (Table 3).

***Table 3**. Impact of time of sowing and plant population on yield of irrigated grain sorghum – Breeza 2013–14*

					Yield (t/ha)	
Variety	**Population (m^2)**	**N (kg/ha)**	**P (kg/ha)**	**Row spacing (cm)**	**TOS 1**	**TOS 2**
MR Scorpio$^{(b)}$	5	100	10	90	5.64	5.66
MR Scorpio$^{(b)}$	7.5	100	10	90	6.40	6.23
MR Scorpio$^{(b)}$	10	100	10	90	6.29	6.21
				5% L.S.D.	0.87 N.S.D.	

Nutrition

In these trials only two aspects of crop nutrition were investigated, nitrogen and phosphorus. Both nutrients were applied at sowing.

In TOS 1 there was a 2.9 t/ha yield benefit from applying 200 kg N/ha compared to the Nil N treatment with the benefit of the 100 kg N/ha rate not significant (Figure 3). In TOS 2 both the 100 and 200 kg N/ha treatments provided significant yield benefit of 2.0 and 2.3 t/ha, respectively over the nil N treatment (Figure 3). However, the difference between the 100 and 200 kg N/ha rates was not significant.

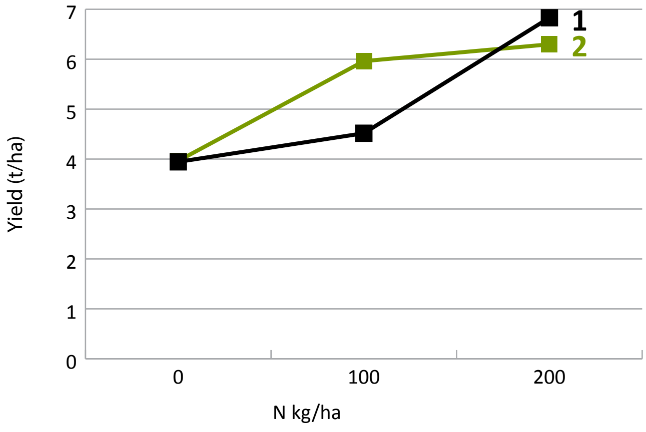

***Figure 3**. Impact of nitrogen rate and time of sowing on irrigated grain sorghum yield*

Responses to phosphorus application were evident in both sowing times, however the response to P was only significant when it was coupled with the application of nitrogen. The responses across the two times of sowing were almost identical with the exception of the TOS 2 treatment where the addition of 100 kg N/ha and 0 kg P/ha yielded significantly higher than the control (Table 4).

***Table 4**. Impact of varying phosphorus and nitrogen rates on grain yield of irrigated sorghum – Breeza 2013–14*

					Yield (t/ha)	
Variety	**Population (m^2)**	**N (kg/ha)**	**P (kg/ha)**	**Row spacing (cm)**	**TOS 1**	**TOS 2**
MR Scorpio$^{\Phi}$	5	0	0	90	3.94 b	3.96 b
MR Scorpio$^{\Phi}$	5	100	0	90	4.52 b	5.96 a
MR Scorpio$^{\Phi}$	5	0	10	90	4.01 b	3.80 b
MR Scorpio$^{\Phi}$	5	100	10	90	5.64 a	5.66 a
MR Scorpio$^{\Phi}$	5	100	20	90	6.05 a	5.45 a
				5% L.S.D.	0.87	

Summary

The results from this irrigated trial at Breeza in the 2013–14 summer cropping season suggests that significant yield gains can be achieved by varying agronomic management practices. The preliminary results from this trial suggest that growers and agronomists should address nutritional issues; in particular ensuring nitrogen supply is sufficient as yield benefits of around 2.9 t/ha were gained from the application of 200 kg N/ha at this site with a low starting nitrogen level. There appeared to be no significant yield response to increasing plant population or varying hybrid selection in this trial with two in-crop irrigations.

In order to fully evaluate potential financial returns from adopting a higher input cost strategy, growers should calculate a gross margin to compare to final returns.

Acknowledgements

Technical assistance provided by Angus Hombsch, Jim Perfrement, Peter Formann, Scott Goodworth and Steve Gengos, is gratefully acknowledged. This research was co-funded by NSW DPI and GRDC under the Northern Region High Yielding Cereal Agronomy Project (DAN 00181). Thanks to Pioneer Hi-Bred and Pacific Seeds for supply of trial seed.

Sorghum in the western zone – Row Configuration x Population x Hybrid – Tulloona 2013–14

Loretta Serafin, Guy McMullen, Nicole Carrigan and Peter Perfrement
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Key findings

In a very low yielding season, where average site yields were just over 1.0 t/ha there was no response to varying row configuration or plant population.

There was a significant difference in hybrid performance with yield being MR Bazley>MR43>2436.

Grain quality also suffered from the hard season with high screening levels, low hectolitre weight and 1000 grain weights.

Varying population and hybrid did provide limited benefits but the impacts were not large enough to change the final grain receival grade.

Introduction

Sorghum is a reliable summer crop in eastern areas of northern NSW. However there is a need to improve the reliability of sorghum in western cropping areas and to assess strategies that will allow growers to adapt to increasingly variable seasonal conditions. The introduction of hybrids with increasing levels of Staygreen (SG), or using a combination of tillering, plant population and row configuration may help improve the reliability of sorghum yield in western regions.

In the eastern zone there has been a reasonable amount of work evaluating population and row spacing. Modelling work has suggested that sorghum can be a reliable component of western cropping systems but this work needs applied research to verify the modelling and give growers confidence to incorporate sorghum into their rotations.

In northern NSW crown rot, a stubble-borne fungal pathogen, continues to be the most prevalent and damaging disease affecting winter cereals. Sorghum is recommended as a break crop but the success is dictated by the amount of breakdown of the winter cereal stubble. Although altering row configuration and population may improve the reliability of sorghum it may also reduce the rate of decomposition of cereal stubble and reduce water accumulation during the fallow period and hence the break crop benefits.

The trial outlined below aims to answer some of these questions and provide data for use in modelling the trial outcomes over long term climatic data sets. This was one of two sites planted across northern NSW in the 2013–14 season. The second site was located near Baradine but failed due to drought.

Site details

Location:	**'Bukulla' Tulloona**
Co-operator:	**Daryl Radford**
Sowing date:	**2 and 3 October 2013**
Harvest date:	**10 February 2014**
Planter:	**Monosem double disc precision planter**
Fertiliser:	**105 kg/ha urea at sowing, 48 kg/ha Starter Z® at sowing**
PreDicta B:	**Nil *Pratylenchus neglectus*, 2.4 *P. thornei*/g soil (medium risk)**
Crown rot:	**46% recovery from crowns of wheat stubble (high risk)**
Paddock history:	**Long fallow from wheat in 2012**

In-crop rainfall (mm):

Table 1. *In-crop rainfall 2013–14 season*

October	November	December	January	February	Total (mm)
13.6	71.4	7.2	24.6	29.6	146.4

Starting soil water

The site was cored at sowing to establish starting soil water. Plant available water (PAW) was estimated to be 51 mm to 1.2 m depth.

Starting soil nutrition

***Table 2**. Soil test results for 'Bukulla' Tulloona*

Soil depth (cm)	Nitrate N (mg/kg)	Sulphur (mg/kg)	Organic carbon %	pH Level ($CaCl_2$)	Phosphorus (Colwell) (mg/kg)	Zinc (DTPA) (mg/kg)
0–10	13	22.4	0.63	7.6	11	1.45
10–30	8	7.1	0.49	8.0	2	0.24
30–60	5	56.8	0.36	8.0	< 2	–
60–90	2	3091.7	0.26	6.4	< 2	–
90–120	1	1152.8	0.20	5.0	4	–

Treatments

Hybrids

- 2436 (low tillering and high SG)
- MR43 (moderate SG and tillering)
- MR Bazley (high tillering and low SG)

Row configuration

- Solid on 1 m spacings
- Single skip
- Double skip
- Superwide (1.5 m spacings)

Plant populations

Populations were targeted using germination for each hybrid and an estimated establishment of 80%. Three populations were targeted in each of the row configurations.

- 15,000 plants/ha
- 30,000 plants/ha
- 50,000 plants/ha

Results

Plant establishment

There was no impact of row configuration on plant establishment at this site (Table 3). The plant populations which established were significantly different but lower than the targeted populations. This was particularly evident with the 5.0 plants/m^2 (50,000 plants/ha) treatment where on average only 3.0 plants/m^2 (30,000 plants/ha) were established most likely due to the hot and dry conditions which followed planting, however there was good separation between the established populations (Table 4). There was also a significant difference in the establishment of the three hybrids with MR43 establishing fewer plants than 2436. There was no significant difference in establishment between MR43 and MR Bazley (data not shown).

***Table 3**. Plant structures data across configurations*
Values followed by the same letter are not significantly different (N.S.D.) at the 95% confidence level

Configuration	Plants/m^2	Tillers/m^2	Tillers/plant	Heads/m^2	Heads/plant
Solid	2.4	4.83 a	2.36	3.87	1.84
SS	2.2	4.43 a	2.24	3.90	1.95
SW (1.5 m)	2.3	4.15 ab	2.15	4.14	2.04
DS	2.0	3.20 b	1.88	3.48	1.84
L.S.D.	N.S.D.	1.00	N.S.D.	N.S.D.	N.S.D.

***Table 4**. Plant structures data across populations*
Values followed by the same letter are not significantly different at the 95% confidence level

Population ('000/ha)	Plants/m^2	Tillers/m^2	Tillers/plant	Heads/m^2	Heads/plant
15	1.4 c	3.87 b	2.87 a	3.32 c	2.41 a
30	2.3 b	4.12 ab	1.87 b	3.85 b	1.69 b
50	2.9 a	4.46 a	1.73 b	4.37 a	1.65 b
L.S.D.	0.5	0.46	0.14	0.47	0.27

Tillers

There were significant differences in the number of tillers produced with configuration, plant population and hybrid but no interaction between the three factors. The number of tillers produced declined as the effective row spacing increased which is likely a function of the increased competition within the row (Table 3). In contrast the number of tillers per m^2 increased as plant population increased. In contrast, the number of tillers per plant declined as the plant population increased (Table 4).

Differences in tillering between sorghum varieties were as expected with MR Bazley producing the most tillers per plant and also per m^2 (4.9/m^2), then MR43 (4.2/m^2), and 2436 being the lowest at 3.3/m^2. Interestingly there was no significant difference in the tiller production per plant between MR Bazley and MR43.

Head numbers

The number of heads per m^2 increased as the plant population increased (Table 4). There was no significant impact of varying row configuration on the number of heads per m^2 (Table 3). The higher tillering hybrid MR Bazley had more heads per m^2 than MR43 and 2436 which were not significantly different from each other (data not shown).

There was no difference in the number of heads produced per plant based with the different row configurations (Table 3). The number of heads per plant declined as the plant population increased from a target of 15 to 30,000/ha but there was no difference between the 30 and 50,000/ha treatments (Table 4). MR Bazley and MR43 produced more heads per plant than 2436 (data not shown).

Dry matter production

There was no response to varying population, row configuration or hybrid on the amount of dry matter produced. On average only 3.86 t/DM/ha was measured at flowering.

Yield

Yield was very low at this site as a result of limited in-crop rainfall. The average site yield was only 1.04 t/ha. There was no yield response to row configuration or plant population in this trial with the only significant difference being between sorghum hybrids. MR Bazley was the highest yielding hybrid at 1.3 t/ha, followed by MR43 at 1.0 t/ha and 2436 was the lowest yielding at 0.8 t/ha.

Grain quality

Protein

The average grain protein was 11.5%, however there was no impact of row configuration or plant population alone on grain protein levels. In terms of hybrid performance, 2436 produced significantly higher grain protein than MR43 which was higher than MR Bazley. There was a significant interaction between hybrid and configuration but the differences could not be explained.

1000 grain weight

Grain weights were very low from this site, on average just over 11 g/1000 seeds. There was an impact of varying row configuration, population and hybrid but the overall impacts on grain weight were small. Grain weight increased as row spacing increased. Grain weight declined as population increased. 2436 had the largest grain weight at 12.07 g/1000 seeds, larger than MR Bazley at 11.57 and MR43 at 10.25 g/1000 seeds.

Hectolitre weight

Hectolitre weights were low, on average 58 kg/hL. Hectolitre weight declined as plant population increased. MR Bazley had the highest hectolitre weight followed by 2436 and then MR43.

Screenings

Screenings as expected were very high at this site, on average 43%. There was a significant impact of varying plant population on screening levels which got higher as the population increased. However, even at the 15,000 plants/ha treatment the level of screenings was still a long way above receival standards for the sorghum grades at 35%. There were also large differences between hybrids, with MR43 having the highest screenings at 50%, followed by MR Bazley at 40% and 2436 at 38%. There was no impact of varying row configuration on screenings.

Summary

In a very dry season with minimal in-crop rainfall, yields at this site were very low, on average just over 1.0 t/ha. There was no significant impact of varying row configuration or plant population under these conditions on grain yield. There were significant differences between hybrids with MR Bazley yielding 1.3 t/ha, followed by MR43 at 1.0 t/ha and then 2436 at 0.8 t/ha.

Grain quality was poor with very high screening levels, low hectolitre weights and 1000 grain weights. Although there were significant differences in population, hybrid or configuration in many of these grain quality attributes they were not large enough to impact on the receival grade.

Acknowledgements

This research was co-funded by NSW DPI and GRDC under project DAN00150 with support from Pacific Seeds. Thanks to Peter Formann, Angus Hombsch and Jim Perfrement (NSW DPI) for technical assistance and to Daryl Radford ‘Lorne’ Tulloona for hosting the trial site.

Precision planter versus airseeder for sorghum production – Breeza 2013–14

Loretta Serafin, Guy McMullen, Nicole Carrigan and Peter Perfrement
NSW DPI, Tamworth

Key findings

There was no significant difference in plant establishment or grain yield across five different plant populations using the two different planters at this site in this season.

Introduction

Sorghum is planted using a range of sowing equipment in the northern grains region. While it is commonly accepted that crops sown using a precision planter have more uniform plant density both within the row and across the paddock, there is very little data to demonstrate if this contributes to an advantage in grain yield at the end of the season.

This trial aimed to compare plant establishment and the impacts on final grain yield and quality from a precision versus 'airseeder' sowing technique; a cone seeder was used to mimic the plant distribution achieved from an airseeder.

Site details

Location:	**Liverpool Plains Field Station, Breeza (Field 4)**
Co-operator:	**NSW DPI**
Sowing date:	**11 December 2013**
Hybrid:	**85G33**
Starting soil water:	**187 mm PAW for sorghum to 1.2 m when cored prior to sowing**
Starting nutrition:	**Starting soil nutrition is outlined in Table 1. The available soil nitrate N was calculated as 47 kg/ha (0–120 cm)**

***Table 1**. Starting soil nutrition*

Depth (cm)	Nitrate (mg/kg)	Colwell P (mg/kg)	Colwell K (mg/kg)	Sulphur (mg/kg)	Organic carbon (%)	Conductivity (dS/m)	pH Level ($CaCl_2$)
0–10	10	26	415	5.5	1.00	0.179	7.9
10–30	6	16	309	10.8	0.78	0.186	7.9
30–60	3	11	211	8.1	0.64	0.238	8.0
60–90	2	18	226	9.6	0.53	0.347	8.1
90–120	1	25	234	9.3	0.44	0.324	8.2

Treatments

Two planters were used to establish the trial:

1. Monosem Precision Planter
2. Janke parallelogram cone seeder (airseeder mimic)

Five plant populations were targeted: 50, 75, 100, 125 and 150,000 plants/ha.

Results

Plant establishment

There was no significant difference in the established plant populations achieved with the two planters. Established plant populations were less than the targeted population but were significantly different to each other. In particular the precision planter established higher populations at the lower target populations compared to the higher target populations (Table 2).

***Table 2**. Established plant populations ('000/ha) of grain sorghum at five target plant populations using precision versus airseeder*

	Plant population ('000/ha)				
Seeder	**50**	**75**	**100**	**125**	**150**
Airseeder	37087	49124	97269	113935	120416
Precision	54861	74306	90278	118056	125694
L.S.D.	20289				
C.V	13.1%				

Yield

There was no significant yield difference across both the type of seeder and plant populations (Table 3). The average yields were 3.5 t/ha across the site. Even though there were quite large differences in the yield between the two planters, the differences were not statistically different.

***Table 3**. Yield (t/ha) of grain sorghum at five target plant populations using precision versus airseeder*

	Plant population ('000/ha)				
Seeder	**50**	**75**	**100**	**125**	**150**
Airseeder	3.12	2.65	3.06	2.95	3.28
Precision	3.98	4.13	4.02	3.92	4.18
L.S.D.	N.S.D.				

Summary

The results from this one site trial have shown no significant difference in the plant establishment or yield achieved at five different plant populations and using two seeders. Repeating the trials in additional seasons and at various trial site locations would assist in verifying the results from this single season and site trial.

Acknowledgements

Technical assistance provided by Angus Hombsch, Jim Perfrement, Peter Formann, Scott Goodworth, Steve Gengos, Craig Chapman and Joe Morphew is gratefully acknowledged. This research was funded by NSW DPI. Thanks to Pioneer Hi-Bred for supply of trial seed.

Evaluation of a new DNA tool to detect Phytophthora in paddocks

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Key findings

Knowledge of *Phytophthora medicaginis* (*Pm*) DNA concentration in soil can assist Phytophthora root rot (PRR) management.

In a field trial, treatments with 0 and 100 oospores/plant resulted in low *Pm* DNA concentrations a month after sowing and had significantly less disease development and significantly higher yields than Treatments with higher oospore concentrations at sowing in 2014.

Similar PRR disease levels and yield losses resulted from medium to high *Pm* soil inoculum concentrations at sowing in the *Pm* susceptible chickpea variety Sonali.

The *Pm* DNA test is capable of identifying *Pm* in soil samples collected from grower paddocks across the northern region.

Pm DNA results and *Pm* isolation results agreed for most paddock samples with 82% of positive and 97% of negative samples being consistent. However, results for three samples indicate that further work is required to address some issues including potential sub-sampling effects.

Introduction

Phytophthora medicaginis (*Pm*), the cause of Phytophthora root rot (PRR) disease of chickpea is endemic and widespread in southern QLD and northern NSW. The pathogen carries over from season to season on infected chickpea volunteers, lucerne, native medics and as resistant structures (oospores) in the soil.

A PreDicta B® soil DNA test has been developed by the South Australian Research and Development Institute (SARDI) under the GRDC project DAS00137. The test aims to quantify the amount of *Pm* DNA in soil samples and to provide a measure of the amount of *Pm* inoculum (infected root tissue and oospores) in paddocks from which those samples were collected.

It would be useful if the DNA levels detected by the *Pm* test prior to sowing could predict the likely level of PRR disease development during the growing season and potential associated losses. For example, would paddocks with nil, low and high *Pm* inoculum level respectively have nil, low and high PRR disease development and yield losses? It is also necessary to evaluate the ability of the *Pm* DNA test to detect *Pm* in soil samples from growers paddocks across the northern grains region.

We assessed the capability of this *Pm* DNA test to:

1. Predict the risk of PRR disease development and potential yield losses in chickpea
2. Quantify *Pm* inoculum in soil collected from commercial paddocks

Site and experimental details

Disease development and yield loss prediction	Inoculum detection
Location: Tamworth Sowing date: 3 July 2014 Variety: Sonali (PRR susceptible) Design: Plots 2 × 2.1 m with six replicates Sampling: *Pm* DNA in soil, *normalised difference vegetation index* (NVDI), disease symptoms, grain yield	Soil samples from paddocks in northern NSW and southern QLD, collected 2013 Glasshouse bioassay to bait *Pm* isolates from soil samples. Sonali seedlings grown in a soil-sand mixture, *Pm* isolated from stem cankers. Soil *Pm* DNA analyses of 400 g soil sample from each paddock

Treatments

Disease development and yield loss prediction	Inoculum detection
Six treatments of 0, 100, 500, 1000, 2000 or 4000 *Pm* oospores per plant applied at sowing	Soil samples from 47 paddocks and one *Pm* control sample (MET14)

Results

Pm inoculum level, PRR disease development and yield

- Soil *Pm* DNA results differed significantly among the oospore treatments one month after sowing but also indicated that some *Pm* was already present at the site (Table1). Background inoculum levels could have contributed to the higher than expected DNA value for the 100 oospores/plant treatment.
- The season in Tamworth was drier than usual but following 39 mm of rain from 18–20 August some PRR symptoms (wilting and chlorosis) were observed, then in mid-September during a period (15–22 September) of hot dry winds and high evaporative demand (≥ 5 mm/day) many plots showed severe PRR disease symptoms.
- In mid-September indirect biomass measurement by the reflectance based NVDI showed significant declines in NVDI values in treatments with increasing numbers of oospores/plant.
- By the end of September the nil oospores/plant had fewer diseased plants than the 100 oospores/plant treatment, which itself had less diseased plants than the Treatments with higher inoculum levels (500 to 4000 oospores/plant treatments). The percentage of diseased plants did not differ between the 500 to 4000 oospores/plant inoculum treatments.
- Disease assessments recorded on the 23 September reflected the final grain yields for this trial, with the 0 and 100 oospores/plant treatments each having the highest and second highest yields respectively, and the yields of treatments between 500–4000 oospores/plant not differing.
- There were relatively weak correlations between the post-sow soil *Pm* DNA concentrations and PRR disease (r = 0.45) and chickpea yields (r = -0.39), although the percentage of diseased plants was a strong predictor of grain yield (r = -0.96).

***Table 1**. Oospore treatment, soil Pm DNA concentration, biomass, PRR assessment and yield in 2014 Pm inoculum level trial (standard error of difference between means, SED; transformed, TS)*

Inoculum treatment (oospores/plant)	*Pm* DNA concentration, (DNA/g soil) 4 August	NVDI 12 September	log-TS % of PRR diseased plants (back TS) 23 September	Grain yield, (kg/ha) log-TS (back TS)
0	44	0.68	0 (8.0)	7.1 (1248.9)
100	1280	0.55	3.1 (65.7)	3.6 (38.1)
500	443	0.34	6.4 (98.1)	1.4 (4.0)
1000	2123	0.47	4.7 (90.8)	1.5 (4.4)
2000	1905	0.36	5.3 (94.5)	1.1 (2.9)
4000	3590	0.30	* (100)	0.5 (1.6)
L.S.D. (*P*=0.05)	1749	0.10	0.87 (SED)	1.3

**100% values excluded from analyses*

Pm DNA detection in soil from commercial paddocks

- Twenty six of the soil samples produced plants with some disease symptoms, but *Pm* like cultures were isolated from only ten samples, nine from grower paddocks and one from the MET14 control soil.

- Of the 48 soil samples (including the MET14 control soil), 11 had positive *Pm* DNA results. Overall, most samples (9/11, 82%) which had positive DNA results yielded *Pm* cultures and most samples (36/37, 97%) which had negative DNA results did not yield *Pm* cultures (Table 2).
- Three samples gave contradictory results. One sample which yielded a *Pm* culture was negative for *Pm* DNA. Sub-sampling error may explain this result as this sample was part of a 5 kg trowel collected sample; the 400 g subsample used for *Pm* DNA analysis may not have contained *Pm* DNA.
- Two other samples were positive for *Pm* DNA but did not yield *Pm* cultures. One of these had one seedling with a canker but *Pm* could not be isolated, in the other sample, seedlings in all five cups remained healthy. These two samples had lower *Pm* DNA values (1,467 and 2,507 *Pm* copies/g soil) than all other samples (range 3022–872,069 *Pm* copies/g soil) except one (1,219 *Pm* copies/g soil). Possible explanations for these results are: (i) more time may be required for symptoms to develop in low *Pm* DNA samples, or (ii) that the pathogen had died but some DNA was still detectable.

Table 2*. Comparison of* Phytophthora medicaginis *(Pm) DNA detection in 48 soil samples and isolation success of Pm from Sonali chickpeas grown in these samples*

		48 samples analysed for *Pm* DNA	
		11/48 + *Pm* DNA	**37/48 nil *Pm* DNA**
48 soil samples baited with chickpeas for *Pm*	10/48 + *Pm* isolates	9/11 (positives)	1/37 (false negatives)
	38/48 nil *Pm* isolates	2/11 (false positives)	36/37 (negatives)

Summary

Pm inoculum level, PRR disease and yield

Phytophthora can reproduce rapidly and cause new infections over a relatively short period. This may explain how for *Pm* the 500 to 4000 oospores/plant treatments had very similar PRR disease symptom measurement values at 23 September, which then led to similar yield outcomes. These results indicate that for a susceptible variety like Sonali, PRR disease can build up to high levels under conducive conditions and cause considerable yield losses despite differences in initial *Pm* inoculum levels. Although the relationships between *Pm* DNA concentrations and PRR disease and chickpea yields were relatively weak, the trial showed low *Pm* inoculum levels (0 and 100 oospores/plant) had significantly less disease and significantly higher yields than treatments with higher starting oospore concentrations.

These initial results are encouraging as they suggest that significantly lower PRR disease and higher yields occur at low *Pm* DNA concentrations with a highly susceptible variety. The test may be suitable at identifying low *Pm* inoculum sites where chickpea varieties with better *Pm* resistance (such as Yorker$^{(b)}$) may be grown with less impact of PRR on yield. The test may also be useful at identifying nil from low *Pm* sites, however, trial sites with nil *Pm* will need to be identified to fully assess this aspect.

Pm **DNA detection in commercial in paddocks and disease risk determination**

The initial results are promising with an overall good correlation between *Pm* DNA detection and *Pm* isolation. However, further work is required to address some issues including impact of sub-sampling.

The DNA result for a soil sample collected from a paddock can only provide an indication of inoculum concentration and disease risk for the areas of the paddock which were sampled. Therefore, the spread and locations of sampling across a paddock will affect how representative DNA results are for that paddock. Because of the risk of rapid PRR disease build up following wet conditions it may be appropriate to treat a negative PreDicta B® test result as indicating a low risk rather than a nil risk, as the pathogen could still be in areas of the paddock that were not sampled and so still cause PRR and reduce yield.

To determine the risk of PRR disease it may be appropriate to target locations in a paddock where there is the best chance of *Pm* inoculum being present. The pathogen thrives in soil with high moisture contents and so is often concentrated in low lying regions of paddocks where pooling of water following rain may occur. Targeting low lying areas and weedy areas of paddocks during PreDicta B® soil sampling may provide the best strategy for predicting a paddocks risk of developing PRR in chickpea.

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Comparison of alternative mode of action herbicides for the control of Group I resistant wild radish (NSW field experiment 2014)

Tony Cook
NSW DPI, Tamworth

Key findings

To control Group I resistant wild radish, there are several alternative herbicides that can maintain excellent control. These herbicides are generally suited to application in winter cereal crops but some other can be applied in broad leaf winter crops.

Managing herbicide resistant wild radish by simply rotating herbicide mode of actions works well, but if doing this for prolonged periods of time herbicide resistance to other groups is likely. To combat this, it is strongly suggested to undertake harvest weed seed management tactics such as wind-row burning to extend herbicide effectiveness.

Make herbicide resistance testing a priority on your wild radish populations. Ensure that many herbicide mode of actions are tested so farmers have a better indication of the range of herbicides that should work or not on their wild radish population.

Introduction

Within a year from announcing detection of the first Group I resistant wild radish infestation at Nyngan NSW in 2013, NSW DPIs weeds research team completed a field experiment on this population. Consideration was given to using many different modes of action herbicides to show growers that there is more to wild radish management than relying on Group I herbicides. Herbicide treatments contained modes of action from groups B, C, F, G, H, I and M. Although the infestation is in a wheat crop, some wheat damaging herbicides such as glyphosate, atrazine, diflufenican, Spinnaker® and Balance® were used to demonstrate to growers that crop sequence changes can be made and thus other mode of actions can be used.

Research questions

- Can wild radish be effectively controlled with other herbicides apart from Group I chemistry?
- If herbicides with other modes of action are effective will they be compatible with in-crop application in different crops that are commonly produced in the Central West region of NSW?

Experiment details

Location:	**Nyngan, central-west NSW in a commercial wheat crop (EGA Gregory$^{Ⓓ}$)**
Treatments:	**17 (16 herbicide treatments + 1 untreated) as outlined in Table 1**
Growth stage:	**Most treatments applied to wild radish at the 4 to 8 leaf stage and wheat at the late tillering stage. A late post-emergence treatment of 2,4-D amine was applied to wild radish at the mid flowering stage and wheat at the late jointing stage**

1 biotypes (populations)

It appears this trial site did not have much, if any, Group I resistant wild radish. The paddock which did have confirmed Group I resistance was fallowed to ensure no wild radish could set seed.

Plot size and design

- Three replicates per treatment
- A total of 51 plots used (1 biotype × 17 herbicide treatments × 3 replicates)
- Plot size 2 m by 10 m

Spraying

- TT 110-01 nozzles with pressure of 2 bars with speed of application designed to deliver a water rate of 100 L/ha.
- Treatments applied on 8 August 2014 at 2 pm. Temperature 17 °C, 43% relative humidity and moderate 3 to 12 km/hr south/easterly breeze.

Measurements

- Wild radish brown out assessment (zero to five rating) on 26 August 2014. That is, 18 days after treatment (18 DAT).
- Wild radish plant counts per 10 m^2 made on 8 October 2014. That is, two months after treatment (2 MAT).

Treatments

Herbicide(s)	**Rate(s)/ha**	**Mode(s) of Action**	**Registered in what crops**
Untreated	Nil	-----	----
2,4-D amine 625	800 mL	I	Winter cereals
2,4-D amine 625 (late post-em)	800 mL	I	Winter cereals
Glean®	20 g	B	Winter cereals
Bromoxynil 200	1 L	C	Winter cereals
Velocity®	1 L	C + H	Winter cereals
Precept®	1 L	I + H	Winter cereals
Diflufenican 500	200 mL	F	Field peas, lentils, lupins
Glyphosate 690	900 g	M	Fallows and RR canola
Atrazine 900	1100 g	C	TT canola
Sencor® 480	580 mL	C	Winter cereals
Balance®	100 g	H	Chickpeas
Hammer® + glyphosate 450	60 mL + 1.38 L	G + M	Fallows
Triathlon®	1 L	F + C + I	Winter cereals
MCPA 500 LVE	1 L	I	Winter cereals
Spinnaker® 700	70 g	B	Chickpeas, fababeans and field pea
MCPA 500 LVE + diuron 900	1 L + 280 g	I + B	Winter cereals

Results

Table 1. *Herbicide active ingredient and rate/ha, wild radish brownout score 18 day after treatment (DAT) and surviving number of plants 2 months after treatment (MAT)*

Herbicide(s)	Rate(s)/ha	Wild radish brownout (0–5) 18 DAT	Wild radish plants per 10 m^2 2 MAT (% control)
Untreated	Nil	0.0	94 (0)
2,4-D amine 625	800 mL	2.6	0 (100)
2,4-D amine 625 (late post-em)	800 mL	0.0 (sprayed after assessment)	18 (82)
Glean®	20 g	2.5	19 (79)
Bromoxynil 200	1 L	1.2	47 (50)
Velocity®	1 L	3.6	0 (100)
Precept®	1 L	3.0	0 (100)
Diflufenican 500	200 mL	2.9	2 (98)
Glyphosate 690	900 g	4.2	41 (57) – seedlings
Atrazine 900	1100 g	2.1	14 (85)
Sencor® 480	580 mL	1.1	62 (34)
Balance®	100 g	2.7	18 (82)
Hammer® + glyphosate 450	60 mL + 1.38 L	4.6	48 (49) – seedlings
Triathlon®	1 L	3.3	0.3 (99)
MCPA 500 LVE	1 L	2.9	0.3 (99)
Spinnaker® 700	70 g	2.3	15 (84)
MCPA 500 LVE + diuron 900	1 L + 280 g	3.3	0 (100)

- Glyphosate treatments did not appear adequate at controlling wild radish. The data indicates that seedlings emerged soon after treatment, however the plants present prior to application were killed. Please note that this site was in a paddock of wheat and some Treatments were selected that were intentionally going to kill the crop. With this example, farmers could consider some glyphosate tolerant crops to achieve high levels of control. As for the late emerging seedlings, these are likely to have produced next to no seeds as competitive effects from well-established crops should greatly suppress growth of later emerging weeds.
- Some herbicides were applied outside the optimum application timing for best efficacy. Herbicides such as Atrazine 900 and Balance® are best suited as pre-emergence treatments but the 80+ percent control after treating 4 to 8 leaf wild radish is encouraging. If applied as a pre-emergence treatment, control levels would be expected to be more in the high 90% range.
- The use of Group H herbicides such as Velocity® and Precept® are herbicides of choice against wild radish. These herbicides are used commonly in Western Australia. Triathlon® appears another good option and does not rely upon Group H chemistry for its control.

- Glean® did not result in high levels of control and may indicate some low level of resistance as its frequency of use in the trial paddock in the past was very high.
- 2,4-D amine and MCPA treatments were very effective when applied as early post-emergent treatments. Control declined with increasing growth stage as evidenced by the lower level of control when 2,4-D was applied one month later when wild radish plants were flowering. If there is a need to treat with Group I phenoxy herbicides, ensure that wild radish plants do not exceed the 4 to 6 leaf stage of development. Group I resistance in WA was first seen as large radish plants suffering herbicide symptoms, but they gradually recovered to produce seed.

Summary

Although herbicide rotation is clearly an easy choice to make and maintains high levels of control, farmers in NSW should also adopt weed seed harvest control tactics to extend the life of their herbicides. If growers simply rotate chemistry for the next decade or more, they are likely to face problems with development of multiple resistances to different modes of action similar to what has developed in Western Australia.

Acknowledgements

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Dose responses of glyphosate resistant and susceptible biotypes of sweet summer grass (*Brachiaria eruciformis*) at the early tiller growth stage – 2014

Tony Cook, Bill Davidson and Bec Miller
NSW DPI, Tamworth

Key findings

The first population of glyphosate resistant (GR) sweet summer grass, found near Emerald in central Queensland, can survive rates of glyphosate between 450 mL/ha up to 2 L/ha, 28 days after application. The registered rates of application for moderate sized plants is between 800 mL and 1.6 L/ha.

Rates as low as 250 mL/ha of glyphosate controlled susceptible populations under glasshouse conditions.

The resistant population appears to have at least an 8-fold level of resistance as the extent of control with 250 mL/ha on a susceptible population was slightly higher than the response of 2 L/ha on a resistant population.

Growers in Central Queensland need to consider and use alternative control options for this weed to prevent or minimise the development of further such glyphosate resistant cases.

Plants grown under glasshouse conditions are likely to be more susceptible to herbicides and it is likely that glyphosate rates higher than 2 L/ha may not be enough to control GR sweet summer grass in the field, especially under less favourable conditions.

Introduction

The first population of glyphosate resistant (GR) sweet summer grass was found near Emerald in central Queensland in 2014. This study aimed to determine the rate response interaction of this GR sweet summer grass population to the application of glyphosate. Rate response data was used to determine the level of resistance of the GR population compared to a susceptible sweet summer grass population. The glyphosate application rates investigated were choose to cover standard commercial boom spray and optical spray technology rates.

Experiment details

Location:	**Tamworth Agricultural Institute, glasshouse**
Treatments:	**Factorial designed experiment with 5 herbicide rates, 2 biotypes (populations – resistant and susceptible), 1 growth stage and 5 replications**
Application:	**Early tillering plants (3 to 5 tillers)**
	Biotypes (populations): Susceptible standard and a GR confirmed biotype sourced from a property north of Emerald
Application rates:	**Glyphosate 450 g/L at 0, 0.25, 0.5, 1, 2, 4 and 8 L/ha (all application using non-ionic surfactant at 0.2% v/v – 200 mL surfactant/100 L water)**
Design:	**Five replicates per treatment. A total of 70 pots used (2 biotypes × 7 rates × 5 replicates)**
Nozzles:	**TT 110-01 nozzles with pressure of 2 bars with speed of application designed to deliver a water rate of 100 L/ha**

Special notes:

The sweet summer grass seed was sown in a heavy clay soil to promote germination and then transplanted at the 3 leaf stage to the experimental pots that contained potting mix.

Plants grown in glasshouse through most of the experiment, however one week prior to spraying they were grown outside to ‘harden-up’. After herbicide application the plants were taken back to the glasshouse for the duration of the experiment.

Measurements: a) Biomass rating (% of untreated) of whole pot using visual assessment at 14, 28 and 42 days after each treatment (DAT), b) plant counts of survivors at 28 and 42 DAT and c) destructive biomass sampling of green material 42 days after each treatment.

Treatments

Herbicide	Rate	Biotype
Glyphosate 450	Nil	Susceptible and resistant
Glyphosate 450	0.25 L/ha	Susceptible and resistant
Glyphosate 450	0.5 L/ha	Susceptible and resistant
Glyphosate 450	1 L/ha	Susceptible and resistant
Glyphosate 450	2 L/ha	Susceptible and resistant
Glyphosate 450	4 L/ha	Susceptible and resistant
Glyphosate 450	8 L/ha	Susceptible and resistant

Results

- At 28 DAT the GR biotype of sweet summer grass (SSG) survived rates up to and including Glyphosate 450 at 2 L /ha (Figure 1 and 3).
- The 1 L/ha rate of glyphosate reduced biomass by 20% at 28 DAT whilst the 2 L/ha rate provided 92% control (Figure 1 and 3).
- All rates of glyphosate used in this experiment were very effective at controlling the susceptible SSG population. The estimated biomass control of susceptible SSG at 28 DAT following application of 250 mL/ha of glyphosate was 98% (Figure 2).

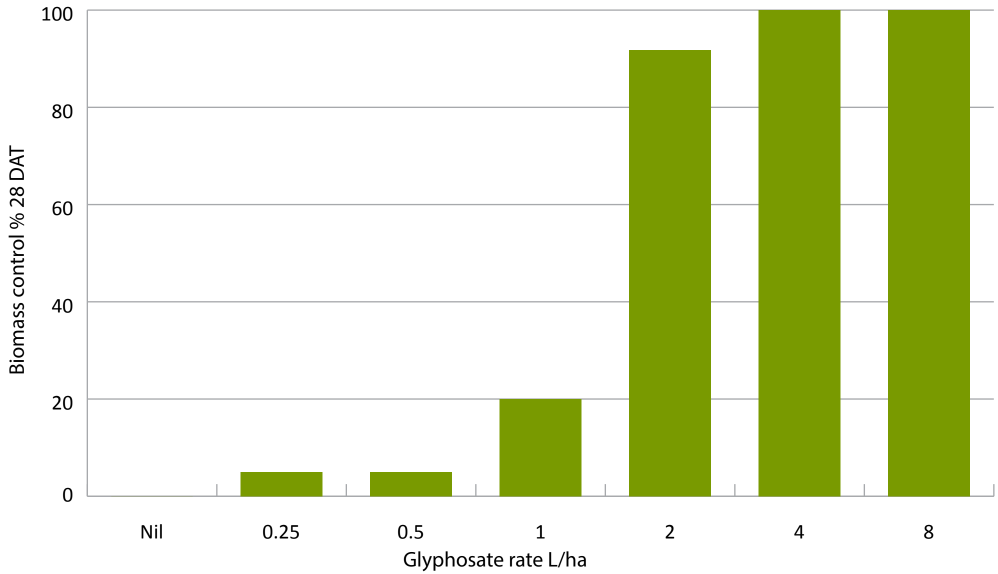

Figure 1. *Biomass control % 28 DAT of GR sweet summer grass showing response to rates of glyphosate.*

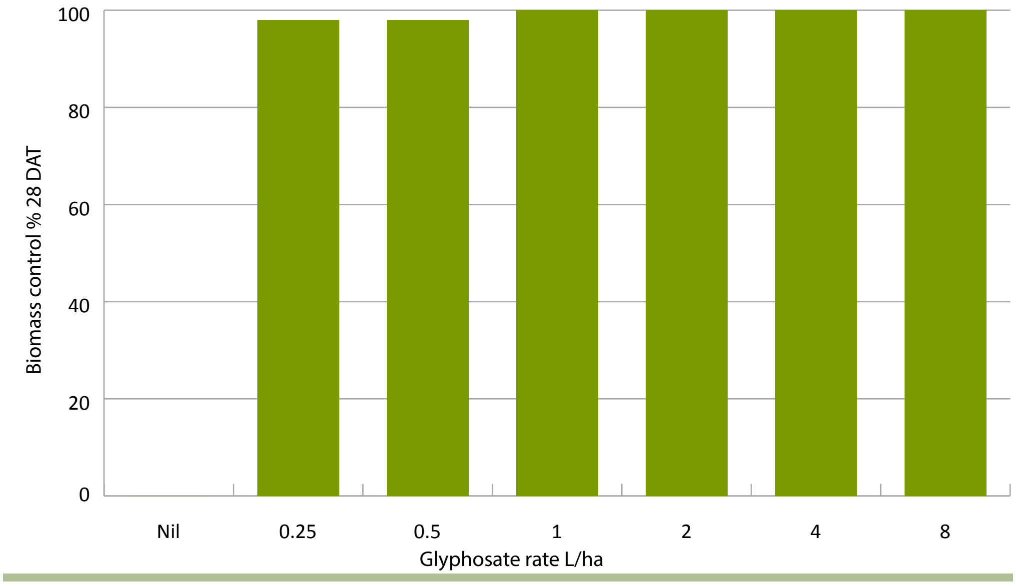

***Figure 2**. Biomass control % 28 DAT of susceptible sweet summer grass showing response to rates of glyphosate.*

***Figure 3**. GR sweet summer grass showing response to rates of glyphosate starting at 8 L/ha on left and graduating to 0.25 L/ha on the right.*

Summary

The recently discovered population of glyphosate resistant sweet summer grass appears to have at least an 8-fold level of resistance. Softer glasshouse conditions may have increased the levels of glyphosate activity as noted by the excellent control following sub-label rates on the susceptible population. Nonetheless, control of the susceptible population after application of 250 mL/ha of glyphosate exceeded control following application of 2 L/ha on a resistant population, thus the conclusion of at least an 8-fold increase in resistance to glyphosate appears valid. It is likely that control using 2 L/ha in the field would be much lower if treated under hotter and drier conditions as glasshouse conditions appear to favour the activity of glyphosate. Alternative weed management strategies, rather than repeat applications of glyphosate, are urgently required in Central Queensland to prevent the development of other cases of glyphosate resistance sweet summer grass.

Acknowledgements

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Comparison of systemic herbicide and paraquat tank mixtures applied under sunlight or evening conditions on glyphosate resistant sowthistle – pot experiment 2014

Tony Cook, Bill Davidson and Bec Miller
NSW DPI, Tamworth

Introduction

Tank mixing a systemic herbicide with a fast acting knockdown herbicide such as paraquat is thought by many agronomists an incompatible combination. The paraquat under daylight condition rapidly desiccates foliage and is believed to prevent translocation of the systemic herbicide. Therefore the purpose of this experiment was to determine whether applying evening tank mixtures of systemic herbicides and paraquat can improve the control of glyphosate resistant sowthistle compared to daylight applications. The overall industry objective is to replace double knocking, which is time consuming and more expensive, with a one-pass spray program.

Key findings

Glyphosate resistant sowthistle was fully controlled by tank mixes of selected systemic herbicides and paraquat at the early flowering growth stage.

There was no difference in control between day and night applications of these tank mixes.

Although glyphosate resistant, the sowthistle was controlled with a treatment containing a mix of glyphosate + paraquat when applied either during day time or during the evening.

A tank mix of paraquat and Velocity® appears to have good potential due to its excellent early brownout of sowthistle, irrespective of day or evening application. The brownout (speed of plant death) was faster than the other treatments examined in this study.

Experiment details

Location:	**Tamworth Agricultural Institute, glasshouse**
Treatments:	**Eight berbicide treatments + 2 untreated nil controls (day time and night time)**
Weed:	**A confirmed glyphosate resistant sowthistle biotype named 'Yellow' which was sourced from the Liverpool Plains district of northern NSW**
Growth stage:	**Early flowering glyphosate resistant sowthistle plants approximately 50 cm tall**
Design:	**5 replicates per treatment, total of 50 pots used (1 biotype × 10 treatments × 5 replicates), 8 inch square pots with 1 plant per pot**
Nozzle:	**TT 110-01 nozzles with pressure of 2 bars with speed of application designed to deliver a water rate of 100 L/ha**
Application time:	**Day applications applied at 8:00 am and night applications after sunset**
Special notes:	**Plants grown in glasshouse most of the time, however one week prior to spraying they were grown outside to 'harden-up'. After herbicide application plants were then returned to the glasshouse for the duration of the experiment**
Measurements:	**a) Biomass control % (estimate) of untreated 14, 28 and 56 DAT (days after treatment); plant counts of survivors at 28 and 56 DAT and c) destructive green sampling of biomass (then oven dried to obtain dry biomass) 56 DAT**

Treatments

Herbicide	Rate/ha	Application timing
Untreated	Nil	Day
Untreated	Nil	Night
Amicide® Advance 700 + Paraquat	1 L + 2 L	Day
Amicide® Advance 700 + Paraquat	1 L + 2 L	Night
Tordon® 75-D + Paraquat	700 mL + 2 L	Day
Tordon® 75-D + Paraquat	700 mL + 2 L	Night
Glyphosate 450 + Paraquat	1.6 L + 2 L	Day
Glyphosate 450 + Paraquat	1.6 L + 2 L	Night
Velocity® + Paraquat	500 mL + 2 L	Day
Velocity® + Paraquat	500 mL + 2 L	Night

All treatments had Uptake® added at 0.5% v/v.

Results

- At 56 DAT, day time applications of hormonal herbicides or glyphosate mixed with paraquat provided 100% control of GR resistant sowthistle (Figure 1).
- At 56 DAT, night time applications of hormonal herbicides or glyphosate mixed with paraquat provided 100% control of GR resistant sowthistle (Figure 2).
- At 14 DAT night application of a tank mix of paraquat and Velocity® provided 99% brownout of the glyphosate resistant sowthistle which was equivalent to day time application at 100% (Figure 3). The brownout (speed of plant death) with this combination of herbicides was faster than the other treatments examined in this study.

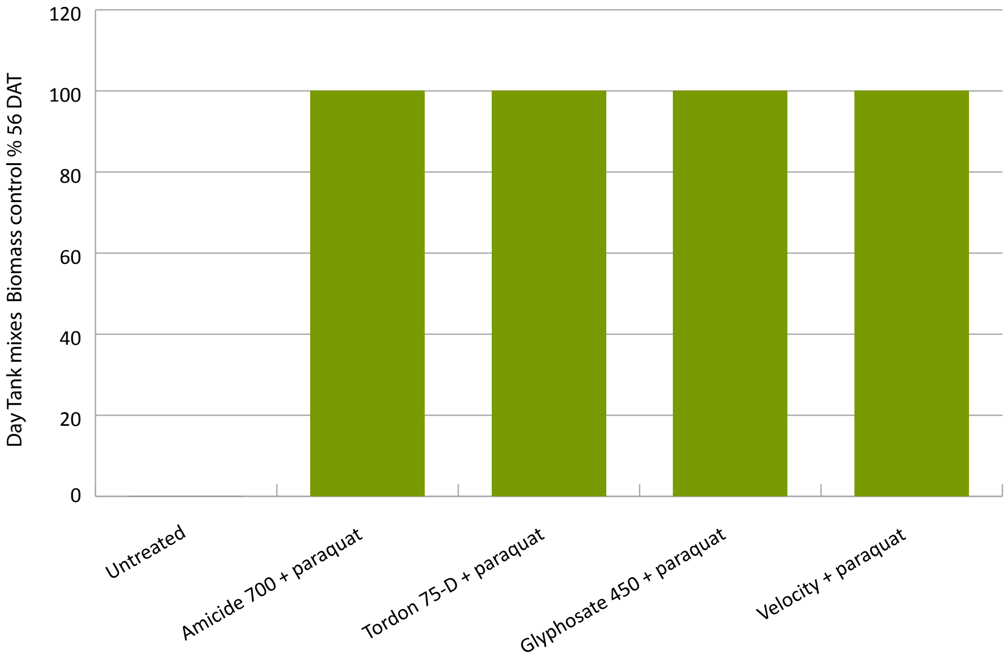

***Figure 1**. Biomass control% 56 DAT of day tank mixes on glyphosate resistant sowthistle.*

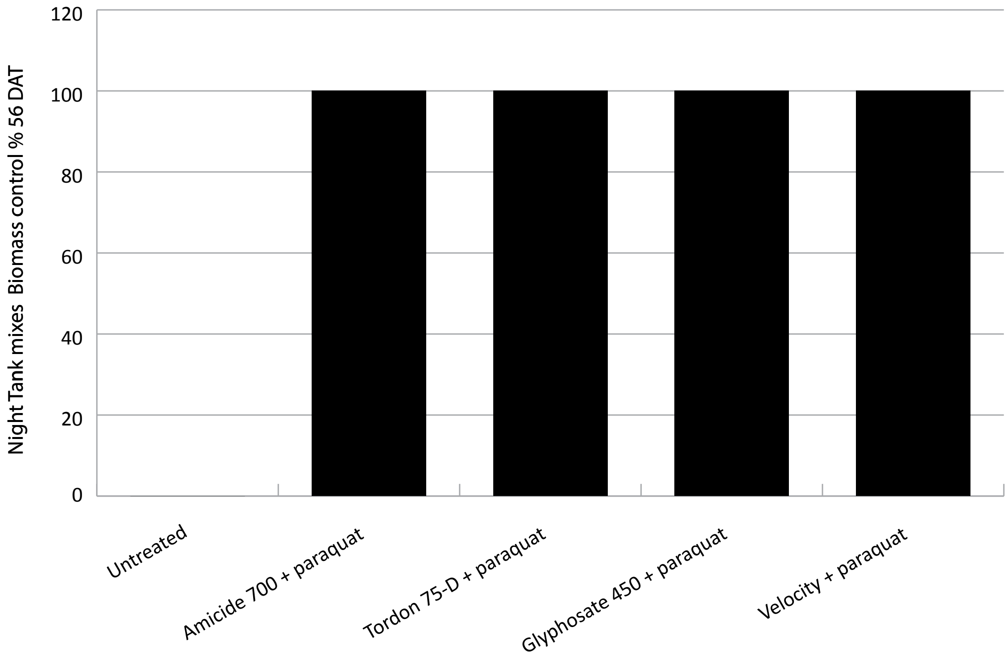

***Figure 2**. Biomass control% 56 DAT of night tank mixes on glyphosate resistant sowthistle.*

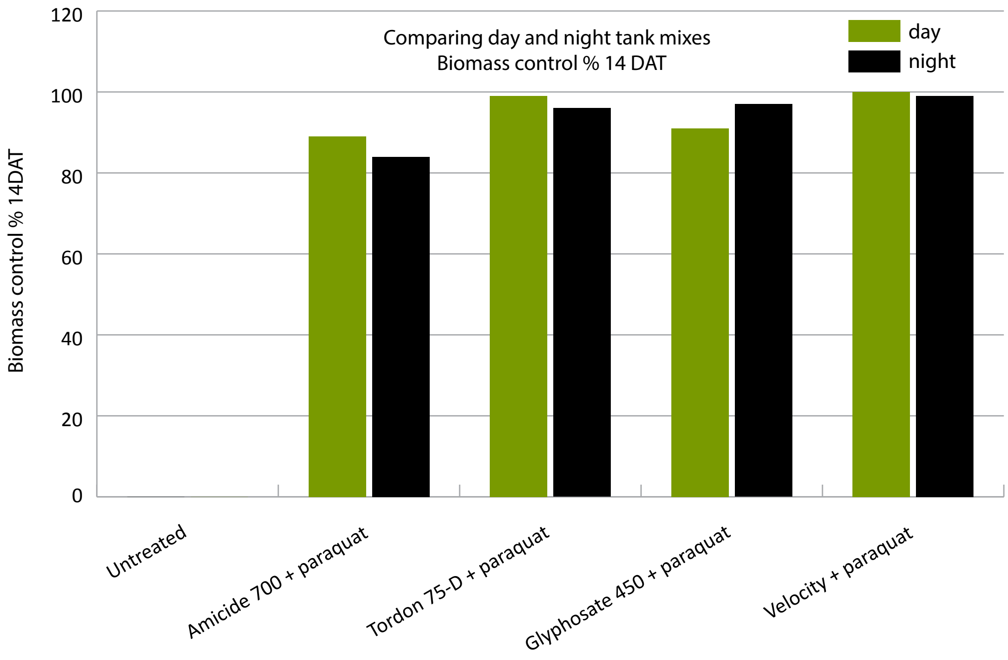

***Figure 3**. Comparing the initial brownouts (estimate of biomass reduction) between daylight and night applications of paraquat + systemic tank mixtures on glyphosate resistant sowthistle 14 DAT.*

Summary

Glyphosate resistant sowthistle has the potential to become problematic in no-till cropping systems, due to its prolific production of wind-blown seed and the loss of glyphosate as a reliable form of control in fallows. Tank mixing systemic herbicides with paraquat has potential as a tactic for controlling glyphosate resistant sowthistle, whilst alleviating the need for costly double knock applications. In this experiment, the tank mixing of glyphosate with paraquat did control resistant plants. A further experiment will investigate whether this is primarily due the paraquat or a syngeristic effect of the two herbicides. However, other systemic herbicides are preferred, especially Velocity® or Tordon® 75-D as they provided quicker plant death and reduce the reliance on glyphosate.

There is some evidence to suggest that the paraquat + 2,4-D amine tank mix has some minor incompatibility after considering the initial biomass reduction assessments.

Results from this study indicate that night applications of tank mixtures (systemic herbicide and paraquat) can be highly effective in killing glyphosate resistant sowthistle at the early flowering stage of weed development. However, this experiment suggests that applying these tank mixtures under daylight conditions is just as effective. This research needs to be undertaken under field conditions, however finding suitable dense infestation in paddocks can be difficult.

There was no apparent advantage of rapid brownout after applying paraquat in the evening. However, full control of glyphosate resistant sowthistle plants was fastest when mixed with Velocity®. This combination of a Group H herbicide mixed with paraquat compares with the effects reported when Balance® was mixed with paraquat in a similar experiment.

Acknowledgements

This research was co-funded by NSW DPI and GRDC under the project code UQ00062.

Comparing effects of night spraying tank mixes and double knocking on glyphosate resistant common sowthistle using boom spray rates – pot experiment 2014

Tony Cook, Bill Davidson and Bec Miller
NSW DPI, Tamworth

Introduction

Tank mixing a systemic herbicide with a fast acting knockdown herbicide such as paraquat is thought by many agronomists as an incompatible combination. The paraquat under daylight conditions rapidly desiccates foliage and is likely to prevent translocation of the systemic herbicide. In theory, applying after dark would delay the rapid foliage desiccation associated with the paraquat allowing uptake of the systemic herbicide overnight. Therefore the purpose of this experiment was to determine whether applying night time tank mixtures of systemic herbicides and paraquat can replace the time consuming practice of double knocking.

Research questions

- Can night spraying a tank mixture of hormonal herbicides and paraquat allow enough time for Group I or H chemistry to translocate sufficiently in sowthistle before paraquat desiccates foliage (when sunlight activates the paraquat)?
- Is there a similar efficacy when applying these tank mixtures in dark conditions compared to the standard double knocking practice?
- Does the effect of having paraquat based treatments applied at night provide better brownout effects?

Experiment details

Location:	**Tamworth Agricultural Institute, glasshouse**
Treatments:	**Nine (8 herbicide treatments + 1 untreated)**
Growth stage:	**Early flowering plants approximately 50 cm tall**
1 biotypes (populations):	**A confirmed glyphosate resistant biotype named 'Yellow' collected from the Liverpool plains region of NSW**
Design:	**Five replicates per treatment** **A total of 45 pots used (1 biotype × 9 treatments × 5 replicates)** **8 inch square pots with one plant per pot**
Sprayi application:	**TT 110-01 nozzles with pressure of 2 bars with speed of application designed to deliver a water rate of 100 L/ha** **Double knock applications applied at 8:00 am and night applications after sunset**
Special notes:	**Plants grown in glasshouse most of the time, however one week prior to spraying they were grown outside to 'harden-up'** **After herbicide application the plants were returned to the glasshouse for the duration of the experiment**

Key findings

Glyphosate resistant sowthistle was completely controlled by both night tank mixes and standard double knocking of selected systemic herbicides and paraquat at the early flowering growth stage.

There is no benefit of applying paraquat after sunset (night spraying) for better brownout of sowthistle. This is contrary to research findings for weeds such as awnless barnyard grass.

Some incompatibility issues arose with paraquat and 2,4-D amine products. This phenomenon was seen in another experiment on fleabane.

A tank mix of paraquat and Balance® appears to have good potential due to its excellent early brownout of sowthistle which was faster than the other treatments examined in this study.

Measurements: **Biomass control % (estimate) of untreated 14, 28 and 56 DAT (days after treatment)**

Plant count of survivors at 28 and 56 DAT

Destructive green sampling of biomass, then oven dried to obtain dry biomass at 56 DAT

Treatments

Herbicide	Rate/ha	Application method
Untreated	Nil	
Tordon® 75-D + Paraquat	1 L + 2 L	Night tank mix
Tordon® 75-D fb Paraquat	1 L + 2 L	Double knock
Balance® + Paraquat	100 g + 2 L	Night tank mix
Balance® fb Paraquat	100 g + 2 L	Double knock
Amicide® 625 + Paraquat	1.8 L + 2 L	Night tank mix
Amicide® 625 fb Paraquat	1.8 L + 2 L	Double knock
Amicide® Advance700 + Paraquat	1.6 L + 2 L	Night tank mix
Amicide® Advance700 fb Paraquat	1.6 L + 2 L	Double knock

All treatments had Uptake® added at 0.5% v/v. 7 days between treatments for double knock treatments

Results

- At 56 DAT night applications of hormonal herbicides and glyphosate mixed with paraquat provide 100% control of the glyphosate resistant sowthistle (Figure 1).
- At 56 DAT double knock applications of both hormonal herbicides and glyphosate followed by paraquat 7 days later provided 100% control of the glyphosate resistant sowthistle (Figure 2).
- The early assessment of brownout 14 DAT, as measured through biomass reduction, suggests a minor to moderate disadvantage of tank mixing paraquat and 2,4-D based products (Figure 3). However, this did not have any impact on longer term control. This incompatibility was noticed with the same combinations on fleabane in another experiment with the stronger concentrations of 2,4-D reducing the knockdown activity of paraquat.

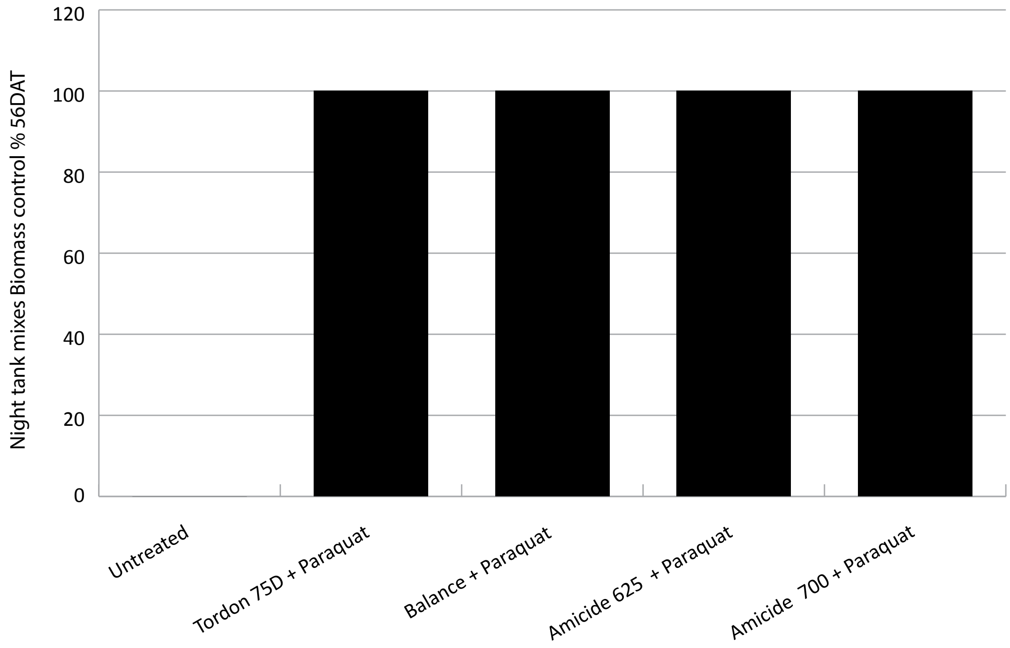

***Figure 1**. Biomass control (%) of glyphosate resistant sowthistle after application of night tank mixes 56 DAT.*

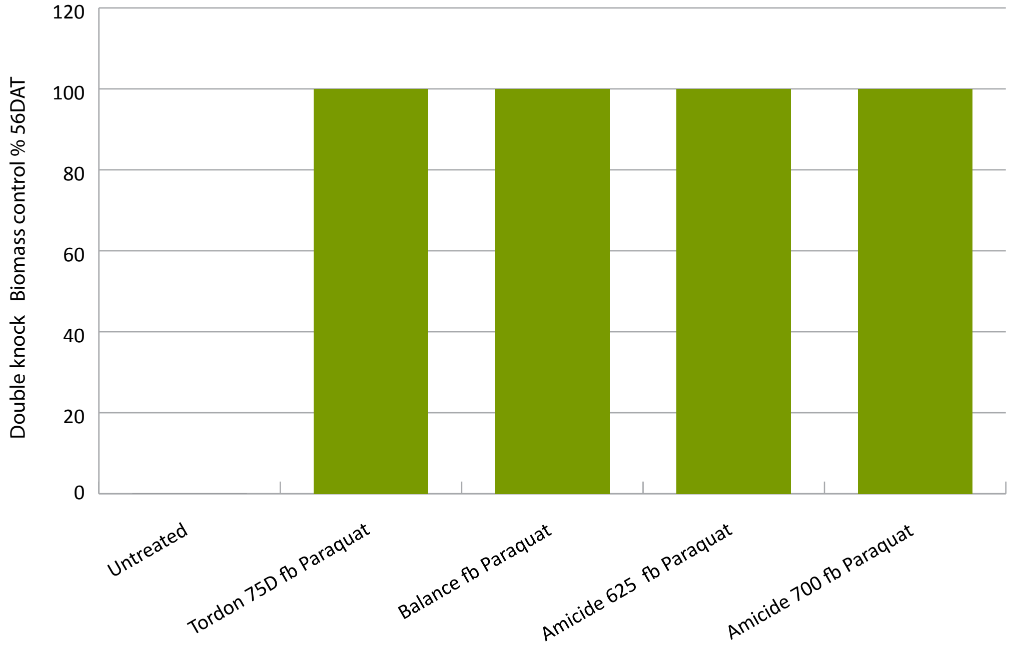

***Figure 2**. Biomass control (%) of glyphosate resistant sowthistle after double knock treatments 56 DAT.*

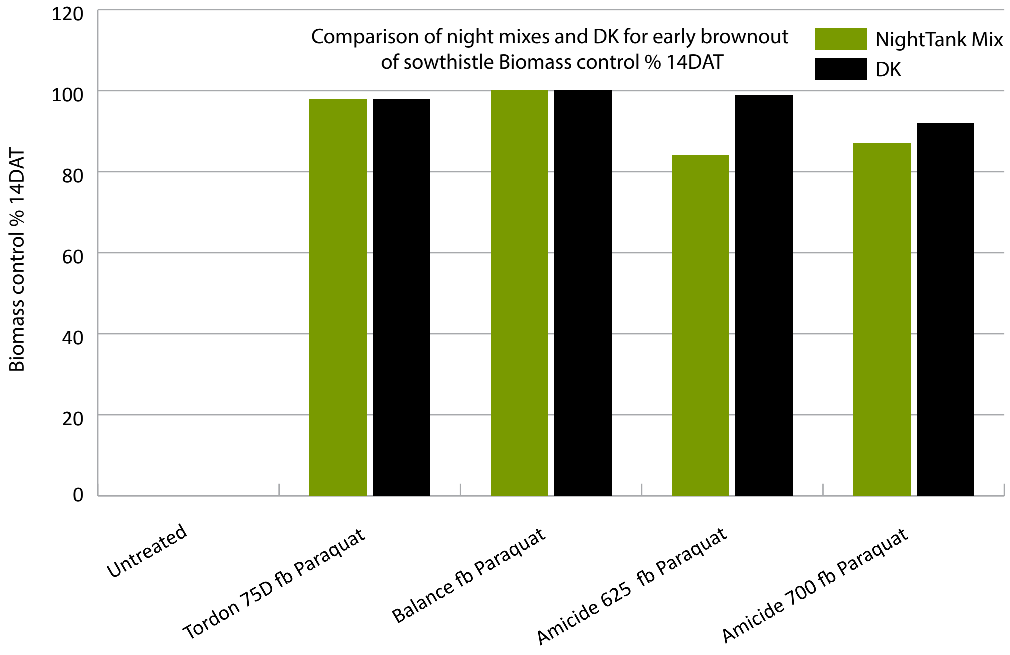

***Figure 3**. Comparison of the speed of brownout between night tank mix treatments and standard double knocking applications (measured as estimated biomass control %) 14 DAT.*

Summary

Glyphosate resistant sowthistle has the potential to become problematic in no-till cropping systems, due to its prolific production of wind-blown seed and the loss of glyphosate as a reliable form of control in fallows. Night tank mixing hormonal herbicides with paraquat has potential as a way of controlling glyphosate resistant sowthistle, whilst alleviating the need for costly double knock applications. This experiment indicates that certain night tank mixes can provide similar control levels to double knocking applications on glyphosate resistant sowthistle.

Acknowledgements

This research was co-funded by NSW DPI and GRDC under the project UQ00062.

Rust management strategies for modern faba bean varieties

Bill Manning[1], Joop van Leur[2], Merv Riley[2] and Stuart Marshman[2]
[1] North West LLS, Gunnedah [2] NSW DPI, Tamworth

Introduction

Faba bean is a rotation crop used in northern NSW to break disease cycles in winter cereals and to maintain soil nitrogen fertility. The Pulse Breeding Australia (PBA) faba bean breeding program aims to breed locally adapted varieties with improved disease resistance. Faba bean rust, *Uromyces viciae-fabea*, is a significant production constraint in northern NSW and growers are advised to apply one early preventative fungicide spray and to monitor disease development in the crop during spring to determine whether follow-up applications are needed.

Key findings

Fungicide application in dry years may not improve yield but can improve seed size.

The soon to be released faba bean line IX220d/2-5 is likely to require a rust management package similar to current commercial varieties.

Site details

Location:	**Liverpool Plains Field Research Station, Breeza**
Co-operator:	**Scott Goodworth, NSW DPI**
Sowing date:	**19 May 2014**

Rainfall Breeza 2014 (mm)

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
0	56	147	19	36	26	18	47	30	8	20	157

Treatments

The trial used three fungicide treatments;

- Control: no fungicide applied.
- Two spray: 1 spray of Mancozeb (750 g/kg) at 1.2 kg/ha on both the 2nd July and 9 September.
- Late spray only: 1 spray of Mancozeb 1.2 kg/ha on the 9 September.

Plant material

A total of nine faba bean varieties were tested;

- PBA Warda$^{\phi}$ released in 2012, classified MR-R (moderately resistant – resistant) to rust.
- Doza$^{\phi}$ released in 2008 classified MR-R to rust.
- IX220d/2-5 a high yielding line with large seeds to be released this year for northern NSW.
- IX506/1-9, IX474/4-3 and IX477/17-15 all lines from the northern breeding program with rust resistance, high yield and good seed size.
- Fiesta: an old variety classified as S (susceptible) to rust.
- PBA Samira$^{\phi}$ - a southern variety with high yield potential.
- AF08207: the most rust resistant line in the southern breeding program.

Potted faba bean plants infected with faba bean rust were placed throughout the trial to ensure early infection with rust and a late irrigation was applied to assist pod fill. Rust scores estimating the percentage of leaf covered with rust pustules were collected in early October.

Results

Rust

Both fungicide treatments significantly reduced rust scores compared to the control. The two spray treatment gave an average rust score of 14.4% and the late spray only treatment 16.2% compared to 26.8% with the nil control (data not shown). Whilst the late spray only treatment was equally successful in limiting rust development in this trial, this may have been a result of the relatively dry season and using a late spray only is not a strategy that would be recommended for industry. The rust severity score of each variety across treatments in outlined below and demonstrates the greater rust resistance in Doza$^{\phi}$ and PBA Warda$^{\phi}$ (Table 1).

Within individual varieties fungicide application made no difference to rust scores in Doza$^{\phi}$ and IX506/1-9. In PBA Warda$^{\phi}$, IX477/17-15 and AF08207 the two spray treatment reduced rust scores compared to the nil treatment, whilst the late spray only did not significantly reduce the severity of rust infection. In IX220d/2-5, Fiesta, PBA Samira$^{\phi}$ and IX474/4-3 both fungicide treatments reduced rust severity scores compared to the nil fungicide control treatment (data not shown).

Table 1. *Severity of rust across all treatments, Breeza 2014.*

Variety	Rust score (%)	Significance (5%)
Fiesta	33.9	a
IX477/17-15	24.4	b
IX220d/2-5	21.1	b
PBA Samira$^{\phi}$	20.0	b
IX474/4-3	18.9	c
IX506/1-9	16.3	c
AF08207	14.7	c
Doza$^{\phi}$	12.2	d
PBA Warda$^{\phi}$	10.8	d

Yield and seed size

The 2014 season was relatively dry and not conducive to large yield losses due to rust infection even though significant differences in the severity of rust occurred between varieties. Overall there was no significant difference in yield between fungicide treatments and the nil control treatment. However, fungicide treatments did significantly increase seed size (Table 2).

Table 2*. Effect of fungicide on yield and seed size, Breeza 2014.*

Treatment	Yield (t/ha)	Significance (5%)	100 seed weight (g)	Significance (5%)
Nil control	2.87	a	61.29	b
Two spray	3.19	a	64.49	a
Late spray only	3.21	a	65.31	a

Only the susceptible variety Fiesta yielded significantly less without fungicide application (2.3 t/ha) compared to 3.2 t/ha with two fungicide treatments. There was no yield benefit from fungicide application in any of the other faba bean varieties examined in this trial at Breeza in 2014.

Breeza has a relatively long season compared to other districts in north-west NSW, and this combined with irrigation enabled all varieties, including those developed for southern Australia, to yield well (2.80 to 3.44 t/ha) and produce good sized seed in 2014 (Table 3). IX220d/2-5 was a stand out in terms of seed size.

Table 3*. Yield and seed size across all treatments, Breeza 2014.*

Variety	Yield (t/ha)	Significance (5%)	100 seed weight (g)	Significance (5%)
IX474/4-3	3.44	a	65.17	b
PBA Warda$^{\phi}$	3.30	a	60.81	c
AF08207	3.23	a	65.12	b
IX220d/2-5	3.08	b	70.59	a
IX477/17-15	3.07	b	64.36	b
Doza$^{\phi}$	3.06	b	58.71	c
PBA Samira$^{\phi}$	2.96	b	60.35	c
Fiesta	2.85	b	63.94	b
IX506/1-9	2.80	b	64.24	b

Summary

The reaction of faba bean varieties in this trial to rust supported previous research and established resistance ratings. The yield of the southern material, PBA Samira$^{\phi}$ and AF08207, at Breeza may not be indicative of their performance elsewhere in northern NSW. Increased seed size associated with fungicide application, even in a season that was not conducive to yield loss from rust, may assist with marketing.

Acknowledgements

Funding by the Grains Research & Development Corporation (GRDC) of the Pulse Breeding Australia Faba Bean Breeding Program (UA00127) is gratefully acknowledged along with technical assistance provided by Ivan Stace.

Tolerance of modern faba bean varieties to two common herbicides

Bill Manning[1], Joop van Leur[2], Merv Riley[2] and Stuart Marshman[2]
[1] North West LLS, Gunnedah [2] NSW DPI, Tamworth

Key findings

The faba bean varieties PBA Warda⁽ᵇ⁾, Doza⁽ᵇ⁾ and IX220d/2-5 all tolerated application of Spinnaker® and Terbyne® well when applied post sowing/pre emergence at registered label rates.

Introduction

Faba bean is a rotational pulse crop used in northern NSW to break cereal disease cycles and to maintain soil nitrogen fertility. The Pulse Breeding Australia (PBA) faba bean breeding program aims to develop locally adapted varieties with improved disease resistance and yield. There is limited information on the reaction of recently released varieties to broadleaf herbicides commonly used in the northern region.

Site details

2014

Location:	**Liverpool Plains Field Research Station, Breeza**
Co-operator:	**Scott Goodworth, NSW DPI**
Sowing date:	**15 May 2014**

Rainfall Breeza 2014 (mm)

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
0	56	147	19	36	26	18	47	30	8	20	157

Treatments

Three varieties were used in the trial;

- PBA Warda⁽ᵇ⁾, released in 2012
- Doza⁽ᵇ⁾, released in 2008
- IX220d/2-5, a high yielding line with good seed size planned for release in 2015 for northern NSW

Three treatments were applied;

- Control: no herbicide applied
- Spinnaker® (750 g/kg Imazethpyr) at 75 g/ha post sow/pre emergent on 15 May
- Terbyne® (750 g/kg Terbuthylazine) at 750 g/ha post sow/pre emergent on 15 May

Conditions were dry after spraying until a rainfall event of 25 mm on 1 June. All plots were scored for weed emergence on 18 June and 24 July and hand chipped after the score was made. Subsequent weed germinations were also controlled by hand chipping. The main weeds present were dead nettle (*Lamium amplexicaul*e), stinging nettle (*Urtica* spp), prickly lettuce (*Lactuca serriola*) and milk thistle (*Sonchus oleraceus*).

Results

Weed numbers were significantly lower in treated plots compared to the control on both 18 June (data not shown) and 24 July (Table 1) assessments. There was no significant difference in the impact of either herbicide on weed counts which both significantly reduced the survival of broadleaf weeds compared to the nil control.

***Table 1**. Weed score (weeds per plot) 70 days after application (24 July)*

Treatment	Weed score 24 July (0–10)	Significance (*P*=0.05)
Control	4.0	a
Spinnaker®	0.78	b
Terbyne®	0.4	b

Overall there was no significant difference in yield associated with the application of these two broadleaf herbicides with the control treatment averaging 3.21 t/ha, Spinnaker® 3.31 t/ha and Terbyne® 3.08 t/ha across the three faba bean varieties (Table 2).

***Table 2**. The impact of herbicide Treatments on yield - Breeza 2014*

Treatment	Doza$^{(b}$	Significance	PBA Warda$^{(b}$	Significance	IX220d/2-5	Significance
Control	3.07	a	3.19	a	3.37	a
Spinnaker®	3.01	a	3.32	a	3.61	a
Terbyne®	2.86	a	3.13	a	3.25	a

Summary

The three faba bean varieties examined in this experiment tolerated the application of two common broad leaf herbicides well with no visual impacts on growth apparent and no significant reduction in yield compared to the nil herbicide control treatment. There also appears to be no difference between these faba bean varieties in their tolerance to Spinnaker® or Terbyne®.

Acknowledgements

Ivan Stace from NSW DPI for technical assistance.

Chickpea Phytophthora root rot varietal rankings and yield loss – 2014

Kevin Moore[1], Lisa Kelly[2], Mal Ryley[4], Kristy Hobson[1], Ted Knights[1], Willie Martin[3], Kris King[3], Steve Harden[1], Paul Nash[1], Gail Chiplin[1] and Sean Bithell[1]
[1] NSW DPI, Tamworth [2] DAFFQ, Toowoomba [3] DAFFQ, Warwick
[4] USQ, Toowoomba

Key findings

Despite dry seasonal conditions, Phytophthora root rot (PRR) caused yield losses in commercial chickpea varieties of between 10% (Yorker$^{\Phi}$) to 74% (PBA Boundary$^{\Phi}$).

Do not grow PBA Boundary$^{\Phi}$ if you suspect the paddock has a PRR risk.

Avoid paddocks with a history of lucerne, medics or chickpea PRR.

Advanced breeding lines have improved resistance to PRR, with CICA1328 having no significant yield loss in this trial.

Varieties with improved resistance to PRR appear to have no yield penalty in the absence of this disease.

Introduction

Phytophthora medicaginis (*Pm*), the cause of Phytophthora root rot (PRR) of chickpea is endemic and widespread in southern Queensland and northern NSW, where it carries over from season to season on infected chickpea volunteers, lucerne, native medics, sulla and as resistant structures (oospores) in the soil. Although registered for use on chickpeas, metalaxyl seed treatment is expensive, does not provide season-long protection and is not recommended. There are no in-crop control measures for PRR and reducing losses from the disease is based on avoiding high risk paddocks and choosing the right variety.

Current commercial varieties differ in their resistance to *Pm*, with Yorker$^{\Phi}$ and PBA HatTrick$^{\Phi}$ having the best resistance levels. Both are rated moderately resistant (MR) with Yorker$^{\Phi}$ slightly better than PBA HatTrick$^{\Phi}$, while Jimbour$^{\Phi}$ is MR-MS, Flipper$^{\Phi}$ and Kyabra$^{\Phi}$ are MS and PBA Boundary$^{\Phi}$ has the lowest resistance level at S.

A range of released chickpea varieties and advanced PBA breeding lines have been evaluated in PRR yield loss trials at the DAFFQ Hermitage research facility, Warwick Queensland from 2007–2014. This report outlines findings from the 2014 trial.

Site and experimental details

Location: **Hermitage Research Station, Warwick, Queenland**

Disease and yield loss prediction	Yield loss caused by PRR calculation
All plots inoculated with *Pm* at sowing PRR level manipulated with and without the fungicide metalaxyl Three replicates	% loss = 100*(Average yield of metalaxyl-treated plots – Average yield of nil metalaxyl plots)/Average yield of metalaxyl-treated plots

Treatments

Variety	PRR protection
Seven genotypes: CICA0912, CICA1211, CICA1328, D06344>F3BREE2AB027, PBA Boundary$^{\Phi}$, PBA HatTrick$^{\Phi}$ and Yorker$^{\Phi}$	Two treatments, (i) seed treatment with thiram, thiabendazole and metalaxyl and regular soil drenches with metalaxyl and (ii) seed treatment with thiram + thiabendazole only with no soil drenches

Results

- In the absence of PRR (metalaxyl seed treatment + soil drenches), yield ranged from 2.76 t/ha (CICA1328) up to 3.23 t/ha (CICA0912)(Table 1).
- The levels of PRR which developed in 2014 were less than those in the 2012 and 2013 trials. However, the 2014 trial confirmed the Yorker$^{\Phi}$>PBA HatTrick$^{\Phi}$> PBA Boundary$^{\Phi}$ resistance ranking.

- Susceptible varieties still suffered substantial yield losses in the 2014 trial with reduced PRR disease pressure, whereas varieties with moderate resistance had reduced yield losses. For example, PBA Boundaryⓓ had a yield loss of 74% which was around 10% lower than in previous trials with higher PRR pressure (85% in 2012; 82% in 2013). In contrast, Yorkerⓓ had 10% yield loss (not significant) in 2014 but lost 35% and 66% in 2012 and 2013, respectively when disease pressure was higher.
- The 2014 trial again confirmed the superior level of PRR resistance in the PBA breeding line CICA1328 (a hybrid between chickpea and a wild *Cicer* species).
- The advanced breeding line CICA1211 (included for the first time in 2014) yielded 3.01 t/ha where PRR was controlled and had a non-significant yield loss of only 12% (Table 1).

__Table 1__. Yield of commercial chickpea varieties and breeding lines with and without Phytophthora root rot, and % yield losses from PRR – Warwick, Qld 2014.

Variety/line	**Yield (t/ha) in absence of *Phytophthora* infection**	**Yield (t/ha) in presence of *Phytophthora* infection**	**% yield loss due to *Phytophthora* infection**
CICA1328[A]	2.76	2.71	2 (ns)
Yorkerⓓ	3.01	2.69	10 (ns)
CICA1211	3.01	2.66	12 (ns)
D06344>F3BREE2AB027[A]	2.93	2.13	27
PBA HatTrickⓓ	2.94	1.98	33
CICA0912	3.23	1.79	45
PBA Boundaryⓓ	2.79	0.73	74
L.S.D. (*P*<0.05)	0.80		na

[A] These lines are crosses between chickpea (*C. arietinum*) and a wild *Cicer* species

ns = not significant at 95% confidence level; na = not applicable.

Summary

- Even in a dry season, substantial losses from PRR can occur in susceptible varieties such as PBA Boundaryⓓ.
- Improved PRR resistance exists in advanced lines. Importantly, in the absence of PRR there appears to be no yield penalty in these lines.

Discussion

The lower yield losses in the 2014 trial compared to the 2012 and 2013 trials are likely associated with lower in-crop rain between July and November. In 2014, there were three months where the monthly total was ≤ 20 mm (July 7 mm, September 20 mm, October 15 mm). In 2013, when PRR development was severe, there was only one month (August 9 mm) when rainfall was ≤20 mm. In 2012, when PRR severity was between that which developed in the 2013 and 2014 trials, there were two months when rainfall was ≤ 20 mm. Further, in 2014 post-sowing conditions were cooler than normal (17 days in July with a minimum temperature ≤ 1°C). The combination of low soil temperatures and low rainfall early in the season in 2014 may have reduced the number of primary infections which developed from the inoculum applied at sowing, and so reduced the capability of further disease development later in the season despite good rainfall in August (45 mm).

Acknowledgements

This research is co-funded by NSW DPI, DAFFQ and GRDC under the Northern NSW Integrated disease management project (DAN00176) and the Northern Integrated disease management project (DAQ00186); we are especially grateful to GRDC for its continued support.

Chickpea Ascochyta – is the pathogen changing?

Kevin Moore[1], Kristy Hobson[1], Prabhakaran Sambasivam[2], Rebecca Ford[2,3], Steve Harden[1], Paul Nash[1], Gail Chiplin[1] and Sean Bithell[1]

[1] Department Primary Industries NSW [2] University Melbourne VIC [3] Griffith University QLD

Ascochyta in 2014 chickpea crops

Ascochyta blight (AB) was first found in the GRDC Northern Region at North Star on 2 July as a small (2–5 plants) focus in a crop of Flipper⚘. By the end of September, AB had been detected in 62 of 332 crop inspections (18.7%), considerably more than was found in 2013 (5/280 crops, 1.8%) and 2012 (11/213 crops, 5.2%). Most of the 2014 cases were in NSW but four were confirmed in Qld, including one crop of PBA Boundary⚘ at Toobeah, west of Goondiwindi. The NSW cases covered an area from Yallaroi in the east, west to Mungindi, Nevertire and Tullamore and south to Forbes.

Four cases of AB were found in July, with the majority detected in August (25) or September (33) with none in October.

Two cases involved Flipper⚘, two PBA Boundary⚘, one PBA Slasher⚘, one Yorker⚘ (that the grower believed was PBA HatTrick⚘) and the rest were PBA HatTrick⚘. This distribution of cases by variety reflects the fact that in 2014, PBA HatTrick⚘ was by far the predominant variety grown in north central NSW, northern NSW and southern Queensland.

Infected crops had typical symptoms of AB including ghosting leaf lesions, mature leaf lesions and stem lesions. In most cases, the disease was limited to isolated areas in the paddock but in several crops the infection was widespread with foci being detected every 10–30 seconds of walking across the paddock. In these crops, stem breakage was common. In spite of the incidence of AB infection and severity of symptoms, all growers were able to manage the disease with judicious use of chlorothalonil fungicides (up to four applications in the worst cases). All growers believed the disease had little if any impact on final yield although it did impact on production costs.

Why was there more Ascochyta in 2014 than in the previous two seasons?

Although total winter crop rainfall was well below average across the region, June and July were above average in southern parts (57.4 mm and 34 mm respectively at Trangie; 57.6 mm and 55.6 mm at Dubbo). At Moree and Goondiwindi, June/July rain was 23.8/5.0 mm and 29.2/15.4 mm, respectively. The AB fungus requires the impact energy of raindrops to disperse its conidia so it has to rain for the disease to establish. That is, dews alone will not produce the initial infection. However, the pathogen only needs 3–6 hours of leaf wetness to infect; a few mm of rain falling late on a winter's day or at night will satisfy that requirement. Although Moree Airport only recorded 23.8/5mm in June/July, the AWS at Kindee (north east of Moree) recorded 44.0/11.4 mm for the same period with 5/2 days >1.0 mm respectively. Kindee is only a few km from a local epidemic of AB in several PBA HatTrick⚘ crops. That the disease did occur over such a broad geographical area is evidence that sufficient rain fell to initiate and spread infections. As well as favourable weather conditions, another explanation for the amount of AB in 2014 is varietal impurity. That is, not every plant in a paddock of PBA HatTrick⚘ was actually a PBA HatTrick⚘ plant. Varietal purity is a concern in the GRDC Northern Region and the presence of plants of susceptible varieties in a crop of PBA HatTrick⚘ would increase disease pressure on bona fide PBA HatTrick⚘ plants.

Key findings

Ascochyta blight occurred in more chickpea crops in the northern region in 2014 than in 2012 and 2013 combined. Most infected crops were PBA HatTrick⚘ but this is also the most commonly grown variety.

Infections in 2014 arose from inoculum in diseased chickpea stubble and infected volunteers.

Research confirmed the fungus varies in its pathogenic ability but there was no evidence it has changed in response to the widespread cultivation of PBA HatTrick⚘.

In localities where Ascochyta was found in 2014, growers are advised to apply an early season preventative fungicide to all 2015 chickpea crops including PBA HatTrick⚘.

***Table 1**. Pathogenicity ranking of 35 isolates of Phoma rabiei collected in 2013 (location and variety collected from) on three chickpea genotypes, ICC3996, Genesis™ 090 and PBA HatTrick$^{(D)}$*

Location	Variety	ICC3996	Genesis™ 090	PBA HatTrick$^{(D)}$
North Star	Flipper$^{(D)}$	Low	Low	Low
North Star	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	High
Tooraweenah	HatTrick$^{(D)}$	Low	Low	High
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Medium
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Medium
Tooraweenah	HatTrick$^{(D)}$	Low	Low	High
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Medium
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Tooraweenah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	High
Garah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	Low
Garah	HatTrick$^{(D)}$	Low	Low	Low

Where did the inoculum come from?

The AB pathogen, *Phoma rabiei* (previously called *Ascochyta rabiei*) survives on volunteer chickpeas, on chickpea residue and on seed. Volunteers with AB were reported in fallows and nearby wheat crops. We tested some of the seed used to plant the crops in the above-mentioned local epidemic. Five thousand seeds (untreated) were surface sterilised and plated to detect any seed borne infections – none were found. This does not exclude seed as a source of primary inoculum, but together with the absence of any lesions on pods of 2012 and 2013 crops, it presents a robust case against seed as the main source of inoculum for the 2014 infections.

We believe the main source of inoculum was infected chickpea residue from 2012 and 2013 crops. We propose the dry summers of 2012–13 and 2013–14 slowed residue breakdown both *in situ* and in the following year's chickpea paddocks and that this provided inoculum for infection of summer volunteers and the 2014 crop.

Has the Ascochyta pathogen changed?

The short answer is we don't yet know. Why? Because we have limited data on pathogenic variability in the pathogen population. However, as a population of living individuals (isolates), we should expect it to change. The little research that has been done shows that there are differences in pathogenicity among isolates. Table 1 classifies 35 isolates of *Phoma rabiei* collected from northern NSW chickpea crops in 2013. Isolates were rated low, medium or high based on their ability to cause disease on ICC3996 (R), Genesis™ 090 (R) or PBA HatTrick⁽ᶦ⁾ (MR). We conclude that none of the isolates caused severe disease on the two resistant genotypes and that most also did not cause severe disease on PBA HatTrick⁽ᶦ⁾ either. Three caused severe, and three caused moderate, disease on PBA HatTrick⁽ᶦ⁾ (Table 1). This establishes that the pathogen varies in pathogenicity.

Another way of assessing pathogenic variability in the AB pathogen populations is to determine the latent period for individual isolates. The latent period is the time from infection to the development of pycnidia, the small dark fruiting bodies that develop in the leaf and stem lesions. Six isolates representing a sub-set of the pathogen population in eastern Australia were evaluated in a growth cabinet (20 °C/15 °C 12 h day/12 h night) on four chickpea genotypes ICC3996 (rated R, coded ICC), Genesis™ 090 (rated R, coded GEN), PBA HatTrick⁽ᶦ⁾ (rated MR, coded HAT) and Kyabra⁽ᶦ⁾ (rated S, coded KYB). There were eight replicates (pots) for each of the 24 genotype by isolate combinations. The latent period was estimated by survival analysis with the status of a pot being whether pycnidia had or had not developed. For each pot, the data is the latent period or the day of last observation if pycnidia had not developed. Details of the isolates are:

- T12437 – 2010, Darling Downs, QLD, highly pathogenic on PBA HatTrick⁽ᶦ⁾ and ICC3996, moderate on Genesis™ 090 (glasshouse)
- 10TEM005 – 2010, Temora, NSW, highly pathogenic on PBA HatTrick⁽ᶦ⁾ and ICC3996, moderate on Genesis™ 090 (glasshouse)
- 13MUR002 – 2013, Murtoa, VIC, highly pathogenic on Genesis™ 090 (field and glasshouse)
- 13DON002 – 2013, Donald, VIC, highly pathogenic on Genesis™ 090 (field and glasshouse)
- TR6415 – 2014, Yallaroi, NSW, highly pathogenic on PBA HatTrick⁽ᶦ⁾ (field)
- 10MEL001– 2010, Melton, SA, extremely low pathogenicity

Latent period (LP) varied with isolate and genotype (Table 2). All isolates had the shortest LP on the most susceptible entry, Kyabra⁽ᶦ⁾ (KYB) and the longest LP on the most resistant entry, ICC3996 (ICC). The isolate from Yallaroi (TR6415) had the shortest LPs on all genotypes and we interpret this as meaning that isolate was the most aggressive in the experiment. This LP experiment complements the pathogenicity work and confirms variability does exist in the pathogen population. However, it does not prove that it has changed in response to the widespread cultivation of PBA HatTrick$^{(D)}$.

***Table 2**. Mean latent period (days) of six* Phoma rabiei *isolates on six isolates of* P. rabiei *on four chickpea genotypes, ICC3996 (ICC), Genesis™ 090 (GEN), PBA HatTrick$^{(D)}$ (HAT) and Kyabra$^{(D)}$ (KYB).*

Genotype	Isolate	Latent period	SE (mean)
GEN	T12437	7.1	0.1
HAT	T12437	6.8	0.2
ICC	T12437	7.8	0.2
KYB	T12437	6.0	0.0
GEN	10TEM005	7.3	0.2
HAT	10TEM005	7.0	0.0
ICC	10TEM005	7.9	0.1
KYB	10TEM005	6.0	0.0
GEN	13MUR002	7.4	0.3
HAT	13MUR002	6.9	0.2
ICC	13MUR002	8.0	0.0
KYB	13MUR002	6.0	0.0
GEN	13DON002	6.1	0.1
HAT	13DON002	6.4	0.2
ICC	13DON002	7.3	0.2
KYB	13DON002	6.0	0.0
GEN	TR6415	6.0	0.0
HAT	TR6415	6.0	0.0
ICC	TR6415	7.1	0.1
KYB	TR6415	6.0	0.0
GEN	10MEL001	7.0	0.3
HAT	10MEL001	6.9	0.1
ICC	10MEL001	7.9	0.1
KYB	10MEL001	6.0	0.0

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Effect of chickpea Ascochyta on yield of current varieties and advanced breeding lines – Tamworth 2014

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Introduction

Ascochyta first caused widespread damage to chickpeas in eastern Australia in 1998. At the time, all Australian chickpea varieties were susceptible (some highly so). Following the 1998 epidemic, efforts to develop chickpea varieties with improved resistance to Ascochyta were increased, aided by considerable support from GRDC. Howzat$^{\phi}$, released in 2002, had better resistance than Amethyst but it was not until 2005 when Flipper$^{\phi}$ and Yorker$^{\phi}$ were released that substantial gains in Ascochyta resistance were available to the chickpea industry. PBA HatTrick$^{\phi}$ (2009) and PBA Boundary$^{\phi}$ (2011) provided even better levels of resistance. Since 1999, field trials have been conducted to determine yield losses caused by Ascochyta in current varieties and advanced breeding lines. We report here on the 2014 trial Variety Management Package (VMP14) conducted at Tamworth.

Key findings

Under medium to high disease pressure, Ascochyta can be successfully and economically managed on susceptible varieties such as Kyabra$^{\phi}$ and Jimbour$^{\phi}$

However, Ascochyta management is easier and more cost effective on varieties with improved resistance e.g. PBA HatTrick$^{\phi}$ and PBA Boundary$^{\phi}$

The level of Ascochyta resistance in the advanced breeding lines CICA0912 and CICA1007 has been improved to the point that in a typical average to dry season neither will require fungicide applications.

Site and experimental details

Location:	**Tamworth Agricultural Institute, NSW DPI**
Sown:	**15 May 2014, standing cereal stubble, disc openers, 40 cm row spacing, plots 4 m × 10 m**
First inoculation:	**15 July, cocktail of 20 isolates, 233,000 spores/mL in 100 L/ha of water; 5.5 hr elapsed before rain started and whilst Ascochyta did develop, not all unprotected plants became infected**
Second inoculation:	**16 August, using same cocktail plus a highly aggressive isolate collected at Yallaroi on 24 July 2014, 833,000 spores/mL. It rained for 3.5 days, and every unprotected plant developed multiple Ascochyta infections**
Rainfall:	**From re-inoculation to desiccation (6 November), 94 mm on 16 rain days (8 days >1.0 mm); long term average for same period 141 mm on 20 rain days (15 days >1.0 mm)**

Treatments

Genotypes:	**Total of 10 being seven released varieties and three advanced breeding lines (Table 1)**
Fungicides:	**Three treatments being low disease (5 sprays 1.0 L/ha chlorothalonil – 720 g/L active); high disease (nil sprays), and VMP treatment with a reduced off-label rate of chlorothalonil**
Replicates:	**Four in a complete randomised block design**

Data for the VMP treatment are not presented here but we describe the fungicide strategies for each genotype as these reflect their Ascochyta rating:

- First VMP fungicide spray for Jimbour$^{\phi}$, Kyabra$^{\phi}$ and CICA1211 applied before the first Ascochyta inoculation.

- First VMP fungicide spray for PBA Monarch⏀ and Genesis™ Kalkee applied 14 August after two infection events, when Jimbour⏀, Kyabra⏀ and CICA1211 were receiving their 2 second spray.
- First VMP fungicide spray for PBA Boundary⏀, PBA HatTrick⏀, Genesis3z 425 and CICA0912 applied on 12 September after four infection events, when Jimbour⏀, Kyabra⏀ and CICA1211 were getting their fourth spray.

__Table 1.__ Chickpea varieties and advanced breeding lines used in the Tamworth VMP14 trial and their current ratings for Ascochyta and Phytophthora
(S – Susceptible, MS – Moderately Susceptible, R – Resistant, MR – Moderately Resistant)

Genotype	Ascochyta (AB)	Phytophthora (PRR)	Notes
Jimbour⏀	S	MS/MR	Industry standard
Kyabra⏀	S	MS	Drought tolerant
PBA Boundary⏀	MR	S	High yield
PBA HatTrick⏀	MR	MR	High yield, moderate AB & PRR
PBA Monarch⏀	MS	VS	Medium/large seeded kabuli
Genesis™ Kalkee	MS/MR	VS	Large seeded kabuli
Genesis™ 425	R	S	Small seeded AB resist kabuli
CICA0912 desi	R	MR/R	Potential release, good AB and PRR
CICA1007 desi	R/MR	MR	Potential release, high yield
CICA1211 desi	S	MR	Potential release, high quality

Results

Conditions were not consistently favourable for Ascochyta development at Tamworth in 2014 and plants grew away from the disease between rain events. Nevertheless, unprotected (Nil) Kyabra⏀ plots were severely affected by Ascochyta and produced no yield; unprotected Jimbour⏀ yielded only 22% of Jimbour⏀ protected with fungicides during the season (Table 2).

In spite of treating all planting seed with the fungicide metalaxyl (and thiram), Phytophthora root rot (PRR), developed following 39 mm of rain on 18–20 August and 18 mm on 25–26 Sep in 2014. By harvest, PRR had become quite severe in some areas of the trial; accordingly, %PRR infection was used as a covariate in the yield analyses. The covariate adjusted yields for label rate (1.0 L/ha) and nil fungicide treatments only are presented and covariate adjusted yields were also used to calculate gross margins (GM)(Table 2).

Key yield findings of VMP14

- Under moderate to high disease pressure, Ascochyta can be successfully managed on susceptible (S) and moderately resistant (MR) varieties with registered rates of chlorothalonil.
- Under these same conditions the Ascochyta resistance of two PBA breeding lines (CICA912 and CICA1007) was robust and application of chlorothalonil did not significantly improve yield.

Susceptible varieties

- Chlorothalonil significantly increased yield of all susceptible varieties.
- Good management of Ascochyta with fungicides in the S variety Kyabra⏀ produced a yield of 2.4 t/ha with a GM of $669/ha compared to zero yield and a GM of minus $377/ha where the disease was not controlled

- CICA1211 was the surprise of the trial, with an unsprayed yield 86% of the sprayed. CICA1211 was rated Susceptible in PBA screening nurseries under very high Ascochyta pressure. In this drier than average season, CICA1211 handled Ascochyta much better than the other S entries, Jimbour⁽ᵖ⁾ and Kyabra⁽ᵖ⁾.

Findings for MR and R/MR varieties:

- PBA HatTrick⁽ᵖ⁾'s improved resistance was confirmed with the unsprayed yielding 76% of the sprayed, although the difference was significant. The difference between GMs (sprayed $630/ha; unsprayed $492/ha) was also significant.
- Unsprayed PBA Boundary⁽ᵖ⁾ yielded 88% of sprayed PBA Boundary⁽ᵖ⁾ with a GM of $637/ha.
- The 2013 released kabuli, PBA Monarch⁽ᵖ⁾ performed well, with an unsprayed yield 74% of the sprayed.
- The potential desi release, CICA0912, performed exceptionally well with no significant yield difference ($P<0.001$) between five sprays of chlorothalonil (2183 kg/ha) and none (2132 kg/ha).
- There was also no difference ($P<0.001$) in yield of the desi line CICA1007 between five (2340 kg/ha) and none (2343 kg/ha).

***Table 2**. Number and rate/ha of chlorothalonil sprays, cost of spraying, grain yield, and gross margin (GM) for ten chickpea genotypes – Tamworth 2014*

Variety and treatment	No.sprays	Spray cost ($/ha)	Yield (kg/ha)	GM $/ha*
Kyabra⁽ᵖ⁾ 1.0L	5	105	2385	669
Jimbour⁽ᵖ⁾ 1.0L	5	105	2180	575
Genesis™Kalkee 1.0L	5	105	1971	681
PBA Monarch⁽ᵖ⁾ 1.0L	5	105	2205	810
PBA HatTrick⁽ᵖ⁾ 1.0L	5	105	2301	630
Genesis™425 1.0L	5	105	2143	775
CICA1211 1.0L	5	105	2244	605
PBA Boundary⁽ᵖ⁾ 1.0L	5	105	2351	653
CICA912 1.0L	5	105	2183	577
CICA1007 1.0L	5	105	2340	649
Kyabra⁽ᵖ⁾ Nil	0	0	0	-377
Jimbour⁽ᵖ⁾ Nil	0	0	501	-76
Genesis™Kalkee Nil	0	0	1461	504
PBA Monarch⁽ᵖ⁾ Nil	0	0	1625	594
PBA HatTrick⁽ᵖ⁾ Nil	0	0	1761	492
Genesis™425 Nil	0	0	1878	732
CICA1211 Nil	0	0	1936	571
PBA Boundary⁽ᵖ⁾ Nil	0	0	2080	637
CICA912 Nil	0	0	2132	659
CICA1007 Nil	0	0	2343	754
L.S.D. (*P*=0.05)			275	133

**GMs also take into account other production costs estimated at $300/ha; chickpea price desi: $450/t, kabuli: $550/t*

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Chickpea Ascochyta – evidence that varieties do differ in susceptibility of pods

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Key findings

Susceptibility of chickpea pods to Ascochyta Blight is important as infection can cause pod abortion and blemish or kill seed; infected seed is also an inoculum source for subsequent crops.

Field trial results indicate that, contrary to current opinion, chickpea varieties do differ in the susceptibility of their pods to Ascochyta.

The results suggest that varietal resistance of chickpea pods is similar to that of vegetative tissue.

Introduction

If chickpea pods get infected by Ascochyta early in their development they abort. If fully developed pods get infected near the peduncle (as many do because the calyx holds water), they will also abort. Pods with developing seeds will abort, or the seed becomes infected and is killed or the seed becomes infected, but remains viable and is a potential source of inoculum to initiate an epidemic.

Current Australian chickpea varieties and advanced breeding lines differ in susceptibility of their vegetative plant tissues to Ascochyta blight (see paper on VMP14 trial in this edition of NGRTR). However, the chickpea industry presently believes that pods of all varieties are equally susceptible to Ascochyta. A chickpea Ascochyta management trial conducted at Tamworth in 2011(VMP11), suggested that may not be the case – anecdotal evidence indicated varieties with higher levels of resistance to Ascochyta e.g. Genesis™425 also developed less disease on their pods.

Should they exist, differences in pod susceptibility among varieties would be invaluable in developing variety specific Ascochyta management recommendations. For the past three seasons we have conducted trials at Tamworth designed specifically to capture data on the susceptibility of pods of different chickpea genotypes to Ascochyta. Each season we protected the plants with fungicides until 50% podding, then waited for a rain event to inoculate the trials but no rain came.

The 2014 Tamworth chickpea Ascochyta yield loss trial, VMP14, which was inoculated before flowering, provided an opportunity to collect data on susceptibility of pods of ten genotypes consisting of released varieties and advanced breeding lines.

Site and experimental details

Location:	**Tamworth Agricultural Institute, NSW DPI**
Details:	**VMP14, including disease ratings of the varieties and breeding lines based on assessments of vegetative tissue, are reported in the preceding paper in this book. The trial was inoculated on 15 July and re-inoculated on 16 August using a new isolate collected at Yallaroi on 24 July 2014. By the end of August, Ascochyta was well established throughout the trial, especially in the unprotected Nil plots (no fungicides)**
Crop development:	**Podding commenced in the second week of September**
Rainfall:	**8 mm on 24 September, 10 mm on 25 September, 16.4 mm on 13 October and 0.6 mm on 14 October in 2014**
Sampling:	**On 29 October, 5–6 plants were collected from the outer 2 rows on each side of the 4 m wide x 10 m long plots. The pods were stripped from each plant, discarding the youngest two pods on each branch (these formed after the last rain event and could not have been infected by Ascochyta)**

Ascochyta assessment:	**Pods were sorted into four classes based on their Ascochyta status: Clean = no Ascochyta lesions; 1 lesion = pods with a single lesion; 2–5 lesions and >5 lesions. A lesion was not called Ascochyta unless pycnidia could be seen either with the naked eye or under a low power dissecting microscope. For each variety the number of pods falling into each of the four Ascochyta classes was analysed using ordinal regression. The model estimates (+/- SE) the 3 cut-off points between the 4 classes and gives a coefficient for each variety.**
Genotypes:	**CICA0912 (C0912), CICA1007 (C1007), Genesis™425 (G425), Genesis™Kalkee (KAL), PBA HatTrick⊕ (HAT), PBA Monarch⊕ (MON), PBA Boundary⊕ (BOU), Kyabra⊕ (KYB) and Jimbour⊕ (JIM).**

Results

We acknowledge that this Ascochyta pod data could be confounded, as the plots (JIM and KYB) with the highest levels of pod infection and the greater number of lesions per pod were also those that had the highest levels of Ascochyta development in the vegetative stage. However, we are confident there was sufficient inoculum pressure in the trial. In particular during the two rain events (25 September and 13 October), all pods in the trial would have been exposed to the same aerosol of conidia (40 unsprayed Nil plots in the trial with a combined area of 1600 m^2 and an estimated 48,000 infected plants, all with leaf and stem lesions bearing pycnidia). Hopefully, a further trial planned in 2015 will clarify the potential issue of variety effects on Ascochyta pod infection.

There were large differences in pod infection among the genotypes. Only 28.6% of JIM and 33.8% of KYB pods were clean (no disease), whereas about 96.8–98.5% of G425, C1007 and C0912 pods had no Ascochyta (Table 1). Not only did JIM and KYB have a greater proportion of Ascochyta infected pods, but these pods were more severely diseased with most of the infected pods having 2–5 or more than 5 Ascochyta lesions per pod (Table 1).

Table 1. *Percentages of pods in each of four Ascochyta categories for ten genotypes in VMP14 trial*

Genotype	% clean	% 1 lesion	% 2–5 lesions	% > 5 lesions
C0912	98.5	1.0	0.3	0.3
C1007	97.2	1.5	1.0	0.3
G425	96.8	2.5	0.3	0.5
KAL	86.7	7.5	5.5	0.3
HAT	86.2	9.3	4.0	0.5
MON	86.2	7.8	3.3	2.8
BOU	84.3	5.5	6.3	4.0
C1211	67.2	13.8	14.5	4.5
KYB	33.8	15.5	30.5	20.3
JIM	28.6	21.8	31.3	18.4

Analysis showed that the varieties can be separated into four groups with no differences between varieties within a group but significant differences between varieties in different groups. The four groups from least to most susceptible were (C1007, C0912, G425), (BOU, HAT, KAL, MON), (C1211) and (JIM, KYB) (Figure 1).

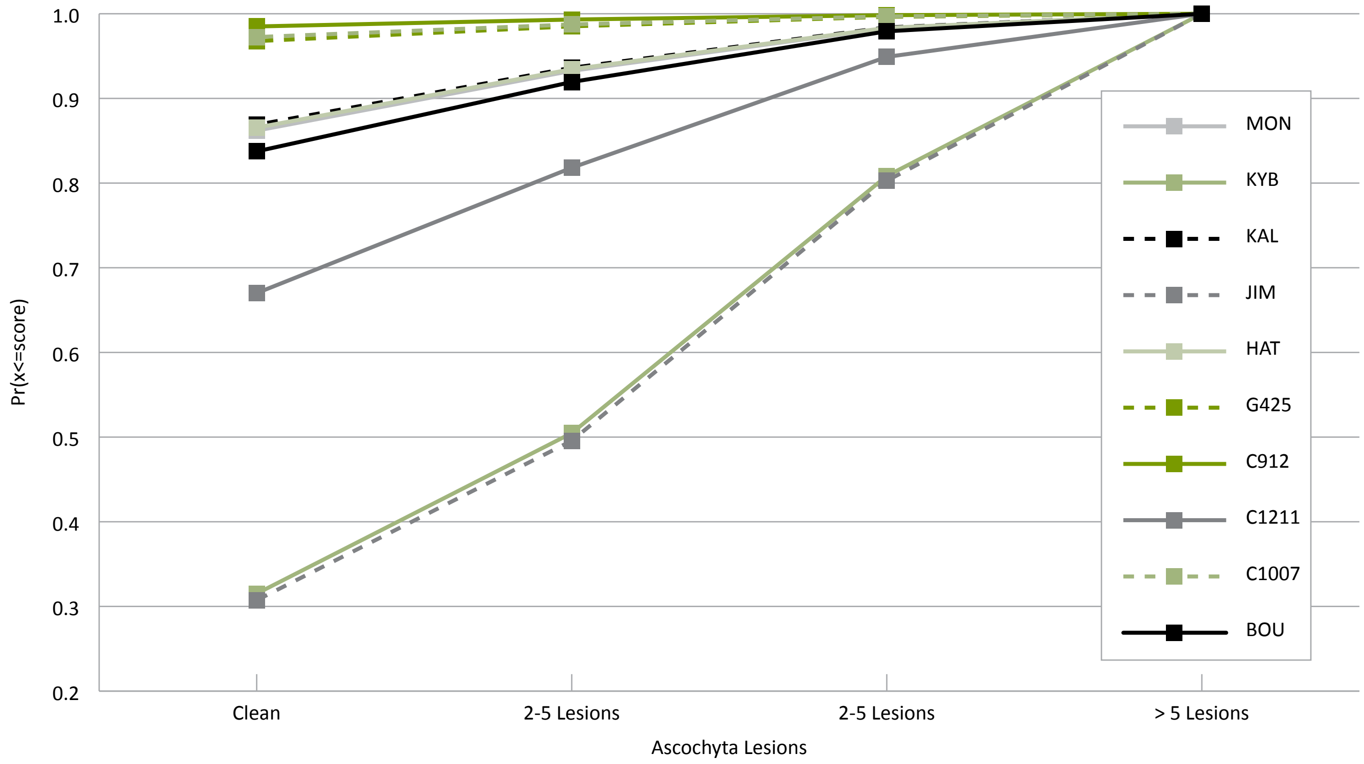

***Figure 1**. Predicted cumulative proportions of pods for each of four categories of Ascochyta lesions for ten chickpea genotypes in VMP14 trial*

Key pod infection findings of VMP14 were:

- Genotypes differed in the number of pods which became infected with Ascochyta.
- Genotypes differed in the severity of Ascochyta on infected pods (i.e number of lesions/pod).
- The ten genotypes fell into four significantly distinct groups in the four pod disease categories with pod resistance from highest to lowest being: C1007, C0912 and G425 > BOU, HAT, KAL and MON > C1211 > JIM and KYB).
- These pod resistance groupings agree closely with current Ascochyta ratings based on the infection of vegetative tissues.

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Impact of cereal varieties on the build-up of *Pratylenchus thornei* across three sowing dates – Narrabri 2013

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Key findings

Cereal variety choice can have a significant impact on the build-up of *Pt* populations within paddocks which was not related to sowing date.

All of the seven durum entries examined left relatively low *Pt* populations in the top 30 cm of soil.

Significant differences were evident between barley and bread wheat varieties with around a 2 or 3 fold difference in final *Pt* populations between the best and worst entries, respectively.

Introduction

The root lesion nematode (RLN) *Pratylenchus thornei* (*Pt*) is widespread in cropping soils through central and northern NSW. Winter cereal varieties differ in the extent of yield loss from *Pt* (*tolerance*) and the numbers of nematodes that multiply in their root systems within a season (*resistance*). Resistance to *Pt* is an important consideration as it dictates a varieties effect on subsequent crops in the rotation. That is, more susceptible varieties allow greater multiplication of *Pt* in their root systems over a season. The higher the resulting *Pt* population left in the soil, the greater the potential for a negative impact on the yield of subsequent crops.

A winter cereal variety trial (durum, bread wheat and barley) trial examining yield response across three sowing dates was conducted near Narrabri in northern NSW in 2013. The harvested plots were left intact and soil cores were taken in March 2014 to assess the effect of winter cereal crop type and variety choice on the build-up of *Pt* in the soil under the 2013 plots. This type of testing evaluates the relative *resistance* of each variety to *Pt* under field conditions.

Site details

Location:	**'Myall Vale' Narrabri**
Co-operator:	**Peter and Sarah Leitch**
Sowing dates:	**TOS 1: 24 April 2013, TOS 2: 1 June 2013, TOS 3: 25 June 2013**
Fertiliser:	**180 kg/ha urea and 70 kg/ha Granulock Supreme Z at sowing**
Starting N:	**175 kg/ha nitrate N to 1.2 m**
Starting water:	**~170 mm (0–180 cm)**
In-crop rainfall:	**~120 mm**
PreDicta B®:	**2.5 *Pt*/g soil at sowing (0–30 cm) average of separate samples across the six ranges**

Treatments

- Seven durum wheat entries (3 released varieties and 4 numbered lines; Table 1).
- 23 barley entries (18 released varieties and 5 numbered lines; Table 1).
- 17 bread wheat entries (16 released varieties and 1 numbered line; Table 1).
- Three replicates of each entry split for sowing date.
- All plots cored (10 cores/plot at 0–30 cm on previous crop row) after harvest (March 2014) to determine final *Pt* populations for each variety across the three sowing dates.
- *Pt* populations determined by PreDicta B® analysis, a soil DNA service provided by the South Australian Research and Development Institute (SARDI), that provides the number of *Pt*/g soil.
- *Pt* data transformed for analysis l*n*(x + 1) to determine significance and back-transformed values are presented in Table 1.

Results

- There was no significant effect of the three sowing dates (24 April to 25 June) on final *Pt* populations ($P = 0.734$) and no interaction between sowing time and variety (*F pr.* = 0.754). However, significant variety differences were evident ($P = <0.001$).

Table 1*. Final* Pratylenchus thornei *soil populations (0–30 cm) produced by 23 barley, 7 durum and 17 bread wheat entries averaged across three sowing dates – Narrabri 2013*

Varieties (across crops) followed by the same letter are not significantly different at 95% confidence level

Variety	*Pt*/g soil	Significance
Barley		
Compassᶲ	2.2	bcdef
Groutᶲ	2.5	bcdefgh
NRB121156	2.5	bcdefgh
Urambieᶲ	2.6	bcdefghi
Commander ᶲ	2.9	cdefghijk
SY Rattlerᶲ	3.0	cdefghijk
Navigatorᶲ	3.1	defghijk
Oxfordᶲ	3.3	defghijkl
Flindersᶲ	3.4	efghijkl
Bassᶲ	3.4	fghijklm
IGB1140	3.4	fghijklm
Fathomᶲ	3.5	ghijklmn
Westminsterᶲ	3.7	hijklmn
Wimmeraᶲ	3.8	jklmnop
Shepherdᶲ	3.9	ijklmnopq
Fairviewᶲ	3.9	ijklmnopq
La Trobeᶲ	4.0	jklmnopq
Scope CLᶲ	4.1	klmnopq
IGB1139	4.1	klmnopq
GrangeRᶲ	4.1	klmnopq
Gairdnerᶲ	4.2	klmnopq
Skipperᶲ	4.2	klmnopq
Bulokeᶲ	4.7	lmnopqr

Variety	*Pt*/g soil	Significance
Durum		
Exp Durum	1.3	a
Caparoiᶲ	1.6	ab
TD241046	1.9	abc
DBA Auroraᶲ	2.0	abc
TD290564	2.1	bcd
TD290491	2.2	bcde
Jandaroiᶲ	2.5	bcdefgh
Bread wheat		
Sunguardᶲ	2.4	bcdefg
Suntopᶲ	2.7	cdefghij
LRPB Spitfireᶲ	3.0	cdefghijk
LRPB Lancerᶲ	3.2	defghijkl
LRPB Vikingᶲ	3.2	defghijkl
Livingstonᶲ	3.5	ghijklmn
Sunvaleᶲ	3.8	hijklmno
EGA Gregoryᶲ	4.1	klmnopq
LRPB Dartᶲ	4.1	klmnopq
Mitchᶲ	5.1	mnopqr
EGA Eaglehawkᶲ	5.2	nopqr
Elmore CL Plusᶲ	5.2	nopqr
SUN663A	5.5	oqr
EGA Bounty	6.3	r
LRPB Crusaderᶲ	6.4	r
Sunvex	6.4	r
LRPB Impalaᶲ	6.7	r

- Final *Pt* populations in the top 30 cm of soil left by the root systems of the previous varieties ranged from 1.3 *Pt*/g of soil (Experimental durum) up to 6.7 *Pt*/g soil (LRPB Impala$^{(\phi)}$) which represents a five-fold difference in final populations (Table 1).
- The build-up in *Pt* populations was relatively modest at this site compared to the average starting population of 2.5 *Pt*/g soil (0–30 cm).
- Durum tended to leave relatively low *Pt* populations in the top 30 cm of soil ranging from 1.3 *Pt*/g (experimental durum) up to 2.5 *Pt*/g (Jandaroi$^{(\phi)}$).
- The bread wheat varieties produced the widest range of final *Pt* populations from 2.4 *Pt*/g (Sunguard$^{(\phi)}$) to 6.7 *Pt*/g (LRPB Impala$^{(\phi)}$).
- The range in final *Pt* populations was narrower with the barley varieties being from 2.2 *Pt*/g (Compass$^{(\phi)}$) to 4.7 *Pt*/g (Buloke$^{(\phi)}$).
- The difference between final *Pt* populations was not significant with the three released durum varieties examined but significant differences did exist within both released bread wheat and barley varieties (Table 1).

Conclusions

Cereal variety choice can have a significant impact on the build-up of *Pt* populations within paddocks, with around a five-fold difference in final populations between the highest and lowest variety at this site in 2013. These differences were due to the variety sown and did not significantly differ among a two month spread in sowing dates.

Acknowledgments

This project was co-funded by NSW DPI and GRDC under the National nematode epidemiology and management program (DAV00128) and Variety Specific Agronomy Project (DAN00129). Thanks to Peter and Sarah Leitch for providing the trial site and to Stephen Morphett, Jim Perfrement, Peter Formann and Rod Bambach (NSW DPI) for sowing, maintaining and harvesting the trial. Assistance provided by Robyn Shapland, Patrick Mortell, Finn Fensbo and Rod Bambach (NSW DPI) in coring plots is greatly appreciated. Soil samples were assessed for RLN populations using PreDicta B® analysis by Dr Alan McKay and his team at SARDI in Adelaide.

Impact of cereal variety and crown rot on the build-up of *Pratylenchus neglectus* – Bithramere 2013

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Introduction

Crown rot, caused by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to winter cereal production across the northern grains region. There are two main species of root lesion nematode (RLN), namely *Pratylenchus thornei* (*Pt*) and *P. neglectus* (*Pn*), which also impact on crop production across the region. Surveys in the northern grains region have established that *Pt* is more widespread and generally at higher populations than *Pn*.

Recent research has demonstrated that infestation with *Pt* can exacerbate the expression of crown rot. However, the interaction of crown rot infection with the multiplication of RLNs has not been investigated. The opportunity was therefore taken to soil core a crown rot variety evaluation trial conducted at Bithramere in 2013 which had a moderate background level of *Pn*, to evaluate relative resistance of varieties to *Pn* and potential interactions with crown rot.

Key findings

Cereal variety choice can have a significant impact on the build-up of *Pt* populations within paddocks which was not related to sowing date.

All of the seven durum entries examined left relatively low *Pt* populations in the top 30 cm of soil.

Significant differences were evident between barley and bread wheat varieties with around a 2 or 3 fold difference in final *Pt* populations between the best and worst entries, respectively.

Site details

Location:	**'Wheatacres' Bithramere**
Co-operator:	**Richard and Michael Bowler**
Sowing date:	**7 June 2013**
Fertiliser:	**0 kg/ha urea and 50 kg/ha Granulock Supreme Z at sowing**
Starting N:	**180 kg/ha nitrate N to 120 cm**
Starting water:	**~194 mm PAW (0-120 cm)**
In-crop rainfall:	**119 mm**
PreDicta B®:	**2.0 *Pn*/g soil (medium risk), 3.4 log *Fusarium* DNA/g (high risk) at sowing (0–30 cm)**
Harvest date:	**21 November 2013**

Treatments

- Two durum varieties (Caparoi$^{\phi}$ and Jandaroi$^{\phi}$)
- Nine bread wheat varieties (EGA Gregory$^{\phi}$, LRPB Crusader$^{\phi}$, LRPB Dart$^{\phi}$, LRPB Lancer$^{\phi}$ LRPB Spitfire$^{\phi}$, Mitch$^{\phi}$, Strzelecki$^{\phi}$, Suntop$^{\phi}$ and Sunguard$^{\phi}$) and one numbered line (SUN663A).
- Added (+CR) or no added (-CR) crown rot inoculum at sowing using sterilised durum grain colonised by at least five isolates of *Fp*.
- All plots cored (20 cores/plot at 0–15 cm on previous crop row) after harvest (March 2014) to determine final *Pn* concentrations for each variety across no added and added CR treatments.
- *Pn* populations determined in soil samples by PreDicta B®, a DNA based test provided by the South Australian Research and Development Institute (SARDI).
- *Pn* data transformed for analysis *ln*(x + 1) to determine significance with back-transformed values are presented in Figure 1.

Results

- The effect of crown rot infection on final *Pn* populations was inconsistent with the added CR treatment significantly increasing *Pn* populations in Mitch$^{\phi}$ and LRPB Dart$^{\phi}$ by 2.7 (1.7 to 4.6 *Pn*/g) and 1.7 fold (3.6 to 6.0 *Pn*/g), respectively.
- Conversely, the final *Pn* population was halved (6.2 *Pn*/g down to 3.0 *Pn*/g) in the added CR treatment with EGA Gregory$^{\phi}$.
- Background crown rot infection levels were high at this site in 2013 which complicated the interpretation of interactions with *Pn*.

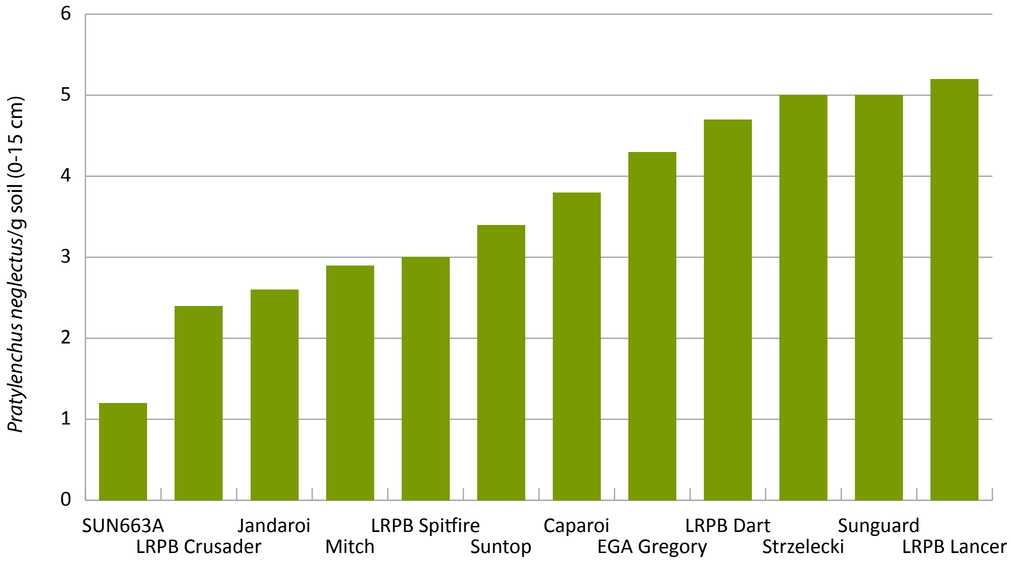

Figure 1*. Final* Pratylenchus neglectus *soil populations (0–15 cm) produced by two durum and ten bread wheat entries – Bithramere 2013*

Bars followed by the same letter are not significantly different at 95% confidence level

- Significant differences were evident between varieties (averaged across CR treatments) in final *Pn* populations developed in the surface 15 cm of soil which ranged from 1.2 *Pn*/g of soil (SUN663A) up to 5.2 *Pn*/g soil (LRPB Lancer$^{\phi}$). This represented a 4.4 fold difference in final populations (Figure 1). The resistance of varieties to *Pn* can be quite different to their resistance to the other RLN species, *P. thornei* (*Pt*) as there are different genes involved. For example, LRPB Lancer$^{\phi}$ is susceptible to *Pn*, as highlighted at this site, but is only moderately susceptible to *Pt*.

Conclusions

- Cereal variety choice can have a significant impact on the build-up of *Pn* populations within paddocks with a 4.4 fold difference in final populations between the highest and lowest variety at this site in 2013. This site had a high background infection level of crown rot. This may have masked any effect of additional CR infection resulting from adding CR inoculum at sowing on the build-up of *Pn* populations in root systems.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Epidemiology and Management Program (DAN00175) and the National Nematode Epidemiology and Management Program (DAV00128). Thanks to the Bowler Family for providing the trial site and to Matt Gardner, Stephen Morphett, Jim Perfrement, Patrick Mortell, Peter Formann and Rod Bambach (NSW DPI) for sowing, maintaining and harvesting trial. Assistance provided by Robyn Shapland, Patrick Mortell, Finn Fensbo and Rod Bambach (NSW DPI) in coring plots is greatly appreciated. Soil samples were assessed for RLN populations using PreDicta B® analysis by Dr Alan McKay and his team at SARDI in Adelaide.

Impact of wheat variety choice on the build-up of *Pratylenchus thornei* – Wongarbon 2013

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Introduction

The root lesion nematode (RLN) *Pratylenchus thornei* (*Pt*) is widespread in cropping soils through central and northern NSW. Winter cereal varieties differ in the extent of yield loss from *Pt* (*tolerance*) and the numbers of nematodes that multiply in their root systems within a season (*resistance*). Resistance to *Pt* is an important consideration as it dictates a varieties effect on subsequent crops in the rotation. That is, more susceptible varieties allow greater multiplication of *Pt* in their root systems over a season. The higher resulting *Pt* population left in the soil the greater the potential for a negative impact on the yield of subsequent crops.

A GRDC funded National Variety Trial (NVT) of wheat varieties examining the yield potential of released and near release cultivars was conducted at Wongarbon in central NSW in 2013. The harvested plots were left intact and soil cores were taken in March 2014 to assess the effect of variety choice on the build-up of *Pt* in the soil under the 2013 plots. This type of testing evaluates the relative *resistance* of each variety to *Pt* under field conditions.

Key findings

Cereal variety choice can have a large impact on the build-up of *Pratylenchus thornei* (*Pt*) populations within paddocks which can then impact on the performance of following crops and/or varieties in the rotation.

Significant differences were evident between varieties with a 15-fold difference in final *Pt* populations between the best (LRPB Gauntlet$^{(\phi)}$) and worse (Mitch$^{(\phi)}$) variety.

Very susceptible varieties should be avoided in paddocks with known RLN populations as they can lead to development of very high populations and disease risk levels in a single season.

Site details

Location:	**Wongarbon, central-west NSW**
Co-operator:	**Angus Kelly**
Sowing date:	**29 May 2013**
Fertiliser:	**200 kg/ha urea and 80 kg/ha Granulock Supreme Z Extra at sowing**
PreDicta B®:	**1.5 *Pn*/g soil (low risk), 3.8 *Pt*/g soil (medium risk) and nil *Fusarium* at sowing (0–30 cm)**
Harvest date:	**14 November 2013**

Treatments

- A total of 38 entries were in the main season evaluation trial made up of 23 released varieties and 15 advanced numbered lines.
- All plots in the main season NVT trial were cored (10 cores/plot at 0–30 cm on previous crop row) after harvest (March 2014) to determine final *Pt* concentration for each variety.
- *Pt* and *Pn* populations determined in soil samples by PreDicta B® analysis, a soil DNA based test provided by the South Australian Research and Development Institute (SARDI).
- *Pt* and *Pn* data transformed for analysis *ln*(x + 1) to determine significance with back-transformed values for *Pt* only are presented for released varieties only in Table 1.

Results

This site had a mixed RLN population at sowing following a canola crop grown in 2012. There was a low level of *Pn* and moderate level of *Pt* across the site as measured separately for each of the six ranges at sowing. Variety impacts on final RLN numbers, as measured in March 2014, were significant for *Pt* at the 95% confidence level but only at a confidence level of 92% for *Pn*. Final *Pn* numbers ranged from 0.2 to 2.4 *Pn*/g soil (0–30 cm) and had a large co-efficient of variation so are not presented.

Significant differences were evident between varieties in final *Pt* populations in the top 30 cm of soil which ranged from 2.7 Pt/g of soil (LRPB Gauntlet⁽ᵈ⁾) up to 41.3 *Pt*/g soil (Mitch⁽ᵈ⁾). This represented a 15 fold difference in final *Pt* populations between varieties (Table 1).

LRPB Gauntlet⁽ᵈ⁾ was the only variety to lower the average *Pt* population below the measured starting level at sowing in 2013. However, it still maintained a medium risk level for the following 2014 crop.

LRPB Crusader⁽ᵈ⁾, Elmore CL Plus⁽ᵈ⁾, Janz⁽ᵈ⁾, LRPB Lincoln⁽ᵈ⁾ and Mitch⁽ᵈ⁾ all increased the *Pt* population from medium risk to a high risk level (>15.0 *Pt*/g soil) for the following 2014 crop.

All other varieties maintained or increased the final *Pt* population to within a medium risk level (2.0 to 15.0 *Pt*/g soil) for the following 2014 crop (Table 1).

***Table 1**. Final* Pratylenchus thornei *soil populations (0–30 cm) produced by 23 bread wheat varieties – Wongarbon 2013*

Values followed by the same letter are not significantly different at 95% confidence level

Variety	*Pt*/g soil	Significance	Variety	*Pt*/g soil	Significance
LRPB Gauntlet⁽ᵈ⁾	2.7	a	Wallup⁽ᵈ⁾	8.7	cdefghijklmn
Suntop⁽ᵈ⁾	4.4	ab	Sunvale⁽ᵈ⁾	9.2	cdefghijklmn
Gascoigne⁽ᵈ⁾	4.7	abc	LRPB Impala⁽ᵈ⁾	10.7	dfghijklmno
LRPB Spitfire⁽ᵈ⁾	4.8	abc	Ventura⁽ᵈ⁾	10.8	dfghijklmno
Sunguard⁽ᵈ⁾	5.2	abcde	Orion⁽ᵈ⁾	11.6	ghjklmnop
EGA Wylie⁽ᵈ⁾	5.5	abcdefg	Ellison⁽ᵈ⁾	12.0	hjklmnop
LRPB Dart⁽ᵈ⁾	5.9	bcdefghi	LRPB Crusader⁽ᵈ⁾	21.6	opqr
Livingston⁽ᵈ⁾	6.1	abcdefghij	Elmore CL Plus⁽ᵈ⁾	23.2	pqr
Condo⁽ᵈ⁾	6.1	abcdefghijk	Janz⁽ᵈ⁾	29.3	qr
Sunmate⁽ᵈ⁾	6.4	bcdefghijk	LRPB Lincoln⁽ᵈ⁾	31.9	r
Baxter⁽ᵈ⁾	7.8	bcdefghijkl	Mitch⁽ᵈ⁾	41.3	r
EGA Gregory⁽ᵈ⁾	8.2	cdefghijklm			

Conclusions

Cereal variety choice can have a significant impact on the build-up of *Pt* populations in paddocks with a 15 fold difference in final populations between the best and worst variety at this site in 2013. Starting *Pt* populations of below 2.0 *Pt*/g soil are considered low disease risk, populations between 2.0 and 15.0 *Pt*/g soil are considered medium risk and above 15.0 *Pt*/g soil are considered high risk for yield loss in intolerant crops or varieties in the northern region. As all varieties maintained a medium disease risk or increased the *Pt* population to high risk at this site in 2013, these results indicated there are serious consequences following production of *Pt* intolerant crops and/or varieties within the rotation. The worst of the varieties increased the *Pt* population from ~3.8 *Pt*/g at sowing in 2013 to around 30–40 *Pt*/g soil as measured prior to sowing in 2014. Recent NSW DPI research has also demonstrated that significant yield loss still occurred in the moderately tolerant wheat variety EGA Gregory⟪D⟫ with high risk (>15.0 *Pt*/kg) populations in the top 30 cm of soil at sowing (Autumn 2013 Northern Grains Region Trial Results).

Very susceptible varieties should be avoided in paddocks with known RLN populations as they can dramatically increase the population to high risk levels in one season.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Variety Trial Program and the National Nematode Epidemiology and Management Program (DAV00128). Thanks to the Kelly family for providing the trial site and to Peter Matthews (NSW DPI mobile trials unit) for sowing, maintaining and harvesting the NVT trial. Assistance provided by Robyn Shapland, Patrick Mortell, Finn Fensbo and Rod Bambach (NSW DPI) in coring plots is greatly appreciated. Soil samples were assessed for RLN populations using PreDicta B® analysis by Dr Alan McKay and his team at SARDI in Adelaide.

Fusarium crown rot of wheat – do not stress!

Rick Graham, Steven Simpfendorfer, Guy McMullen and Neroli Graham
NSW DPI, Tamworth

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$^{(D)}$.

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$^{(D)}$), one barley (Commander$^{(D)}$) and one durum variety (Caparoi$^{(D)}$)
- 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$^{(D)}$ 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$^{(D)}$ 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.

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⦶ 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.

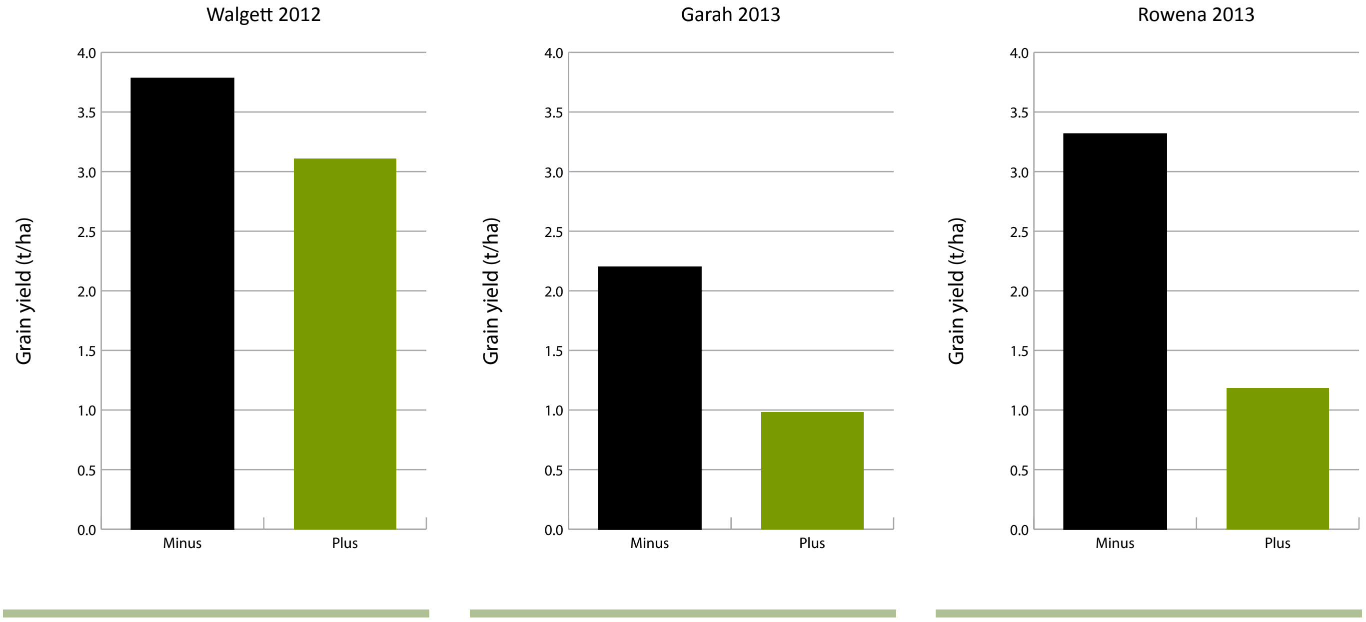

Figure 1*. Grain yield (t/ha) for the durum wheat cv. Caparoi⦶ plus and minus Fp infection, average across row spacing and plant populations at Walgett in 2012 (a), Garah in 2013 (b), and Rowena (c) in 2013. Bars represent L.S.D. (P=0.05).*

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.

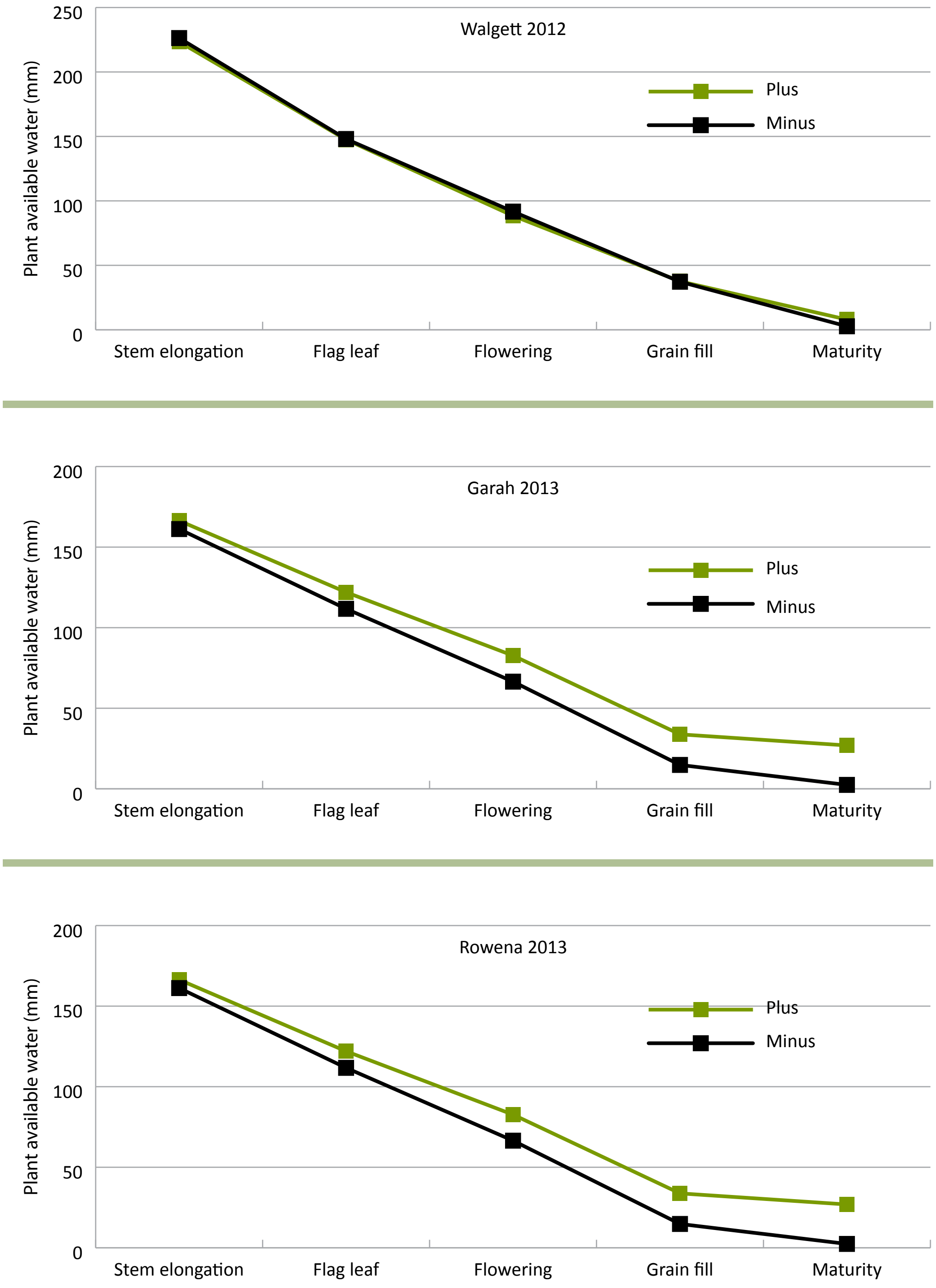

Figure 2*. Impact of crown rot (plus and minus Fp infection) on soil water use of the durum wheat cv. Caparoi*$^{\text{\textcircled{P}}}$ *(0–150 cm) – Walgett 2012 (a), Garah 2013 (b), Rowena 2013 (c). Bars represent L.S.D. (P=0.05).*

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⦶ 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⦶ 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

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175) and Variety Specific Agronomy Project (DAN00129). Thanks to Dave Denyer, David and Tim Cameron, Andrew and Bill Yates for providing the trial sites and to Stephen Morphett, Jim Perfrement, Patrick Mortell, Peter Formann and Rod Bambach (all NSW DPI) for sowing, maintaining and harvesting trials. Matt Gardner (formerly NSW DPI) is also acknowledged for his assistance with managing the trials in 2012 and 2013.

‘Spiking’ with stubble reduces the risk of failures to warn with crown rot testing using PreDicta B® – 2013

Steven Simpfendorfer[1], Alan McKay[2] and Shawn Rowe[2]
[1] NSW DPI Tamworth, [2] SARDI, Adelaide

Key findings

PreDicta B® is a good technique for identifying the level of risk for crown rot (and other soil-borne pathogens) prior to sowing. However, this requires a dedicated sampling strategy and IS NOT a simple add on to a soil nutrition test.

Soil cores should be targeted at the previous winter cereal rows; if evident;and any stubble fragments should be RETAINED.

Short pieces of stubble (1–2 from each PreDicta B® soil sampling location) from previous winter cereal crops and/or grass weed residues can be added to the soil sample to enhance detection of the *Fusarium* spp. that cause crown rot.

‘Spiking’ soil samples with stubble will reduce the likelihood of ‘failure to warn’ situations for crown rot but unfortunately will also increase the probability of false warnings.

Introduction

PreDicta B® is a DNA based soil test which detects levels of a range of cereal pathogens that is commercially available to growers through the South Australian Research and Development Institute (SARDI). The main pathogens of interest in the northern grains region detected by PreDicta B® are *Fusarium* spp. (crown rot), *Bipolaris sorokiniana* (common root rot), *Pythium* (damping off) and both *Pratylenchus thornei* and *P. neglectus* (root lesion nematodes, RLNs). Over recent years PreDicta B® has been shown to be a reliable method for assessing RLN populations but is perceived by industry to be less reliable in assessing levels of crown rot risk in the northern region.

Between 2010 and 2012, we conducted an annual winter cereal pathogen survey of 248 paddocks across 12 districts in central and northern NSW. The three year survey measured the DNA levels of the *Fusarium* pathogen at sowing compared to the infection levels that had developed by harvest. This research found that in 75% of paddocks, PreDicta B® at sowing predicted the actual level of infection that developed in the crop as measured after harvest within one risk category. In 3% of paddocks PreDicta B® overestimated the risk of infection compared to actual development levels (false warning) but of more concern was that PreDicta B® underestimated the risk of crown rot in 22% of paddocks (failure to warn).

The underestimation of crown rot risk is potentially due to the crown rot fungus being stubble-borne while PreDicta B® is a soil based test. Further investigation found that soil nutrition sampling strategies were often being used to collect both the soil nutrition and PreDicta B® samples. This is significant because soil nutrition samples are normally collected between the rows with stubble removed whereas PreDicta B® samples need to be collected along the row of the previous cereal crop and incorporate any stubble residues.

Improving the accuracy and calibrating PreDicta B® in the northern region for crown rot is important for advisers and growers to enable better planning for their winter crop and varietal selection prior to sowing and to avoid costly yield losses from this disease. This is particularly relevant leading into the 2015 cropping season with a high durum grain price last season likely to see many growers considering durum this year. Durum is highly susceptible to crown rot so the cost of getting it wrong and sowing into a high disease risk paddock is significant.

The following paper reports on collaborative research conducted by NSW DPI and SARDI across central/northern NSW in 2013 to improve the accuracy of the PreDicta B® test in assessing crown rot risk by fine tuning soil sampling techniques and recommendations.

Detection issue?

Currently there are three separate tests within PreDicta B® that detect common *Fusarium* species causing crown rot across Australia – two tests which detect variations in *F. pseudograminearum* populations and a third test which detects both *F. culmorum* and *F. graminearum* but cannot differentiate between these two species. The failure to warn of the risk of crown rot in 22% of paddocks could be related to the inability of the current PreDicta B® tests to actually detect other species/variants of *Fusarium* causing crown rot across the region. A national survey was conducted in 2013 and 2014 with over 800 *Fusarium* isolates collected from wheat and barley plants with basal browning characteristic of crown rot infection from across Australia. Molecular analysis determined that all *Fusarium* species known to cause crown rot are being detected by the current PreDicta B® assays. Hence, there is no detection issue with the current PreDicta B® tests that could contribute to the underestimation of crown rot risk.

Is the addition of stubble ('spiking') an improvement?

In 2013 each of the six ranges in 13 cereal NVT sites and 8 NSW DPI district pathology (DP) trials were cored using PreDicta B® (Table 1). Two separate soil samples were collected from each range at each of the 21 field sites spread from central NSW up into southern Queensland. All cores were targeted at the previous winter cereal rows if evident. Previous winter cereal crop stubble was also collected across each separate range at coring if present and used to spike soil samples. Twenty-five lowest nodes (1 cm segments around node) were cut from the corresponding stubble sample and added to one of the samples collected from each range. All samples were then sent to SARDI for PreDicta B® analysis.

***Table 1**. Location of field trial sites in 2013*

Site No.	Location
1	NVT Bellata
2	NVT Bullarah
3	NVT Coolah
4	NVT Coonamble
5	NVT Gilgandra
6	NVT Macalister
7	NVT Merriwa
8	NVT North Star
9	NVT Spring Ridge
10	NVT Trangie
11	NVT Tulloona
12	NVT Westmar
13	NVT Wongarbon
14	DP Narrabri
15	DP Terry Hie Hie
16	DP Bithramere
17	DP Spring Ridge
18	DP Tamworth
19	DP Garah
20	DP Rowena
21	DP Macalister

After harvest stubble was collected from all plots of three varieties (EGA Gregory$^{\Phi}$, Suntop$^{\Phi}$ and Caparoi$^{\Phi}$ or Spitfire$^{\Phi}$) at each site. Twenty-five crowns from each plot were trimmed, surface sterilised and plated onto laboratory media to determine the incidence of crown rot infection that developed during 2013 based on the recovery of *Fusarium*.

PreDicta B® risk for crown rot is the sum of all three *Fusarium* tests which are then converted to a log scale to normalise the data. Current PreDicta B® crown rot risk categories for durum wheat are used in the northern region and corresponding harvest infection levels based on plating have also been developed for the region (Table 2).

***Table 2**. Current PreDicta B® crown rot risk levels and corresponding harvest infection level*

PreDicta B® (log *Fusarium* DNA/g soil)	Risk or harvest disease level	Incidence of infection (% *Fusarium* recovery)
< 0.6	Below detection limit (BDL)	< 2
0.6–1.4	Low	3–12
1.4 –2.0	Medium	13–24
> 2.0	High	≥ 25

Addition of stubble fragments to soil samples was only possible at a few sites with previous cereal stubble being present at 7 of the 21 sites (2, 4, 5, 8, 12, 16 and 18). The addition of stubble increased the crown rot risk level at six of the sites. The risk level changed from low to high at 2 sites (sites 4, NVT Coonamble and 12, NVT Westmar), low to medium at 2 sites (sites 5, NVT Gilgandra and 8, NVT North Star) and medium to high at 2 sites (sites 2, NVT Bullarah and 18, DP Tamworth) (Figures 1 and 2). For the last site (site 16, DP Bithramere) the log *Fusarium* DNA/g increased from 2.5 to 4.3 with the addition of stubble but this did not increase the predicted crown rot risk level as both values represented a high risk of crown rot development.

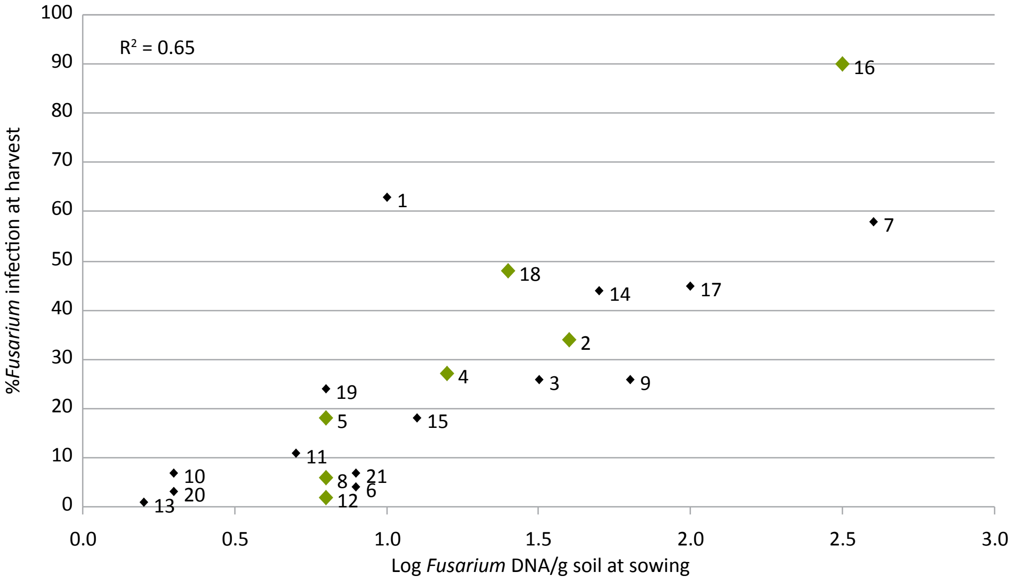

***Figure 1**. Relationship between at sowing DNA levels of* Fusarium *using PreDicta B® and incidence of crown rot infection at harvest – 'Unspiked' samples in 2013*

Sites spiked with stubble represented by green diamonds (sites 2, 4, 5, 8, 12, 16 and 18)

There was a 65% correlation between unspiked PreDicta B® results collected at sowing and the actual incidence of crown rot infection that developed by harvest (Figure 1). Fourteen sites in 2013 had a low or BDL risk for crown rot development based on unspiked PreDicta B® soil tests at sowing. At eight of these sites (6, 8, 10, 11, 12, 13, 20 and 21) the DNA test correctly predicted the actual level of disease which developed while at six sites (1, 4, 5, 15, 18 and 19) PreDicta B® underestimated the risk of disease development. This is generally considered a 'failure to warn' and was particularly evident at site 1 (NVT Bellata) where only a 1.0 log *Fusarium* DNA value was measured at sowing but 63% of plants were infected with crown rot at harvest. In the medium risk category the DNA test correctly predicted the incidence of disease development at two sites (3 and 9) but underestimated the risk at two sites (2 and 14). All three sites predicted to be in the high risk category by the DNA test at sowing (sites 7, 16 and 17) did develop high infection levels during the 2013 season (Figure 1).

The addition of stubble to the PreDicta B® soil samples ('spiking') collected from 7 of the 21 sites at sowing reduced the correlation with the incidence of plants infected with crown rot at harvest down to 51% (Figure 2). However, spiking with stubble at sites 4, 5 and 18 removed them from the low risk category into their correct level of disease incidence at harvest. That is, these were no longer 'failure to warn' situations, with the stubble spiking correctly predicting the risk at sowing of what developed by harvest in the crop. Stubble spiking also corrected the underestimation of risk from medium to high at site 2. Spiking did not change risk categories at site 16 which was high with both the unspiked and spiked soil samples. However, the higher DNA level in the spiked sample better reflected the higher disease incidence (90%) at this site relative to other sites (max. 63%) in 2013.

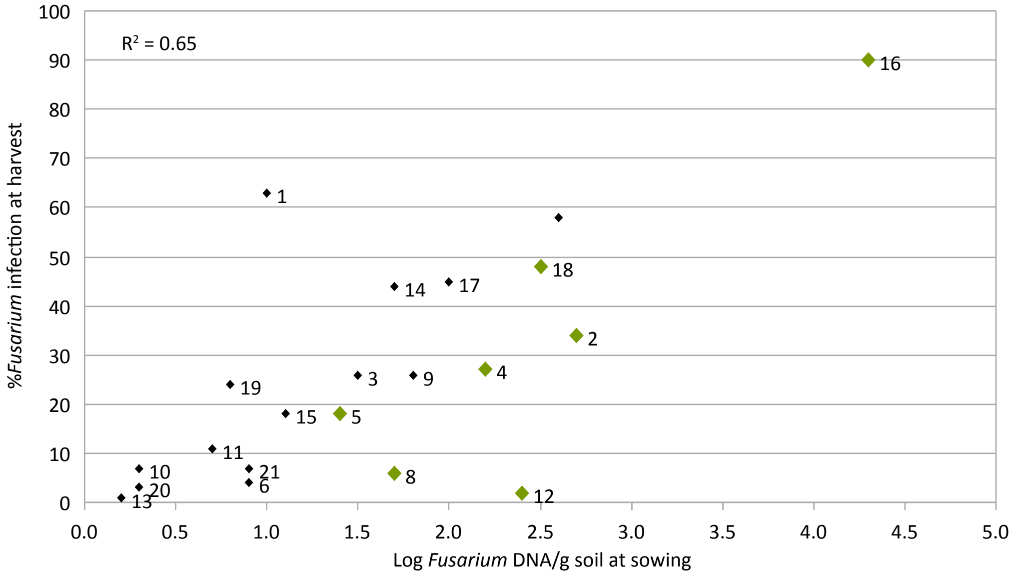

***Figure 2**. Effect of 'spiked' samples at 7 sites on the relationship between at sowing DNA levels of* Fusarium *using PreDicta B® and incidence of crown rot infection at harvest – 2013*

Sites spiked with stubble represented by green diamonds (sites 2, 4, 5, 8, 12, 16 and 18)

Unfortunately, in two situations (sites 8 and 12) spiking led to an overestimation of the crown rot risk at sowing. Spiking pushed site 8 into a medium risk category but only 6% of plants were infected at harvest while site 12 was pushed into a high risk category with only 2% of plants infected at harvest. These situations would be considered false positives and potentially lead to a missed opportunity for growers where they could have grown a winter cereal crop with minimal risk of yield loss from crown rot.

Conclusions

PreDicta B® is a soil based test so with the collection of cores targeted at the previous winter cereal rows it can provide a good measure of *Fusarium* levels in the crowns below ground but is restricted in its ability to detect levels in above ground stubble. Adding stubble ('spiking') is likely to increase the overestimation of crown rot risk (false positives) while reducing the likelihood of underestimation or 'failure to warn' which we consider to be the preferred situation for growers.

The addition of stubble is also likely to reduce sampling issues following wetter summers (e.g. some northern regions in 2014–15) which can result in greater survival of *Fusarium* in above ground residues. Significant summer rainfall can lead to rapid decomposition of the crowns of previous cereal crops below ground which reduces the survival of *Fusarium* in this tissue. However, standing stubble dries out relatively quickly following rainfall events and can hence harbour crown rot inoculum for an extended period. Soil sampling, even targeted at the previous cereal row, will only detect *Fusarium* levels in the crowns. Hence, the addition of stubble to PreDicta B® soil tests will compensate for situations where there is still significant survival of *Fusarium* in above ground residues.

Recent collaborative research in the northern region between SARDI and NSW DPI has demonstrated that use of a smaller diameter (1 cm) soil core (e.g. Accucore) to collect 30–45 cores (depending on sampling depth) targeted at the previous cereal row if evident provides a good measure of both RLN and crown rot risk along with a range of other pathogens. This number of cores collected spatially across the paddock is required to account for the potential variability in the distribution of crown rot inoculum.

This research continued across further sites in the northern region in 2014 and was expanded to around 160 NVT sites nationally. This will facilitate further refinement of sampling strategies and calibration of risk categories across regions.

Acknowledgments

This project was co-funded by NSW DPI, SARDI and GRDC under the national improved molecular diagnostics for disease management project (DAS00137) and the national crown rot epidemiology and management program (DAN00175). Assistance provided by Robyn Shapland, Finn Fensbo, Patrick Mortell, Kay Warren, Tara Burns and Karen Cassin (NSW DPI); Herdina, Russell Burns, Aidan Thomson, Ina Dumitrescu, Danuta Pounsett, Irena Dadej, Daniele Giblot-Ducray (SARDI); and Diane Hartley (CSIRO) is greatly appreciated.

Regional crown rot management – Bithramere 2014

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease. Two trials were conducted at this site in 2014. The first trial was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Queensland to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. The second trial was aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects. This same trial was conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Key findings

Heavy crown rot infection in inoculated plots led to yield loss ranging from 14% (Sunguardᶲ) up to 47% (EGA Gregoryᶲ) even in this relatively high yielding site (average yield of 4.67 t/ha) in 2014.

Variety choice had a large impact on yield in the presence of high levels of crown rot infection with all but two entries being between 0.65 t/ha (Sunmateᶲ) to 1.71 t/ha (LRPB Spitfireᶲ) higher yielding than EGA Gregoryᶲ.

Sunguardᶲ was also the only entry to have screening levels <5% in the presence of high crown rot infection at this site in 2014 with LRPB Spitfireᶲ just exceeding the threshold.

In-crop fungicide application at GS30, provide a *modest* yield benefit of between 0.23 to 0.34 t/ha when targeted at the base EGA Gregoryᶲ plants infected with crown rot.

Site details

Location:	**'Wheatacres' Bithramere**
Co-operator:	**Richard and Michael Bowler**
Sowing date:	**5 June 2014**
Fertiliser:	**150 kg/ha Urea and 60 kg/ha Granulock Supreme Z at sowing**
Starting N:	**80 kg/ha nitrate N to 120 cm**
Starting water:	**~190 mm PAW (0–120 cm)**
In-crop rainfall:	**190 mm**
PreDicta B®:	**Nil RLN, 1.2 log *Fusarium* DNA/g (low risk) at sowing (0–30 cm)**
Fungicide date:	**15 August at GS30**
Harvest date:	**28 November 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commanderᶲ).
- One durum variety (Caparoiᶲ).
- Ten commercial bread wheat varieties (LRPB Lincolnᶲ, EGA Gregoryᶲ, LRPB Dartᶲ, Sunmateᶲ, LRPB Gauntletᶲ, LRPB Lancerᶲ, LRPB Spitfireᶲ, Mitchᶲ, Suntopᶲ and Sunguardᶲ; listed in order of increasing resistance to crown rot).
- Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregoryᶲ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000)

- Three in-crop application strategies at GS31 using Turbo Teejet (110015) nozzles at ~300 L/ha
- Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).
- On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
- Droppers – solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Result

Trial 1. Variety evaluation

Yield

This was a relatively high yielding site in 2014 with yield in the no added CR treatment (black bars) ranging from 4.31 t/ha in the durum variety Caparoiⓓ up to 5.06 t/ha in the barley variety Commanderⓓ (Figure 1).

All entries had significant yield loss under high crown rot infection (added CR) which ranged from 14% (0.65 t/ha) in Sunguardⓓ up to 47% (2.16 t/ha) in EGA Gregoryⓓ.

None of the varieties were lower yielding than EGA Gregoryⓓ under high levels of crown rot infection in the added CR treatment with the durum variety Caparoiⓓ and bread wheat variety LRPB Lincolnⓓ having equivalent yield.

All other entries were higher yielding than EGA Gregoryⓓ under high levels of crown rot infection (green bars) with the yield benefit ranging from 0.65 t/ha with Sunmateⓓ up to 1.71 t/ha with LRPB Spitfireⓓ (Figure 1).

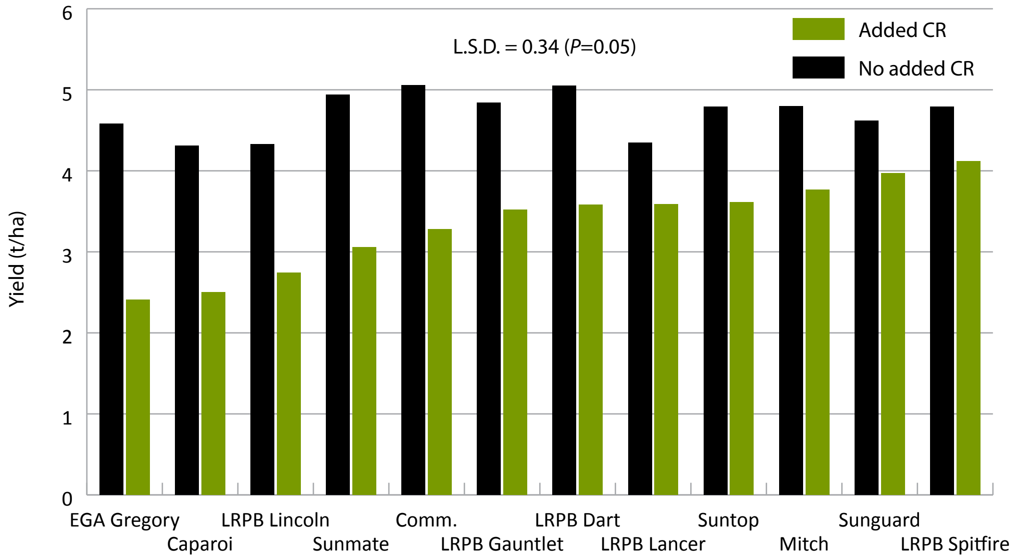

Figure 1. *Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Bithramere 2014*

Grain protein

- The addition of crown rot inoculum at sowing did not significantly change protein levels in any variety.
- Protein levels were quite low at this site ranging between 9.4% (Mitchⓓ) up to only 10.5% (LRPB Lancerⓓ; Figure 2).

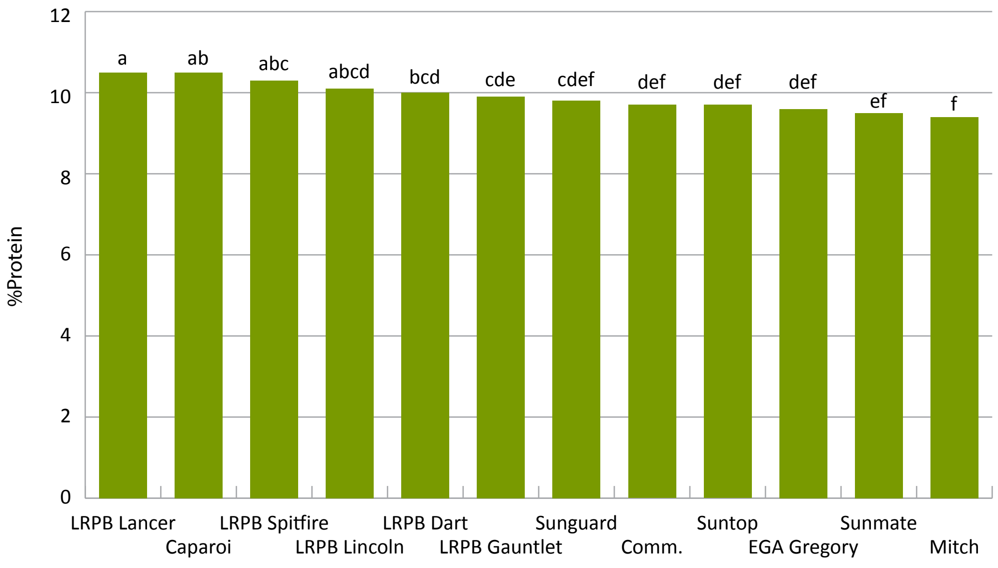

***Figure 2**. Average protein concentration achieved by varieties – Bithramere 2014*

Bars with the same letter are not significantly different (P=0.05)

Screenings

In the no added CR treatment (black bars), Mitchⓓ, EGA Gregoryⓓ, LRPB Dartⓓ, Suntopⓓ and LRPB Lincolnⓓ all had screening levels (< 2.0 mm) greater than 5% (range 5.1 to 6.8%; Figure 3).

LRPB Spitfireⓓ was the only entry not to have a significant increase in screenings in the presence of high crown rot infection.

In all other entries the level of screenings increased by between 1.6% (Sunguardⓓ) to 8.7% (EGA Gregoryⓓ) when CR was added (green bars).

Sunguardⓓ was the only variety to maintain <5.0% screenings in the presence of high levels of crown rot infection with LRPB Spitfireⓓ (5.1%) being very close to this threshold (Figure 3).

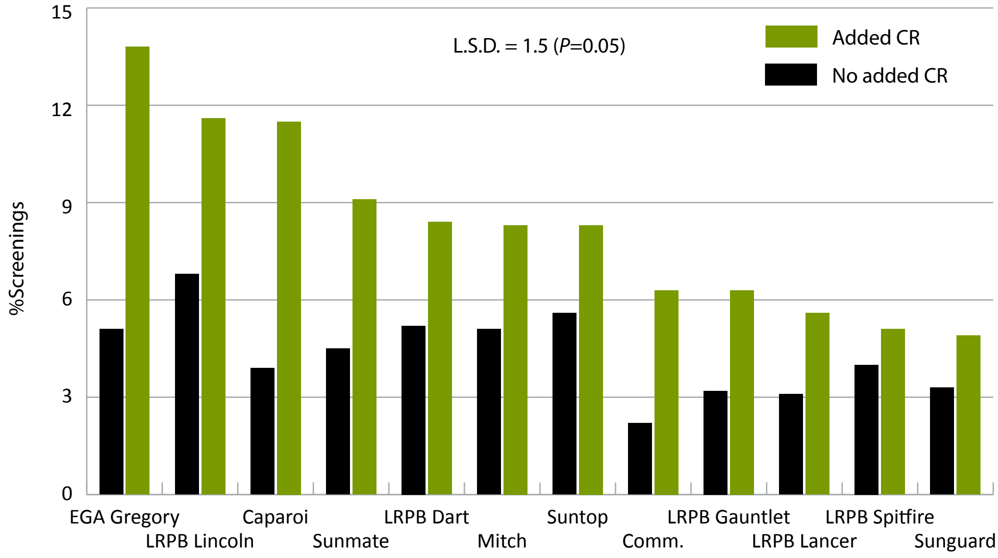

***Figure 3**. Level of screenings achieved by varieties in no added and added crown rot treatments – Bithramere 2014*

Trial 2. Fungicide application evaluation

- The effect of treatments was not significant at the added CR versus no added CR level of interaction.
- Fungicide application at GS 30 provided a modest increase in yield of 0.23 t/ha with on crop application and 0.34 t/ha when applied with droppers over the nil treatment (3.35 t/ha).
- Above crop application did not provide a yield benefit over the nil treatment.
- None of the fungicide application treatments had a significant impact on grain protein or screenings.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to Richard and Michael Bowler for providing the trial site and to Rick Graham, Stephen Morphett, Jim Perfrement and Peter Formann (NSW DPI) for sowing, maintaining and harvesting the trial. Thanks to Patrick Mortell (NSW DPI) for grain quality assessments and Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Regional crown rot management – Mungindi 2014

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease. Two trials were conducted at this site in 2014. The first trial was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Queensland to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. The second trial was aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects. This same trial was conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Key findings

LRPB Spitfire$^{\phi}$, and Suntop$^{\phi}$ were between 0.44 t/ha to 0.66 t/ha higher yielding than EGA Gregory$^{\phi}$ under high levels of crown rot infection.

LRPB Spitfire$^{\phi}$ was also the only entry to have screening levels under 5% in the presence of high crown rot infection and tough seasonal conditions at this site in 2014.

In-crop fungicide application at GS39, even when targeted at the base of plants infected with crown rot, did not provide any benefit in EGA Gregory$^{\phi}$ at this site.

Site details

Location:	**'Bullawarie' Mungindi**
Co-operator:	**Andrew Earle**
Sowing date:	**16 May 2014**
Fertiliser:	**60 kg/ha Urea and 40 kg/ha Granulock 12Z at sowing**
Starting N:	**19 mg/kg to 0.6 cm**
PreDicta B®:	**Nil RLN and 1.7 log *Fusarium* DNA/g (medium risk) at sowing (0–30 cm)**
Fungicide date:	**26 August at GS39**
Harvest date:	**24 October 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commander$^{\phi}$).
- One durum variety (Caparoi$^{\phi}$).
- Ten commercial bread wheat varieties (LRPB Lincoln$^{\phi}$, EGA Gregory$^{\phi}$, LRPB Dart$^{\phi}$, Sunmate$^{\phi}$, LRPB Gauntlet$^{\phi}$, LRPB Lancer$^{\phi}$, LRPB Spitfire$^{\phi}$, Mitch$^{\phi}$, Suntop$^{\phi}$ and Sunguard$^{\phi}$; listed in order of increasing resistance to crown rot).
- Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregory$^{\phi}$ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000)
- Three in-crop application strategies at GS39 using Turbo Teejet (110015) nozzles at ~300 L/ha
  - Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).

- On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
- Droppers - solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Results

Trial 1. Variety evaluation

Yield

- Mungindi was a relatively low yielding site in 2014 due to low fallow moisture and seasonal conditions. This resulted in a higher than desired variation in yield across the site (cv = 18.5%). The results should therefore be interpreted with caution but have been presented as they are largely in line with variety performance under crown rot infection at other sites. It is interesting to evaluate crown rot impacts on yield and grain quality under tougher seasonal conditions as experienced at Mungindi in 2014.
- In the no added CR treatment (black bars) yield ranged from 0.88 t/ha in the durum variety Caparoi⁽ᵇ⁾ up to 1.34 t/ha in the bread wheat variety Mitch⁽ᵇ⁾ (Figure 1).
- Suntop⁽ᵇ⁾ was the only variety where yield loss from the addition of crown rot inoculum at sowing was not significant. With the other varieties, yield loss from crown rot ranged from 29% (0.27 t/ha) in the barley variety Commander⁽ᵇ⁾ up to 71% (0.74 t/ha) in the bread wheat variety LRPB Lincoln⁽ᵇ⁾
- None of the varieties were lower yielding than EGA Gregory⁽ᵇ⁾ under high levels of crown rot infection in the added CR treatment.
- Eight of the entries were higher yielding than EGA Gregory⁽ᵇ⁾ under high levels of crown rot infection (green bars) with the yield benefit ranging from 0.26 t/ha with Commander⁽ᵇ⁾ barley up to 0.66 t/ha with Suntop⁽ᵇ⁾ (Figure 1).

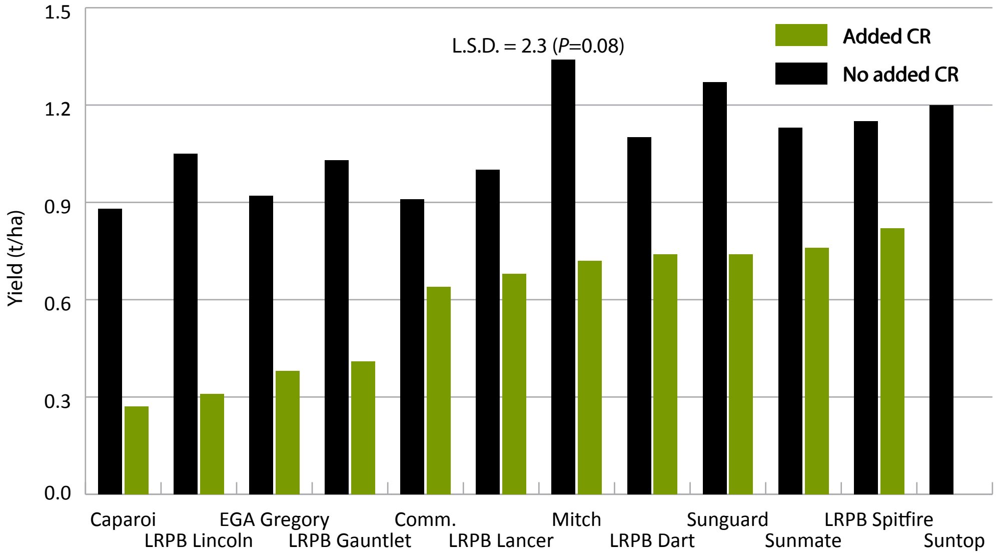

***Figure 1**. Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Mungindi 2014*

Grain protein

- There was no significant impact of crown rot on protein levels in any of the varieties (data not shown).

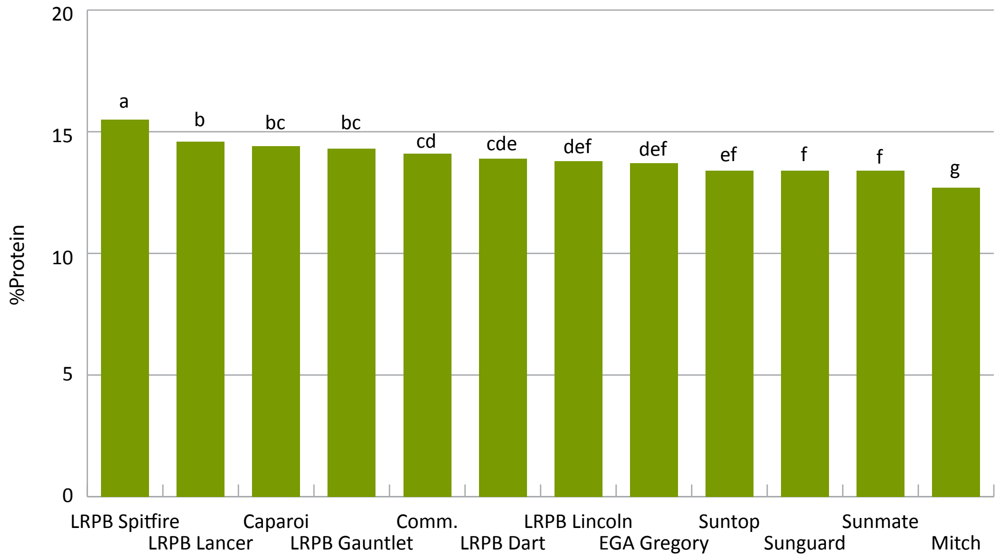

***Figure 2**. Average protein concentration achieved by varieties – Mungindi 2014*

Bars with the same letter are not significantly different (P=0.05)

- There were significant differences between varieties in their levels of grain protein when averaged across crown rot treatments.
- Grain protein levels ranged from 12.7% in Mitch⁽ᵖ⁾ up to 15.5% in LRPB Spitfire⁽ᵖ⁾ (Figure 2).

Screenings

- In the no added CR treatment (black bars), Mitch⁽ᵖ⁾ had a higher level of small grain (<2.0 mm) at 5.3% screenings than all other bread wheat varieties, except Suntop⁽ᵖ⁾ and LRPB Lincoln⁽ᵖ⁾ (Figure 3).
- Commander⁽ᵖ⁾ barley was the only entry not to have a significant increase in screenings (< 2.5 mm with barley) in the presence of high crown rot infection.
- In all other entries the level of screenings increased by between 3.1% (LRPB Spitfire⁽ᵖ⁾) to 14.2% (LRPB Lincoln⁽ᵖ⁾) in the added CR treatment (green bars).
- LRPB Spitfire⁽ᵖ⁾ was the only variety to maintain less than 5.0% screenings in the presence of high levels of crown rot infection (Figure 3).

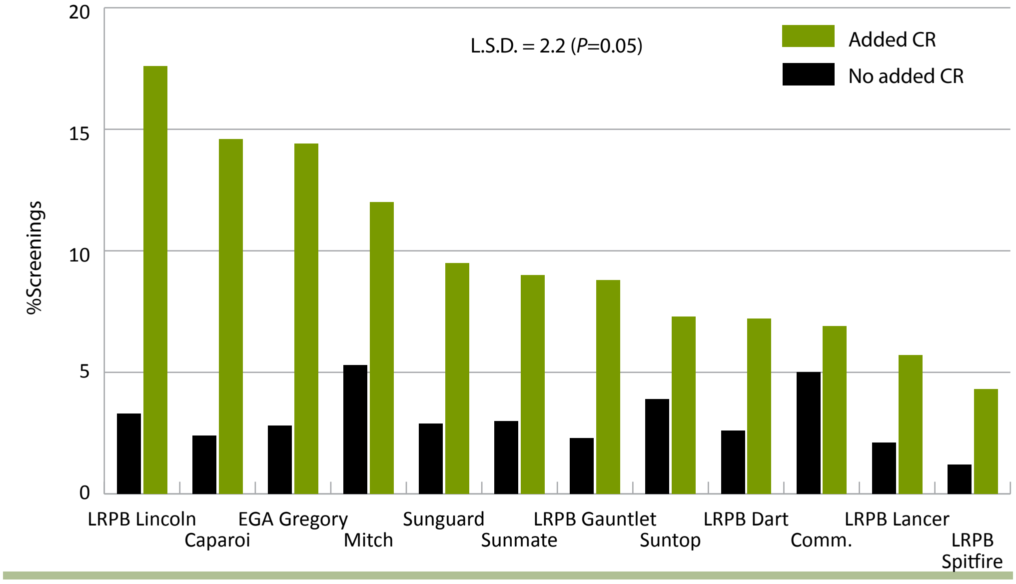

Figure 3*. Impact of crown rot on the level of screenings – Mungindi 2014*

Trial 2. Fungicide application evaluation

- There was no significant effect of in-crop fungicide application at GS39 on the yield, grain protein levels or screenings in EGA Gregory$^{\phi}$ at this site in 2014.
- This was later than desired application which may have limited any impact which has still only been *minor* at other sites in 2013 and 2014.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to Andrew Earle for providing the trial site and to Douglas Lush (QDAFF Mobile Trial Unit) for sowing, maintaining and harvesting the trial. Thanks to Patrick Mortell (NSW DPI) for grain quality assessments and to Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Regional crown rot management – North Star 2014

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease. Two trials were conducted at this site in 2014. The first trial was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Queensland to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. The second trial was aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects. This same trial was conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Key findings

The bread wheat varieties LRPB Spitfireᶲ, LRPB Lancerᶲ, *Suntop*ᶲ and Mitchᶲ were between 0.30 t/ha to 0.84 t/ha higher yielding than EGA Gregoryᶲ under high levels of crown rot infection.

In-crop fungicide application at GS39 when targeted at the base of plants infected with crown rot using droppers provided a 0.40 t/ha yield benefit in EGA Gregoryᶲ.

Site details

Location:	**'Glenhoma' North Star**
Co-operator:	**Malcolm Doolin**
Sowing date:	**16 May 2014**
Fertiliser:	**100 kg/ha urea and 90 kg/ha Granulock 12Z at sowing**
Starting N:	**93 mg/kg to 60 cm**
In-crop rainfall:	**~105 mm**
PreDicta B®:	**0.9 Pn/g (low), 1.0 *Pt*/g (low) and 1.3 log *Fusarium* DNA/g (low risk) at sowing (0–30 cm)**
Fungicide date:	**13 August at GS39**
Harvest date:	**31 October 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commanderᶲ).
- One durum variety (Caparoiᶲ).
- Ten commercial bread wheat varieties (LRPB Lincolnᶲ, EGA Gregoryᶲ, LRPB Dartᶲ, Sunmateᶲ, LRPB Gauntletᶲ, LRPB Lancerᶲ, LRPB Spitfireᶲ, Mitchᶲ, Suntopᶲ and Sunguardᶲ; listed in order of increasing resistance to crown rot).

Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregoryᶲ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000).
- Three in-crop application strategies at GS31 using Turbo Teejet (110015) nozzles at ~300 L/ha.

- Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).
- On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
- Droppers – solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Results

Trial 1. Variety evaluation

Yield

The barley variety Commander was included in this trial but was excluded from all analysis as a residual herbicide issue visibly affected the growth of all barley at this site.

In the no added CR treatment (black bars) yield ranged from 4.11 t/ha in the durum variety Caparoi⫪ up to 5.47 t/ha in the bread wheat variety Suntop⫪ (Figure 1).

Mitch⫪ was the only variety where yield loss from the addition of crown rot inoculum at sowing was not significant. With the other varieties, yield loss from crown rot ranged from 6% (0.30 t/ha) in LRPB Spitfire⫪ up to 23% (1.14 t/ha) in LRPB Lincoln⫪.

LRPB Lincoln⫪ (0.33 t/ha), LRPB Dart⫪ (0.38 t/ha) and Caparoi⫪ (0.70 t/ha) were lower yielding than EGA Gregory⫪ under high levels of crown rot infection in the added CR treatment.

LRPB Spitfire⫪ (0.30 t/ha), LRPB Lancer⫪ (0.42 t/ha), Suntop⫪ (0.62 t/ha) and Mitch⫪ (0.84 t/ha) were all higher yielding than EGA Gregory⫪ under high levels of crown rot infection (Figure 1).

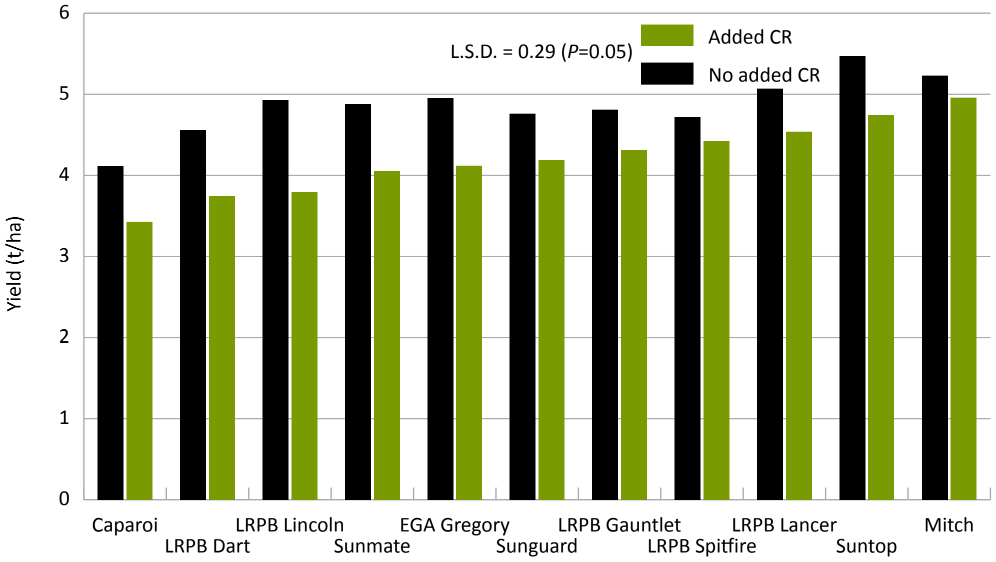

Figure 1. *Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – North Star 2014*

Grain protein

- Protein levels were slightly reduced in the added CR treatment in LRPB Gauntlet⫪ (0.3%), EGA Gregory⫪ (0.4%) and LRPB Spitfire⫪ (0.4%). There was no significant impact of crown rot on protein levels in the remaining varieties (data not shown).

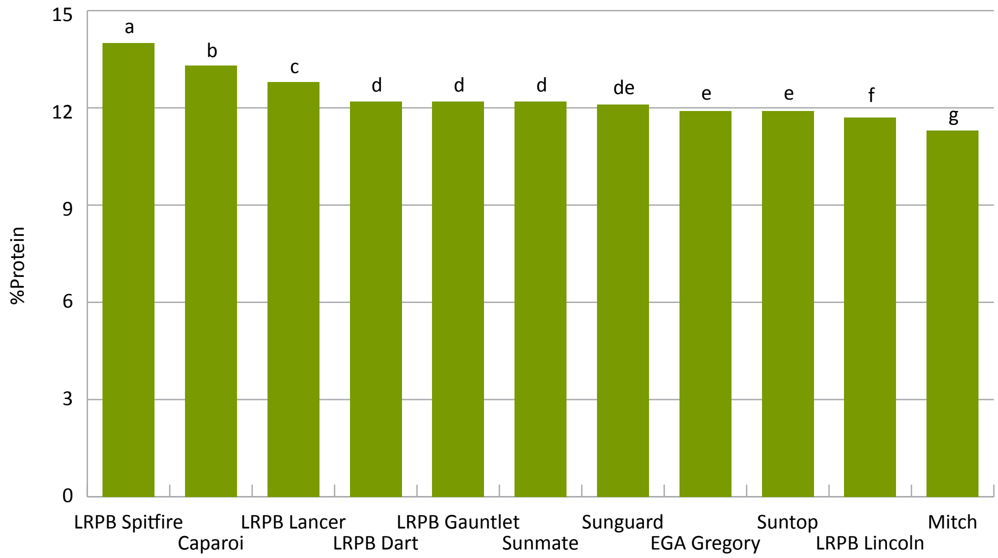

Figure 2*. Average protein concentration achieved by varieties – North Star 2014*

Bars with the same letter are not significantly different (P=0.05)

- There were significant differences between varieties in their levels of grain protein when averaged across crown rot treatments.
- Grain protein levels ranged from 11.3% in Mitch⊕ up to 14.0% in LRPB Spitfire⊕ (Figure 2).

Trial 2. Fungicide application evaluation

Yield

- The in-crop fungicide application did not have a significant interaction with the crown rot inoculum treatment.
- Fungicide application at GS39 provided a significant yield benefit over the nil treatment with the dropper (0.40 t/ha) application technique only which was targeted at the base of plants (Figure 3).

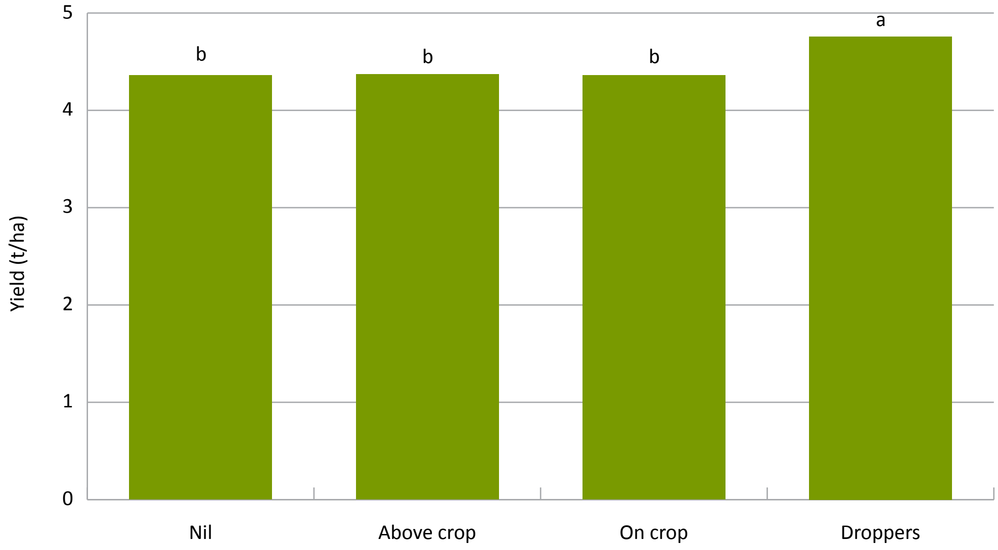

Figure 3*. Effect of fungicide application technique on grain yield of EGA Gregory⊕ averaged across crown rot inoculum treatments – North Star 2014*

Bars with the same letter are not significantly different (P=0.05)

Grain protein

- Fungicide application at GS39 using the various techniques had not impact on grain protein levels.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to Malcolm Doolin for providing the trial site and to Peter Mathews and Gerard Lonergan (NSW DPI Mobile Trial Unit) for sowing, maintaining and harvesting the trial. Thanks to Patrick Mortell (NSW DPI) for grain quality assessments and to Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Regional crown rot management – Spring Ridge 2014

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease. Two trials were conducted at this site in 2014. The first trial was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Queensland to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. The second trial was aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects. This same trial was conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Key findings

This was a relatively high yielding site in 2014 but moderate background infection levels of crown rot complicated yield loss interpretations.

Under moderate background infection levels LRPB Lancer⌽ was 1.06 t/ha, Suntop⌽ was 1.08 t/ha and LRPB Spitfire⌽ was 1.12 t/ha higher yielding than EGA Gregory⌽. This represented up to a 27% difference in grain yield based on variety choice at this site in 2014.

Three varieties were higher yielding than EGA Gregory⌽ under high infection levels (added CR) with the benefit being 0.38 t/ha in LRPB Gauntlet⌽, 0.48 t/ha in LRPB Spitfire⌽ and 0.75 t/ha in Suntop⌽.

In-crop fungicide application at GS32, provide a yield benefit of between 0.27 to 0.52 t/ha in EGA Gregory⌽ with all application treatments but was improved when targeted at the base of plants infected with crown rot.

Site details

Location: **'Nowley' Spring Ridge**
Co-operator: **Richard Heath and Noel Ticehurst, University of Sydney**
Sowing date: **14 May 2014**
Fertiliser: **230 kg/ha urea and 60 kg/ha Granulock Supreme Z at sowing**
Starting N: **120 kg/ha nitrate N to 120 cm**
Starting water: **~130 mm PAW (0–120 cm)**
In-crop rainfall: **170 mm**
PreDicta B®: **0.7 *Pn*/g, 0.5 *Pt*/g and 2.1 log *Fusarium* DNA/g (high risk) at sowing (0–30 cm)**
Fungicide date: **15 August at GS32**
Harvest date: **20 November 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commander⌽).
- One durum variety (Caparoi⌽).
- Ten commercial bread wheat varieties (LRPB Lincoln⌽, EGA Gregory⌽, LRPB Dart⌽, Sunmate⌽, LRPB Gauntlet⌽, LRPB Lancer⌽, LRPB Spitfire⌽, Mitch⌽, Suntop⌽ and Sunguard⌽; listed in order of increasing resistance to crown rot).
- Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregory⌽ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000)
- Three in-crop application strategies at GS32 using Turbo Teejet (110015) nozzles at ~300 L/ha

- Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).
- On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
- Droppers – solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Results

Trial 1. Variety evaluation

Yield

- This was a relatively high yielding site but had a moderate level of background infection from crown rot as indicated from the DNA soil test at sowing. This complicates interpretation of the impact of crown rot on yield loss.
- Yield in the presence of background infection levels in the no added CR treatment (black bars) ranged from 4.16 t/ha with EGA Gregory$^{\phi}$ up to 5.28 t/ha with LRPB Spitfire$^{\phi}$ (Figure 1). This represents a 27% yield difference associated with variety choice.
- None of the varieties were lower yielding than EGA Gregory$^{\phi}$ under high levels of crown rot infection in the added CR treatment.
- Three varieties were significantly higher yielding than EGA Gregory$^{\phi}$ under high levels of crown rot infection (green bars) with the yield benefit being 0.38 t/ha with LRPB Gauntlet$^{\phi}$, 0.48 t/ha with LRPB Spitfire and 0.75 t/ha with Suntop$^{\phi}$ (Figure 1).

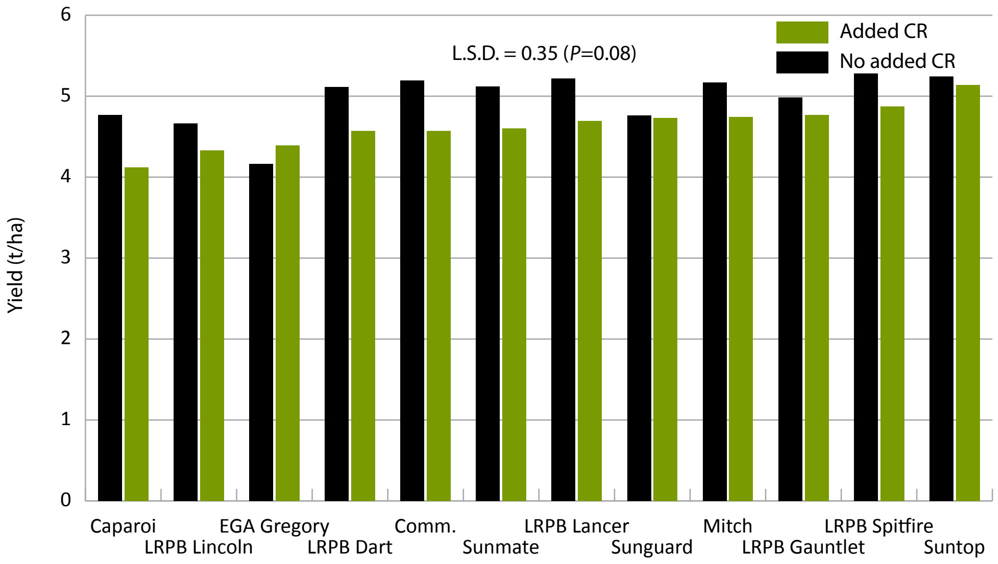

***Figure 1**. Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Spring Ridge 2014*

Grain protein

- The addition of crown rot inoculum at sowing did not significantly change protein levels in any variety.
- Protein levels were quite low at this site ranging between 9.8% (Sunmate$^{\phi}$) up to only 12.9% (LRPB Spitfire$^{\phi}$; data not shown).
- The only significant differences in grain protein levels between varieties were that Sunmate$^{\phi}$ was lower than all other varieties and LRPB Spitfire$^{\phi}$ was higher than three varieties (Suntop$^{\phi}$, EGA Gregory$^{\phi}$ and Sunmate$^{\phi}$).

Screenings

- The interaction of crown rot inoculum treatments on the level of screenings was not significant in any variety.
- However, significant differences were apparent between varieties in their levels of screenings (< 2.0 mm for wheat and durum; < 2.5 mm for barley) averaged across inoculum treatments. Screenings ranged from 2.9% (LRPB Lancer$^{(\phi)}$) up to 7.5% (LRPB Lincoln$^{(\phi)}$)(Figure 1).

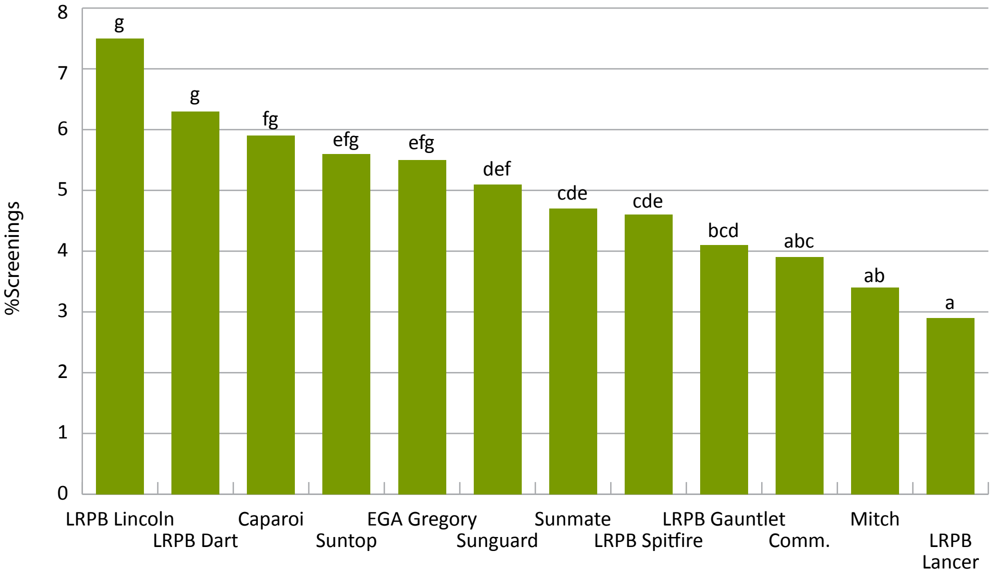

Figure 2. Level of screenings achieved by varieties – Spring Ridge 2014

Bars with the same letter are not significantly different (P=0.05)

Trial 2. Fungicide application evaluation

- The effect of treatments on yield and grain quality was not significant at the added CR versus no added CR level of interaction.
- Fungicide application at GS32 provided a significant increase in yield with all application treatments compared to the nil control (4.00 t/ha). The yield benefit in EGA Gregory$^{(\phi)}$ was 0.27 t/ha with above crop application, 0.48 t/ha with droppers and 0.52 t/ha when applied on crop.
- On crop application provided an additional 0.25 t/ha yield benefit over the above crop application treatment. Other differences between application treatments were not significant.
- None of the fungicide application treatments had a significant impact on grain protein levels.
- Application using droppers reduced the level of screening to 5.0% compared to the nil control of 6.3% which was the only significant effect of application treatments on screenings.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to Richard Heath and Noel Ticehurst (University of Sydney) for providing the trial site and to Rick Graham, Stephen Morphett, Jim Perfrement and Peter Formann (NSW DPI) for sowing, maintaining and harvesting the trial. Thanks to Patrick Mortell (NSW DPI) for grain quality assessments and Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Regional crown rot management – Terry Hie Hie 2014

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Key findings

The bread wheat varieties LRPB Spitfire$^{\phi}$, Sunguard$^{\phi}$ and Mitch$^{\phi}$ were between 0.29 t/ha to 0.60 t/ha higher yielding than EGA Gregory$^{\phi}$ under high levels of crown rot infection.

The performance of the barley variety Commander$^{\phi}$ was poor at this site with 53% (1.90 t/ha) yield loss from high crown rot infection. This emphasises that barley is very susceptible to crown rot infection and if early stress occurs this disease can significantly impact on biomass production and subsequent yield.

In-crop fungicide application at GS30 provided a *small* (0.19–0.26 t/ha) yield benefit when targeted at the base of plants infected with crown rot.

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease. Two trials were conducted at this site in 2014. The first trial was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Queensland to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. The second trial was aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects. This same trial was conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Site details

Location:	**'Maneroo' Terry Hie Hie**
Co-operator:	**David and Rob Anderson**
Sowing date:	**29 May 2014**
Fertiliser:	**170 kg/ha urea and 76 kg/ha Granulock Supreme Z at sowing**
Starting N:	**65 kg/ha N to 1.2 m**
Starting water:	**~20 mm (0–120 cm)**
In-crop rainfall:	**95 mm**
PreDicta B®:	**0.3 *Pt*/g and 1.9 log *Fusarium* DNA/g (medium) at sowing (0–30 cm)**
Fungicide date:	**13 August at GS30**
Harvest date:	**3 November 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commander$^{\phi}$).
- One durum variety (Caparoi$^{\phi}$).
- Ten commercial bread wheat varieties (LRPB Lincoln$^{\phi}$, EGA Gregory$^{\phi}$, LRPB Dart$^{\phi}$, Sunmate$^{\phi}$, LRPB Gauntlet$^{\phi}$, LRPB Lancer$^{\phi}$, LRPB Spitfire$^{\phi}$, Mitch$^{\phi}$, Suntop$^{\phi}$ and Sunguard$^{\phi}$; listed in order of increasing resistance to crown rot).
- Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregory⊕ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000)
- Three in-crop application strategies at GS30 using Turbo Teejet (110015) nozzles at ~300 L/ha
    - Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).
    - On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
    - Droppers – solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Results

Trial 1. Variety evaluation

Yield

- There was a moderate level of background crown rot infection across this site as predicted by the DNA soil test results at sowing. Under this background level of crown rot infection (no added CR) yield ranged from 3.56 t/ha in the barley variety Commander⊕ down to 2.46 t/ha in the wheat variety LRPB Lincoln⊕ (Figure 1).
- All varieties suffered significant yield loss with the addition of crown rot inoculum at sowing which ranged from 19% (0.60 t/ha) in Sunguard⊕ up to 53% (1.90 t/ha) in Commander⊕.
- Only Commander⊕ (0.34 t/ha) and Caparoi⊕ (0.61 t/ha) were lower yielding than EGA Gregory⊕ in the added CR treatment.
- LRPB Spitfire⊕ (0.29 t/ha), Sunguard⊕ (0.55 t/ha) and Mitch⊕ (0.60 t/ha) were all higher yielding than EGA Gregory⊕ under high levels of crown rot infection (Added CR; Figure 1).

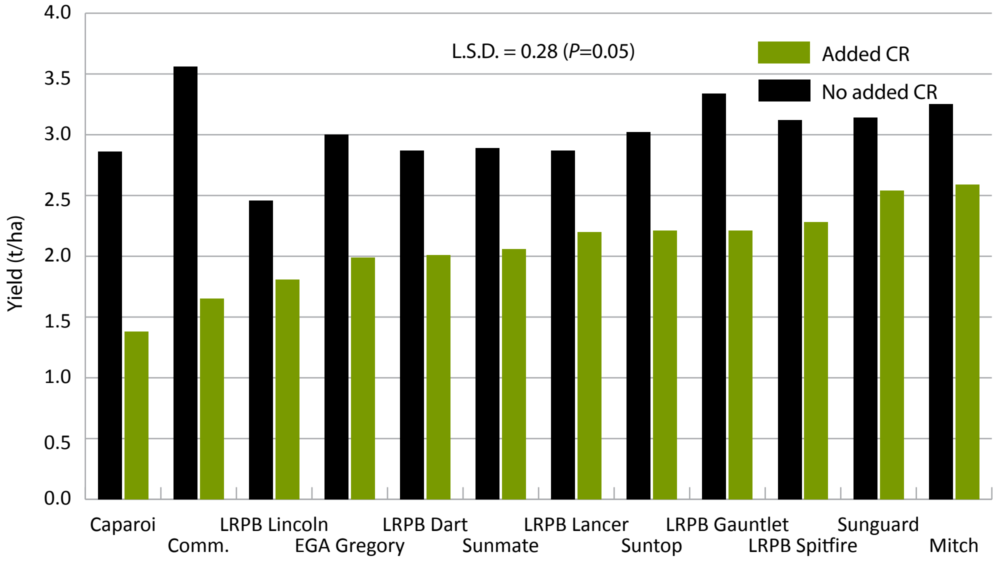

***Figure 1**. Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Terry Hie Hie 2014*

Protein

- Protein levels ranged between 11.6% (Sunmate$^{\phi}$) up to 13.9% (LRPB Lancer$^{\phi}$) in the no added CR treatment (Figure 2).
- Under high crown rot infection levels (added CR) protein levels were significantly reduced in all entries except Sunmate$^{\phi}$, LRPB Spitfire$^{\phi}$, LRPB Dart$^{\phi}$, Caparoi$^{\phi}$ and Commander$^{\phi}$.
- Protein levels were reduced by between 0.3% (Suntop$^{\phi}$) to 0.6% (LRPB Gauntlet$^{\phi}$) in the added CR treatment in the remaining varieties (Figure 2).

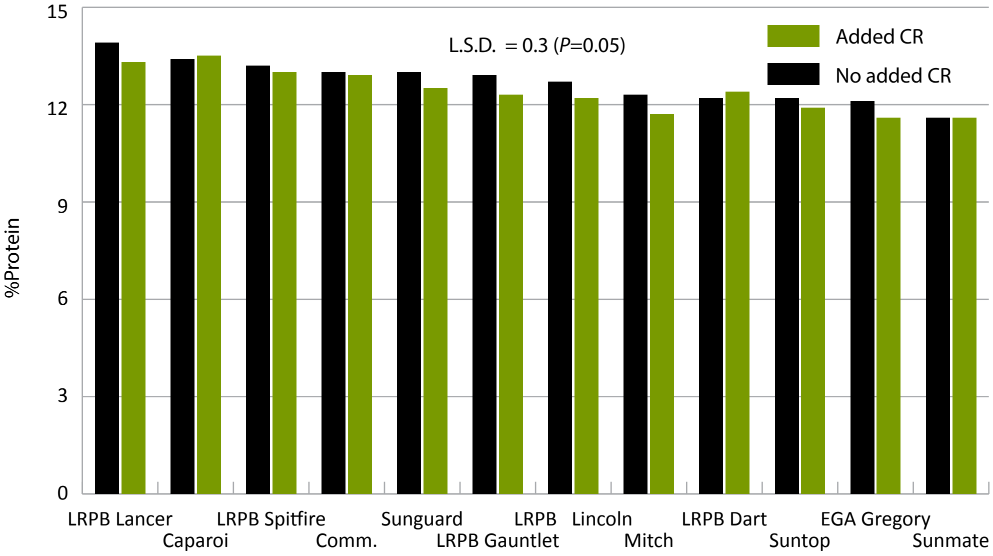

***Figure 2**. Average protein concentration achieved by varieties added CR and no added CR treatments – Terry Hie Hie 2014*

Trial 2. Fungicide application evaluation

Yield

- In-crop fungicide application did not have a significant interaction with the crown rot inoculum treatment likely due to moderate background infection levels already being present.
- Fungicide application at GS30 provided a *small* but significant yield benefit over the nil treatment with the on-crop (0.19 t/ha) and dropper (0.26 t/ha) application techniques which were targeted at the base of plants (Figure 3).

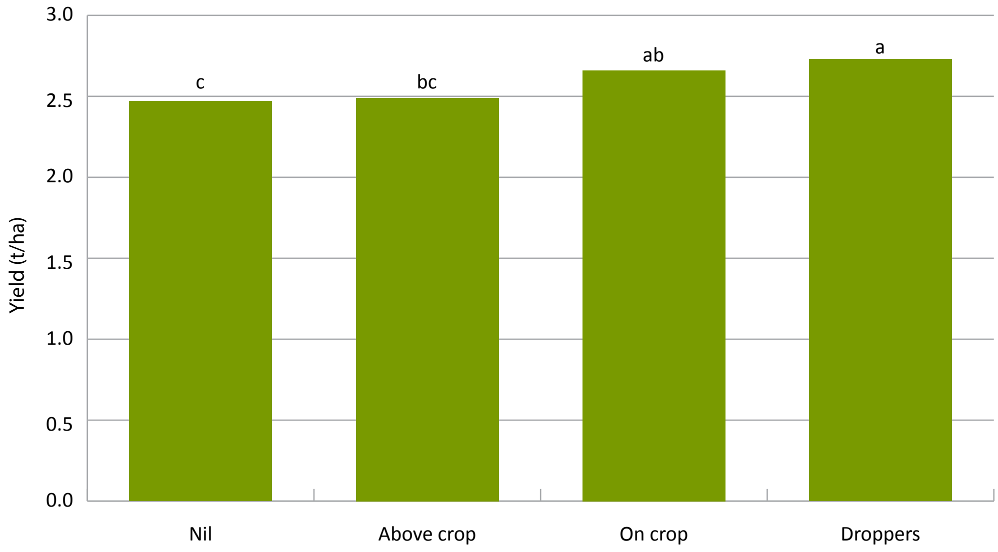

***Figure 3**. Effect of fungicide application technique on grain yield of EGA Gregory⏀ averaged across crown rot inoculum treatments – Terry Hie Hie 2014*

Bars with the same letter are not significantly different (P=0.05)

Grain protein

- Fungicide application at GS30 using the various techniques had no impact on grain protein levels.

Conclusions

Barley is very susceptible to infection by the crown rot fungus. However, barley tends to yield better in the presence of crown rot infection due to its earlier maturity relative to bread wheat providing an escape mechanism which reduces its exposure to evaporative stress during the critical grain filling stage. This is often referred to as tolerance.

The crown rot fungus is triggered by moisture/temperature stress to proliferate in the base of infected tillers regardless of when the stress occurs. If there is limited stored soil moisture and relatively high temperatures at earlier growth stages, such as at this site in 2014, then the crown rot fungus will still proliferate which can reduce biomass production and even kill plants. This has been particularly noticeable in commercial durum and barley crops in the northern region in previous seasons and was evident in inoculated plots of Commander⏀ at this site in 2014. This is the likely reason for the 53% yield loss of Commander⏀ in the presence of high levels of crown rot infection at this site in 2014.

Around 20% yield loss still occurred in the best of the bread wheat varieties Sunguard⏀ and Mitch⏀ in the presence of high crown rot infection. Variety choice is therefore not a sole solution to crown rot but rather just one element of an integrated management strategy to limit losses from this disease.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to David and Rob Anderson for providing the trial site and to Rick Graham, Stephen Morphett, Jim Perfrement and Peter Formann (NSW DPI) for sowing, maintaining and harvesting the trial. Thanks to Patrick Mortell (NSW DPI) for grain quality assessments and Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Varietal yield response to crown rot across two sowing times – Garah 2013

Steven Simpfendorfer, Rick Graham and Guy McMullen
NSW DPI, Tamworth

Key findings

Yield in the presence of crown rot was generally in the order of barley > bread wheat > durum on the earlier sowing time.

The yield advantage of barley in the presence of crown rot was lost relative to bread wheat with delayed sowing.

Delayed sowing generally increased the level of screenings which was further exacerbated by crown rot infection.

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

Introduction

Crown rot, caused predominantly by *Fusarium pseudograminearum* (*Fp*), is a major constraint to winter cereal (bread wheat, durum wheat and barley) production in the northern grains region. Yield loss is related to the *expression* of whiteheads which 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 crown rot by bringing grain-fill forward a week or two when temperatures are generally lower. Earlier sowing potentially also facilitates increased root growth early in the season which may result in deeper root exploration and access to soil moisture throughout the season. However, sowing time needs to be balanced against the risk of excessive early vegetative growth depleting soil moisture reserves prior to 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 a range of durum, wheat and barley varieties across two sowing times at Garah in north-west NSW in 2013.

Site details

Location:	**'Miroobil' Garah**
Co-operators:	**Andrew and Bill Yates**
Sowing dates:	**Time 1: 1 May 2013, Time 2: 31 May 2013**
Fertiliser:	**180 kg/ha urea and 70 kg/ha Granulock Supreme Z at sowing**
Starting N:	**80 kg/ha nitrate N to 1.2 m**
Starting water:	**~160 mm (0–180 cm)**
In-crop rainfall:	**140 mm**
PreDicta B®:	**1.5 *Pratylenchus thornei*/g soil (low risk),** **0.8 log *Fusarium* DNA/g (low risk) at sowing**

Treatments

Four barley varieties (Commander$^{\phi}$, GrangeR$^{\phi}$, Grout$^{\phi}$ and Oxford$^{\phi}$).

Four durum wheat varieties (Caparoi$^{\phi}$, EGA Bellaroi$^{\phi}$, Jandaroi$^{\phi}$ and Hyperno$^{\phi}$).

Ten bread wheat varieties (EGA Gregory$^{\phi}$, EGA Wylie$^{\phi}$, LRPB Dart$^{\phi}$, LRPB Impala$^{\phi}$, LRPB Lancer$^{\phi}$, LRPB Spitfire$^{\phi}$, Mitch$^{\phi}$, Strzelecki$^{\phi}$, Sunguard$^{\phi}$ and Suntop$^{\phi}$).

Added (plus) or no added (minus) crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Results

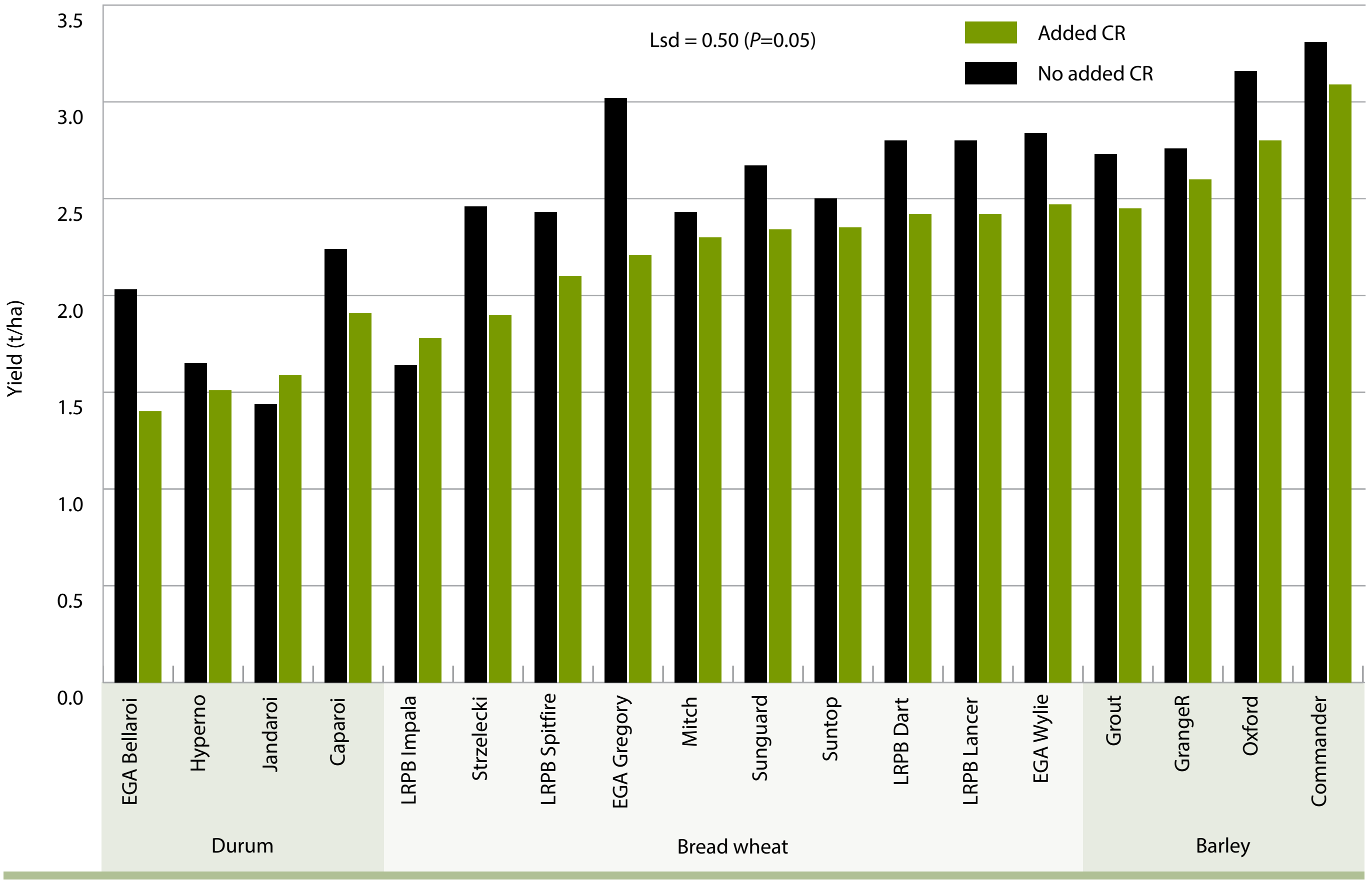

Figure 1*. Impact of crown rot on yield of durum, bread wheat and barley sown 1 May – Garah 2013*

- Frost damage was evident in the earlier sowing time (1 May) particularly in the quicker durum (Hyperno⁽ᶦ⁾ and Jandaroi⁽ᶦ⁾), bread wheat (LRPB Impala⁽ᶦ⁾ and Mitch⁽ᶦ⁾) and barley (Grout⁽ᶦ⁾) varieties.
- Yield loss from crown rot infection on the first sowing time was highest in EGA Bellaroi⁽ᶦ⁾ (31%) and EGA Gregory⁽ᶦ⁾ (27%).
- Crown rot infection can reduce early biomass production within a crop if moisture is limiting which can translate into slightly delayed maturity. This delayed maturity associated with crown rot infection may have slightly reduced exposure to frost in two of the varieties (Jandaroi⁽ᶦ⁾ and LRPB Impala⁽ᶦ⁾) which out weighed the crown rot impact resulting in slightly improved yield.
- Excluding severely frosted affected varieties, yield in the presence of crown rot (green bars) was generally highest in barley varieties, intermediate in bread wheat and lowest in durum varieties on the first sowing time (Figure 1).

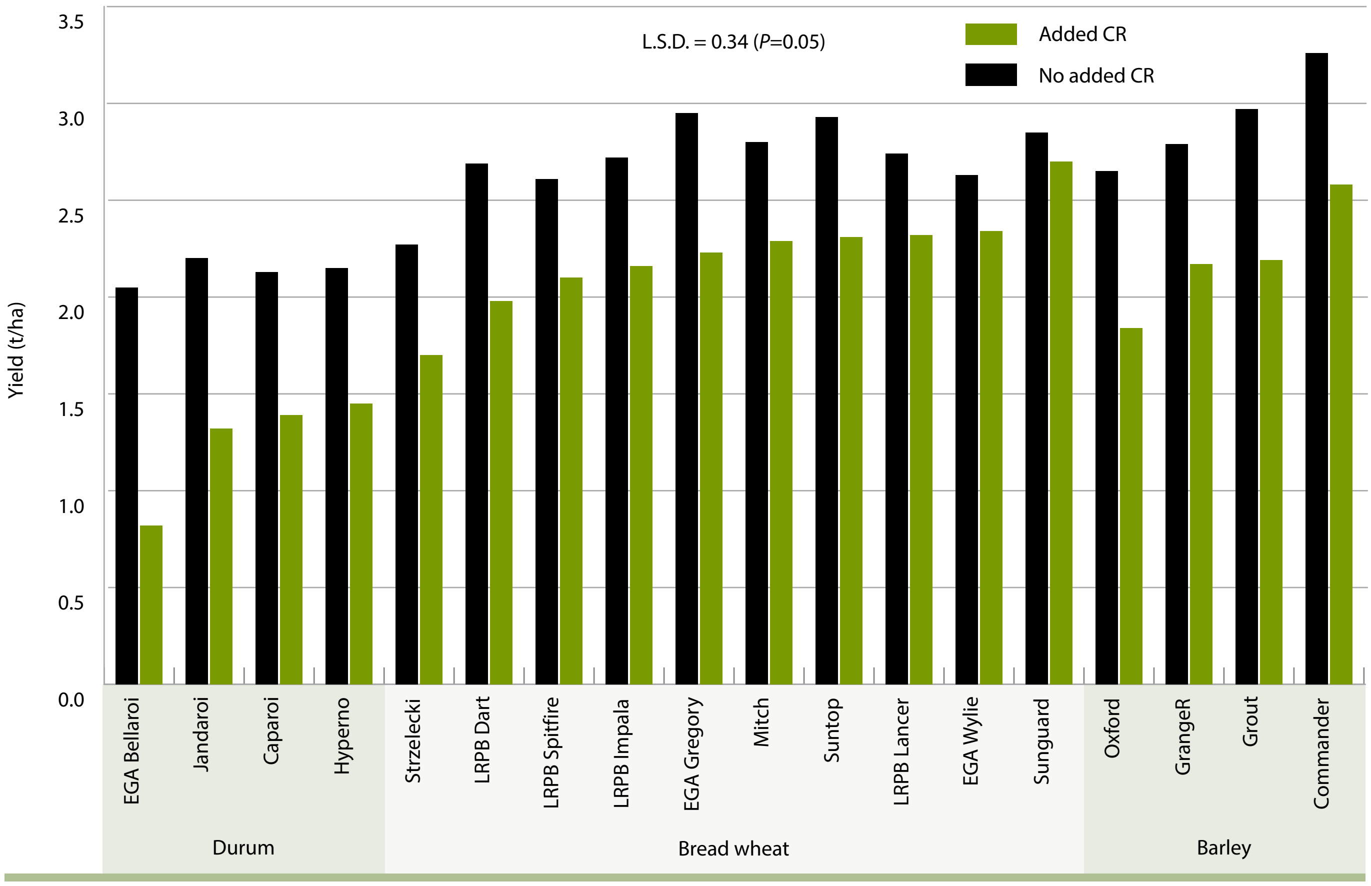

Figure 2*. Impact of crown rot on yield of durum, bread wheat and barley sown 31 May – Garah 2013*

- The second sowing time (31 May) was not visibly impacted on by frost.
- Yield loss from crown rot averaged 38% in durum, 25% in barley and 19% in bread wheat on the second sowing time.
- Yield loss in the four durum varieties ranged from 60% in EGA Bellaroi⁽ᐝ⁾ to 32% in Hyperno⁽ᐝ⁾.
- Yield loss ranged from 27% (LRPB Dart⁽ᐝ⁾) down to only 6% (Sunguard⁽ᐝ⁾) in the 10 bread wheat varieties.
- Yield loss ranged from 30% (Oxford⁽ᐝ⁾) down to 21% (Commander⁽ᐝ⁾) in the four barley varieties.
- Actual yield in the presence of crown rot infection (green bars) on the second sowing time was highest in the bread wheat variety Sunguard⁽ᐝ⁾ with many of the other bread wheat varieties being equivalent or better than the barley varieties. The four durum varieties were the lowest yielding entries at both sowing dates in the presence of crown rot reflecting their increased susceptibility to this disease.

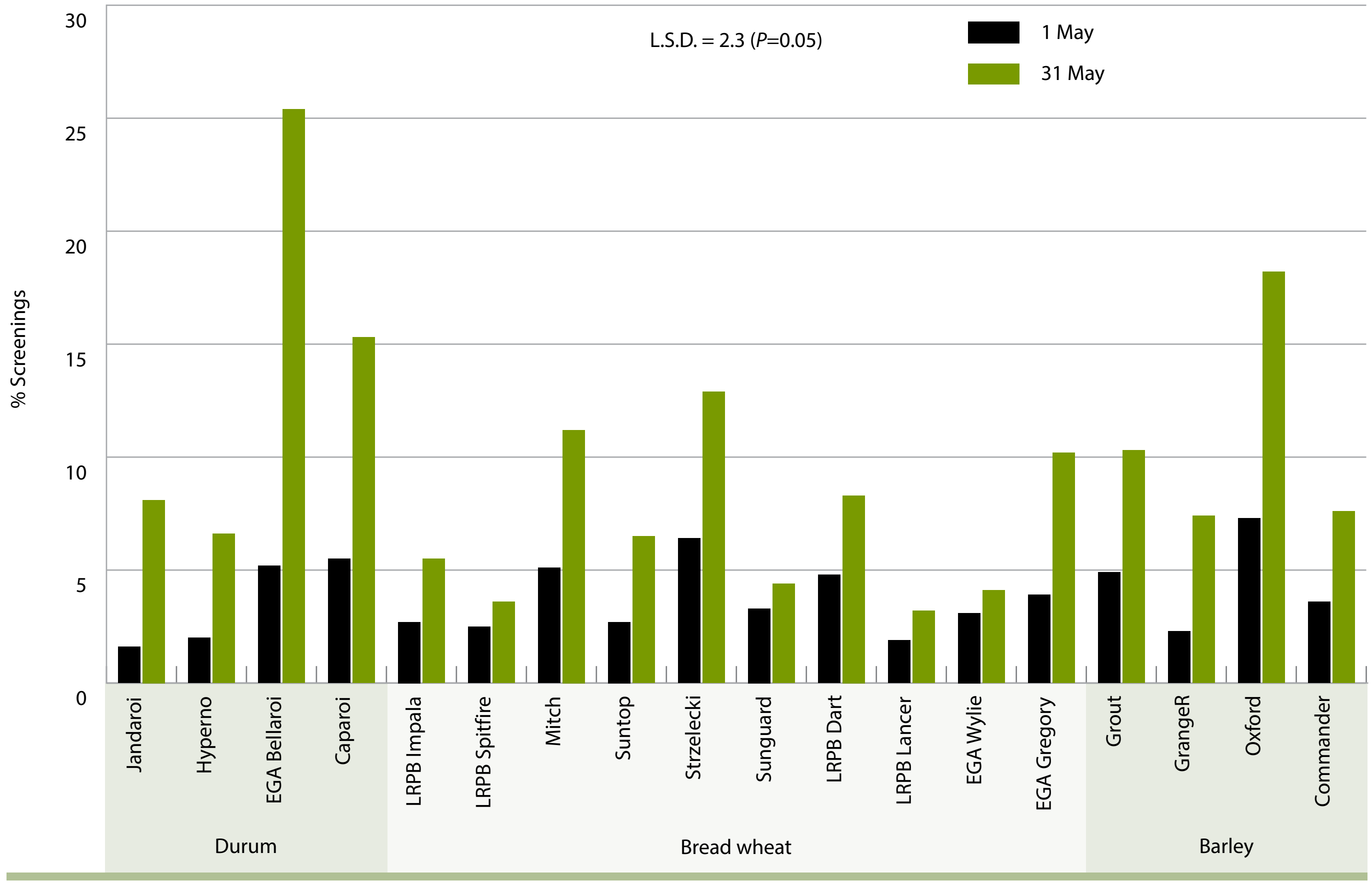

***Figure 3**. Grain screenings in the presence of crown rot infection across two sowing times – Garah 2013*

- Delaying sowing until 31 May significantly increased the level of screenings in the presence of added CR in all entries excluding four bread wheat varieties (EGA Wylie$^{\phi}$, LRPB Lancer$^{\phi}$, LRPB Spitfire$^{\phi}$ and Sunguard$^{\phi}$) compared to the first sowing time on 1 May (Figure 3).
- Increases in screenings with delayed sowing in the four durum varieties ranged from 20.2% in EGA Bellaroi$^{\phi}$ to 4.6% in Hyperno$^{\phi}$ in the presence of added CR.
- Screenings associated with delayed sowing in the presence of added CR in the ten bread wheat varieties was highest in Strzelecki$^{\phi}$(6.5%), EGA Gregory$^{\phi}$ (6.3%) and Mitch (6.1%).
- Increased screenings with delayed sowing in the four barley varieties ranged from 11.0% in Oxford$^{\phi}$ to 4.0% in Commander$^{\phi}$ in the presence of added CR.

Implications

Sowing date and variety maturity choice is a balance between the risk of frost versus terminal heat stress in the northern grain region. Both can have a significant impact on grain yield as highlighted at Garah in 2013. However, in the presence of severe crown rot infection the final yield of varieties, even though impacted by frost, was generally equivalent or higher than the yield obtained with increased crown rot expression but no frost on a later sowing date. The big difference was in the impact of crown rot on grain quality with delayed sowing significantly increasing the levels of screenings in most varieties likely due to increased heat stress during grain filling (Figure 3).

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-fill too far into hotter conditions. This can reduce yield by itself but if there is also an underlying issue with crown rot then delayed sowing significantly exacerbates the expression of this disease with negative impacts on both yield and grain quality.

Varieties do differ in their extent of yield loss from crown rot infection. EGA Gregory$^{\text{⊕}}$ was the highest or amongst the highest yielding varieties at both sowing dates in the absence of significant crown rot infection. However, EGA Gregory$^{\text{⊕}}$ suffers greater yield loss from crown rot than some newer bread wheat varieties. Hence, production of more susceptible varieties needs to be targeted to low risk paddocks based on either stubble or DNA testing such as PreDicta B®.

Barley is generally considered more tolerant (reduced yield impact) of crown rot than bread wheat as it tends to somewhat escape severe evaporative stress, which exacerbates expression of the disease, by maturing earlier. However, this trial highlights that this escape mechanism is dependant on sowing time with all four barley varieties suffering a much higher percentage yield loss from crown rot on the later sowing time relative to the earlier timing. Barley is very susceptible to infection by the crown rot fungus and if sown later in its planting window will be trying to fill grain under hotter conditions that can lead to significant yield loss from crown rot.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the Northern NSW Integrated Disease Management Project (DAN00176) and Variety Specific Agronomy Project (DAN00129). Thanks to Andrew and Bill Yates for providing the trial site and to Matthew Gardner, Stephen Morphett, Jim Perfrement, Patrick Mortell, Peter Formann and Rod Bambach (all NSW DPI) for sowing, maintaining and harvesting the trial.

Varietal yield response to crown rot across two sowing times – Garah 2014

Steven Simpfendorfer, Rick Graham and Guy McMullen
NSW DPI, Tamworth

Key findings

Averaged across all 28 entries in this trial crown rot resulted in 14% (not significant) yield loss with the early sowing on 2 May.

Delaying sowing from 2 May until 12 June resulted in an average yield loss of 48% from crown rot infection.

Individual varieties of durum, bread wheat and barley differed significantly in their extent of yield loss and actual yield in the presence of crown rot infection.

The bread wheat varieties Wallup⟨PBR⟩, Suntop⟨PBR⟩, Sunguard⟨PBR⟩ and LRPB Lancer⟨PBR⟩ were between 0.28 and 0.52 t/ha higher yielding than EGA Gregory⟨PBR⟩ in the presence of crown rot.

The barley varieties Commander⟨PBR⟩, Compass⟨PBR⟩, Fathom⟨PBR⟩, La Trobe⟨PBR⟩ and Hindmarsh⟨PBR⟩ were between 0.28 and 0.82 t/ha higher yielding than EGA Gregory⟨PBR⟩ in the presence of crown rot.

Introduction

Crown rot, caused predominantly by *Fusarium pseudograminearum* (*Fp*), is a major constraint to winter cereal (bread wheat, barley and durum wheat) production in the northern grains region. Yield loss is largely related to the *expression* of whiteheads which 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 crown rot by bringing grain-fill forward a week or two when temperatures are generally lower. Earlier sowing potentially also facilitates increased root growth early in the season which may result in deeper root exploration and access to soil moisture throughout the season. 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 at Garah in north-west NSW in 2014.

Site details

Location:	**'Miroobil' Garah**
Co-operators:	**Andrew and Bill Yates**
Sowing dates:	**Time 1: 2 May 2014, Time 2: 12 June 2014**
Fertiliser:	**180 kg/ha urea and 60 kg/ha Granulock Z extra at sowing**
Starting N:	**45 kg N/ha to 1.2 m**
Starting water:	**~25 mm PAW to 1.2 m**
In-crop rainfall:	**100 mm**
PreDicta B®:	**1.0 *Pratylenchus thornei*/g soil (low risk),** **Nil *Fusarium* at sowing (0–30 cm)**

Treatments

Four durum wheat varieties (Caparoi⟨PBR⟩, DBA Aurora⟨PBR⟩, Jandaroi⟨PBR⟩ and Hyperno⟨PBR⟩) and two numbered durum lines (TD241046 and TD290564).

Eleven bread wheat varieties (EGA Gregory⟨PBR⟩, Lincoln⟨PBR⟩, LRPB Gauntlet⟨PBR⟩, LRPB Lancer⟨PBR⟩, LRPB Spitfire⟨PBR⟩, Mitch⟨PBR⟩, Strzelecki⟨PBR⟩, Sunguard⟨PBR⟩, Sunmate⟨PBR⟩, Suntop⟨PBR⟩ and Wallup⟨PBR⟩) and one numbered line (SUN663A).

Ten barley varieties (Bass⟨PBR⟩, Commander⟨PBR⟩, Compass⟨PBR⟩, Fathom⟨PBR⟩, Gairdner⟨PBR⟩, GrangeR⟨PBR⟩, Hindmarsh⟨PBR⟩, La Trobe⟨PBR⟩, Navigator⟨PBR⟩ and Oxford⟨PBR⟩).

Added or no added crown rot at sowing using sterilised durum grain colonised by at least five isolates of *Fp*.

Results

The trial site at Garah had low but reasonable yield in 2014 given the lack of stored soil moisture at sowing and in-crop rainfall of only 100 mm which fell as four main events of 33 mm at sowing, 11 mm mid June, 35 mm at the start of September and 18 mm mid October. The October rain was too late to be effective with harvest occurring at the end of that month. The rainfall event at the start of September may have been more effective for the later sowing. This site had a co-efficient of variation of 17.7% so results should be considered with caution but the variety rankings are consistent with previous data and other sites in 2014. Pathology assessments of samples collected from each plot will occur and may assist in explaining and correcting for some of the variability in yield at this site.

Sowing time impacted on the extent of yield loss from crown rot was not significant with the early sowing time but was highly significant with the second sowing time. There was 48% yield loss (1.61 t/ha uninfected down to 0.85 t/ha infected) with 12 June sowing when averaged across all entries. However, the interaction between sowing time and crown rot infection was not significant at the variety level. Hence, the impact of crown rot infection on the yield of individual varieties is presented as the average of both sowing dates where significant differences were apparent (Figure 1).

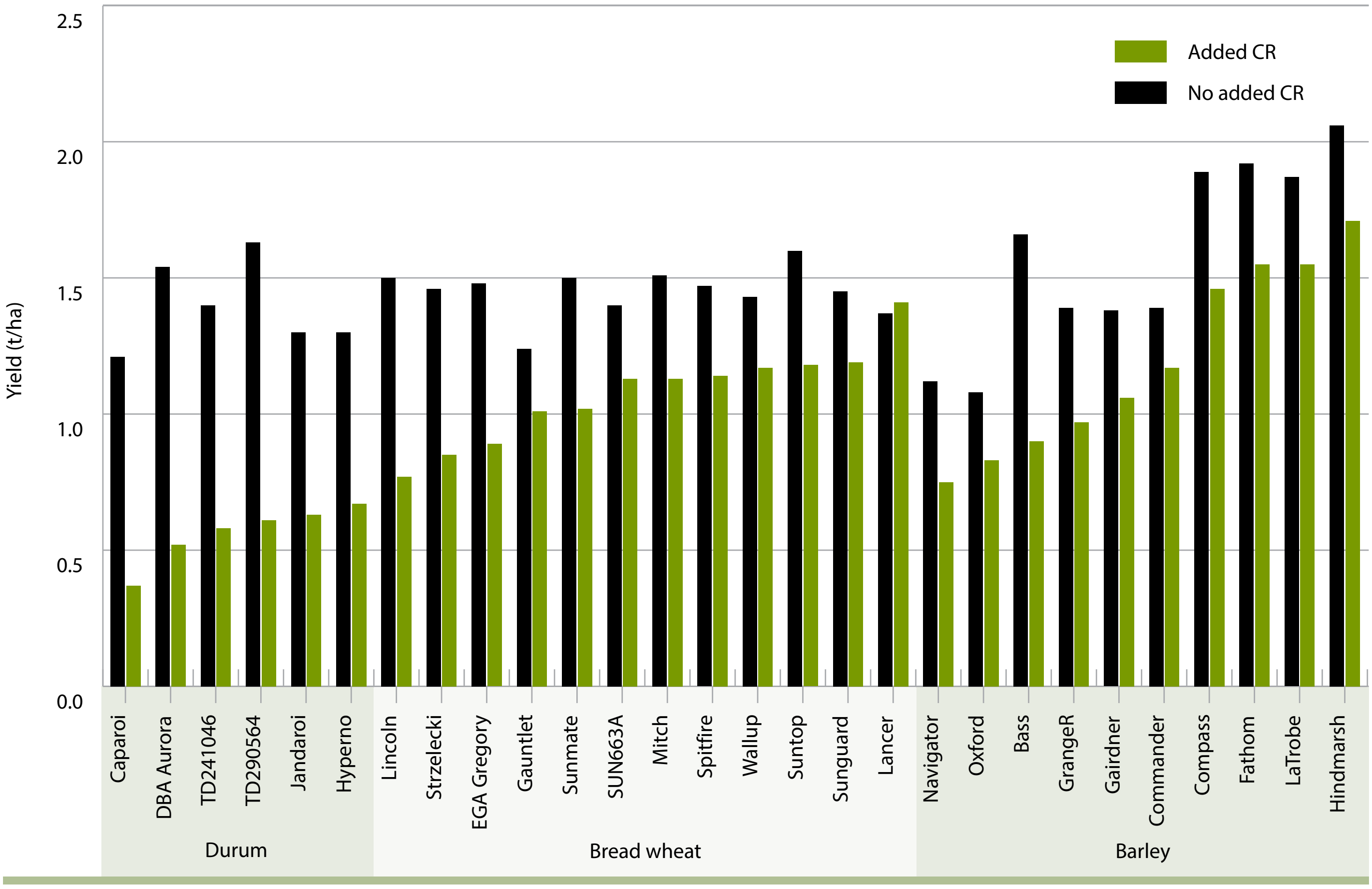

***Figure 1**. Impact of crown rot on yield of durum, wheat and barley averaged across two sowing times – Garah 2014*

- In the absence of crown rot infection (no added CR) yield in the durum varieties ranged from 1.21 t/ha (Caparoi$^{(\phi)}$) to 1.63 t/ha (TD290564), in the bread wheat from 1.24 t/ha (LRPB Gauntlet$^{(\phi)}$) to 1.60 t/ha (Suntop$^{(\phi)}$) and in the barley from 1.08 t/ha (Oxford$^{(\phi)}$) to 2.06 t/ha (Hindmarsh$^{(\phi)}$) (Figure 1).
- The reduced yield associated with crown rot infection was significant with all entries with the exception of LRPB Gauntlet$^{(\phi)}$, LRPB Lancer$^{(\phi)}$, Oxford$^{(\phi)}$ and Commander$^{(\phi)}$. In the remaining entries yield loss in the durum varieties ranged from 49% (Hyperno$^{(\phi)}$) to 70% (Caparoi$^{(\phi)}$), in the bread wheat from 18% (Sunguard$^{(\phi)}$) to 49% (Lincoln$^{(\phi)}$) and in the barley from 17% (Hindmarsh$^{(\phi)}$ and La Trobe$^{(\phi)}$) to 46% (Bass$^{(\phi)}$). This equated to a loss in yield of between 0.26 t/ha with Sunguard$^{(\phi)}$ up to 1.03 t/ha with DBA Aurora$^{(\phi)}$ (Figure 1).

- Actual yield in the presence of crown rot infection (added CR) ranged in the durum varieties from 0.37 t/ha (Caparoi$^{\phi}$) to 0.67 t/ha (Hyperno$^{\phi}$), in the bread wheat from 0.77 t/ha (Lincoln$^{\phi}$) to 1.41 t/ha (LRPB Lancer$^{\phi}$) and in the barley from 0.75 t/ha (Navigator$^{\phi}$) to 1.71 t/ha (Hindmarsh$^{\phi}$) (Figure 1).
- The four bread wheat varieties Wallup$^{\phi}$ (0.28 t/ha), Suntop$^{\phi}$ (0.29 t/ha), Sunguard$^{\phi}$ (0.30 t/ha) and LRPB Lancer$^{\phi}$ (0.52 t/ha$^{\phi}$) were significantly higher yielding than EGA Gregory$^{\phi}$ in the presence of added crown rot.
- The five barley varieties Commander$^{\phi}$ (0.28 t/ha), Compass$^{\phi}$ (0.57 t/ha), Fathom$^{\phi}$ (0.66 t/ha), La Trobe$^{\phi}$ (0.66 t/ha) and Hindmarsh$^{\phi}$ (0.82 t/ha$^{\phi}$) were significantly higher yielding than EGA Gregory$^{\phi}$ in the presence of added crown rot.
- Grain quality data was not available at the time of writing this report.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the Northern NSW Integrated Disease Management Project (DAN00176) and Variety Specific Agronomy Project (DAN00129). Thanks to Andrew and Bill Yates for providing the trial site and to Stephen Morphett, Jim Perfrement, Peter Formann and Rod Bambach (all NSW DPI) for sowing, maintaining and harvesting the trial.

Yield response of wheat, barley and durum varieties to crown rot – Rowena 2013

Steven Simpfendorfer and Rick Graham
NSW DPI, Tamworth

Key findings

Sunguardᶲ, EGA Wylieᶲ, Mitchᶲ, LRPB Lancerᶲ and Commanderᶲ were between 0.59 t/ha to 0.37 t/ha higher yielding than EGA Gregoryᶲ under high crown rot pressure.

Variety selection is not the sole solution to crown rot with the best entries still suffering around 40% yield loss at this site where a full soil moisture profile at planting, late sowing and limited in-crop rainfall were very conducive to disease expression.

Crown rot also negatively impacted on grain quality with a 0.6 to 1.4% decrease in protein levels and a 3 to 16% increase in the level of screenings in the majority of entries.

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Varieties have been shown to differ in their yield loss from crown rot largely in line with their resistance ratings to this disease. However, the actual yield and maintenance of grain quality in the presence of crown rot infection is also an important consideration for growers as this impacts on their economic return. This trial examined the impact of crown rot on commonly grown and recently released durum, bread wheat and barley varieties at Rowena in north-west NSW in 2013.

Site details

Location:	**'Woolondoon' Rowena**
Co-operator:	**David and Tim Cameron**
Sowing date:	**30 May 2013**
PAW sowing:	**275 mm (0–120 cm)**
Fertiliser:	**180 kg/ha granular urea and 70 kg/ha Granulock 12Z at sowing**
In-crop rainfall:	**48 mm**
PreDicta B:	**Nil *Pn*, 0.6 *Pt*/g soil (low risk), nil *Fusarium* and 1.2 log *Bipolaris* DNA/g at 0–30 cm**

Treatments

Four barley varieties (Commanderᶲ, GrangeRᶲ, Groutᶲ and Oxfordᶲ).

Four durum wheat varieties (Caparoiᶲ, EGA Bellaroiᶲ, Jandaroiᶲ and Hypernoᶲ).

Ten bread wheat varieties (EGA Gregoryᶲ, EGA Wylieᶲ, LRPB Dartᶲ, LRPB Impalaᶲ, LRPB Lancerᶲ, LRPB Spitfireᶲ, Mitchᶲ, Strzeleckiᶲ, Sunguardᶲ and Suntopᶲ).

Added (plus) or no added (minus) crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Results

Yield

- In the absence of crown rot infection (no added CR) yield in the durum varieties ranged from 2.78 t/ha (Hypernoᶲ) to 3.21 t/ha (Jandaroiᶲ), in the bread wheat from 3.08 t/ha (LRPB Spitfireᶲ) to 3.57 t/ha (LRPB Lancerᶲ) and in the barley from 2.80 t/ha (Oxfordᶲ) to 3.65 t/ha (Commanderᶲ) (Figure 1).
- Crown rot infection had a large impact on yield in all varieties with yield loss in the durum varieties ranging from 57% (Hypernoᶲ) to 81% (EGA Bellaroiᶲ), in the bread wheat from 39% (EGA Wylieᶲ) to 58% (Strzeleckiᶲ) and in the barley from 48% (Oxfordᶲ) to 64% (GrangeRᶲ). This equated to a loss in yield of between 1.28 t/ha with EGA Wylieᶲ up to 2.29 t/ha with EGA Bellaroiᶲ (Figure 1).

- Actual yield in the presence of crown rot infection (added CR) ranged in the durum varieties from 0.54 t/ha (EGA Bellaroi$^{\phi}$) to 1.21 t/ha (Jandaroi$^{\phi}$ and Hyperno$^{\phi}$), in the bread wheat from 1.41 t/ha (Strzelecki$^{\phi}$) to 2.03 t/ha (Sunguard$^{\phi}$) and in the barley from 1.14 t/ha (GrangeR$^{\phi}$) to 1.81 t/ha (Commander$^{\phi}$)(Figure 1).
- The four bread wheat varieties Sunguard$^{\phi}$ (0.59 t/ha), EGA Wylie$^{\phi}$ (0.58 t/ha), Mitch$^{\phi}$ (0.55 t/ha) and LRPB Lancer$^{\phi}$ (0.46 t/ha$^{\phi}$) were significantly higher yielding than EGA Gregory$^{\phi}$ in the presence of added crown rot.
- Commander$^{\phi}$ (0.37 t/ha) was the only barley variety that was significantly higher yielding than EGA Gregory$^{\phi}$ in the presence of added crown rot.
- The two durum varieties Caparoi$^{\phi}$ and EGA Bellaroi$^{\phi}$ were the only entries which were significantly lower yielding than EGA Gregory$^{\phi}$ in the presence of added crown rot.

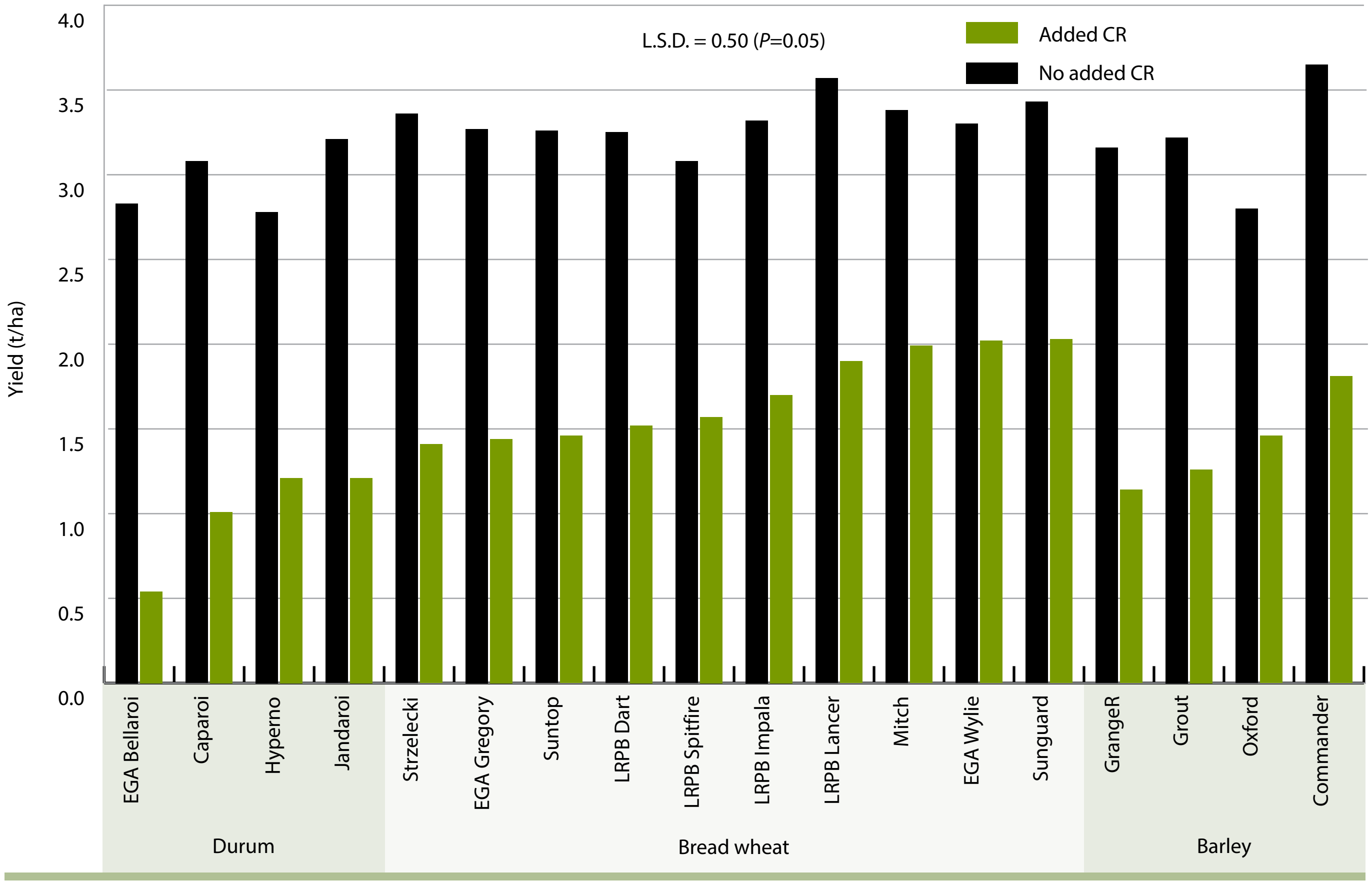

Figure 1*. Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Rowena 2013*

Protein

- Protein levels ranged between 12.1% (LRPB Impala$^{\phi}$) up to 15.4% (EGA Bellaroi$^{\phi}$) in the absence of crown rot infection (data not shown).
- Crown rot infection significantly reduced grain protein levels in all but six of the 18 entries (Jandaroi$^{\phi}$, Mitch$^{\phi}$, LRPB Spitfire$^{\phi}$, Sunguard$^{\phi}$, Suntop$^{\phi}$ and Grout$^{\phi}$). Crown rot infection reduced protein levels by between 0.6% in EGA Wylie$^{\phi}$ to 1.4% in EGA Bellaroi$^{\phi}$ in the remaining varieties (data not shown).

Screenings

In the absence of crown rot infection (no added CR) screening levels in the durum varieties ranged from 2.8% (Jandaroi$^{\phi}$) to 6.7% (Hyperno$^{\phi}$), in the bread wheat from 3.3% (LRPB Spitfire$^{\phi}$) to 10.1% (Mitch$^{\phi}$) and in the barley from 4.9% (Commander$^{\phi}$) to 14.8% (Oxford$^{\phi}$) (Figure 2).

Crown rot infection significantly increased the level of screenings in all entries except the barley variety Oxford$^{\text{⚐}}$ which already had nearly 15% screenings in the absence of this disease. Screening levels were increased with crown rot infection by around 3–6% in bread wheat, 5–6% in barley and were highest in durum with around a 10–16% increase. Since receival standards for durum grades DR1 and DR2 are 5% or less, and DR3 is 10% or less this would have meant a drop in grade to delivering as Feed wheat only, which would also cause a significant reduction in returns to a grower (Figure 2).

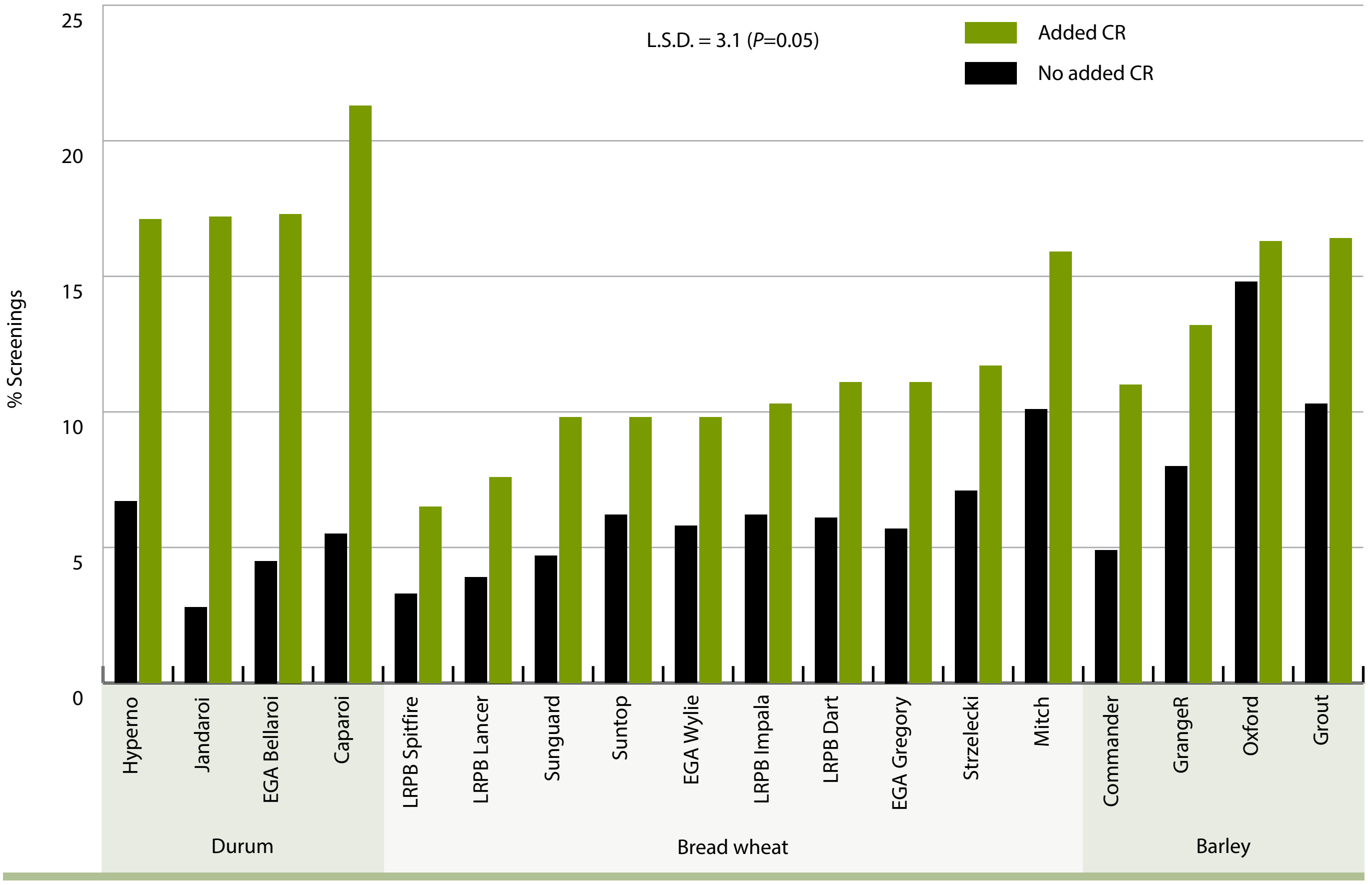

***Figure 2**. Percentage screenings of varieties with no added and added crown rot – Rowena 2013*

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the Northern NSW Integrated Disease Management Project (DAN00176) and Variety Specific Agronomy Project (DAN00129). Thanks to David and Tim Cameron for providing the trial site and to Matthew Gardner (formerly NSW DPI), Stephen Morphett, Jim Perfrement, Patrick Mortell, Peter Formann and Rod Bambach (all NSW DPI) for sowing, maintaining and harvesting the trial.

Regional crown rot management – Macalister Queensland 2014

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Key findings

Only the bread wheat variety Mitch$^{\phi}$ was higher yielding (0.74 t/ha) than EGA Gregory$^{\phi}$ under high levels of crown rot infection.

The performance of the barley variety Commander$^{\phi}$ was poor at this site with 64% (2.65 t/ha) yield loss from high crown rot infection. This emphasises that barley is very susceptible to crown rot infection and if early stress occurs this disease can significantly impact on biomass production and subsequent yield.

In-crop fungicide application at GS30 provided a *small* (0.19 t/ha) yield benefit when targeted at the base of plants infected with crown rot using droppers.

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease.

Two trials were conducted at this site, firstly a variety trial which was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Queensland to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. A second trial aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects was also conducted. This fungicide trial was also conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Control of crown rot using fungicides has been studied extensively with limited success and quite variable outcomes. There is only one fungicide seed treatment currently registered for *suppression only* of crown rot in winter cereals. As the name implies, crown rot primarily infects the base of plants through the sub-crown internode, crown and/or outer leaf sheaths at the base of tillers at the soil surface.

Site details

Location: **'Curraweena' Macalister Queensland**
Co-operator: **Rob Taylor**
Sowing date: **29 May 2014**
Fertiliser: **40 kg/ha Granulock 12Z at sowing**
Starting N: **59 mg/kg to 0.6 m**
In-crop rainfall: **~52 mm**
PreDicta B®: **0.3 *Pt*/g soil (low risk), 0.8 log *Fusarium* DNA/g (low) at sowing (0–30 cm)**
Fungicide date: **11 August at GS30**
Harvest date: **3 November 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commander$^{\phi}$).
- One durum variety (Caparoi$^{\phi}$).
- Ten commercial bread wheat varieties (LRPB Lincoln$^{\phi}$, EGA Gregory$^{\phi}$, LRPB Dart$^{\phi}$, Sunmate$^{\phi}$, LRPB Gauntlet$^{\phi}$, LRPB Lancer$^{\phi}$, LRPB Spitfire$^{\phi}$, Mitch$^{\phi}$, Suntop$^{\phi}$ and Sunguard$^{\phi}$; listed in order of increasing resistance to crown rot).
- Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregoryᶲ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000)
- Three in-crop application strategies at GS31 using Turbo Teejet (110015) nozzles at ~300 L/ha
  - Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).
  - On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
  - Droppers – solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Results

Trial 1. Variety evaluation

Yield

- In the no added CR treatment (black bars) yield ranged from 2.91 t/ha in LRPB Lincolnᶲ up to 4.53 t/ha in Mitchᶲ (Figure 1).
- Crown rot infection had a large impact on yield at this site in 2014. All varieties suffered significant yield loss under high levels of crown rot infection (added CR) which ranged from 35% in the bread wheat variety Mitchᶲ (1.59 t/ha) up to 64% in the durum variety Caparoiᶲ (2.49 t/ha) and the barley variety Commanderᶲ (2.65 t/ha).
- Commanderᶲ, Caparoiᶲ, Sunmateᶲ, LRPB Dartᶲ, and LRPB Lincolnᶲ were between 0.73 to 1.01 t/ha lower yielding than EGA Gregoryᶲ under high crown rot infection (green bars).
- Only the bread wheat variety Mitchᶲ was higher yielding than EGA Gregoryᶲ under high levels of crown rot infection (green bars) with a yield benefit 0.74 t/ha (Figure 1).

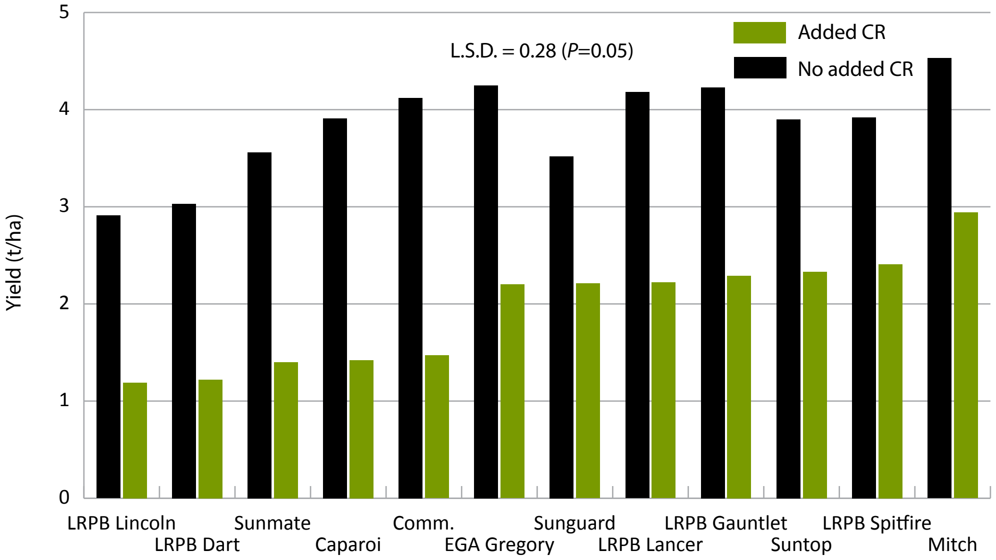

***Figure 1**. Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Macalister 2014*

Grain protein

- Protein levels ranged between 11.0% (Mitch$^{\Phi}$) up to 14.3% (LRPB Spitfire$^{\Phi}$) in the absence of crown rot infection (black bars; Figure 2).
- Crown rot infection (green bars) significantly increased grain protein levels in all varieties except LRPB Spitfire$^{\Phi}$ and LRPB Gauntlet$^{\Phi}$.
- The increase in protein levels associated with crown rot infection and reduced yield ranged from 0.4% (Mitch$^{\Phi}$, EGA Gregory$^{\Phi}$ and LRPB Lincoln$^{\Phi}$) up to 1.0% (Suntop$^{\Phi}$; Figure 2).

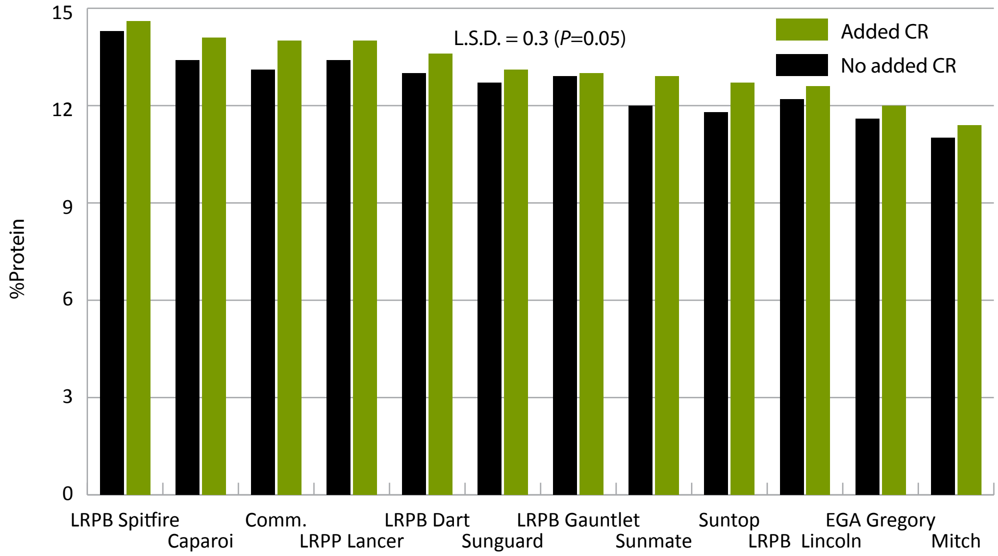

Figure 2*. Average protein concentration achieved by varieties with no added and added crown rot – Macalister 2014*

Trial 2. Fungicide application evaluation

- The interaction of fungicide application with crown rot inoculum treatments was not significant.
- Averaged across crown rot treatments application at GS30 targeted at the base of EGA Gregory$^{\Phi}$ plants using droppers provided a small (0.19 t/ha) yield benefit over the nil treatment (3.22 t/ha).
- The other fungicide application treatments did not have a significant impact on yield.
- Fungicide application did not significantly change protein levels compared to nil treatments.

Conclusions

Barley is very susceptible to infection by the crown rot fungus. However, barley tends to yield better in the presence of crown rot infection due to its earlier maturity relative to bread wheat providing an escape mechanism which reduces its exposure to evaporative stress during the critical grain filling stage. This is often incorrectly referred to as tolerance.

The crown rot fungus is triggered by moisture/temperature stress to proliferate in the base of infected tillers regardless of when the stress occurs. If there is limited stored soil moisture and relatively high temperatures at earlier growth stages, such as at this site in 2014, then the crown rot fungus will still proliferate which can reduce biomass production and even kill tillers and whole plants. This has been particularly noticeable in commercial durum and barley crops in the northern region in previous seasons and was evident in inoculated plots of Commander$^{\phi}$ at this site in 2014. This is the likely reason for the 64% yield loss of Commander$^{\phi}$ in the presence of high levels of crown rot infection at this site.

Around 35-40% yield loss still occurred in the best of the bread wheat varieties Mitch$^{\phi}$, LRPB Spitfire$^{\phi}$, Sunguard$^{\phi}$ and Suntop$^{\phi}$ in the presence of high crown rot infection. Variety choice is therefore not a sole solution to crown rot but rather just one element of an integrated management strategy to limit losses from this disease.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to Rob Taylor for providing the trial site and to Douglas Lush (QDAFF Mobile Trial Unit) for sowing, maintaining and harvesting the trial. Thanks to Patrick Mortell and Robyn Shapland (NSW DPI) for grain quality assessments and to Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Regional crown rot management – Trangie 2014

Steven Simpfendorfer[1], Finn Fensbo[1], Robyn Shapland[1], Greg Brooke[2], Jayne Jenkins[2] and Scott Richards[2]
[1] NSW DPI, Tamworth [2] NSW DPI, Trangie

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease. Two trials were conducted at this site in 2014. The first trial was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Queensland to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. The second trial was aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects. This same trial was conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Key findings

The impact of crown rot on yield at this site was quite high in 2014 with 56% yield loss in EGA Gregory$^{\Phi}$.

Variety selection had a large impact on yield in the presence of high levels of crown rot infection with LRPB Spitfire$^{\Phi}$, Suntop$^{\Phi}$, Sunguard$^{\Phi}$ and Commander$^{\Phi}$ between 1.29 t/ha to 1.52 t/ha higher yielding than EGA Gregory$^{\Phi}$.

The in-crop application of fungicide, even targeted at the base of infected plants, did not provide a significant yield or grain quality benefit at this site in 2014.

Site details

Location:	**Trangie Agricultural Research Centre**
Sowing date:	**16 May 2014**
Fertiliser:	**70 kg/ha MAP at sowing; 77 L/ha Easy N (14 July)**
Starting N:	**193 kg/ha Total N to 1.2 m**
In-crop rainfall:	**142 mm**
PreDicta B®:	**0.3 *Pratylenchus thornei*/g soil (low risk), nil crown rot at sowing (0–30 cm).**
Fungicide date:	**14 August at GS31**
Harvest date:	**5 Nov 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commander$^{\Phi}$).
- One durum variety (Caparoi$^{\Phi}$).
- Ten commercial bread wheat varieties (LRPB Lincoln$^{\Phi}$, EGA Gregory$^{\Phi}$, LRPB Dart$^{\Phi}$, Sunmate$^{\Phi}$, LRPB Gauntlet$^{\Phi}$, LRPB Lancer$^{\Phi}$, LRPB Spitfire$^{\Phi}$, Mitch$^{\Phi}$, Suntop$^{\Phi}$ and Sunguard$^{\Phi}$; listed in order of increasing resistance to crown rot).
- Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregory⁽ᶲ⁾ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000)
- Three in-crop application strategies at GS31 using Turbo Teejet (110015) nozzles at ~300 L/ha
  - Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).
  - On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
  - Droppers – solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Results

Trial 1. Variety evaluation

Yield

- In the no added CR treatment (black bars) yield ranged from 2.84 t/ha in the bread wheat variety LRPB Lancer⁽ᶲ⁾ up to 3.81 t/ha in the barley variety Commander⁽ᶲ⁾

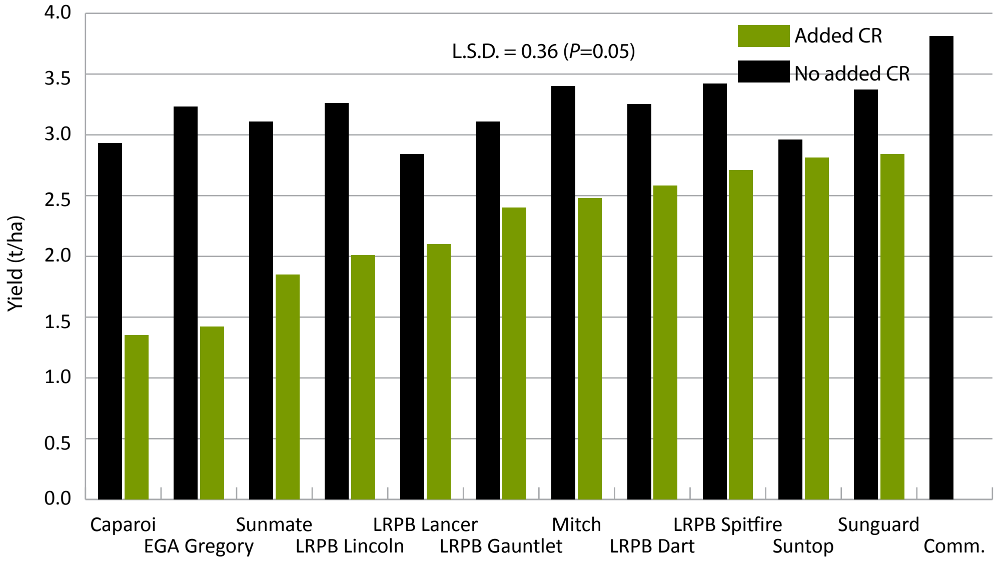

***Figure 1**. Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Trangie 2014*

Grain protein

- The addition of crown rot inoculum at sowing did not significantly change protein levels in any variety.
- Protein levels were relatively low at this site ranging between 9.8% (Mitch⁽ᶲ⁾) up to only 12.0% (LRPB Lancer⁽ᶲ⁾) with significant differences apparent between varieties (Figure 2).

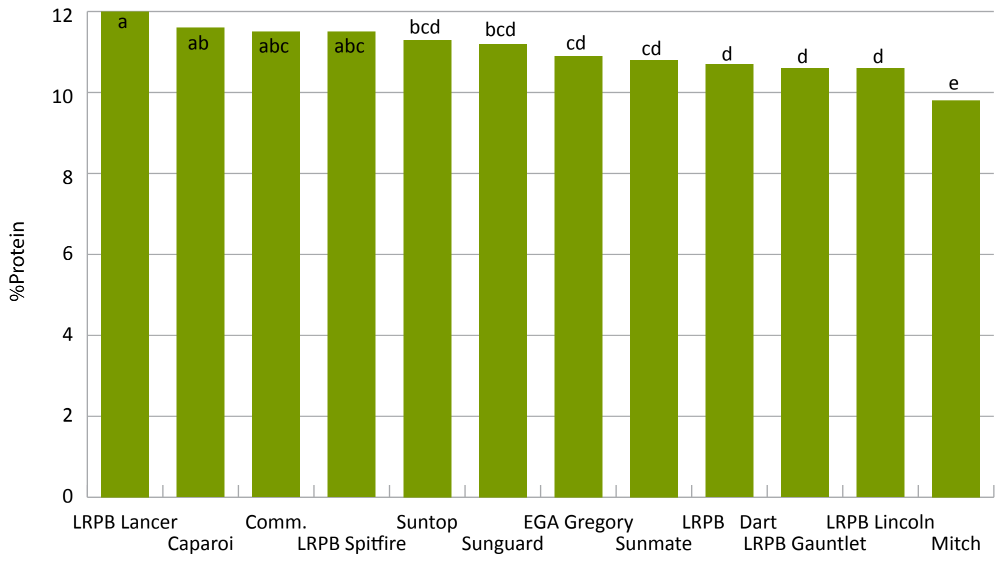

***Figure 2**. Average protein concentration achieved by varieties – Trangie 2014*

Bars with the same letter are not significantly different (P=0.05)

Trial 2. Fungicide application evaluation

- Crown rot infection resulted in 40% yield loss in EGA Gregory⁽ᵃ⁾ but none of the in-crop fungicide treatments significantly affected yield or protein levels.

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to Patrick Mortell (NSW DPI) for grain quality assessments and to Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Regional crown rot management – Westmar Queensland 2014

Steven Simpfendorfer, Finn Fensbo and Robyn Shapland
NSW DPI, Tamworth

Key findings

Only the bread wheat variety Suntop$^{\phi}$ was higher yielding (0.75 t/ha) than EGA Gregory$^{\phi}$ under high levels of crown rot infection.

In-crop fungicide application at GS33 provided a *small* yield benefit when targeted at the base of plants infected with crown rot with the on crop (0.34 t/ha) and dropper (0.40 t/ha) treatments.

Introduction

Crown rot (CR) caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to the production of winter cereals in the northern grains region. Cereal varieties differ in their resistance to crown rot which can have a significant impact on their relative yield in the presence of this disease. Two trials were conducted at this site in 2014. The first trial was one of 12 conducted by NSW DPI in 2014 across central/northern NSW extending into southern Qld to examine the impact of crown rot on the yield of one barley, one durum and ten bread wheat varieties. The second trial was aimed at taking a step back in the approach of using foliar fungicides to determine if targeting application at the base of tillers might improve the level of control and provide more consistent effects. This same trial was conducted across nine sites in 2013 so when combined with this additional data from 2014 will firmly establish the potential of in-crop fungicide management of crown rot.

Site details

Location:	**'Enarra' Westmar Queensland**
Co-operator:	**Phil Coggan**
Sowing date:	**15 May 2014**
Fertiliser:	**140 kg/ha urea and 40 kg/ha Granulock 12Z at sowing**
Starting N:	**33 mg/kg to 0.6 m**
PreDicta B®:	**0.2 *Pn*/g, 0.3 *Pt*/g and nil *Fusarium* DNA/g at sowing (0–15 cm)**
Fungicide date:	**12 August at GS33**
Harvest date:	**22 October 2014**

Treatments

Trial 1. Variety evaluation

- One barley variety (Commander$^{\phi}$).
- One durum variety (Caparoi$^{\phi}$).
- Ten commercial bread wheat varieties (LRPB Lincoln$^{\phi}$, EGA Gregory$^{\phi}$, LRPB Dart$^{\phi}$, Sunmate$^{\phi}$, LRPB Gauntlet$^{\phi}$, LRPB Lancer$^{\phi}$, LRPB Spitfire$^{\phi}$, Mitch$^{\phi}$, Suntop$^{\phi}$ and Sunguard$^{\phi}$; listed in order of increasing resistance to crown rot).
- Added or no added crown rot at sowing using sterilised durum grain colonised by at least five different isolates of *Fp*.

Trial 2. Fungicide application evaluation

- EGA Gregory$^{\phi}$ with added or no added crown rot at sowing using infected durum grain.
- One fungicide (Prosaro® at 300 mL/ha + 0.25% Chemwet 1000)

- Three in-crop application strategies at GS33 using Turbo Teejet (110015) nozzles at ~300 L/ha
    - Above crop – foliar spray 50 cm above crop height (i.e. normal rust spray with most of product deposited on upper leaf surfaces).
    - On crop – boom dropped to crop height and nozzles moved between wheat rows (i.e. product hitting base of plant and soil).
    - Droppers – solid rod from boom down to below canopy height then two nozzles angled at ~45 degrees towards base of tillers on opposite crop rows (i.e. all of product targeted at base of plants).

Results

Trial 1. Variety evaluation

Yield

- In the no added CR treatment (black bars) yield ranged from 1.78 t/ha in LRPB Spitfireᶲ up to 2.86 t/ha in Mitchᶲ (Figure 1).
- Crown rot infection had a large impact on yield at this site in 2014 in some varieties. Yield loss under high levels of crown rot infection (added CR) was only significant in Sunmateᶲ (24%), LRPB Gauntletᶲ (26%), Mitchᶲ (32%), EGA Gregoryᶲ (40%), LRPB Lincolnᶲ (52%) and Caparoiᶲ (59%) which equated to 0.64 t/ha to 1.29 t/ha of lost grain yield.
- LRPB Lincolnᶲ and Caparoiᶲ were between 0.68 t/ha and 0.81 t/ha lower yielding than EGA Gregoryᶲ under high crown rot infection, respectively (green bars).
- Only the bread wheat variety Suntopᶲ was higher yielding than EGA Gregoryᶲ under high levels of crown rot infection (green bars) with a yield benefit of 0.75 t/ha (Figure 1).

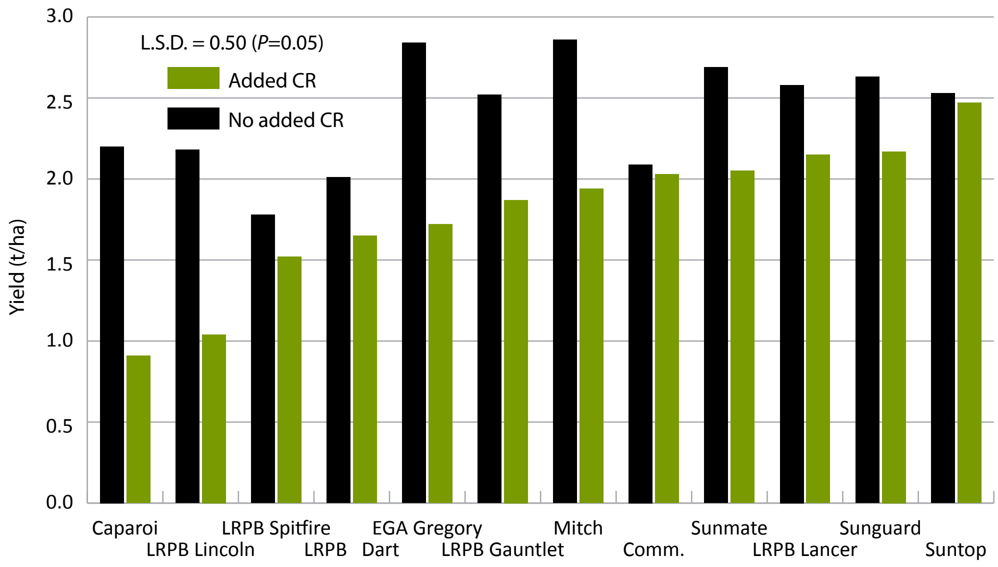

Figure 1*. Yield (t/ha @ 11% moisture) of varieties with no added and added crown rot – Westmar 2014*

Grain protein

- The addition of crown rot inoculum at sowing did not significantly change protein levels in any variety.
- Protein levels ranged between 11.0% (Mitchᶲ) up to only 14.0% (LRPB Spitfireᶲ) with significant differences apparent between varieties (Figure 2). Reduced protein levels in many varieties were generally related to increased grain yield which resulted in protein dilution.

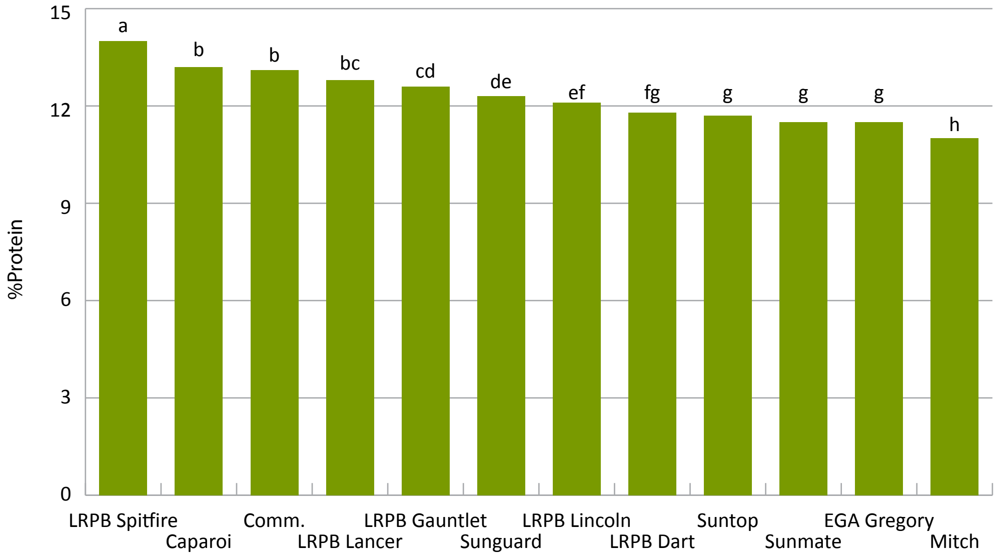

***Figure 2**. Average protein concentration achieved by varieties – Westmar 2014*

Bars with the same letter are not significantly different (P=0.05)

Trial 2. Fungicide application evaluation

- In-crop fungicide application did not have a significant interaction with the crown rot inoculum treatments at this site.
- Fungicide application at GS33 provided a *small* but significant yield benefit over the nil treatment with the on-crop (0.34 t/ha) and dropper (0.40 t/ha) application techniques which were targeted at the base of plants (Figure 3).
- Grain protein levels were reduced by 0.7% in the added CR treatments where no fungicide was applied in-crop (nil treatment).
- Grain protein levels were reduced by 0.5% in the added CR treatment with above crop application but protein differences between crown rot treatments was not significant with on crop and dropper applications (data not shown).

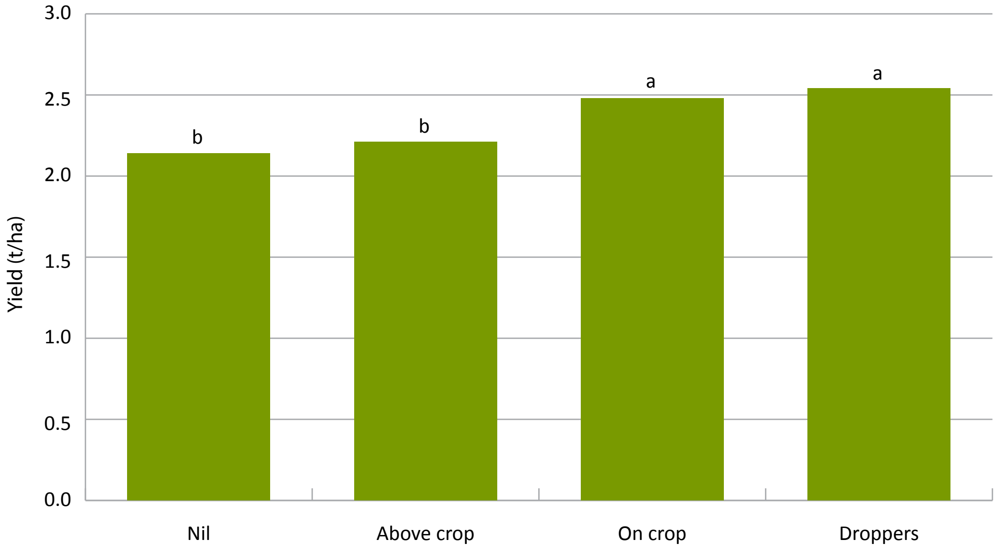

***Figure 3**. Effect of fungicide application technique on grain yield of EGA Gregory⦶ – Westmar 2014*

Bars with the same letter are not significantly different (P=0.05)

Acknowledgements

This project was co-funded by NSW DPI and GRDC under the National Crown Rot Management and Epidemiology Project (DAN00175). Thanks to Phil Coggan for providing the trial site and to Douglas Lush (QDAFF Mobile Trial Unit) for sowing, maintaining and harvesting the trial. Thanks to Patrick Mortell (NSW DPI) for grain quality assessments and to Jason Lowien (GrainCorp) for use of an NIR machine to determine grain protein levels.

Gross margin comparison of summer pulses, Liverpool Plains 2013–14

Natalie Moore[1], Nathan Ensbey[1], Kathi Hertel[2] and Guy McMullen[3]
[1] NSW DPI, Grafton [2] NSW DPI, Narrabri [3] NSW DPI, Tamworth

Key findings

A trial was conducted to evaluate the gross margin of the summer pulses; soybean and mungbean; compared with sorghum and sunflower in a dryland cropping system on the Liverpool Plains. Based on a grain yield of 8.03 t/h and a price of $265.00/t sorghum achieved the highest gross margin ($1600/ha) of the four summer crop types evaluated in this trial during the 2013–2014 season. Sorghum also had the highest input costs at $527/ha. The next highest gross margins were $1573 for mungbean (yield of 2.05 t/ha and premium grade grain price of $1000/t) and $1500/ha for the highest yielding soybean variety (yield of 2.91 t/ha and grain price of $650/t).

Results illustrated the variation in yield that can be obtained across different soybean cultivars and the yield penalty that can result in planting a variety later than recommended. Soybean growers need to follow agronomic best practice guidelines to ensure that yield potential is reached.

Mungbean was the only crop that required grading costs ($105/t) to achieve a premium grade price.

Soybean could be viewed as a lower risk option when compared to sorghum and sunflower due to lower crop establishment costs. In the event of a total crop failure, losses would be $143/ha less for the soybean crop compared with the sorghum crop based on input costs.

This analysis does not take into account the dollar value of residual nitrogen from the soybean or mungbean crops, the disease resistance status of different varieties or the value of rotation crops in providing disease breaks.

Introduction

The adoption of pulses (grain legumes) into northern NSW farming systems has been affected by grower experiences of lower than expected yields and variable grain quality. Inconsistent prices have also reduced adoption. With recent improvements in summer pulse varieties and a wider recognition of the long-term benefits of pulse crops in the farming system, pulses are becoming a more viable option for growers in central and northern NSW. The inclusion of well grown pulse crops in a cereal cropping system provides benefits such as:

- increased crop diversity and spread of economic risk
- reduced carry-over of winter cereal diseases such as crown rot
- expanded options for weed management, which reduces the likelihood of herbicide resistance
- improved management of crop stubble as pulses leave high nitrogen residues that break down more rapidly.

The Northern Pulse Agronomy Initiative is a new NSW DPI and GRDC funded project (DAN00171) that aims to identify the major issues constraining the yield of winter and summer pulses in northern NSW and provide growers and advisors with improved agronomic guidelines to achieve the yield potential and carry over benefits of pulse crops. The target summer pulse crops are soybean and mungbean. In the first stage of this project multi-site, multi-season research trials have been established to identify optimum plant populations, sowing times and row spacings for new varieties of soybean and mungbean.

Additionally a small number of short-term replicated trials on grower's farms and grower surveys are being conducted to obtain baseline data on the performance of pulse crops in farming systems in central and northern NSW. This paper reports on a trial to compare the gross margins of four summer crop options at the Parraweena Pastoral Company property at Blackville on the southern Liverpool Plains. The trial compared four soybean cultivars and one mungbean cultivar with the dominant summer crops sorghum and sunflower in a field trial with two replicates. Gross margin analysis was completed for each crop treatment. Soil moisture and nutrient samples were taken before and after the crop. Grain yield measurements will also be taken from the sorghum that was sown over the trial site in 2014–2015.

Site details

Location:	**Blackville, southern Liverpool Plains NSW**
Co-operator:	**Parraweena Pastoral Company, Joe Fleming (Farm Manager) and John Hosking (Agronomist)**
Paddock history:	**2013 – fallow, 2012 – wheat, 2011 – chickpea, 2010–11 – sorghum**
Planter:	**For sorghum and sunflower, Excel double disc planter fitted with John Deere Max Emerge planter boxes with vacuum metering. For soybean and mungbean, Excel double disc planter with air-seeder metering**
Row spacing:	**Single rows at 75 cm spacing for all crops in the trial**

Soil characteristics

***Table 1**. General soil characteristics of trial site at Parraweena Pastoral Company, Blackville NSW prior to sowing (Soil analysis conducted by CSBP Laboratory)*

Soil depth (cm)	pH (Ca)	OM (%)	Organic carbon (%)	CEC (meq/100) g)	ECe (dS/m)	Ca:Mg	Texture
0–15	7.7	2.8	1.6	73	0.543	2.05	Heavy clay
15–90	7.5	2.06	1.2	72	0.893	1.05	Heavy, dark grey clay

Rainfall

This is a dryland farming system that depends entirely on rainfall. Each crop type in this trial was sown as close as possible to its optimum sowing time so as to not unfairly disadvantage the yield potential of the different crop types. The fallow rainfall from November 2012 to the sowing time for each crop type was: sorghum and soybean: 500.3 mm, sunflower and mungbean: 535.7 mm. The total rainfall at this site from November 2012 to the completion of the trial in May 2014 is presented in Figure 1.

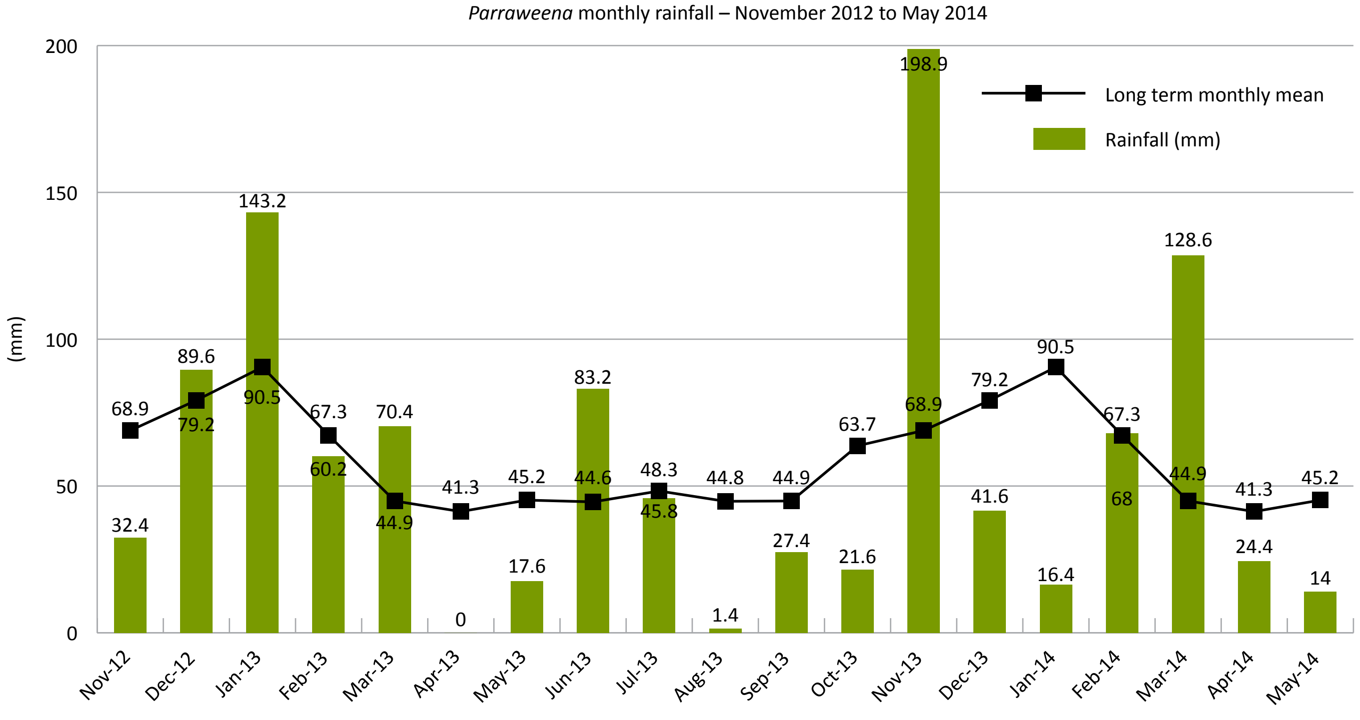

***Figure 1**. Monthly rainfall for Parraweena Pastoral Company, November 2012 to May 2014*

Treatments

The summer crop options were chosen by the collaborator due to their proven suitability to the region and previous performance on this farm: sorghum cultivar MR43, soybean cultivars Moonbi$^{\phi}$ and Richmond$^{\phi}$, mungbean cultivar Jade AU$^{\phi}$ and sunflower cultivar Ausigold 4. Two additional soybean varieties were also included: Soya791 as an historic benchmark variety for the region and the unreleased breeding line PR443, which was under evaluation by the Australian Soybean Breeding Program.

Each treatment was sown in a plot 12 rows (9 m) wide and 191 m long (area of 0.17 ha per plot) to suit the collaborator's planting and harvesting equipment. Two replicates were sown in a randomised design. Each plot was harvested and weighed to obtain yield data. Data presented are the average values of two replicates per treatment.

Sorghum and soybean were sown on 7 and 12 December respectively. The sowing dates and plant populations (Table 2) were within the recommended ranges for all the crop varieties in the trial except for the soybean variety Moonbi$^{\phi}$, which is recommended for early sowing dates from mid November to early December on the Liverpool Plains. Although the sowing date of 12 December was past the recommended window for soybean variety Moonbi$^{\phi}$, it was retained in the trial with the expectation of lower than potential yield. Sunflower and mungbean were sown on the 20 and 22 December respectively following a rain event.

***Table 2**. Summer crop trial summary Parraweena Pastoral Company, Blackville NSW 2013–2014*

Crop	Sowing date	Harvest date	Days to harvest (days after sowing)	Target plant population (plants/ha)	In-crop rainfall (mm)
Sorghum	7 Dec 2013	15 May 2014	159	60,000	279
Soybean	12 Dec 2013	8 May 2014	154	200,000	289.2
Mungbean	20 Dec 2013	8 May 2014	142	220,000	253.8
Sunflower	22 Dec 2013	28 Apr 2014	144	30,000	243.6

Results

The trial had good establishment and was well managed for weeds and insect pests and incurred no damage that would significantly affect grain yield. Lower than average rainfall was received in December and January (see Figure 1 above), however, growing conditions were adequate for the remainder of the season. All the plots in both replicates of the trial were harvested at maturity and grain yields calculated.

Gross margin analysis

The NSW DPI farm budgeting tools available at **www.dpi.nsw.gov.au/agriculture/farm-business/budgets** were used to calculate the gross margins for each treatment in consultation with Fiona Scott, Agricultural Economist with NSW DPI. Variable costs included in-crop herbicide and fertiliser applications, cost of planting and harvesting, machinery costs and grain grading costs. The grain prices used in the gross margin analysis reflected actual prices received by the collaborator on sale of the grain from this trial. To obtain a premium price for mungbean, 20% of the mungbean grain required grading at a cost of $105/t. Table 3 summarises the yield results, grain prices and gross margin analysis for this trial. Yield figures are the average of two field replicates.

***Table 3**. Grain yield and gross margin analysis of summer crop comparison trial, Parraweena Pastoral Company, Blackville NSW 2013–14.*

Crop	Grain yield (t/ha)	Grain price ($/t)	Income ($/t)	Variable costs[a] ($/ha)	Gross margin ($/ha)
Sunflower	2.42	700.00	1694.00	520.57	1173.43
Sorghum	8.03	265.00	2127.95	527.21	1600.74
Mungbean[b]	2.05	1000.00	1701.50	476.32	1573.68
Soybean *cv. PR443*	2.91	650.00	1885.00	384.17	1500.83
Soybean *cv. Richmond*	2.31	650.00	1501.50	384.17	1117.33
Soybean *cv. Soya791*	2.09	650.00	1358.50	384.17	974.33
Soybean *cv. Moonbi*	1.92	650.00	1248.00	384.17	863.83

[a] Variable costs included in-crop herbicide and fertiliser applications, cost of planting and harvesting, machinery costs and grain grading costs.

[b] Twenty percent of the mungbean grain required grading at a cost of $105/t. The price of $1000/t used in this analysis was for premium grade. Grading can result in 5 to 8% losses to the total yield according to the Australian Mungbean Association.

Sorghum and mungbean produced the greatest gross margins in this trial with $1600/ha and $1573/ha respectively. This was a result of the high yield of the sorghum crop (8.03 t/ha) and the high prices received for premium grade mungbean in 2014 ($1000/t).

There was a wide spread of yield among the four soybean varieties leading to a variation of $637/ha in gross margin between the different varieties. The highest yielding soybean cultivar PR443 had a gross margin of $1500 just $100/ha below the sorghum crop. As expected sowing the soybean variety Moonbi(b) later than its recommended sowing window for the Liverpool Plains resulted in a yield penalty for this variety. This occurs when any soybean variety is sown later than its recommended window because the crop does not spend long enough in the vegetative phase (accumulating stem height, leaf matter and nodes on stems) before it commences flowering and pod fill. The result is shorter plants with less shoot biomass available to set and fill the pods.

The lower yielding soybean varieties ($863 – $1117/ha) and sunflower ($1173/ha) produced the lowest gross margins in this trial.

Sorghum and sunflower have the highest variable costs out of the cropping options in this example, mainly due to their need for application of nitrogen fertiliser. The sorghum crop received 93 kg/ha of nitrogen, which in dollar terms equated to $143/ha. The sunflower crop received 74 kg/ha of nitrogen equating to $115/ha.

Summary

This trial offers growers and advisors a case study of gross margin data comparing summer crop options grown under the same conditions in one season. Whilst sorghum had the highest gross margin in this trial it also had the highest input costs, which could result in higher losses when crops fail.

The soybean crop had the lowest variable costs compared to the other crop options and could be viewed as a lower risk option when compared to sorghum and sunflower. In the event of crop failure losses were $143/ha lower in the soybean crop compared with the sorghum crop. However, care must be taken to choose a soybean variety suitable to the region and to sow it at the recommended time.

Along with mungbean, soybean has the ability to fix atmospheric nitrogen to supply adequate nitrogen for the crop cycle. A well nodulated and well grown soybean crop fixes significantly more nitrogen than is required for the crop and leaves up to 60 kg/ha of residual nitrogen for the following crop or pasture. This equates to $91/ha based on urea being 46% N with a cost of $700/t. The book *Managing legume and fertiliser N for northern grains cropping* by David Herridge (published by GRDC, 2013), presents N fixation data from a range of legume rotation crops and pastures and compares common grain legumes for their N fixation potential.

Residual soil nitrate levels were assessed by soil sampling and analysis after the trial was harvested and before the following sorghum crop was grown over the trial site in 2014–2015. Soil analyses and grain yield measurements from the sorghum crop will be reported in a subsequent paper in the NSW DPI Northern Grains Region Trial Results book.

As with sorghum, soybean and mungbean provided an even post-harvest stubble cover, that aided in the retention of moisture and provided a better fit for the zero-tillage and double cropping practices utilised on this farm. The sunflower crop residue left an uneven coverage and the large stalks can cause problems after harvest. The collaborator for this study commented that sunflower is better suited to the hillier/ rockier slopes on their property due to the ease of harvesting a taller crop, provided that a specialised header front is available. However, sunflower crop residue results in more bare ground than the other crops studied in this trial, which increases the risk of erosion damage.

Results of this on-farm trial confirm that mungbean and soybean are viable summer crop options in northern NSW capable of producing a positive gross margin. However, growers need to follow agronomic best practice guidelines, and recommended sowing dates for varieties to ensure that maximum grain yield potential is possible.

In choosing a summer crop option rotational benefits need to be considered beyond a single season and in the context of a long term whole-of-farm strategy. In this project we aim to quantify some of the longer term benefits of pulses in the cropping system particularly quantifying nitrogen fixation of soybean and mungbean in northern NSW. Nitrogen fixation measurements from a selection of trial sites are being undertaken in collaboration with the GRDC project *Optimising nitrogen fixation of grain legumes – northern region* (DAQ00181), led by Dr Nikki Seymour, QDAF.

In the economic analysis of these results no consideration of the disease resistance status of different varieties e.g. resistance to powdery mildew, was taken into account. An estimate of the dollar value of a legume rotation crop in breaking disease cycles of cereal crops e.g. crown rot, was also not taken into account. These factors should be a consideration in choice of both crop and variety, especially where disease pressure is known to be high or when predicted weather conditions are known to favour the development of common diseases such as powdery mildew.

Acknowledgements

This project is co-funded by NSW DPI and GRDC (project number DAN00171). The authors gratefully acknowledge the collaboration of Joe Fleming, Parraweena Pastoral Company and John Hosking, private agronomist. Advice on gross margin analysis by Fiona Scott, Agricultural Economist, NSW DPI Tamworth is gratefully acknowledged. Technical assistance with soil samples by Loretta Serafin, Peter Perfrement and Delphi Ramsden, NSW DPI Tamworth and Sam Blanch, NSW DPI Grafton and technical assistance with biomass sampling and harvest operations by Craig Chapman, Joe Morphew and Rosie Holcombe, NSW DPI Narrabri is also gratefully acknowledged.

Durum wheat variety response to nitrogen management – Tamarang 2014

Rick Graham, Guy McMullen and Gururaj Kadkol
NSW DPI, Tamworth

Introduction

Durum wheat (*Triticum turgidum*) production is generally targeted at high yielding environments that have the potential to achieve grain protein content (GPC) of 13% and above. The highest grade of durum (ADR1) needs to achieve a minimum grain receival standard of 13% GPC with a maximum of 5% screening. The most common reason for grain quality receival downgrading in newer cultivars, has generally been due to grain screenings being > 5% and GPC below 13%. Price downgrades are associated with decreasing GPC and grain plumpness (screenings), with the lowest quality durum (ADR3) accepted for semolina and pasta production having a minimum 10% GPC with a maximum of 10% screenings.

It has also been observed that some varieties, particularly those with smaller grain size, have a tendency towards higher levels of screenings with increased rates of nitrogen (N) applied upfront and or prior to stem elongation. In high yielding environments, there is also the potential for the new high yielding durum varieties to have issues related to lower GPC. This is due essentially, to the 'yield dilution effect' where at a given rate of available N, any increase in grain yield, will result in a decrease in GPC.

The aim of this trial was to achieve protein targets for durum in a high yielding environment and establish whether variety differences exist as a result of N management strategies. This information would be important to maximising yield potential and grain quality of individual durum varieties.

Key findings

Durum varieties had differential grain quality responses to nitrogen management.

The advanced breeding line 241046 had excellent grain size and good grain stability achieving low screening levels across high starting N rates which out performed Caparoi⁽ᴾ⁾.

The newly released variety DBA Aurora⁽ᴾ⁾ (tested as UAD0951096) appears to have reduced grain size and increased risk of downgrading due to screenings.

DBA Aurora⁽ᴾ⁾ due to its increased risk of screenings appears to offer less flexibility in terms of response to sowing date considerations and agronomic management in comparison to both 241046 and Caparoi⁽ᴾ⁾.

DBA Aurora⁽ᴾ⁾ should be avoided if sowing is delayed and in environments where there is potential (e.g. high starting N) for downgrading from high levels of screenings.

Site details

Location:	**'The Point' Tamarang**
Co-operators:	**Chris Wirth**
Previous crop:	**Long fallow out of cotton**
Soil type:	**Black vertosol**
Sowing date:	**30 June 2014**
Fertiliser:	**60 kg/ha Granulock Z extra at sowing**
Starting N:	**160 kg N/ha (0–120 cm)**
Starting water:	**~210 mm PAW to 120 cm**
In-crop rainfall:	**170 mm**

Treatments

The trial included four durum wheat entries, two commercially released varieties Caparoi⁽ᴾ⁾ and DBA Aurora⁽ᴾ⁾ (UAD0951096), and two advanced breeders lines from the Northern Durum breeding program 241046 and 290564 in a fully replicated, factorial design with six N treatments in total. N treatments were 0, 20, 40, 80, 160, and a 2 × 40 kg N/ha split application (at sowing: GS31) all applied as urea (46% N). N treatments were side banded at sowing, apart from the split application which had half applied at planting and half at stem elongation (total 80 kg N/ha).

Results

- Increasing rates of applied N, were found to provide no grain yield benefit, with no significant difference in grain yield between the nil rate and N rates of up to 80 kg/ha N, upfront or split application (Table 1). The results supported the '11% grain protein rule' which indicated that starting soil N levels was sufficient to optimise yield potential.
- In contrast to yield, there was a significant (P<0.001) GPC response to applied N, with GPC increasing with increasing rates of N application, with the critical GPC of 13% achieved at > 80 kg of applied N (Table 1), with no difference between varieties.
- However, there were significant variety responses with 241046 having a grain yield advantage over the other durum entries and DBA Aurora⟬ being lower yielding than the other entries (Table 2).

***Table 1**. Grain yield (t/ha) and grain protein concentration (GPC; %) for six rates of applied nitrogen (kg N/ha).*

Rate of N application (kg N/ha)	Grain yield (t/ha)	GPC (%)
0	5.99	11.5
20	6.04	11.9
40	6.00	12.2
80 split (40 + 40)	5.96	12.8
80	5.93	13.0
160	5.81	14.1
L.S.D. (*P*=0.05)	0.13	0.6

***Table 2**. Mean varietal grain yield (t/ha), grain protein concentration (GPC; %), grain nitrogen yield (GNY; kg N/ha), screenings (%), test weight (hL/kg) and thousand grain weight (TGW; g) averaged across N treatments*

Variety	Grain yield (t/ha)	Grain protein (%)	Grain N removal (kg N/ha)	Test Wt (g)	Screening (%)	TGW (g)
241046	6.22	12.8	138.3	80.8	1.3	42.5
290564	6.03	12.7	134.4	81.7	3.4	36.9
Caparoi⟬	5.93	12.4	128.6	82.4	2.1	39.2
DBA Aurora⟬	5.63	12.4	120.8	79.6	6.5	35.1
L.S.D. (P = 0.05)	0.11	0.5	5.3	0.5	0.4	1.5

- The level of screenings was significant (P<0.001) with a variety, N rate and a variety by N rate interaction. Increased screenings were generally associated with higher rates of N application. The newly released variety DBA Aurora⦹ appeared to have difficulty achieving the ADR1 screening requirements of less than 5% and was adversely affected by increasing rates of N application (Figure 1). In contrast, Caparoi⦹, 241046 and 290564 were able to maintain good grain stability, achieving low screenings (< 5%) across N application rates (Figure 1 and Table 2).

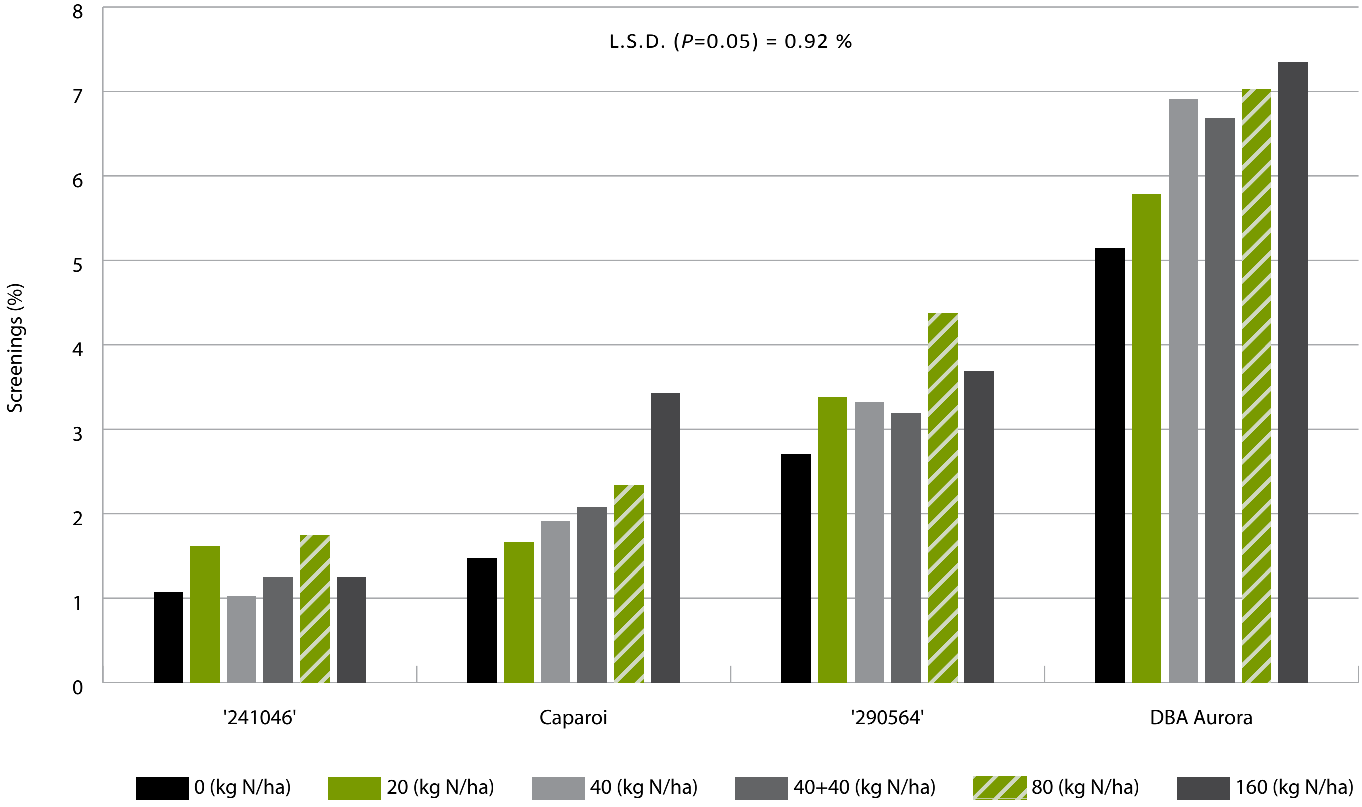

***Figure 1**. Effect of six nitrogen rates on screenings (%) in four durum varieties*

- 241046 appears to have excellent grain size (TGW of 42.5 g) and reduced screenings in comparison to the other varieties in this trial including Caparoi⦹ (TGW 39.2 g) which is one of the larger grained durum varieties (Table 2). 241046 maintained its grain size relative to the other varieties with increasing rates of N application (Figure 2). The relationship between grain size and screenings averaged across N treatments is shown in Figure 3, and illustrates the effect of grain size on potential for increased screenings.

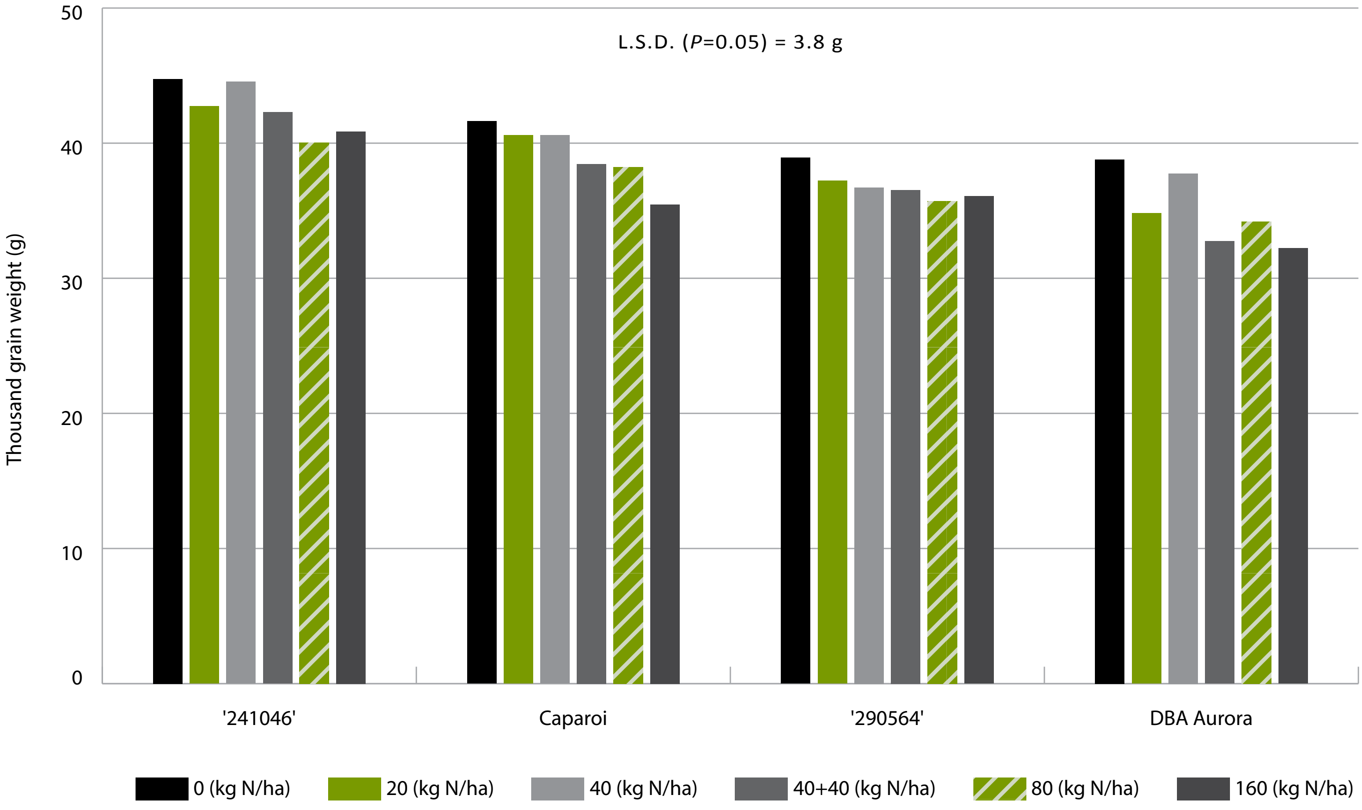

Figure 2. *Varietal response for grain size (g) for six nitrogen rates*

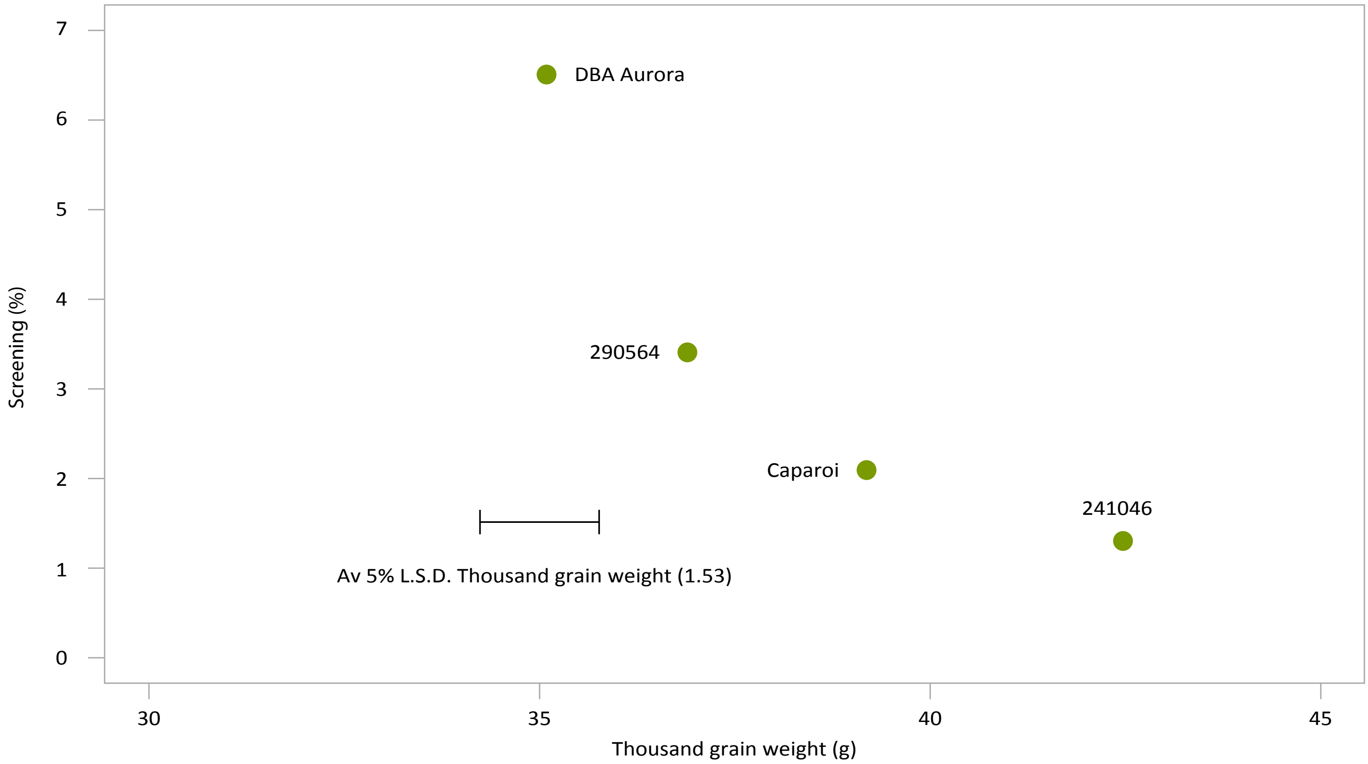

Figure 3. *Relationship between screenings (%) and TGW (g) for four durum varieties averaged over all nitrogen treatments - Tamarang 2014*

Summary

In high yielding environments such as on the Liverpool Plains of northern NSW, with high starting N rates, from a late time of sowing (30 June) durum varieties were shown to have differential responses, in terms of grain quality parameters. The advanced breeding line 241046 was shown to exhibit excellent grain size and good grain stability achieving low screenings across high starting N rates. In contrast, the newly released variety DBA Aurora⟏ (tested as UAD0951096) was shown to have a reduced grain size and increased risk of downgrading due to grain screenings. The results from this trial, found that an additional 80 kg N/ha was required to achieve ADR1 grain receival standards. Caparoi⟏, an acknowledged large seeded durum variety, along with 241046 and 290564, were able to achieve ADR1 specifications for both GPC and screenings. DBA Aurora⟏ due to high screenings, failed to meet these specifications.

These preliminary results would indicate that DBA Aurora⟏ has an increased risk of quality downgrading due to grain screenings with a late sowing window under high levels of available N. In contrast the advanced breeder line 241046 due to its large seed size, reduced likelihood of screenings, and higher yield would appear to have a good fit in this environment and out performed Caparoi⟏ in this trial. It would appear that DBA Aurora⟏ should be avoided if sowing is delayed and in environments where there is potential (e.g. high starting N) for downgrading from increased levels of screenings. DBA Aurora⟏ due principally to its increased risk of screenings would appear to offer less flexibility in terms of response to environmental considerations and agronomic management in comparison to 241046 and Caparoi⟏.

The response of durum varieties to N management, will be further studied to help ascertain if variety × environment × management guidelines including time of sowing and N application, can be put in place to further optimise varietal yield and grain quality potential in the northern grains region.

Acknowledgements

This trial was co-funded by NSW DPI and GRDC under the Variety Specific Agronomy Project (DAN00167). Technical assistance provided by Stephen Morphett, Jim Perfrement, Peter Formann, Jim Keir, Jan Hosking, Rod Bambach, Neroli Graham and Richard Morphett (all NSW DPI) are also gratefully acknowledged.

Soybean variety comparison – Liverpool Plains 2013–14

Kathi Hertel[1], Craig Chapman[1] and Steven Harden[2]
[1] NSW DPI, Narrabri [2] NSW DPI, Tamworth

Key findings

Moonbi⦶ and Richmond⦶, two varieties released from the Australian Soybean Breeding Program have both shown improvement over the now outclassed Soya791 in the areas of yield, seed size and seed quality in this experiment.

Overall site yield was 2.01 t /ha. Richmond⦶, released in 2014 yielded 133% of the site average. There was no significant yield difference between Moonbi⦶ and Richmond⦶. The lowest yielding variety was Hale at 1.16 t/ha or just 58% of the site average.

Soya791 results should be treated with caution. Seed quality was poor and despite adjustments to seeding rates, poor establishment and subsequent growth compromised performance throughout the season.

Introduction

Improving the yield potential and reliability of pulses in Northern Grains Region farming systems is a major focus of the Northern Pulse Agronomy Initiative project. Benefits of pulse crops include:

- improving the productivity of subsequent crops
- reducing the impacts of disease and weeds
- increasing soil fertility
- enhancing farm income
- increasing crop diversity and economic risk
- producing a protein food source, increasingly in demand by a global population.

This experiment is one of a number of research studies into summer pulses, specifically soybean and mungbean, conducted by NSW DPI researchers at Grafton, the Australian Cotton Research Institute (Narrabri) and the Trangie Agricultural Institute. Additional sites are also located on farms located throughout Northern Grains Region.

One of the aims of the project is to investigate agronomic constraints to achieving yield potential of summer pulses. Data from experiments will be used to develop variety specific agronomy recommendations for newer varieties as well as general pulse agronomy recommendations. This experiment includes older varieties as well as newer varieties to assess gains in yields and improvements in desirable agronomic traits of recently released varieties.

Site details

Location:	**'Windy Station' Pine Ridge**
Co-operator:	**Romani Pastoral Company** **Peter Winton (Crop Manager)**
Planting date:	**12 December 2013**
Harvest date:	**29 May (167 DAS)**
Comments:	**The experiment was sown into marginal seedbed moisture, however 18. 4 mm of rainfall fell** **5 days after sowing. In-crop rainfall totalled 265.1 mm** **The season was characterised by little in-crop rainfall and above average daily maximum temperatures during the vegetative growth phase. This was in sharp contrast to the reproductive phase where lower, close to optimum temperatures and frequent rainfall events favouring grain development occurred**

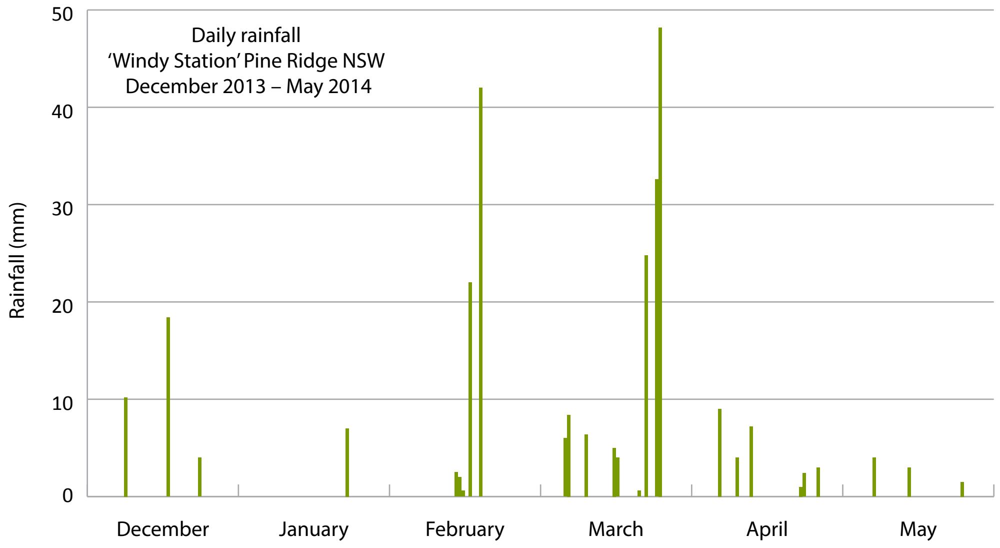

***Figure 1**. Daily rainfall events at "Windy Station" Pine Ridge in 2013–14*

***Table 1**. Site temperature (°C)*

	December	January	February	March	April	May
Minimum	11.7	8.8	9.3	5.3	-0.4	-3.6
Minimum (mean)	*16*	*15.2*	*15.4*	*13.1*	*9.4*	*4.2*
Maximum	39.6	45.1	37.8	31.7	29.4	25.9
Maximum (mean)	*34.1*	*35.1*	*31.3*	*27.3*	*24.8*	*21.4*
Overall mean	25.1	25.1	23.4	20.3	17.1	12.8

Treatments

- Six varieties were evaluated.
- Moonbi$^{\text{(b}}$ is a clear hilum variety released in 2010. A short season variety, it is resistant to powdery mildew and has better weathering tolerance than Soya 791.
- Richmond$^{\text{(b}}$ is a clear hilum variety released in 2013 with the highest weathering tolerance of any current clear hilum varieties. Moonbi$^{\text{(b}}$ and Richmond$^{\text{(b}}$ are suited to production on the Liverpool Plains.
- Soya791, now outclassed has a brown hilum and is suited to soy flour production. It is susceptible to race 15 of Phytophthora.
- Hale has been a popular soybean variety grown on the Liverpool Plains but is now outclassed. It is the quickest maturing of the varieties tested in this trial.
- Bunya$^{\text{(b}}$ is no longer recommended due to its 'Very susceptible' rating to powdery mildew.
- PR443 is an experimental line under evaluation from the Australian Soybean Breeding Program.

Results

Establishment

- Target plant population for the trial was 35 plants/m^2. Crop establishment was measured 26 days after sowing. Soya791 recorded significantly lower populations in all plots, averaging 15 plants/m^2. Investigations into the seed used revealed only 66% germination, with the remaining seed made-up of 11% dead seeds and 23% abnormal seedlings that produced diseased and damaged cotyledons and stunted roots. Whilst seeding rates were calculated to achieve the specified target population, the combination of poor quality seed and low seedbed moisture affected establishment. Planting depth was not measured.

Plant growth and development

- Crop vegetative growth phase (sowing to late January / mid-February – depending on variety) recorded just 3 rainfall events – totalling 39.6 mm. The most significant fall was 18.4 mm that occurred 5 days after sowing. Daily temperatures during this period were above historical averages, only 4 days recording a maximum temperature below 30 °C. The four day period 15–18 January recorded daily maximum temperatures of between 43 and 45.1 °C.
- Hale was the quickest maturing variety, commencing flowering during the last week of January, followed by Bunya$^{(\phi)}$ and Moonbi$^{(\phi)}$ in the first week of February.
- Observations 88 DAS (11 March) recorded Hale with pods containing green seed filling the pod cavity (growth stage R6). Moonbi$^{(\phi)}$ averaged GS R5 where seeds within pods were still increasing in size within the pod. Soya 791 and PR443 were at GS R4, where pods were still lengthening prior to seed development. Richmond$^{(\phi)}$ was transitioning between GS R4 and R5 as pods reached full length and seed formation within commenced. Seasonal conditions during March recorded average daily temperatures between 20 and 23 °C and daily maximums below 30 °C and rainfall totalling 136 mm over 9 days.

Height at flowering

- Overall crop height at flowering showed significant differences between varieties (Figure 2). Bunya$^{(\phi)}$ was the tallest at 70 cm. There was no significant difference between all other varieties with the exception of Hale, averaging 56 cm.

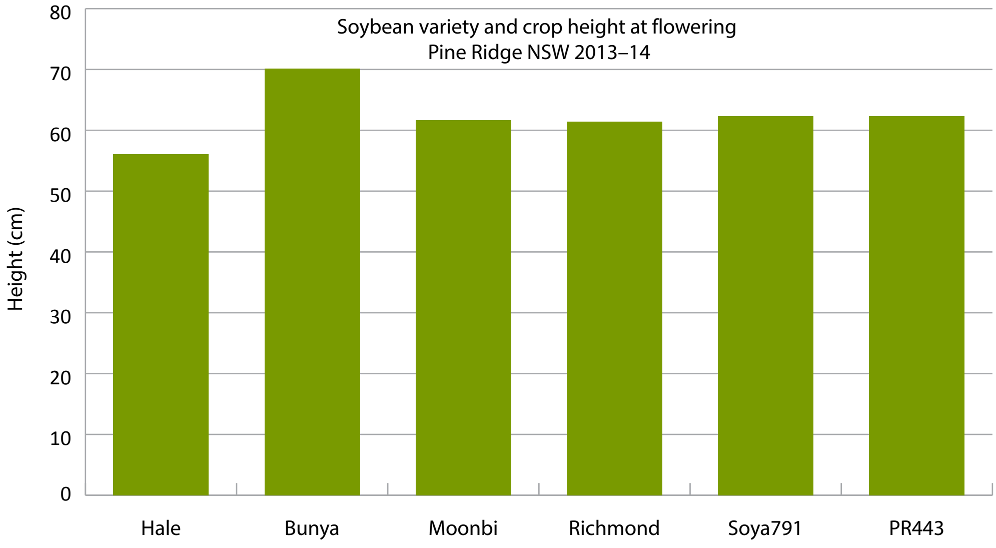

***Figure 2**. Height of soybean varieties at flowering at 'Windy Station' Pine Ridge in 2013–14*

Yield

- Overall site yield was 2.01 t /ha (Table 2). The experimental line PR443 yielded 2.51 t/ha, equivalent to 25% above the site average. Whilst Richmond$^{\phi}$ yielded 2.27 t/ha, in this experiment this was not statistically different to PR443. Similarly, there was no significant difference between Moonbi$^{\phi}$ yielding 2.12 t/ha and Richmond$^{\phi}$. The lowest yielding variety was Hale at 1.16 t/ha or just 58% of the site average.

Table 2*. Soybean grain results at "Windy Station" Pine Ridge in 2013-14.*

Variety	Yield (t/ha)	Yield as % site mean	Yield as % Soya 791	Oil (%)	Seed protein (%) DM basis	100 seed weight (g)
Moonbi$^{\phi}$	2.12	106	108	19.10	43.20	20.75
Richmond$^{\phi}$	2.27	113	116	18.73	43.40	21.20
Soya 791	1.96	98	100	18.57	41.40	19.64
Bunya$^{\phi}$	2.01	105	102	19.43	42.77	25.31
Hale	1.16	58	59	19.90	42.60	15.00
PR443	2.51	125	128	18.70	41.23	20.96
Site mean	2.01			19.07	42.43	20.48
L.S.D. (p 0.05) *(p 0.1)	0.35			*0.96	1.41	1.67

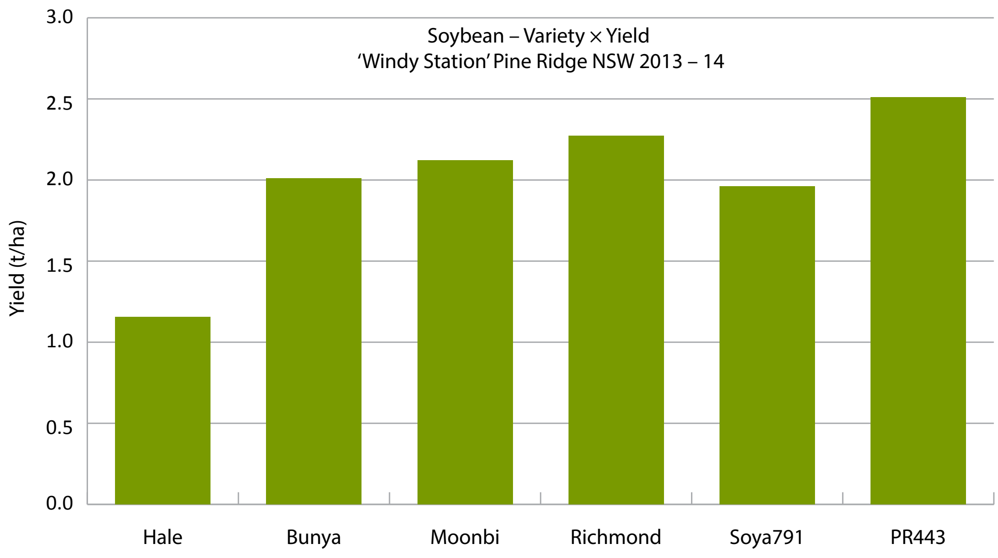

Figure 3*. Variety yields at 'Windy Station' Pine Ridge in 2013–14*

Seed size

- Seed size, measured as a 100 seed weight is an inherent varietal characteristic. In order from largest to smallest, varieties were ranked as follows: Bunya$^{\phi}$ > Richmond$^{\phi}$ > PR443 > Moonbi$^{\phi}$ > Soya 791 > Hale.

Oil

- There were significant differences in seed oil content varieties (L.S.D. 0.96). Average oil content was 19.07%.

Protein

- There was no significant difference in seed protein levels between varieties with the exception of PR443 and Soya 791 which both measured significantly lower protein contents at 41.12% and 41.4% respectively (L.S.D. 1.409). Richmondᶲ measured the highest protein level at 43.4%. Average protein content was 42.43%.

Summary

- This experiment includes key soybean genotypes from the Australian Soybean Breeding Program adapted for the Northern Grains Region. The recently released elite genotypes, Moonbiᶲ and Richmondᶲ have demonstrated the improvements that have been made compared with the benchmark variety Soya 791. Results in this experiment show differences in agronomic characteristics, grain quality and yield performance.
- In conjunction with biomass measurements and collected samples, further results are pending from the collaborative work with the GRDC funded Project DAQ00181: Optimising nitrogen *fixation in grain legumes – northern region*, led by Dr Nikki Seymour at DAFF in Queensland. The data aims to quantify the nitrogen benefit to northern farming systems over the longer term.

Acknowledgements

Project funding by NSW DPI and GRDC under the Northern Pulse Agronomy Initiative Project (DAN00171).

Romani Pastoral Company, Peter Winton (Crop Manager) 'Windy Station' Pine Ridge.

Hale seed kindly supplied by Brian Fletcher ('Marydale' Caroona) and John Webster (Quirindi Grain & Produce, Quirindi NSW); Bunyaᶲ seed kindly supplied by Ian Morgan (PB Agrifood, Toowoomba Queensland).

Technical support: Joe Morphew, Pete Formann, Rosie Holcombe, Jim Murphy, Joel Hargreaves and Dave Eglington.

Quality testing conducted by Futari Grain Technology Services, Narrabri.

Soybean response to planting with Precision planter and cone seeder – Liverpool Plains 2013–14

Kathi Hertel[1], Loretta Serafin[2], Craig Chapman[1] and Peter Perfrement[2]
[1] NSW DPI, Narrabri [2] NSW DPI, Tamworth

Introduction

The Northern Grains Region is characterised by zero till farming systems that include both summer and winter grain crops. Rapid, even crop establishment is a fundamental management objective in crop production. To achieve this, accurate seed placement is necessary. Investment in planting equipment is one of the largest expenditures a farm operation makes; hence selecting the best seeder is imperative.

The objective of this experiment is to compare two planter types, a small plot cone seeder with narrow tynes to simulate an airseeder and a Monosem disc precision planter. This experiment compared the effects of the two planters on crop establishment and the overall performance of Moonbi$^{\phi}$ soybeans sown at 5 targeted populations.

Site details

Location:	**NSW DPI Liverpool Plains Field Station, Breeza**
Crop:	**Soybean**
Variety:	**Moonbi$^{\phi}$**
Planting date:	**11 December 2013**
Fertiliser:	**110 kg/ha Granulock Zn**
Row spacing:	**90 cm (on 1.8 m beds)**
Soil type:	**Black vertosol**
Irrigation:	**14 November 2013 (pre-water), 8 January 2014, 23 January 2014, 4 February 2014, 14 February 2014**
Harvest date:	**30 May 2014 (167 DAS)**

Key findings

There was a significant difference in the type of planter on soybean crop establishment ($p < 0.05$ L.S.D. 4.22), the Monosem disc seeder averaged 13 plants/m^2 and the cone seeder with the tyne assembly averaging almost double – 25.4 plants/m^2.

Sown on 90 cm row spacing, as target × populations increased, the percentage of seed that established progressively declined: achieving 95% establishment at the target population of 10 plants/m^2 to 55% of seed (or 27 plants/m^2) where 50 plants/m^2 were targeted.

Soybean yield was significantly impacted by the type of planter. Overall yield sown with the tyne planter was 2.54 t/ha, the disc planter averaging 2.12 t/ha ($p < 0.05$ L.S.D. 0.14). These differences are largely attributed to the interaction between planter and population, which was not statistically significant.

Crop population impacted significantly on yield. Highest yields were recorded where populations achieved by the tyne planter averaged 23, 31 and 35 plants/m^2. Yields were 2.64, 2.73 and 2.87 t/ha respectively ($p < 0.05$ L.S.D. 0.27).

Planting equipment and crop populations had no significant effect on soybean seed quality characteristics like seed size, oil or protein content.

***Table 1**. Starting soil nutrition: Breeza 2013–14*

Depth (cm)	Nitrate (mg/kg)	Colwell P (mg/kg)	BSES Phosphorus	Sulphur (mg/kg)	Organic carbon (%)	pH Level ($CaCl_2$)
0–10	13	26	717.04	5.5	1.0	7.9
10–30	9	16	711.45	10.8	0.79	7.9
30–60	7	11	-	8.1	0.64	8.0
60–90	5	18	-	9.6	0.53	8.1
90–120	6	25	-	9.3	0.44	8.2

Comments:

A fall of 10 mm rain was recorded at the site the day before planting, No further rainfall was received before irrigation on 8 January. Daily soil temperatures at 10 cm depth reached maximums exceeding 30 °C in the 16 days after planting, peaking at 38.9 °C. Seed viability was tested prior to planting, measuring 83% germination. The remaining 20% of the seed comprised 2% dead seed, 2% hard seed and 16% abnormal seeds that produced broken and split cotyledons and stunted roots. Seeding rates were calculated using this information.

Irrigations were applied, maintaining non-limiting PAW throughout the vegetative and reproductive growth phases of the crop.

Based on observations in other experiments sown on the same day, Moonbi$^{(d)}$ began to flower around 28 January (52 DAS), 5 days after irrigation. The first 2 weeks of flowering saw daily temperatures reaching maximums of around the mid 30s with 4 days reaching 37 °C. Crop available soil water was maintained with irrigation applied every 10–14 days throughout flowering, pod development and pod fill. Early pod development coincided with daily maximum temperatures steadily declining from the low 30s to mid- to late 20s. By 11 March (94 DAS) plants had reached growth stage R6 where seeds had reached full size within the pod and were now filling as protein and oil were being accumulated.

***Table 2**. Site rainfall (mm) 2013–14*

December	January	February	March	April	Total
28 (5)	0	56 (4)	163 (9)	19 (3)	**119.3**

[1] In-crop rainfall: 142 mm ** Number of wet days in brackets*

[1] NOTE: In-crop rainfall refers to the sum of rainfall events from planting date to physiological maturity.

***Table 3**. Site temperature (°C)*

	December	January	February	March	April
Minimum	4.6	13	12.2	9.9	2.3
Minimum (mean)	*15.8*	*17.5*	*17*	*15*	*11.5*
Maximum	41.3	45.2	37.5	32	31.1
Maximum (mean)	*33.7*	*34.7*	*32.1*	*28.5*	*26.3*
Overall mean	26.7	26.1	24.6	21.8	18.9

Treatments

- Crop: Soybeans
- Variety: Moonbi⟨D⟩
- Planters: 1. Cone seeder – tyne assembly, 90 cm row spacing
  2. Monosem Precision disc planter – sown in a twin row configuration at 90 cm and 75 cm spacings; being 7.5 cm apart.
- Target crop populations: 10 plants/m^2, 20 plants/m^2, 30 plants/m^2, 40 plants/m^2, 50 plants/m^2

Results

Establishment

- Crop establishment was measured 34 days after sowing. The width of the raised beds from centre-to-centre was 1.8 m. Consequently with the tyne seeder set at 90 cm row spacings and the outside of the twin row of the Monosem precision planter, this created very little margin for error for seed placement into seedbed conditions for rapid germination and emergence. Consequently emergence was uneven where seed placement was on the margins of the bed that collapsed or slumped.
- There was a significant difference in the type of planter on crop establishment ($p < 0.05$ L.S.D. 4.22), the Monosem disc seeder averaged 13 plants/m^2 and the cone seeder with the tyne assembly averaging almost double – 25.4 plants/m^2 (Figure 1)
- Overall, crop establishment sown with the tyne planter was generally higher than establishment with the disc planter, but high variability within plots resulted in statistically no significant difference.
- There was a significant interaction between target populations and crop establishment (Table 4). The percentage of seed that successfully grew progressively declined with higher target populations, only 55% of seed or 27 plants/m^2 where 50 plants/m^2 were targeted.

***Table 4**. Comparison of soybean establishment and target populations at Breeza in 2013.*

Target plant population (/m^2)	10 plants	20 plants	30 plants	40 plants	50 plants
Site mean (plants/m^2)	9.5	17.3	18.4	23.4	27.4
Site mean as % of target population	95	87	61	59	55
L.S.D. (P <0.05)	7.45				

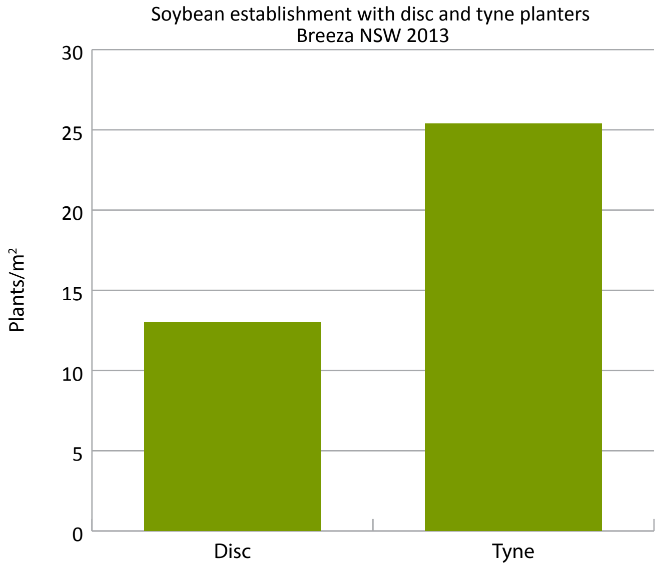

Figure 1*. Comparison of planters on soybean establishment at Breeza in 2013*

Yield

- The type of planter had no significant impacts on soybean yield. Overall crop yield sown with the tyne planter was 2.54 t/ha. This is 8% above the overall site average yield. The average soybean yield sown with the disc planter was 2.12 t/ha ($p < 0.05$ L.S.D. 0.14), equivalent to 91% of the overall site yield. However, these differences are likely due to the interaction between planter and population, which was not statistically significant.
- Crop population impacted significantly on yield (Table 5). Highest yields were recorded with the target populations of 30, 40 and 50 plants/m^2. Yields were 2.50, 2.52 and 2.61 t/ha respectively ($p < 0.05$ L.S.D. 0.27) (Table 5). The 10 and 20 plants/m^2 treatments yielded significantly less.
- The interaction between planter type and population was not significant (Figure 2) with similar yields achieved by both planters at each target population.

Table 5*. Effect of plant population on soybean yield across planter type at Breeza in 2013.*

Population (population /m^2)	10 plants	20 plants	30 plants	40 plants	50 plants
Yield (t/ha)	1.81c	2.21b	2.50a	2.52a	2.61a
L.S.D. ($P<0.05$)			0.27		

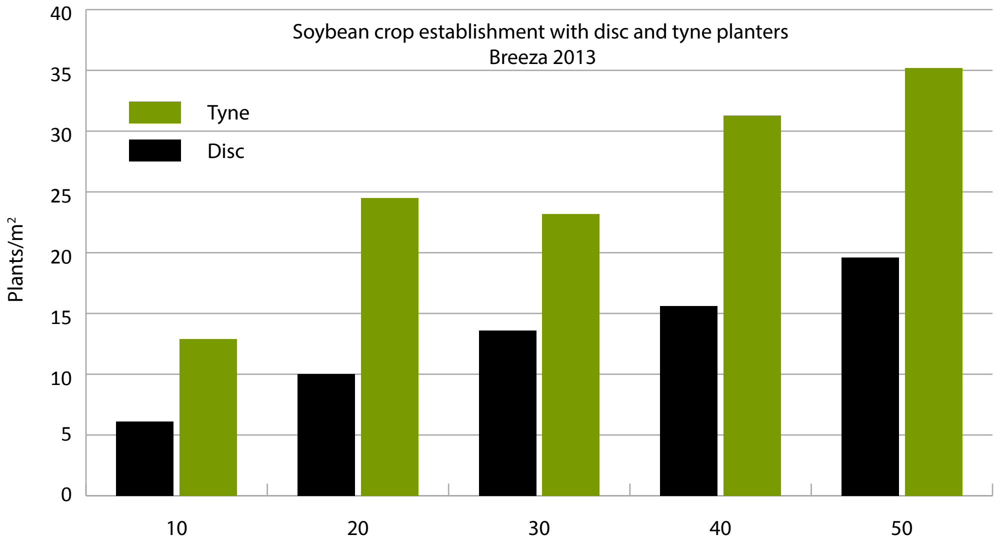

***Figure 2**. Comparison of planters on soybean yield at Breeza in 2013*

Seed size

- There was no significant effect on seed size of either type of planter alone or planter type × crop population interactions. Overall trial mean was 23.55 g/100 seeds.

Oil

- There was no significant effect on oil content of either type of planter alone or planter type × population interactions. Overall trial mean was 20.6%.

Protein

- There was no significant effect on protein content of either type of planter alone or planter type × population interactions. Overall trial mean was 41.28%.

Summary

Seed placement in this experiment was adversely affected by the uneven edges of the raised beds. The often poor seed:soil contact was further exacerbated by high soil and air temperatures in the days following planting that is known to be detrimental to the embryo and early germination process. While plant population and planter type had significant impacts on yield, there was no interaction between the two.

Acknowledgements

Project funding by NSW DPI and GRDC under the Northern Pulse Agronomy Initiative Project (DAN00171).

Experimental design: Steven Harden.

Technical support: Joe Morphew, Scott Goodworth, Steve Gengis, Rosie Holcombe, Jim Murphy, Joel Hargreaves and Dave Eglington.

Quality testing conducted by Futari Grain Technology Services – Narrabri.

Nitrogen response of six wheat varieties – Merriwa 2014

Greg Brooke[1], Peter Matthews and Guy McMullen[3]
[1] NSW DPI, Trangie, [2] NSW DPI, Orange, [3] NSW DPI Tamworth

There were consistent responses of higher grain protein levels with increasing applied nitrogen rates in all varieties tested.

The background level of nitrogen was high at this site which masked any yield response but there was a trend for decreasing yield with increasing rates of N application.

Screenings levels were pushed higher in some varieties with increasing N rates and was most pronounced in Suntopᶲ.

LRPB Lancerᶲ and LRPB Spitfireᶲ had significantly higher grain protein concentrations than other varieties across all N rates.

Introduction

Nitrogen is the nutrient needed in greatest quantity by wheat for growth and to meet maximum yield. In recent seasons there has been a trend towards lower grain protein levels in commercial wheat crops in the northern grains region. Protein levels of < 10.5% in a prime hard variety usually indicate that insufficient N levels have not only limited grain protein concentrations but also yield. Soil testing for N prior to sowing remains an important budgeting indicator of the need for additional applied N to maximise yield and grain protein levels with consideration of starting soil water and target yield. This trial aimed to determine the effect of N application on the yield and grain quality of six common bread wheat varieties

Site details

2013 crop:	**Canola**
Location:	**Merriwa**
Co-operator:	**M and K Campbell**
Sowing date:	**22 May 2014**
Starting moisture:	**294 mm rainfall recorded from January to April**
In-crop rainfall:	**147mm (May to October)**
Fertiliser:	**70 kg/ha Grain Legume Starter**
Fungicide:	**300 mL Prosaro Mid August (~Z32)**
Total starting N:	**265 kg N/ha (0–120 cm)**

Treatments

- Six wheat varieties: LRPB Dartᶲ, EGA Gregoryᶲ, Sunguardᶲ, Suntopᶲ, LRPB Lancerᶲ and LRPB Spitfireᶲ
- Five nitrogen (N) rates: 0; 20; 40; 80 or 160 kg N/ha applied as urea pre-drilled at sowing.
- One split application: 40 kg N/ha at sowing (as urea) and 40 kg N/ha in-crop (as urea) at Z25.

Results

- Due to the high starting soil N levels, there was no significant effect of N application rates on grain yield in the six varieties in this trial.
- Suntopᶲ was significantly higher yielding than the other varieties averaged across the N Treatments (Table 1).

***Table 1**. Yield, grain protein and screenings of six wheat varieties averaged across N Treatments – Merriwa 2014*

Variety	Yield (t/ha)	Protein (%)	Screenings (%)
Suntop$^{\phi}$	5.66	12.0	7.3
LRPB Spitfire$^{\phi}$	5.41	13.3	5.0
EGA Gregory$^{\phi}$	5.35	12.3	5.2
LRPB Dart$^{\phi}$	5.28	12.2	6.8
LRPB Lancer$^{\phi}$	5.23	13.2	4.5
Sunguard$^{\phi}$	5.16	12.5	4.4
L.S.D. (*P*=0.05)	0.15	0.2	0.6

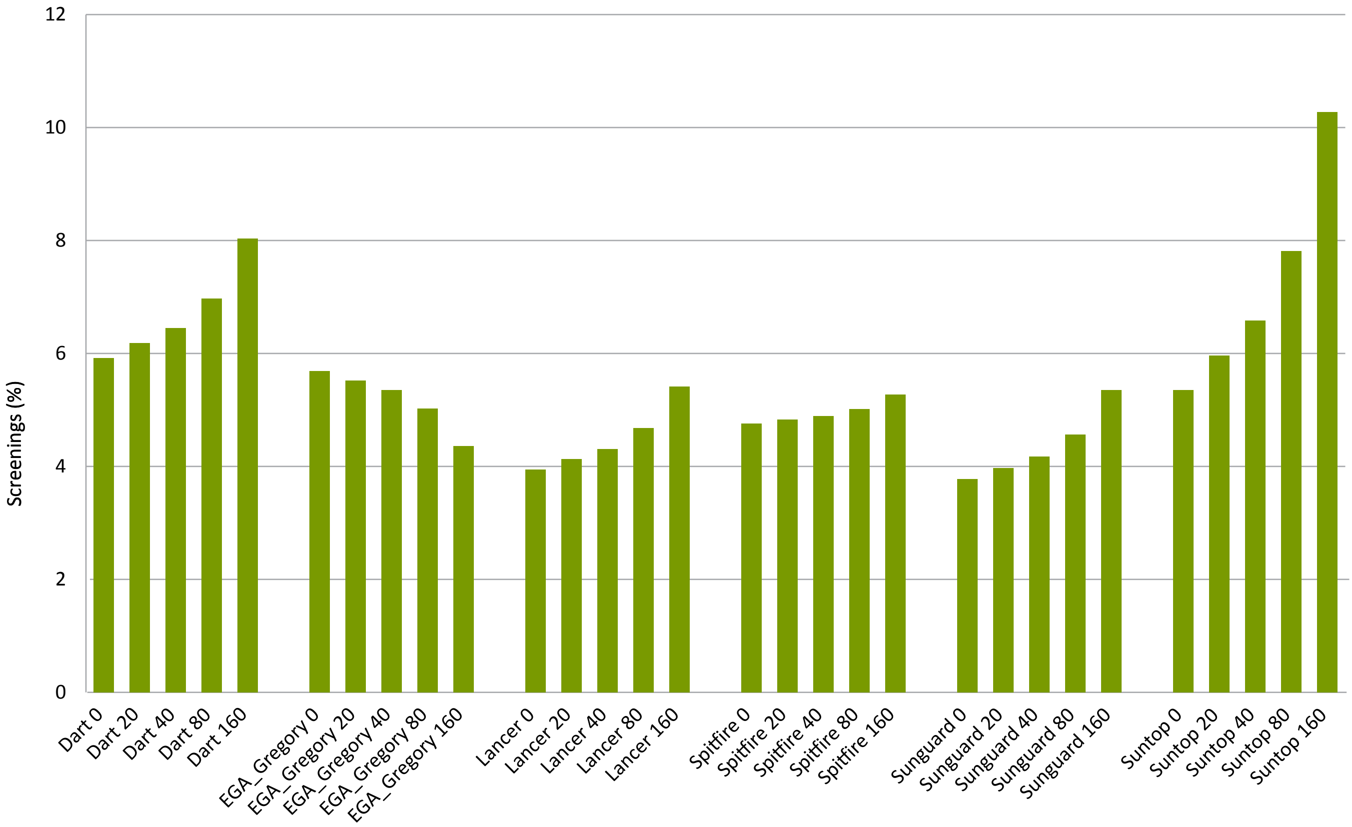

***Figure 1**. Effect of nitrogen application on screening levels (%) in six wheat varieties – Merriwa 2014. (L.S.D. = 0.9)*

- Screening levels increased with increasing N application rates in LRPB Dart$^{\phi}$, LRPB Lancer$^{\phi}$, Sunguard$^{\phi}$ and Suntop$^{\phi}$ with the negative impact most pronounced in Suntop$^{\phi}$ (Figure 1).
- Screening levels were stable in LRPB Spitfire$^{\phi}$ across N rates but de*creased slightly with increasing N application rates in EGA Gregory*$^{\phi}$.

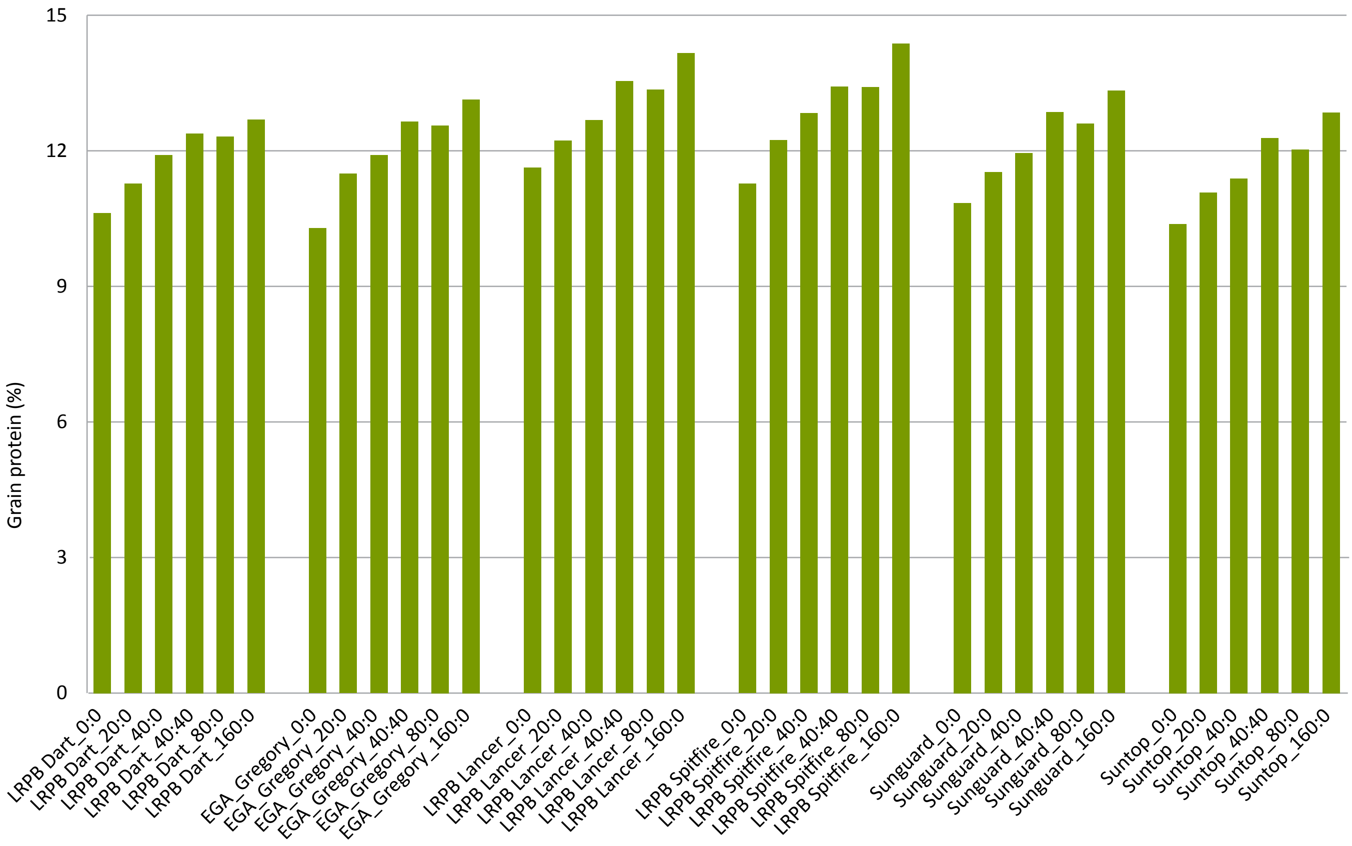

***Figure 2**. Effect of nitrogen application on the grain protein levels (%) in six wheat varieties – Merriwa 2014 (L.S.D. = 0.6)*

- Increasing N application rates resulted in higher grain protein levels with all varieties with around a 2–3% increase between the 0 and 160 kg N/ha rate (Figure 2).
- LRPB Lancer$^{\Phi}$ and LRPB Spitfire$^{\Phi}$ produced higher grain protein levels than the other wheat varieties across the N application rates (Figure 2).

Summary

The site and season experienced at Merriwa in 2014 were conducive to obtaining high wheat yields. High background N levels, crop rotation and good in-crop agronomy also facilitated to the production of high yields. However, the addition of nitrogen in every variety caused a trend for the production of lower yield, likely related to 'haying-off', increased the level of screenings in some varieties but increased grain protein concentrations in all varieties.

The grain protein response in all varieties was good with EGA Gregory$^{\Phi}$ for example increasing from 10.3% to 13.1% at the highest application rate with both LRPB Spitfire$^{\Phi}$ and LRPB Lancer$^{\Phi}$ exceeding 14% protein at this rate. However, the economics of this approach are questionable considering the already high background N levels in the soil profile at this site which also resulted in slight yield suppression and increased screenings in some varieties. Nitrogen management strategies need to be matched with starting N levels through the soil profile to maximise return on investment.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00167). Thanks to Mark and Karen Campbell Merriwa for the trial site and assistance; Peter Mathews NSW DPI for sowing and in-crop agronomy, Gavin Melville for Biometric support and Jayne Jenkins, Scott Richards, Paddy Steele, Liz Jenkins, Sally Wright and Lizzie Smith (all NSW DPI) for technical assistance.

Nitrogen and sowing time response of six wheat varieties – Wongarbon 2014

Greg Brooke[1], Peter Matthews[2] and Guy McMullen[3]
[1] NSW DPI Trangie [2] NSW DPI Orange [3] NSW DPI Tamworth

Introduction

Nitrogen is the nutrient needed in greatest quantity by wheat for growth and to meet maximum yield. In recent seasons there has been a trend towards lower grain protein levels in commercial wheat crops in the northern grains region. Protein levels of < 10.5% in a prime hard variety usually indicate that insufficient N levels have not only limited grain protein concentrations but also yield. Soil testing for N prior to sowing remains an important budgeting indicator of the need for additional applied N to maximise yield and grain protein levels with consideration of starting soil water and target yield. This trial aimed to determine the effect of N application on the yield and grain quality of six common bread wheat varieties across two sowing dates

Key findings

There was no significant effect of N application on yield due to high background soil N levels but there was a slight increase in protein and screening levels with increased rates of N application.

Nitrogen management strategies need to be matched with starting N levels through the soil profile to maximise return on investment.

Earlier sowing increased yield across all varieties and tended to slightly reduce both protein and screening levels.

Site details

Location:	**'Hillview' Wongarbon**
Co-operator:	**Kelly family**
2012 crop:	**Lucerne (4 years)**
2013 crop:	**Wheat**
Sowing dates:	**Time of sowing 1 (TOS 1) 30 April 2014** **Time of sowing 2 (TOS 2) 16 May 2014**
In-crop urea:	**TOS 1: 18 June (This was prior to Z30 but rainfall provided opportunity)** **TOS 2: 16 July (approx. Z30)**

Rainfall*:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
29.4	60.8	138.6	68.6	22.4	64.2	38.2	19.9	17.6	25.8	16.4

Frost events (°C)*:

Aug 2	Aug 3	Aug 6	Aug 7	Aug 8	Aug 14	Sep 3	Sep 4	Sep 18	Sep 20	Oct 2
-1.0	-3.0	-3.2	-2.4	-1.7	-3.8	-1.8	-1.0	-1.2	-1.4	-1.2

** source nvtonline from 'Tinytag' monitor at site*
Note: In TOS 1 LRPB Spitfire$^{\phi}$, Suntop$^{\phi}$ and LRPB Dart$^{\phi}$ were at Z33 on 17 August

Fertiliser:	**70 kg/ha Grain Legume Starter**
Fungicide:	**300 mL Prosaro® mid-July (Z32 in TOS 1)**
Starting nutrition:	**Phosphorus (Colwell) 34 mg/kg 0–10 cm;** **8 mg/kg 10–30 cm** **Total N 491 kg N/ha (0–120 cm)**
Harvest date:	**14 November 2014**

Treatments

- Six wheat varieties: LRPB Dartᶲ, EGA Gregoryᶲ, Sunguardᶲ, Suntopᶲ, LRPB Lancerᶲ and LRPB Spitfireᶲ
- Five nitrogen (N) rates: 0, 20, 40, 80 or 160 kg N/ha applied as urea pre-drilled at sowing.
- One split application: 40 kg N/ha at sowing as urea and 40 kg N/ha in-crop as urea at Z25.
- Two sowing dates: 30 April (TOS 1) and 16 May (TOS 2).

Results

- There was no significant effect of N rate on yield (data not shown) due to very high background N levels at this site.
- There was a slight but significant effect of N rate on protein when averaged across varieties and sowing time with a 0.5% increased from the 0 kg N/ha (15.2%) to the 160 kg N/ha (15.7%) application rate.
- Similarly, N application increased screenings when averaged across varieties and sowing times by 0.7% from the 0 kg N/ha (11.5%) to the 160 kg N/ha (12.2%) application rate.
- There was a significant effect of sowing time on yield which was reduced on the second sowing time by between 0.17 t/ha (6%) in Sunguardᶲ up to 0.39 t/ha (13%) with LRPB Spitfireᶲ (Table 1).
- Later sowing (TOS 2) also increased the grain protein level by between 0.9% (Sunguardᶲ) to 1.4% (LRPB Spitfireᶲ) (Table 1).
- Screenings were also increased with later sowing in all varieties, except LRPB Spitfireᶲ, by between 2.5% (Suntopᶲ) to 5.5% (Sunguardᶲ) (Table 1).
- LRPB Dartᶲ was the highest yielding variety at both sowing dates followed by Suntopᶲ.
- Protein levels were highest in LRPB Lancerᶲ at both sowing dates while LRPB Spitfireᶲ and EGA Gregoryᶲ tended to have the lower levels of screenings across sowing dates (Table 1).

***Table 1**. Effect of sowing time on yield, protein and screening levels in six wheat varieties – Wongarbon 2014.*

Variety	TOS	Yield (t/ha)	Protein (%)	Screenings (%)
LRPB Dart⚘	1	3.27	13.9	10.1
	2	3.01	14.9	14.7
EGA Gregory⚘	1	2.89	14.6	7.3
	2	2.67	15.8	10.5
LRPB Lancer⚘	1	2.66	16.1	10.1
	2	2.30	17.3	13.2
LRPB Spitfire⚘	1	2.92	15.2	8.2
	2	2.53	16.5	9.2
Sunguard⚘	1	2.74	15.4	11.0
	2	2.57	16.3	16.5
Suntop⚘	1	3.15	14.3	13.9
	2	2.85	15.5	16.4
L.S.D. (*P*=0.05)		0.10	0.2	1.2

Summary

Yields were lower than expected at this site in 2014 likely due to a degree of stem frosting in August and a relatively dry finish to the season. The tough finish to the season is reflected in the level of screenings which ranged from 8.2% up to 16.5% across varieties and sowing times.

This property 'Hillview' where this trial was located in 2014 has a four year lucerne pasture phase followed by three years of cropping. This trial was the second wheat crop after the lucerne phase and consequently high soil N levels (491 kg N/ha) were still present for the 2014 season. This limited the impact of additional N application on yield and grain quality. Nitrogen management strategies need to be matched with starting N levels through the soil profile to maximise return on investment.

Acknowledgements

This research was funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00167). Thanks to the Kelly family at Wongarbon for the trial site and assistance; Peter Mathews NSW DPI for sowing and in-crop agronomy, Gavin Melville for Biometric support and Jayne Jenkins, Scott Richards, Paddy Steele, Liz Jenkins, Sally Wright and Lizzie Smith (all NSW DPI) for technical assistance.

Effect of macro and micro nutrients on yield and protein in wheat – Nyngan 2013 and 2014

Greg Brooke and Leigh Jenkins
NSW DPI, Trangie

Key findings

Applying nil fertiliser and the omission of phosphorus caused the greatest reductions in yield in both seasons.

The greatest losses in grain protein levels occurred where nil fertiliser was applied or nitrogen was omitted in 2013 only.

There were no significant impacts from omitting any of the trace elements on wheat yield at these two sites in these two years.

Omitting copper (Cu) significantly reduce grain protein levels in 2013 only.

Introduction

The value of the macronutrients, nitrogen (N) and Phosphorus (P), to maximising wheat yield and grain protein levels is well established in Australian cropping soils. However, growers in central-west NSW have repeatedly sought information on the value of using trace elements in the production of wheat crops and whether there are economic responses to any of these elements in their cropping soils.

The methodology for this trial was to provide a one-off application at growth stage 32 (Z32) of eight foliar trace elements as chelates and take one away e.g All nutrients *minus* boron or all nutrients *minus* copper. This is generally termed a nutrient omission trial. The trials also re-examined the value of the maconutrients N, P and K in a similar nutrient omission design.

Site details

Location:	**Nyngan red loam**
Co-operator:	**Komoora 2013, Wilgaree 2014**
Wheat variety:	**2013: LRPB Dart⊕ @ 100 seeds/m^2** **2014: Suntop⊕ @ 100 seeds/m^2**
Sowing date:	**2013: 24 May, 2014: 12 May**
N application:	**2013: 6 June 100 kg/ha urea top-dressed to all except for nil N and nil fertiliser treatments** **2014: 21 May 100 kg/ha urea top-dressed to all except for nil N and nil fertiliser treatments**
P application:	**100 kg/ha triple super at sowing applied to all treatments except nil fertiliser and nil P**
Foliar application:	**2013: 16t August at GS Z31** **2014: 17 July Z 31**
Paddock history:	**2013 paddock: canola 2012** **2014 paddock: long-fallowed 2013, canola 2012**
Soil test results:	**2013 'Komoora'** **Phosphorus (Colwell) 0–10 cm = 50 mg/kg, 10–30 cm = 11 mg/kg** **Nitrogen 140 kg N/ha (0–100 cm) pH Ca 5.5** **2014 'Wilgaree'** **Phosphorus (Colwell) 0–10 cm = 39 mg/kg, 10–30 cm = 7 mg/kg** **Nitrogen 176 kg N/ha (0–100 cm) pH Ca 4.5**

Treatments

- The basis of this trial is nutrient *omission*. The treatments listed e.g. Calcium (Ca) means all nutrients were applied *except* for Calcium and so on.
- The trace elements Boron (Bo), Calcium (Ca), Copper(Cu), Iron (Fe), Potassium (K), Magnesium (Mg), Manganese (Mn), and Zinc (Zn) were all applied in the chelated form as foliar sprays at growth stage Z 31 as individual nutrients in multiple passes. Products were applied in 100 L/ha water.

Ca	100 g/ha	Applied at Z 31
Mg	60 g/ha	Applied at Z 31
Zn	140 g/ha	Applied at Z 31
Mn	130 g/ha	Applied at Z 31
Cu	70 g/ha	Applied at Z 31
Fe	130g/ha	Applied at Z 31
K	440 mL/ha	Applied at Z 31
Bo	310 mL/ha	Applied at Z 31
N (as urea)	46 kgN/ha	Applied as urea – top-dressed
P (as Trifos)	20 kg P/ha	Applied in-furrow at sowing

- There were basically two control treatments of a nil fertiliser treatment where all macro and micronutrients were omitted and a full fertiliser (All) treatment where all macro and micronutrients were applied.

Results

The 2013 season had limited in-crop rainfall with a hot and dry finish to the season which limited yield across Treatments to around 2.0 t/ha. However, significant yield loss still occurred with the nil fertiliser treatment and from omitting phosphorus even in this water-limited situation (Figure 1). Omission of any other macro or micronutrients did not significantly impact on yield compared the full fertiliser (All) treatment in 2013.

In contrast, the 2014 season was an above average year for Nyngan which was reflected in much higher yield which averaged around 4.0 t/ha. Significant yield loss occurred with the nil fertiliser treatment and from omitting either phosphorus in 2014 (Figure 1). Omission of the other maconutrients (N or K) or any of the micronutrients did not significantly impact on yield compared the full fertiliser (All) treatment in 2014. The wheat crop was fresh at the time of foliar application of nutrients in both years. Neither root nor foliar diseases were visibly present throughout the growing seasons in either year.

Nutrient treatments only impacted on grain protein levels in 2013 with a significant reduction occurring in the nil fertiliser treatment and with the omission of nitrogen or copper (Figure 2).

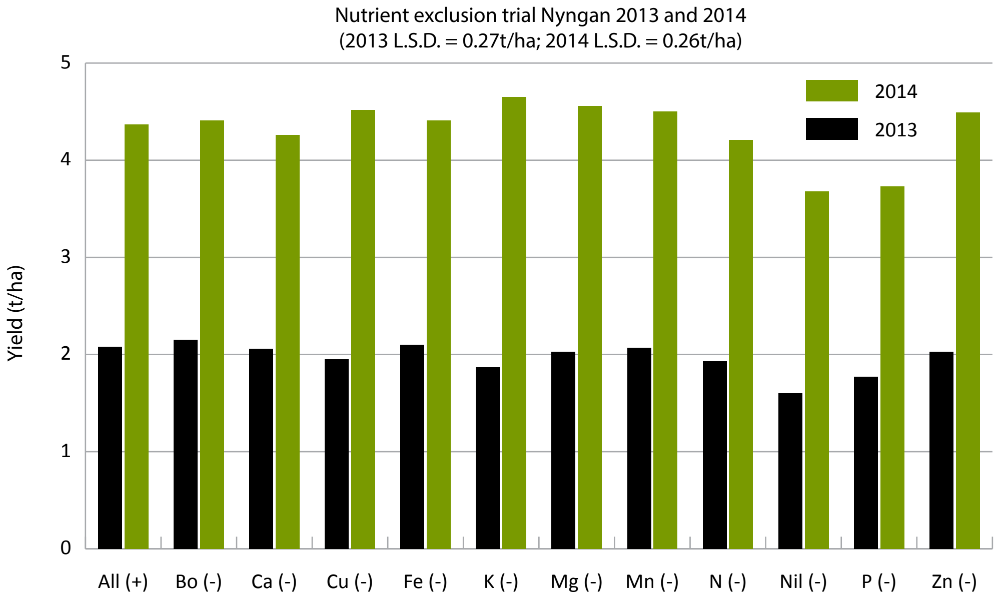

Figure 1. *Wheat yield with omission of a range of macro and micro nutrients – Nyngan 2013 and 2014*

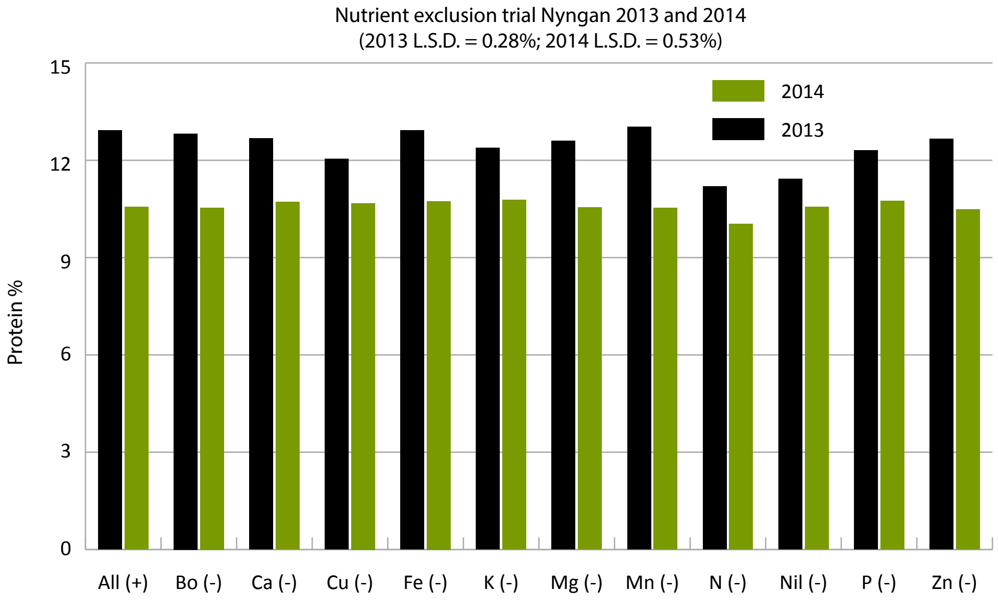

Figure 2. *Wheat protein levels with omission of a range of macro and micro nutrients – Nyngan 2013 and 2014*

Summary

The nil fertiliser treatment had the greatest impact on yield causing significant reductions in both years. This was followed very closely by the Nil P treatment in both seasons. The omission of nitrogen did not significantly impact on yield in either season likely due to moderate background soil N levels at the sites in both years.

In 2013 the nil N, nil fertiliser and nil Cu treatments all significantly reduced grain protein levels but there were no significant treatment effects in 2014.

These trials reinforce the importance of firstly applying adequate rates of the macronutrients P and N to maximise yield and grain protein levels. These nutrients need to be matched to existing soil levels based on testing prior to sowing. For example, the moderate background levels of N reduced responsiveness of further N application at these sites. Full soil testing for levels of all macro and micronutrients may have indicated which nutrients may have provided a response in yield or protein. Generally, micronutrients require a maintenance level to maximise yield with further application not providing additional benefit or potentially being detrimental as it shifts the balance with other elements.

Further work could concentrate on timing of the application of foliar trace elements or seed applied/soil applied with or without foliar application based around more thorough soil testing to assist in interpretation of responses or lack thereof.

Acknowledgements

This project is co-funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00167). Thanks to Gerard Lonergan, Peter Formann, Jayne Jenkins, Scott Richards, Paddy Steele, Lizzie Smith and Sally Wright (all NSW DPI) for technical assistance. Thanks to Gavin Melville Biometrician Trangie for data analysis.

Wheat variety response to nitrogen management – Tamarang 2014

Rick Graham and Guy McMullen
NSW DPI, Tamworth

Key findings

Lancer$^{\phi}$ appears to have good grain stability, achieving low screenings across both N rates and sowing dates, and was the variety with the highest grain nitrogen yield (GNY), showing good grain yield (GY) response to increasing N rates.

Spitfire$^{\phi}$ although lower yielding than Suntop$^{\phi}$, was due to its high grain protein concentration (GPC), still able to achieve a comparable GNY. EGA Gregory$^{\phi}$ due in part to its lower GPC and Dart$^{\phi}$ principally a result of its lower GY, were the varieties with the lowest GNY.

Variety selection played an important role, with the main season varieties Suntop$^{\phi}$, Lancer$^{\phi}$ and EGA Gregory$^{\phi}$ yielding well over both sowing dates. EGA Gregory$^{\phi}$ was however, less GY responsive to increasing rates of N application.

EGA Eaglehawk$^{\phi}$ was particularly impacted both in terms of GY and screenings with delayed sowing, and increasing N rates, failing to achieve grain receival screening standards of ≤ 5.0 %. Dart$^{\phi}$ and to a lesser extent Suntop$^{\phi}$ experienced screening issues with later sowing and increasing rates of N application.

Introduction

It is generally accepted that there are only minor differences between commercial wheat varieties, in terms of grain protein accumulation or grain nitrogen yield (GNY). This is essentially due to the 'yield dilution effect' where at a given rate of available N, any increase in grain yield (GY) will result in a decrease in grain protein concentration (GPC). In recent years however, studies have found that Spitfire$^{\phi}$ may under certain environmental conditions achieve a higher GNY than other bread wheat varieties. A preliminary investigation of GNY in VSAP wheat N response trials conducted between 2011 and 2013, found that Spitfire$^{\phi}$ achieved a higher GNY than EGA Gregory$^{\phi}$ in the majority of northern NSW trials with differences ranging from 0–18 kg N/ha (P. Martin, pers. comm.). There has also been some suggestion that this GNY response in Spitfire$^{\phi}$ is more evident on sites with high levels of available N (soil + applied).

Based on these perceived differences, a series of N management trials were conducted in the northern grains region of NSW in 2014 to determine if varieties do vary in their response to N nutrition, and to also examine the influence of N management on N use efficiency .The aim being to ensure that if variety differences do exist, that variety selection considerations and N management strategies are established to maximise yield potential and grain quality.

Site details

Location: **'The Point' Tamarang**
Co-operators: **Chris Wirth**
Previous crop: **Long fallow out of cotton**
Soil type: **Black vertosol**
Sowing dates: **Time 1: 9 May 2014, Time 2: 30 June 2014**
Fertiliser: **60 kg/ha Granulock Z extra at sowing**
Starting N: **160 kg N/ha (0–120 cm)**
Starting water: **~210 mm PAW to 120 cm**
In-crop rainfall: **170 mm**

Treatments

The trial included six varieties; Dart$^{\phi}$, EGA Eaglehawk$^{\phi}$, EGA Gregory$^{\phi}$, Lancer$^{\phi}$, Spitfire$^{\phi}$ and Suntop$^{\phi}$, in a fully replicated, factorial design with six N treatments in total. N treatments were 0, 20, 40, 80, 160, and a 2 × 40 kg N/ha split application (at sowing: GS31) all applied as urea (46%N). N treatments were side banded at sowing, apart from the split application which had half applied at planting and half at stem elongation (total N 80 kg/ha).

Results

Early sowing: 9 May 2014

- There was a significant ($P<0.001$) GY and GPC response for applied N. GY increased with applied N rates up to ~80 kg N/ha, with no significant difference between the 80 kg N/ha rates and the 160 kg N/ha rate. In contrast, GPC increased with increasing rates of N (Table 1).

Table 1. *Grain yield (t/ha), grain protein concentration (GPC; %) and grain nitrogen yield (GNY; kg N/ha) for six rates of applied nitrogen (kg N/ha).*

Rate of N application (kg N/ha)	Grain yield (t/ha)	GPC(%)	GNY(kg N/ha)
0	6.18	9.8	106.0
20	6.37	10.1	112.8
40	6.54	10.5	121.2
80 split (40 + 40)	6.83	11.6	137.8
80	6.75	11.4	134.9
160	6.85	12.6	151.0
L.S.D. (*P*=0.05)	0.14	0.2	4.3

- Suntopᶲ and Lancerᶲ had a GY advantage over other varieties when averaged across all treatments, with the earlier maturing variety Dartᶲ achieving the lowest overall yield response (Table 2).
- Lancerᶲ was GY responsive to increasing rates of N, showing a good yield response at both the 80 kg N/ha rates (up front and split) with an increase although not significant at the higher 160 kg N/ha application rate (Figure 1). It is interesting to note, that Dartᶲ and EGA Gregoryᶲ also trended towards a GY response for the split 80 kg N/ha rate.
- EGA Gregoryᶲ and Suntopᶲ showed good GY potential at the 0 N rate compared to the other varieties with EGA Gregoryᶲ for example out yielding Lancerᶲ (6.47 vs 6.14 t/ha) but was not as responsive to higher N rates applied up-front (Figure 1).

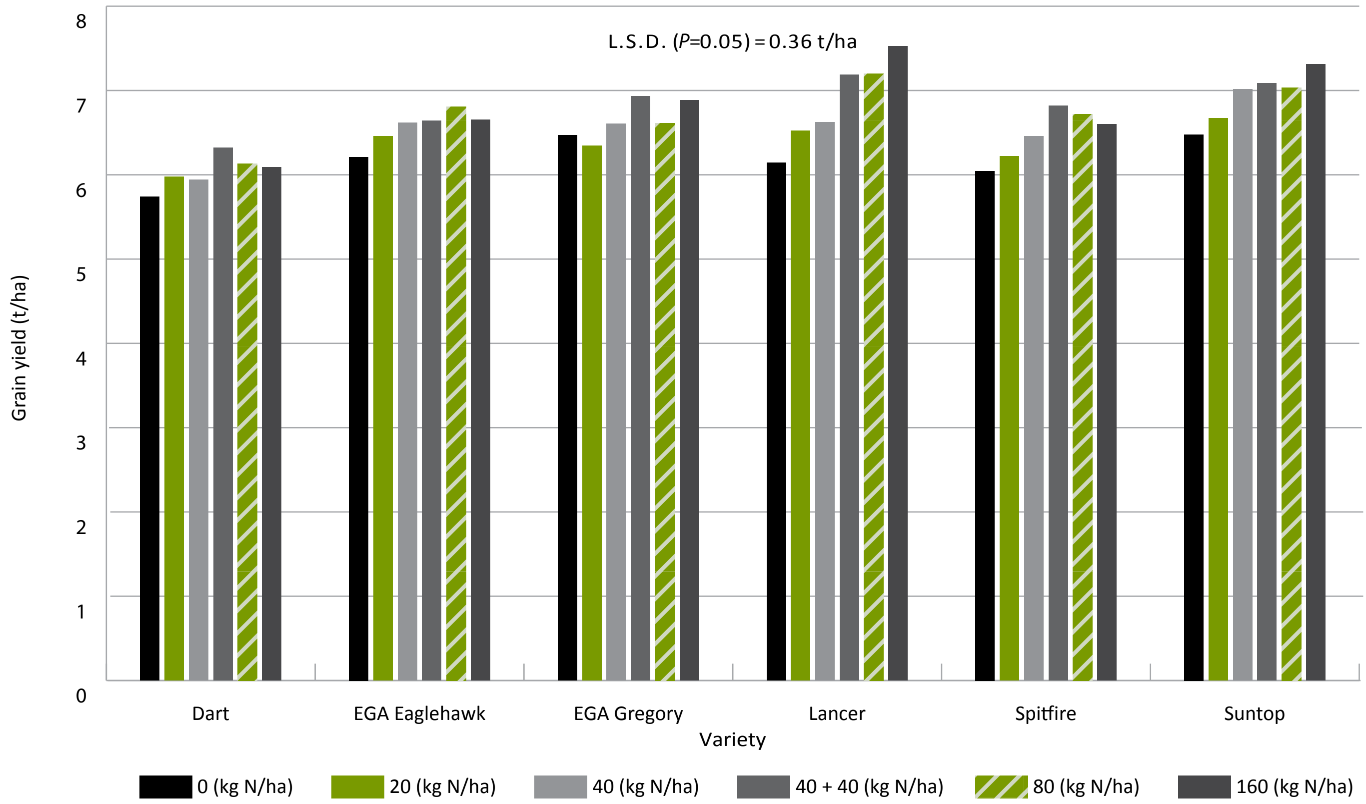

Figure 1. *Grain yield (t/ha) response to differing rates of nitrogen (kg N/ha) for six wheat varieties – Tamarang 2014*

***Table 2.** Mean varietal grain yield (t/ha), grain protein concentration (GPC) (%), grain nitrogen yield (GNY) (kg N/ha), screenings (%), test weight (kg/hL) and thousand grain weight (TGW)(g) averaged across N treatments*

Variety	**Grain yield (t/ha)**	**GPC (%)**	**GNY (%)**	**Screening (%)**	**Test Wt (kg/hL)**	**TGW (g)**
LRPB Dart$^{\Phi}$	6.03	11.4	120.7	4.5	85.2	35.2
EGA Eaglehawk$^{\Phi}$	6.57	10.9	126.2	3.0	85.5	34.5
EGA Gregory$^{\Phi}$	6.64	10.2	119.0	2.9	85.8	39.2
LRPB Lancer$^{\Phi}$	6.87	11.3	136.9	1.9	86.0	39.9
LRPB Spitfire$^{\Phi}$	6.48	11.5	130.9	3.2	86.7	41.1
Suntop$^{\Phi}$	6.93	10.7	130.3	3.2	83.9	37.2
L.S.D. (p=0.05)	0.14	0.2	4.2	0.3	0.3	0.7

- The apparent inverse relationship between GY and GPC can be seen with the changes in variety rankings for GPC vs GY (e.g. Dart$^{\Phi}$ and Suntop$^{\Phi}$; Table 2). This is also illustrated using a trend line where GY and GPC for the six varieties were averaged for all N treatments and plotted against each other (Figure 2). When looking at GNY to gain a clearer picture of this response (GP vs GPC) there were significant variety differences (Table 2). Lancer showed that it was the highest GNY variety averaged across all treatments, with EGA Gregory$^{\Phi}$ due in part to its lower GPC and Dart$^{\Phi}$ principally a result of its lower yield, the lowest GNY varieties. Spitfire$^{\Phi}$ although lower yielding than Suntop$^{\Phi}$, was however due to its high GPC, still able to achieve a comparable GNY.

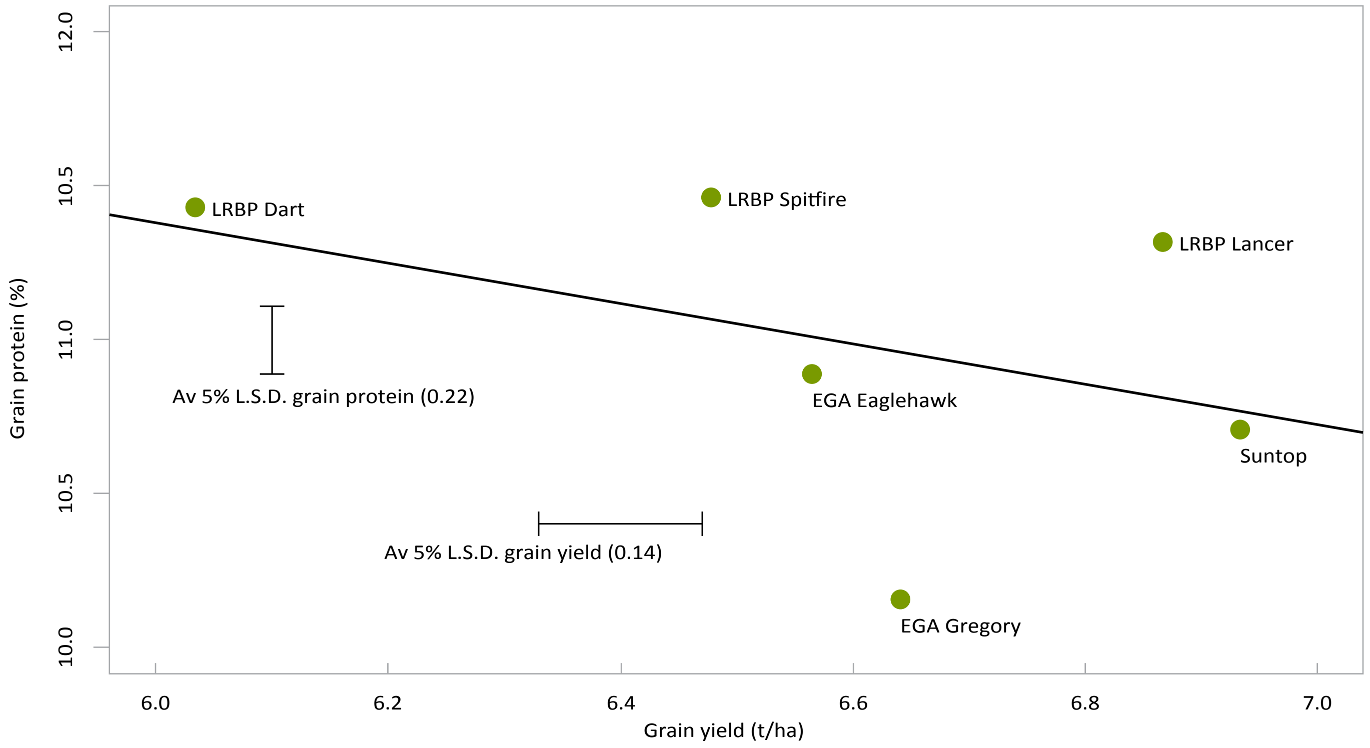

***Figure 2.** Relationship between grain yield (t/ha) and grain protein concentration (%) for six wheat varieties averaged over all nitrogen treatments – Tamarang 2014*

- All varieties were well above the minimum test weight requirement of 76.0 kg/hL for all N rates (Table 2). Variety responses to N rate although quite variable were generally within the 5.0% maximum grain screenings receival standard, only Dart⍚ at 5.3% exceeding this at the high 160 kg N/ha rate, with EGA Eaglehawk⍚ at 4.6% screenings the next highest also at the 160 kg N/ha rate (data not shown).

Delayed sowing: 30 June 2014

- In contrast to the earlier sowing date (9 May), increasing N rate provided no GY benefit. This may have been due to the effect of colder temperatures (soil and air) on plant growth resulting in reduced root growth, tiller numbers, dry matter accumulation, N uptake and efficiency. Conversely, the effect of heat and or moisture stress during the shortened critical grain fill period would also have influenced yield potential and grain quality parameters. There were however, significant (P<0.001) variety differences in terms of GY and GPC (Table 3).

Table 3. *Mean varietal grain yield (t/ha) and grain protein concentration (GPC; %) averaged across N treatments*

Variety	Grain yield (t/ha)	GPC (%)
LRPB Dart⍚	4.89	12.4
EGA Eaglehawk⍚	4.38	12.3
EGA Gregory⍚	5.33	12.3
LRPB Lancer⍚	5.10	12.9
LRPB Spitfire⍚	4.68	13.7
Suntop⍚	5.26	12.0
L.S.D. (p=0.05)	0.12	0.2

- GPC also increased with increasing rates of N application (data not shown), which is consistent with increasing amounts of N being available for protein deposition as GY remained relatively constant across increasing N application rates.
- The level of grain screenings was significant with (P<0.001) variety, N rate response and a variety × N rate interaction. EGA Eaglehawk⍚ in particular, was adversely impacted by both delayed sowing and increasing N application rate (Figure 3). Increased screenings were also generally associated with increasing N rates in other varieties. Dart⍚, similar to the earlier sowing date, had problems achieving screenings of ≤ 5.0 % with delayed sowing. Suntop⍚ also had issues achieving grain screening specifications at N rates of 40 kg N/ha and above. In contrast, Lancer⍚ was able to maintain its grain size and appears to have good grain stability, achieving low screenings across N rates (Figure 3). Both Spitfire⍚ and EGA Gregory⍚ also showed relatively good grain size stability with a delayed sowing time and increasing N application rates.

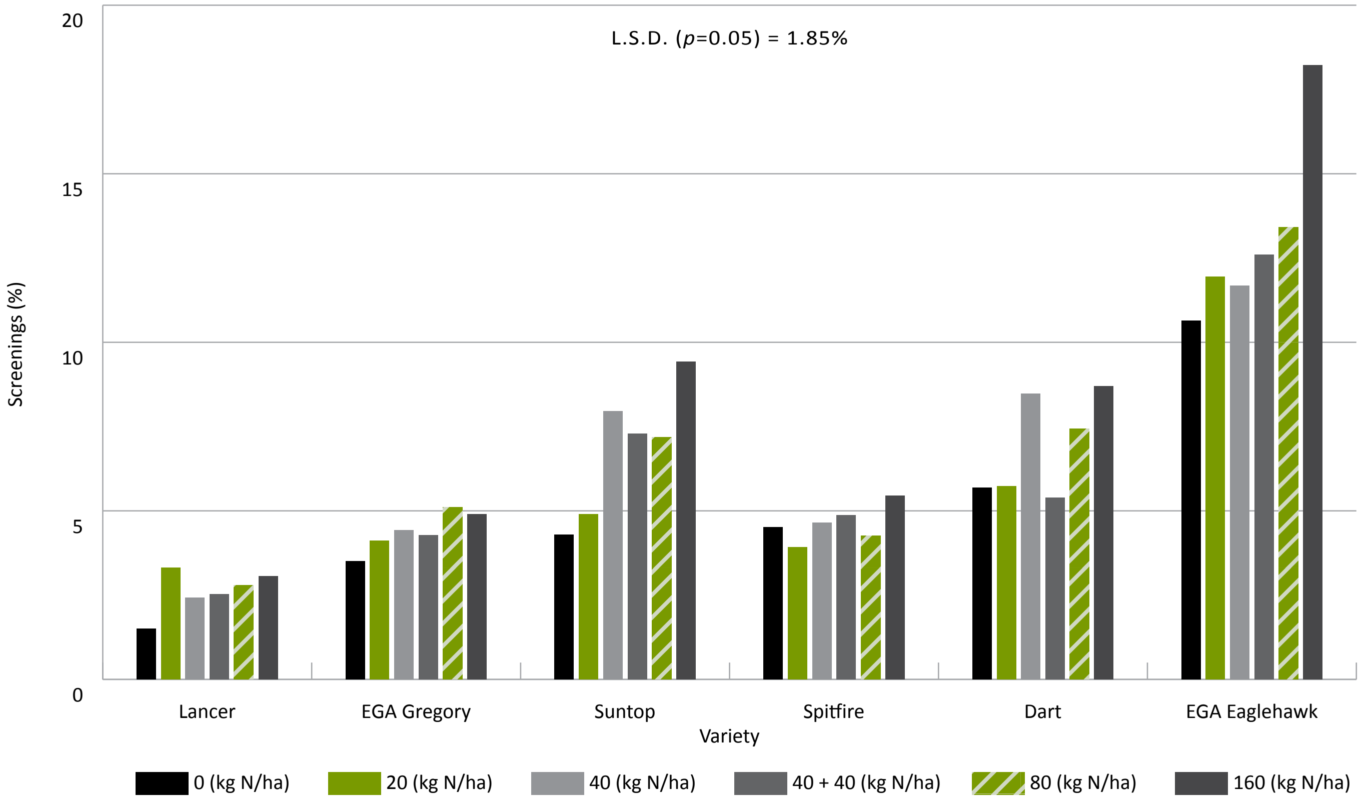

Figure 3. *Varietal response for screenings (%) for six nitrogen rates with a delayed sowing*

Summary

Sowing time had a significant effect on GY response to N application rate. Delayed sowing apart from adversely impacting on GY potential, also had an adverse effect on grain quality, and screenings in particular. Variety selection was shown to play an important role, the main season varieties Suntop$^{\phi}$, Lancer$^{\phi}$ and EGA Gregory$^{\phi}$ produced good yields over both sowing dates. The shorter season varieties Dart$^{\phi}$ and Spitfire$^{\phi}$ had no yield advantage over the main season varieties from a later sowing date. The longer season variety EGA Eaglehawk$^{\phi}$ was particularly impacted both in terms of GY and screenings with delayed sowing, failing to achieve grain receival screening standards of ≤ 5.0 %. Suntop$^{\phi}$ also experienced grain screening issues with later sowing and increasing rates of N application.

Lancer$^{\phi}$ appears to have good grain stability achieving low screenings across N rates and sowing dates, and was also the variety with the highest GNY. Spitfire$^{\phi}$ achieved a higher GNY (11.9 kg N/ha) than EGA Gregory$^{\phi}$, which is consistent with previous Northern region VSAP trials. These results highlight the importance of variety selection/maturity considerations, and underline the potential for varietal differences in terms of GY, grain quality, and GNY responses to N management and sowing time.

Varietal responses to N management, will be further investigated, to help ascertain if variety × environment × management guidelines can be put in place to further optimise varietal yield and grain quality potential in the northern grains region.

Acknowledgements

This trial was co-funded by NSW DPI and GRDC under the Variety Specific Agronomy Project (DAN00167). Technical assistance provided by Stephen Morphett, Jim Perfrement, Peter Formann, Jim Keir, Jan Hosking, Rod Bambach and Richard Morphett (all NSW DPI) are also gratefully acknowledged.

Delaying soil nitrate availability reduces nitrogen loss when growing sorghum on Vertosols

Graeme Schwenke and Bruce Haigh
NSW DPI, Tamworth

Introduction

In northwest NSW, grain sorghum crops are fertilised with nitrogen either before, or at, sowing. Once applied, the fertiliser (usually urea or ammonia gas) is converted through to the nitrate (NO_3^-) form by the process of nitrification. This leads to a substantial pool of nitrate in the surface soil that is potentially at risk of loss through denitrification – should waterlogging occur while the crop is still establishing. Waterlogged soils can quickly become anaerobic (oxygen depleted). In anaerobic soils, soil nitrate is converted into the gases nitric oxide (NO), nitrous oxide (N_2O) and di-nitrogen (N_2), which are not held in the soil but diffused out into the atmosphere. Nitrous oxide is a greenhouse warming gas that is accumulating in the atmosphere. However, most of the N lost during denitrification is N_2 which does not affect global warming but can constitute a significant loss of applied N from the paddock.

Our trials in 2012–13 showed that N_2O emissions can be relatively high under waterlogged conditions. Our trials in 2013–14 aimed to reduce N_2O emissions by delaying the availability of soil nitrate before significant crop N-uptake occurs. Production of nitrate from urea can be delayed either (a) chemically – by using a nitrification inhibitor (3,4-dimethylpyrazole phosphate, DMPP) with urea (ENTEC®), or (b) physically – by not applying the fertiliser until the crop is actively growing. ENTEC® urea produces ammonium which accumulates in the soil or is used by the growing plant, rather than converted to nitrate.

In the 2013–14 summer, we ran two field trials comparing N_2O emissions emanating from cracking clay soils (vertosols) that were fertilised using these two delayed-nitrate strategies. The results were compared to the standard strategy of applying standard urea at sowing and a nil-N control.

Site details

Main trial (auto chambers)

Location:	**Tamworth Agricultural Institute**
Co-operator:	**NSW DPI**

On-farm trial (manual chambers)

Location:	**Romney Vale, near Quirindi**
Co-operator:	**Ian Carter**

Key findings

Nitrogen can be lost from the soil as gases, including the greenhouse gas nitrous oxide (N_2O) particularly between when N fertiliser is applied at sowing and when plants establish a strong demand for N uptake.

To reduce the risk of this loss occurring, we trialled delaying the availability of soil nitrate supply to until the crop was well established through (a) using ENTEC® (urea coated with DMPP, a nitrification inhibitor), and (b) by applying urea at the booting growth stage.

Compared to urea applied at sowing, using ENTEC® reduced N_2O emissions by 65–100%. However, since there was not waterlogging events, there was no grain yield benefit of the ENTEC®.

Delaying urea application until booting reduced N_2O emissions by 95–100% compared to at-sowing urea, but the dry conditions meant that the late applied N was not used to improve grain yield or protein above that of the nil-N control.

Treatments

Tamworth trial	Quirindi trial
Nil N applied* Urea side-banded at planting: 80, 100*, 120 kg N/ha ENTEC® side-banded at planting: 80, 100*, 120 kg N/ha Urea or ENTEC® top-dressed at booting: 20 December 2013 (100* kgN/ha)	Nil N applied* Urea side-banded at planting: 80*, 100*, 120* kg N/ha ENTEC® side-banded at planting: 80*, 100*, 120* kg N/ha Urea or ENTEC® top-dressed at booting: 6 December 2013 (100* kg N/ha)
Variety: MR Bazley Row spacing: 75 cm Sown: 5 November 2013 Harvested: 10 March 2014	Variety: MR Bazley Row spacing: 75 cm Sown: 22 October 2013 Harvested: 19 March 2014
*Auto gas emissions chambers on these treatments. Sampled 8 times/day for whole year from planting	*Manual gas emissions chambers on these treatments. Sampled every 1–14 days, depending on rain, from sowing till harvest

Results

Grain production

Tamworth trial

- Average grain yield across the trial was 3.0 t/ha and mean protein was 8.1%. These yields are much lower than what the site is capable of (e.g. >5 t/ha in 2010).
- There was a clear response to N fertiliser added at sowing in both yield and protein. The only significant differences in yield due to N application rate was with 100 kg N urea which yielded lower than either the 80 or 120 kg N rate. However, this was not a true rate response effect but was actually caused by sowing problems in one of the 100 kg N urea treatment plots.
- There were real treatment effects when N fertiliser was applied post-sowing, with the grain yield of the urea treatment no different from the nil-N control and the post-sowing ENTEC® treatment only marginally better. Grain protein in the two post-sowing N application treatments was also no different from the nil-N control treatment. These results reflect the paucity of rainfall between when these late N applications were made in December 2013 and grain harvest.

Quirindi trial

- Grain yields averaged 3.1 t/ha at the site and were not significantly affected by any N treatment, although the nil-N treatment did have the lowest yield. Grain protein averaged 11.1% and was not significantly affected by N fertiliser treatment. However, the nil N treatment did have the lowest protein of the trial treatments. It appears that the combination of adequate soil mineral N at sowing and the dry growing season limited the yield and grain N uptake potential such that the added N had no impact on grain yield or grain protein.

Gas Emissions

Tamworth trial

- Emissions from the ENTEC®-treated urea treatment were only a third of that from the standard urea treatment applied at the same time and at the same N rate.
- One year after sowing, the N_2O emission factor for the urea was 0.64%, compared to just 0.22% for the ENTEC®-urea, and only 0.12% for the 100 kg of urea-N/ha applied at booting. While this may make the urea applied post-sowing seem attractive due to its reduced N_2O emissions, it should be noted that the extreme dry weather after this application meant that the crop did not benefit from the applied N fertiliser.

Quirindi trial

- Results from the manual chamber measurements were similar in magnitude to those from the Tamworth auto chamber site for the standard urea treatment. At the end of the growing season we calculated an emission factor of 0.4% for 100 kg urea-N/ha but only 0.22% for 80 kg urea-N/ha.
- At the Quirindi trial the N_2O emissions from ENTEC® plots were no different to the background (nil-N plots) so the N_2O reduction was 100%.
- The post-sowing N application at Quirindi produced no N_2O emissions greater than the nil-N treatment until rains in February 2014 started emissions from both late-applied urea and ENTEC® treatments, giving them an emission factor by the end of the season of 0.08% (urea) and 0.13% (ENTEC®). It is most likely that emissions from these treatments in particular, and all other plots to a lesser degree, would have continued throughout the post-harvest fallow, as occurred at the Tamworth trial.

Summary

- Results from both trials showed that ENTEC® urea was very effective in reducing N_2O emissions, with 67–100% less N_2O emitted when compared to standard urea.
- In this season, there was no yield benefit of ENTEC® urea over standard urea, because there was no denitrification of nitrate from the urea. Therefore the crop got its N equally from either urea or ENTEC®.
- Delaying the application of urea from at-sowing to post-sowing to reduce the time of risk between application and plant N uptake proved effective in reducing N_2O emissions, but was not beneficial in this season's conditions as the lack of rainfall after application meant the fertiliser was not used.
- Due to the dry growing season the crop did not use all the N provided. So, unused nitrate in the soil led to some post-harvest N_2O emissions. We are currently investigating the carry over value of this applied N with a following sorghum crop in 2014–15.

Acknowledgements

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Nitrogen losses by denitrification can be large from waterlogged Vertosols growing sorghum

Graeme Schwenke and Bruce Haigh
NSW DPI, Tamworth

Key findings

Denitrification can lead to a significant loss of fertiliser nitrogen if soils become waterlogged after heavy rain. Waterlogging depletes the soil of oxygen, so microorganisms use nitrate instead of O_2 as an electron-acceptor, converting nitrate to the gases nitric oxide, nitrous oxide and di-nitrogen.

We used ^{15}N isotope-labelled urea to trace the fate of urea applied at sowing to field-grown sorghum. Trials were located on black Vertosol soils at two sites – near Tamworth and Quirindi – in the 2012–13 summer season.

In-crop rainfall was above average for part of the season at the Tamworth site, but well above average at the Quirindi site.

Between 12 and 45% of the N applied as ^{15}N urea in 2012–13 was not recovered in either soil or plant samples, so was presumed lost through denitrification.

Introduction

In ordinary season conditions, most fertiliser nitrogen (N) applied as urea or ammonia gas at sowing (or pre-sowing) is converted by soil micro organisms to ammonium (NH_4^+) and then to nitrate (NO_3^-). Both ammonium and nitrate can be taken up by plants for growth. However, should the soil become waterlogged (oxygen-depleted), substantial amounts of nitrate-N can be lost as gases from the soil through the process of denitrification. Previous work in Queensland has found losses up to and exceeding 80% of the fertiliser N applied, depending on the time of year, the period of waterlogging and the availability of a labile carbon source such as fresh crop residues. In waterlogged soils, soil nitrate is converted into the gases nitric oxide (NO), nitrous oxide (N_2O) and di-nitrogen (N_2), which are not held in the soil but diffuse out into the atmosphere.

Our main plot trials in 2012–13 showed that N_2O emissions were quite high under the waterlogged conditions encountered, especially at the Quirindi trial (see 2014 Trial Results Book). However, the main avenue of N loss from denitrification is via N_2 which is difficult to measure directly given that the atmosphere is mainly composed of N_2. Using ^{15}N-labelled fertiliser we are able to measure the ^{15}N used by the harvested crop and the ^{15}N remaining in the soil, and then the difference between these amounts and the amount originally added represents that lost as gas. Since we incorporated the ^{15}N fertiliser into the soil surface volatilisation should be minimal. Therefore, the 'missing' ^{15}N should represent the total N lost as the result of denitrification.

Site details

Main trial

Location:	**Tamworth Agricultural Institute**
Co-operator:	**NSW DPI**

On-farm trial

Location:	**Romney Vale, near Quirindi**
Co-operator:	**Ian Carter**

Treatments

Tamworth trial	Quirindi trial
^{15}N-urea (10% atom enrichment) side-banded at planting (40, 120, 200 kg N/ha) in mini-plots (1 m^2 each) located within larger plots (36 m^2)	^{15}N-urea (10% atom enrichment) side-banded at planting (40, 120, 200 kg N/ha) in mini-plots (0.75 m^2 each) located within larger plots (36 m^2)
Variety: MR Bazley Row spacing: 75 cm Sown: 23 October 2012 Harvested: 22 March 2013	Variety: MR Bazley Row spacing: 75 cm Sown: 8 December 2012 Harvested: 3 May 2013
Plants within mini-plots were hand harvested and grain hand-threshed. Large roots were separated from soil. Soil within mini-plots was sampled from 0–0.1 m, 0.1–0.2 m, 0.2–0.3 m, 0.3–0.6 m. All samples analysed for total N% and ^{15}N content. Deeper cores had no ^{15}N.	
Plant rows either side of mini-plots were also sampled for check of N scavenging, and nearby nil-N plots also sampled (soil and plant) to gauge the natural abundance of ^{15}N in the soil.	

Results

Rainfall

- Figure 1 shows the monthly rainfall totals at the (a) Tamworth and (b) Quirindi trial sites, along with the long-term median monthly rainfall. At Tamworth, rainfall was below average early in the growing season, but slightly above average in December and February. At the Quirindi site, rainfall was more than double the long-term average in January and March, and also well above average in February. Total in-crop rainfall was 322 mm at Tamworth, and 427 mm at Quirindi.
- The soil at Quirindi was of heavier texture (80% clay) than that at the Tamworth trial site (44% clay). Heavier clay soils are typically more slowly drained and often remain oxygen depleted for longer.

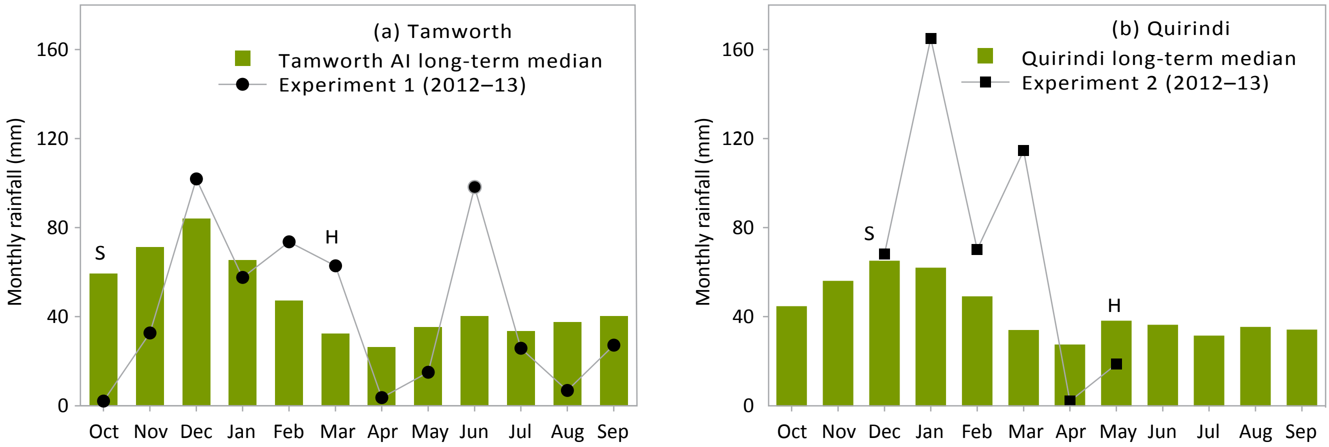

***Figure 1**. Long-term monthly rainfall (bars) and measured monthly rainfall totals (points and line) recorded at the Tamworth and Quirindi trial sites in the 2012–2013 summer season (S – sow, H – harvest)*

Tamworth trial

- Figure 2 (left) shows the recovery of ^{15}N from the mini-plots at the Tamworth trial site. There appears to be some differences in total and fractional recoveries of ^{15}N between the three N rate treatments. Total ^{15}N recovery within the mini-plots ranged from 66–77% although we also recovered varying amounts (0–22%, average = 9.6%) of the applied ^{15}N in adjoining rows outside the mini-plots. Therefore, the total ^{15}N recoveries in plant and soil were actually 88% (40 kg N/ha), 79% (120 kg N/ha) and 74% (200 kg N/ha). This means that unrecovered ^{15}N presumed lost from the soil-plant system as gases, was 12%, 21% and 26% for the 40, 120 and 200 kg N/ha treatments, respectively, which equates to N losses from the applied urea of 5, 25 and 52 kg N/ha from the three different N rate treatments.

Quirindi trial

- At the Quirindi trial site, N losses from ^{15}N labelled urea were even greater than at Tamworth, which was not surprising considering the lengthy period of waterlogging at the site in January–February 2013. Figure 2 (right) shows the average recoveries of the applied ^{15}N in the soil (mostly near the surface), in large plant roots, and in the plant tissues and grain. The amount of ^{15}N scavenged by the plants in the adjoining buffers rows averaged just 2% (range: 0–5%), which meant that the total recoveries of applied ^{15}N in the soil-plant system were 57%, 55%, and 72%. This equates to gaseous losses (unrecovered ^{15}N) of 17, 54 and 56 kg N/ha from the three different N rate treatments.

- Linking these results with the N_2O measured using automated and manual chambers at the same trials, we found that the ratio of N_2:N_2O loss varied from 13:1–61:1 across both sites and N rates, with no clear treatment effects. This highlights the fact that there is not a fixed ratio between gases lost, but that it varies with local weather conditions and soil properties.

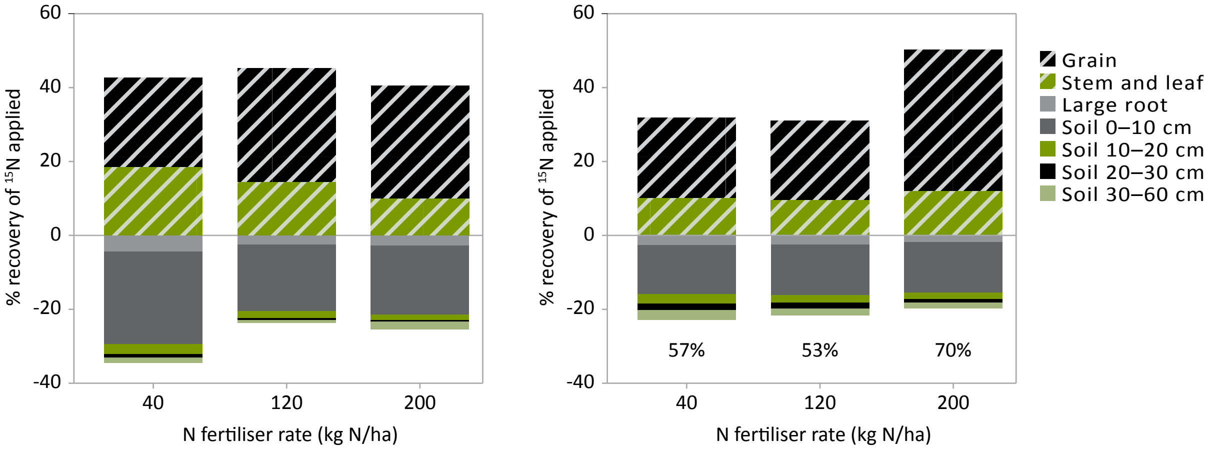

Figure. 2. *Recovery of applied ^{15}N in soil, roots, shoots and grain sampled from within the mini-plots at harvest in the Tamworth (left) and Quirindi (right) trial sites. The total recovery from within the mini-plot areas (not including ^{15}N found in plants of adjoining rows) are given at the top of each bar*

Summary

- Unrecovered ^{15}N, presumed lost from the soil-plant system as N_2, N_2O and NO gases, ranged 12–26% at the Tamworth (drier) site and 28–45% at the Quirindi (wetter) site.
- This equates to N losses from fertiliser of 5–17 kg N/ha (40 kg N/ha), 25–54 kg N/ha (120 kg N/ha) and 52–56 kg N/ha (200 kg N/ha applied).
- The largest portion of applied ^{15}N fertiliser was found in the harvested grain, followed by the topsoil (0–0.1 m), and then the above-ground plant material. The topsoil portion would also have included fine roots not easily separated out during sample processing.

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