Department of Primary Industries

Northern Grains Region Trial Results Autumn 2013

RESEARCH & EXTENSION – INDEPENDENT RESEARCH FOR INDUSTRY

Editors: Loretta Serafin, Steven Simpfendorfer, Matthew Gardner and Guy McMullen

Grains Research & Development Corporation

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Editing and compilation

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

Front cover photos: (large background photo) Canola windrowing – Matthew Gardner;
(smaller photos, left to right) Sowing trial at Breeza – Matthew Gardner,
Dr Kevin Moore speaking to growers at a chickpea field day – Loretta Serafin,
Crown rot infected wheat – Steven Simpfendorfer

Production

Design by Melissa Collins, Campaign Graphic Design.
Production by Barry Jensen, NSW DPI Orange.

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 and Narrabri, conduct a range of on-farm research trials across plant breeding, agronomy, physiology, nutrition and crop protection.

This is the fourth edition of the Northern Grains Region Trials Book and it has grown significantly since the first edition. The 2013 volume includes over 70 papers reporting on trials from across the northern grains region from Dubbo to the Queensland border. 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. In many cases the research that is reported will prompt more 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 the Northern Grains Region Trials Book a valuable resource into the future.

The Research & Development Team,
NSW Department of Primary Industries

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Crop protection

Sowing time response of 15 barley varieties – Trangie 2012

Rohan Brill NSW DPI, Coonamble

Introduction

Barley is known to be more tolerant of frost than wheat; therefore flowering can occur earlier in the spring or even into late winter. In most north and central western NSW environments flowering of barley could safely occur 7–10 days earlier than flowering of wheat to avoid frost damage.

The main place for barley in the crop rotation is following wheat. This extends the cereal phase in the rotation without risking foliar disease carry over that occurs in wheat on wheat situations. Barley also has a logistical fit since it is generally harvested earlier than wheat and can achieve good yields in dry years relative to wheat and broadleaf rotation crops.

These results are a continuation of trials which have been reported in previous editions of the Northern Grains Region Trial Results Book.

Key findings

Yield was maximised by sowing early, regardless of plant maturity. Flowering dates from this early sowing ranged from 30th August for Hindmarsh[PBR] to 23rd September for Navigator[PBR].

Commander[PBR], Hindmarsh[PBR] and the new feed variety Fathom[PBR] achieved above average yield from all three sowing dates. Across several seasons, Hindmarsh[PBR] has performed best from early sowing, while Commander[PBR] has had similar yield from either early or mid-season sowing.

Site details

Location:	**Trangie**
Soil type:	**Grey vertosol (cracking clay)**
2011 crop:	**Canola**
2010 crop:	**Wheat**
Root Lesion Nematodes:	**Nil**
Plant Available Water (sowing):	**180 mm**
Nitrogen:	**177 kg/ha (0–90 cm)**
Phosphorus:	**22 mg/kg (Colwell, 0–10 cm)** **40 mg/kg (BSES)**

Treatments

3 sowing dates – 30 April (dry sown, 12 mm recorded 3 May), 21 May, 12 June
6 accredited malting barley varieties – Bass[PBR], Buloke[PBR], Commander[PBR], Gairdner[PBR], Navigator[PBR] and Schooner[PBR]
1 food variety – Hindmarsh[PBR]
3 feed varieties – Fathom[PBR], Oxford[PBR] and Urambie[PBR]
5 varieties undergoing malt evaluation – IGB1101, Flinders[PBR], Skipper[PBR], Westminster[PBR], Wimmera[PBR]

Results

- Grain yield was maximised from the early sowing date, regardless of plant maturity (Figure 1).
- There was no yield loss from very early flowering, with varieties flowering in late August achieving high yield in this season.
- Late sowing resulted in significant yield loss, even where quick varieties such as Hindmarsh[PBR] flowered at similar dates as early sown slow varieties (e.g. Urambie[PBR] and Navigator[PBR]).
- Grain yield of Commander[PBR], Hindmarsh[PBR] and Fathom[PBR] were relatively high at each of the three sowing dates (Figure 2).
- The older varieties Schooner[PBR] and Gairdner[PBR] had relatively low yield at each of the three sowing dates.
- Commander[PBR] and Oxford[PBR] had lower grain protein than most other varieties.

Figure 1: Effect of flowering date on yield of 15 barley varieties sown at three dates at Trangie in 2012

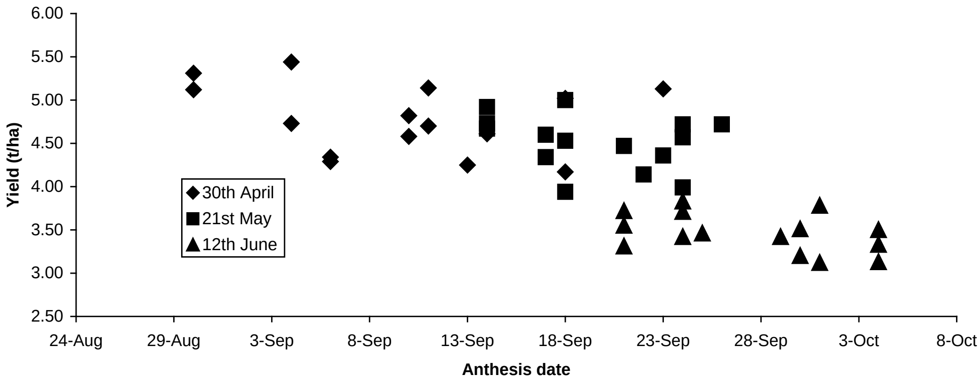

Figure 2: Grain yield, grain protein concentration and anthesis date of 15 barley varieties sown at three dates at Trangie in 2012

Variety	Yield (t/ha) and protein (%)						Anthesis date		
	30th April (dry)		21st May		12th June		30th April	21st May	12th June
Bass(b)	4.58	14.1	4.47	14.0	3.51	13.9	10-Sep	21-Sep	30-Sep
Buloke(b)	4.34	13.1	4.34	13.2	3.42	13.2	6-Sep	17-Sep	24-Sep
Commander(b)	5.14	12.8	5.00	12.1	3.83	12.0	11-Sep	18-Sep	24-Sep
Fathom(b)	5.44	13.3	4.67	13.3	3.72	13.2	4-Sep	14-Sep	21-Sep
Flinders(b)	4.82	14.2	4.53	14.2	3.42	14.1	10-Sep	18-Sep	29-Sep
Gairdner(b)	4.25	13.5	4.14	13.6	3.12	13.9	13-Sep	22-Sep	1-Oct
Hindmarsh(b)	5.31	12.9	4.73	13.1	3.55	13.4	30-Aug	14-Sep	21-Sep
IGB1101	5.12	12.8	4.92	12.5	3.31	12.7	30-Aug	14-Sep	21-Sep
Navigator(b)	5.13	13.4	4.72	13.8	3.50	13.6	23-Sep	26-Sep	4-Oct
Oxford(b)	4.61	12.4	4.72	12.2	3.78	12.1	14-Sep	24-Sep	1-Oct
Schooner(b)	4.29	14.1	3.94	13.9	3.46	14.2	6-Sep	18-Sep	25-Sep
Skipper(b)	4.73	12.9	4.60	13.0	3.71	13.2	4-Sep	17-Sep	24-Sep
Urambie(b)	5.02	13.2	4.57	13.4	3.33	13.1	18-Sep	24-Sep	4-Oct
Westminster(b)	4.17	13.5	3.99	13.5	3.20	13.5	18-Sep	24-Sep	30-Sep
Wimmera(b)	4.70	13.7	4.36	14.1	3.13	14.0	11-Sep	23-Sep	4-Oct
Mean of sow time	4.78	13.3	4.51	13.3	3.47	13.3			
l.s.d. p = 0.05	Yield ST	0.13	Protein ST	0.42					
	Yield Variety	0.21	Protein Variety	0.31					

ST = Sowing time.

Summary

The 2012 season was the fourth year where a barley time of sowing trial was conducted at Trangie Agricultural Research Centre. The trials in 2009, 2010 and 2012 all had the highest yield from the earliest sowing. In 2011 there was no effect of sowing time on yield. Based on these four years of trials, it is recommended to sow barley from early to mid-May. Within this range, sowing date decisions need to be based on specific variety choice. Hindmarsh$^{\Phi}$ has yielded best from early May sowing dates, even when flowering occurs in late August. Commander$^{\Phi}$ has performed just as well from a mid-May sowing date as an early May sowing date, not necessarily because of reduced frost exposure from the later sowing, but more that the later sowing of Commander$^{\Phi}$ has a reduced lodging risk and reduced vegetative growth.

Agronomic management recommendations for Hindmarsh$^{\Phi}$ and Commander$^{\Phi}$ are also quite different. Hindmarsh$^{\Phi}$ responds favourably to high plant populations (100–150 plants/m^2) and early nitrogen applications, whereas the target plant population of Commander$^{\Phi}$ should be moderate (about 80 plants/m^2). Early nitrogen application to Commander$^{\Phi}$ may lead to increased lodging.

The relatively lower grain protein of Commander$^{\Phi}$ may be an advantage where nitrogen levels are high; however with declining soil nitrogen levels in northern NSW, Commander$^{\Phi}$ may be less likely to achieve the required 9% threshold for malting grades. This highlights the importance of soil testing at least a few paddocks each year to make sound nitrogen decisions.

While not compared experimentally, this barley time of sowing trial was adjacent to the 2012 wheat time of sowing trial. The average yield of the barley trial was 4.2 t/ha compared with 3.2 t/ha in the wheat trial. Again this highlights the risk management benefits of barley, being able to maintain relatively high yield in a tight finish compared with wheat.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

AGRONOMY

Grazing potential and grain recovery of eight spring barley varieties – Somerton 2012

Matthew Gardner, Loretta Serafin, Peter Formann NSW DPI, Tamworth
Dougal Pottie NSW DPI, Gunnedah

Key findings

Westminster⏀ produced the greatest dry matter for grazing of all the barley varieties and still only had a significantly lower grain yield than one variety, Urambie⏀.

Urambie⏀ produced the highest grain yield that was significantly better than four other varieties. However, it produced the poorest quality grain of all varieties with extremely pinched grain (>20% screenings).

Utilising spring barley varieties for short grazing periods may provide an opportunity to rest early sown grazing cereals.

It is also recommended that if spring barley varieties are going to be grazed that they are sown 7–10 days earlier to maximise biomass accumulation and compensate for delayed flowering time.

Introduction

Well managed dual purpose cereals provide producers with an opportunity for increased profitability and flexibility in mixed farming systems, by enabling increased winter stocking rates and generating additional income from forage as well as grain recovery. Barley, with its vigorous early growth, generally produces more dry matter for grazing and greater grain yield compared to grazed wheat. Typically dual purpose crops are sown earlier and use longer season varieties that produce greater dry matter for grazing. In some circumstances grazing can be beneficial to grain production by reducing lodging or in seasons with dry springs grazing can increase grain yield due to reduced water use in the vegetative stages leaving more soil water for grain-fill. The objective of this experiment was to investigate the dry matter production and grain recovery of main season 'grain only' barley varieties compared to typical grazing varieties.

Site details

Location:	**"Clermont Park", Somerton**
Co-operators:	**Andrew & Belinda Davidson**
Sowing date:	**20th April, 2012**
Fertiliser:	**70 kg/ha Nitrogen as Urea, 75 kg/ha Supreme Z Extra**
Dry Matter Assessment 1:	**22nd June**
Grazing 1:	**24th June**
Dry Matter Assessment 2:	**19th July**
Grazing 2:	**22nd–26th July**
Grain Harvest:	**13th November, 2012**

Treatments

There were ten barley varieties included in the trial: Yambla⏀, Urambie⏀, Grange⏀, Henley⏀, Grout⏀, Oxford⏀, Westminster⏀, Commander⏀, Fathom⏀ and Fairview⏀. Yambla⏀ and Urambie⏀, which are the established winter barley lines currently used for grazing and grain recovery systems, were included to gauge the relative performance of the spring type (grain only) barley varieties.

Two dry matter assessments were conducted, with each assessment being followed by a 'crash' grazing with sheep to remove the dry matter evenly across all plots. Following the second grazing the animals were excluded for the remainder of the season to allow grain recovery to be determined in mid November. Also following the second grazing 50 kg N/ha was applied in the form of liquid UAN through streaming bars across the whole trial site. The trial was harvested using a KEW plot header on the 13th of November.

Results

Dry Matter Yield

Grange⁽ᵈ⁾ and Oxford⁽ᵈ⁾ produced the smallest quantity of dry matter (DM) prior to the first grazing, while all other varieties produced similar quantities of DM (approximately 2.0–2.3 t/ha)(Figure 1). Westminster⁽ᵈ⁾ had the greatest DM production (3.2 t/ha) between the 1st and 2nd grazing, whilst the lowest DM production (less than 2.2 t/ha) was observed for Urambie⁽ᵈ⁾, Grange⁽ᵈ⁾ and Commander⁽ᵈ⁾. All varieties produced more than a total of 4 t/ha of DM for grazing, while Westminster⁽ᵈ⁾ produced in excess of 5 t/ha, which was significantly greater than all other varieties.

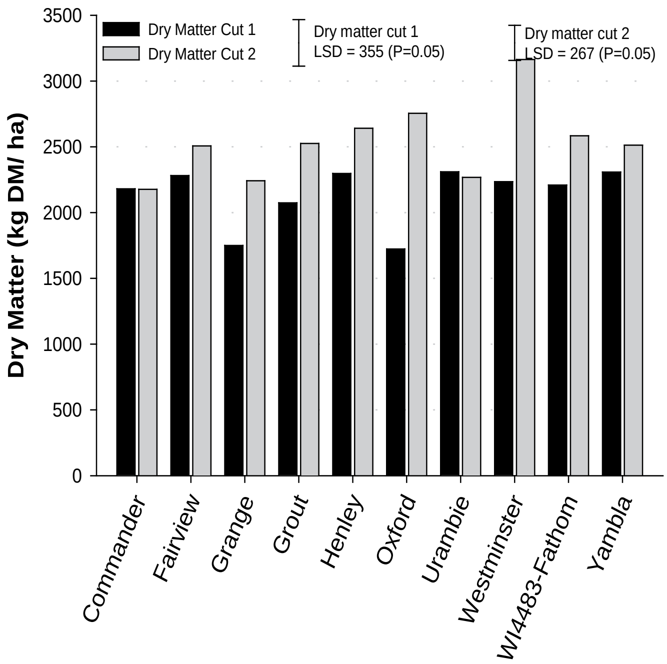

Figure 1: *Dry matter yield immediately prior to grazing 1 and 2*

Grain Yield and Quality

Urambie⁽ᵈ⁾ had significantly higher grain yield (≥0.6 t/ha) than Grout⁽ᵈ⁾, Henley⁽ᵈ⁾, Westminster⁽ᵈ⁾ and Yambla⁽ᵈ⁾ (Table 1). All other varieties had similar grain yields to these varieties with an average yield of 3.3 t/ha.

Yambla⁽ᵈ⁾ had a protein content of 12.4%, which was significantly greater than all other varieties, while Grange⁽ᵈ⁾, Grout⁽ᵈ⁾ and Oxford⁽ᵈ⁾ produced grain protein levels less than 10% (Table 1). All other varieties had protein contents between 10 and 11%. Yambla⁽ᵈ⁾ was the only variety with a grain protein concentration outside the receival standards for malting barley of 9–12%.

Commander⁽ᵈ⁾ had the greatest retention of all varieties, while Henley⁽ᵈ⁾ was the only other variety with retention above 70% (the minimum retention to meet malt barley specifications). Oxford⁽ᵈ⁾, Yambla⁽ᵈ⁾ and Urambie⁽ᵈ⁾ had the lowest retentions with 38.8, 23.4 and 15.6%, respectively. All other varieties had retentions of between 55 and 70% (Table 1).

The low retentions observed for Oxford⁽ᵈ⁾, Urambie⁽ᵈ⁾ and Yambla⁽ᵈ⁾ corresponded with high screenings of 14.1, 26.0 and 18.9%, respectively. Fathom⁽ᵈ⁾ had 9.7% screenings, which was significantly higher than the remaining varieties that had screenings between 4.3 and 6.0% (Table 1).

There was no significant difference between test weights of varieties with all varieties being between 66 and 69 kg/hL (data not shown).

Table 1: *Grain yield, protein, retention and screenings for ten barley varieties following two crash grazing events. Values designated with different letters within each column are significantly different (P=0.05).*

Variety	Grain Yield (t/ha)	Protein (%)	Retention (%)	Screenings (%)
Commander⁽ᵈ⁾	3.2 ab	10.1 cd	75.9 a	4.3 e
Fairview⁽ᵈ⁾	3.3 ab	10.7 bc	57.7 c	5.2 e
Grange⁽ᵈ⁾	3.3 ab	9.8 d	68.9 b	5.7 e
Grout⁽ᵈ⁾	3.1 b	9.8 d	56.7 c	5.4 e
Henley⁽ᵈ⁾	3.1 b	10.4 c	70.3 b	5.7 e
Oxford⁽ᵈ⁾	3.3 ab	9.7 d	38.8 e	14.1 c
Urambie⁽ᵈ⁾	3.7 a	11.0 b	15.8 g	26.0 a
Westminster⁽ᵈ⁾	3.0 b	11.1 b	68.0 b	6.0 e
Fathom⁽ᵈ⁾	3.4 ab	10.2 cd	48.3 d	9.7 d
Yambla⁽ᵈ⁾	2.9 b	12.4 a	23.6 f	18.9 b
Lsd (P=0.05)	0.5	0.4	5.2	3.4

Summary

Westminsterⓓ produced the greatest dry matter for grazing of all the barley varieties and only had significantly lower grain yield than Urambieⓓ. Although Urambieⓓ had significantly greater grain yield than some varieties it had the poorest quality of all varieties with extremely pinched grain (>20% screenings). Interestingly Commanderⓓ maintained grain quality better than all other varieties and based on the quality parameters measured would have still met Graincorp specifications for malting barley in 2012. This trial was 'crash' grazed twice by sheep a month apart however, in practice the spring type barley varieties may have been better suited to a single grazing during tillering or two lighter grazings. This practice may have improve grain recovery and quality. Utilising spring barley varieties for short grazing periods may provide an opportunity to rest early sown grazing cereals, typically oat, grazing barley or dual purpose wheat varieties. It is also recommended that if spring barley varieties are going to be grazed that they are sown 7–10 days earlier to maximise biomass accumulation and compensate for delayed flowering time associated with grazing.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Thanks to our co-operators Andrew and Belinda Davidson "Clermont Park", Somerton, for their generous provision of the trial sites, stock for grazing and support of the trials. Technical assistance provided by Rod Bambach, Jan Hosking, Patrick Mortell, Stephen Morphett, Jim Perfrement and Ben Frazer are also gratefully acknowledged.

Response of eighteen barley varieties to three planting times at Tamworth in 2012

Matthew Gardner, Patrick Mortell and Stephen Morphett NSW DPI, Tamworth

Introduction

The autumn break in NSW occurs anywhere between March and June, with the reliability of the break being more inconsistent in northern NSW compared to the south. There a large number of barley varieties available to growers across a wide range of maturities providing the opportunity to plant barley crops from late March until late June and still have the crop flowering when the risks of frost and heat stress are acceptable. Between mid September to the first week in October is the optimum flowering window for cereal crops at Tamworth to avoid excessive frost risk (>10%) and limit exposure to heat stress later in the season. Varieties differ in the ability to achieve high yields from different sowing times. Trials were conducted at Tamworth to determine the yield and quality of a range of barley varieties across three different sowing times. In addition, phenology information was collected throughout the season to further assist in sowing time recommendations.

Site details

Tamworth Agricultural Institute

Location:	**Paddock 30**
Previous Crop:	**Canola**
Starting N:	**62 kg N/ha (0–120 cm)**

Treatments

There were 18 entries with varying maturities and agronomic traits used in the trials in 2012 which included both commercially available varieties and advanced breeder lines (Table 1). These entries were sown on three separate occasions 26th April, 20th May and the 20th June.

Results

The 2012 season started with full profile of moisture and had good rainfall through Autumn and early winter. After significant rainfall in mid July (94 mm) there was only 78 mm between August and November.

The optimum flowering window at Tamworth in 2012 was between the 10th September and the 29th September. Based on Figure 1 it appears that there is a cliff face in yield loss when varieties flowered after the 30th September, however all the yields after this date were from the 20th June sowing. Typically the optimum flowering window for Tamworth is between the 20th of September and the 5th of October. The poor performance of the final Time of Sowing (TOS) may be explained partially by the delay in flowering beyond the optimum window, but the lack of in-crop rainfall and run of frost following planting may have also contributed to the lower yields.

Key findings

In 2012 the optimum sowing window appeared to shift forward 10 days compared to the traditional flowering window between 20th of September to October 5th.

Fathom[⊕] emerged as a high yielding feed variety across all three planting times along with Grange⊕ and Fairview⊕.

Oxford⊕ performed well from the early planting time, which supports it's strong performance in the past two seasons in the same trials.

The final TOS had 33% lower yields than TOS 1 and 2, which was likely a result of flowering time, lack of in season rainfall and the high incidence of frost during early development.

Maturity was not always a good indicator of yield performance from a given planting time, with quick maturing varieties yielding well with early plantings and long season varieties performing well from late season planting. Grain quality may better separate variety performance.

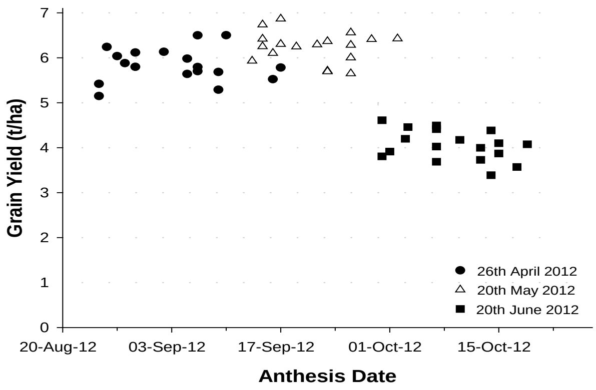

Figure 1: *Relationship between grain yield and anthesis date for three sowing dates at Tamworth in 2012.*

Delaying planting date from the 26th April to the 20th May had no significant effect on yield when averaged across the 18 barley varieties in 2012. The last TOS however, resulted in a 33% yield loss compared to TOS 2. The first TOS flowered 18 days earlier than the traditional optimum flowering window, while TOS 2 and 3 flower in the optimum window. Oxfordᶲ and Fairviewᶲ were the highest yielding varieties from TOS 1, both of which are mid to long season varieties (Table 1). Fathomᶲ, Grangeᶲ and IGB1101 also achieved in excess of 6.0 t/ha from TOS 1, which is interesting given that both Fathomᶲ and IGB1101 are quicker varieties. Both these varieties flowered in the last week of August in 2012, which would be considered to have a high risk of frost. SY Rattlerᶲ and Fathomᶲ achieved the highest grain yield for TOS 2, while Commanderᶲ, Navigatorᶲ, Grangeᶲ, Oxfordᶲ and Hindmarshᶲ all had yields between 6.2 and 6.4 t/ha. From the final TOS Fairviewᶲ, Fathomᶲ, Grangeᶲ and IGB1101 were the better performing varieties. The performance of Fairviewᶲ was interesting considering it flowered in mid October. Oxfordᶲ and Navigatorᶲ are both longer season options, however not as long as Urambieᶲ, which had a similar anthesis date. Grange is slightly quicker than Commanderᶲ, which had similar maturity to Bassᶲ and Fairviewᶲ. IGB1101, which is a possible replacement for Hindmarshᶲ, has a similar maturity to Hindmarshᶲ (Table 1).

Table 1: *Grain yield, yield rank and days to anthesis for 18 barley varieties at three sowing times at Tamworth in 2012. Lsd's for TOS and variety were 0.34 t/ha and 0.26 t/ha, respectively (P<0.05).*

Variety	Yield (t/ha) and rank within sow time						Days from sowing to anthesis		
	26th April		20th May		20th June		26th April	20th May	20th June
Bassᶲ	5.98	7	5.71	16	4.17	7	130	123	109
Commanderᶲ	5.79	10	6.37	7	3.69	16	131	123	106
Fairviewᶲ	6.50	2	5.70	17	4.38	5	131	123	113
Fathomᶲ	6.12	5	6.74	2	4.50	2	123	115	106
Flindersᶲ	5.64	14	6.30	9	3.73	15	130	122	112
Gairdnerᶲ	5.29	17	6.56	3	3.39	18	134	126	113
Grangeᶲ	6.13	4	6.25	12	4.41	4	127	119	106
Groutᶲ	6.04	6	6.25	11	3.81	14	121	115	99
Hindmarshᶲ	5.42	16	6.42	5	3.91	12	119	115	100
IGB 1101	6.24	3	5.93	15	4.61	1	120	113	99
Navigatorᶲ	5.78	11	6.43	4	4.10	8	142	132	114
Oxfordᶲ	6.50	1	6.28	10	3.57	17	135	126	116
Shepherdᶲ	5.15	18	6.11	13	4.46	3	119	116	102
Skipperᶲ	5.80	9	6.30	8	4.20	6	123	117	102
SY Rattlerᶲ	5.88	8	6.87	1	4.03	10	122	117	106
Urambieᶲ	5.52	15	6.01	14	3.87	13	141	126	114
Westminsterᶲ	5.68	13	5.65	18	4.00	11	134	126	112
Wimmeraᶲ	5.70	12	6.41	6	4.08	9	131	129	118
TOS Average	5.8		6.3		4.0		129 (3rd Sep)	121 (21st Sep)	108 (8th Oct)

When looking at the results of Urambie⦶ (long season), Commander⦶ (mid season) and Grout⦶ (short season) it is interesting to note that there is little difference in their yield performance across the three planting times (Figure 2a). This is despite a 20, 15 day difference in flowering time between Grout⦶ and Urambie⦶ for the first, second and third TOS (Figure 2b). The delay in flowering between a short and mid season variety ranged from 10 days at TOS 1 to 6 days at TOS 3.

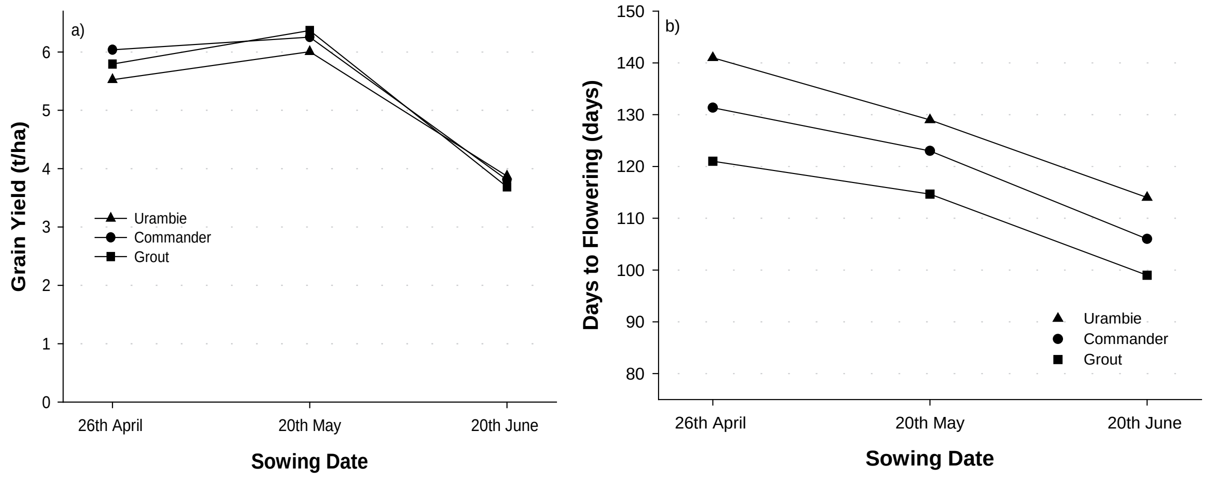

Figure 2: *Grain yield (a) and days from sowing to flowering (b) at three sowings dates for Urambie⦶, Commander⦶ and Grout⦶ at Tamworth in 2012.*

Summary

From the barley TOS, Fathom⦶ emerged as a high yielding feed variety across all three planting times along with Grange⦶ and Fairview⦶. Oxford⦶ was a good yielding variety from the earlier planting. IGB1101 appears to be a viable Hindmarsh⦶ replacement with slightly better yields and similar maturity. It was interesting that even when quick maturing varieties flowered in the last week of August their yield performance was similar to a long season variety that flowered more than 20 days later. Similarly for TOS 3 longer season varieties achieved similar yields as quicker maturing varieties despite flowering in mid October compared to late September.

Grain quality may distinguish better between varieties that have flowered outside the optimum flowering window. These analyses are currently being conducted. Despite the large number of frosts in 2012 the optimum sowing window appeared to shift forward 10 days compared to the traditional flowering window between 20th of September to October 5th for Tamowrth.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Technical assistance provided by Rod Bambach, Bruce Haigh, Jan Hosking, Jim Perfrement and Peter Formann are also gratefully acknowledged.

Lodging management for Commander⦶ – Moree, Gurley and Breeza 2012

Matthew Gardner, Stephen Morphett and Jim Perfrement NSW DPI, Tamworth

Key findings

In all trials PGR treatments were shown to reduce lodging to some degree, which was most likely a function of the reduced plant height obtained from PGR applications.

Yield responses to PGR application ranged from −13% to +16% for Commander⦶ and Oxford⦶ compared to the untreated control. Commander⦶ was usually more responsive to the application of PGRs than Oxford⦶.

Of the PGR treatments the combined Cycocel® + Moddus® treatment resulted in the most consistent reduction in plant height and greatest responses in grain yield, whether negative or positive.

These results highlight the variability in responses to PGR application, which makes it difficult to accurately predict the economic benefit of using PGRs within cropping systems.

Introduction

Plant growth regulators (PGRs) have been used routinely in high input, high yielding cereal systems in Europe and NZ for some time to shorten crop height and reduce the incidence of lodging. Lodging results in significant losses in crop production due to reduced movement of water, nutrients and translocation of plant stored carbohydrates through the stem into the head. Lodging also reduces grain quality, increases harvest losses and the actual cost of the harvesting process. Although gibberellin inhibitors and ethylene producers are the two main PGR groups, the research presented here only investigated gibberellin inhibitor products. These products act by blocking gibberellin biosynthesis which reduces internode length in stems thereby decreasing plant height. There are a number of phases in this pathway and different PGRs act at different points. For example chlormequat (Cycocel®) acts early in the pathway while more recently developed products such as trinexapac-ethyl (Moddus®) act on later stages.

PGRs have also been reported to have a yield enhancement effect by improving the proportion of crop dry matter that is partitioned into grain yield. This effect is related to a reduction in the plant resources required for stem elongation with these resources then available for grain-fill. Some PGRs have also been associated with increased root growth resulting in improved water extraction from soil. Yield responses to PGRs can be highly variable with responses ranging from −40% to +20% depending on product choice, application time, crop or variety and growing season conditions.

Site details

Breeza

Location:	**Liverpool Plains Research Station**
Previous Crop:	**Wheat**
Starting N:	**71 kg N/ha (0–120 cm)**
Sown:	**14th June 2012**

Moree

Location:	**“Bonniedoon”**
Co-operator:	**Paul and Charles Tattam**
Previous Crop:	**Chickpeas**
Starting N:	**51 kg N/ha (0–120 cm)**
Sown:	**20th May 2012**

Gurley

Location:	**“Murray Cumummualah”**
Co-operator:	**Scott Carrigan**
Soil:	**Grey Vertosol**
Starting N:	**91 kg N/ha (0–120 cm)**
Sown:	**31st May 2012**

Treatments

In 2012 a series of trials were conducted to investigate the capacity of PGRs to reduce lodging in Commander⦶ (high yielding with poor straw strength) barley. Commander⦶ and Oxford⦶ (high yielding with good straw strength) were grown at a target plant population of 120 plants/m^2 with four treatments of: nil PGR, Cycocel® (0.2 L/ha), Moddus® (1.0 L/ha) and a combination of Cycocel® (0.2 L/ha) + Moddus® (1.0 L/ha). PGRs were applied in each season at stem elongation (GS31) at a 100 L/ha water rate. Sites were established at Gurley, Moree and Breeza. At the Breeza site there was no Moddus® only treatment. There was also a plus or minus defoliation implemented at the same growth stage to physically remove the canopy biomass. Defoliation was done to a height of approximately 5 cm with a lawn mower and all cut dry matter was removed from the plots with the catcher. The Breeza site was under irrigation to try and exacerbate the lodging risk. Due to a lack of significance in treatment effects on plant height, grain yield and a lack of lodging at Gurley, only the Breeza and Moree results are presented.

Results

Lodging severity was greater at the Breeza site compared to the Moree site, which was likely a result of the irrigated conditions implemented at Breeza (Table 1). At anthesis in Moree it appeared that lodging was going to be severe in Commander⦶, however, a dry finish to the season ensured that lodging remained minimal. Oxford⦶ at Moree had no evidence of lodging throughout the entire season while the severity of lodging in Oxford⦶ at Breeza was 56% lower than that in Commander⦶. Defoliation had minimal affect on lodging severity in Oxford⦶, whereas for Commander⦶ at Moree and Breeza lodging severity was reduced by 40% and 22% on average across all treatments with defoliation, respectively (Table 1). The use of Cycocel® reduced lodging severity in Commander⦶ and Oxford⦶ at Breeza by approximately 14% compared to the untreated control. In contrast the reduction in lodging severity was 40% and 48% from the Cycocel® + Moddus® treatment for Commander⦶ and Oxford⦶ at Breeza, respectively.

Table 1: *Lodging scores (Scale 0–9, where 0 is standing and 9 is flat on the ground) at harvest for the Moree and Breeza sites. Minus and plus relate to defoliation treatments.*

PGR Treatment	Moree				Breeza			
	Commander⦶		Oxford⦶		Commander⦶		Oxford⦶	
	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus
Nil	3.4	1.9	0.0	0.0	8.5	6.5	3.5	3.3
Cycocel®	2.2	1.5	0.0	0.0	7.5	5.3	3.0	3.0
Moddus®	0.0	1.0	0.0	0.0	–	–	–	–
Cycocel® + Moddus®	0.0	0.0	0.0	0.0	4.8	4.3	2.0	1.5

The ability of PGRs to reduce the severity of lodging appears related to their capacity to restrict plant height (Figure 1). At Breeza and Moree the Cycocel® + Moddus® treatment was the most effective at reducing plant height (Figure 1a and b). The Cycocel® + Moddus® treatment significantly reduced plant height by 40% and 12% for Commander⦶ and Oxford⦶, respectively, at Moree. There was a large difference between the extent of height reduction measured at the two sites with the maximum height reduction being 9 cm at Breeza compared to 34 cm at Moree. The maxiumum height reduction at Breeza was 9 cm and 4 cm for Commander⦶ and Oxford⦶, respectively, which were both with the Cycocel® + Moddus® treatment. The Cycocel® treatment significantly reduced plant height at Moree in both Oxford⦶ and Commander⦶, but had no significant effect on plant height at Breeza. The Moddus® only treatment was more effective at reducing plant height than the Cycocel® only treatment at Moree (Figure 1a).

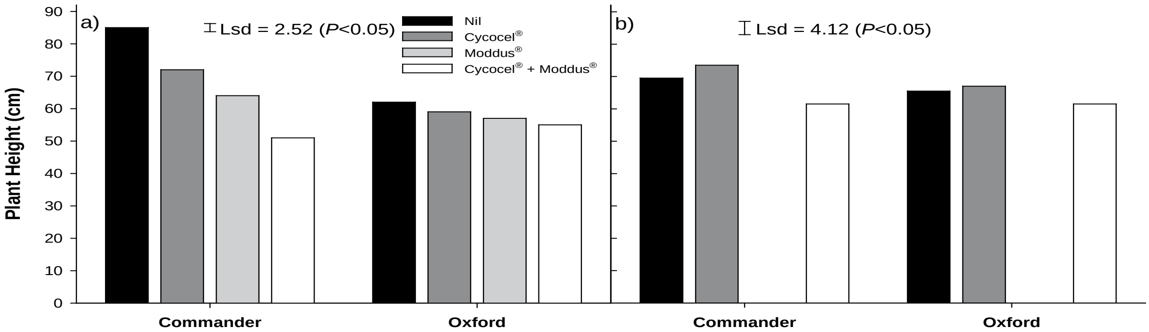

***Figure 1:** Plant height at a) Moree and b) Breeza for Commander$^{(\phi)}$ and Oxford$^{(\phi)}$ barley treated with either no PGR, Cycocel®, Moddus® or a Cycocel® + Moddus® mixture at stem elongation.*

There was a contrasting effect of PGR treatments on grain yield at Moree and Breeza (Figure 2). At Moree the Cycocel® + Moddus® treatment significantly reduced grain yield by 0.9 and 0.25 t/ha for Commander$^{(\phi)}$ and Oxford$^{(\phi)}$, respectively. The Moddus® treatment at Moree also reduced grain yield by 0.4 t/ha compared to the untreated control. The Cycocel® treatment had no impact on grain yield at either site for Commander$^{(\phi)}$ or Oxford$^{(\phi)}$. At Breeza grain yield significantly increased for Oxford$^{(\phi)}$ and Commander$^{(\phi)}$ by 0.7 and 1.1 t/ha compared to the control treatment, respectively, where the Cycocel® + Moddus® treatment was applied. Regardless of treatment the yield of Oxford$^{(\phi)}$ was approximately 1.5 t/ha greater under the irrigated conditions at Breeza compared to Commander$^{(\phi)}$. The same difference in grain yield between varieties was not observed at Moree under dryland conditions.

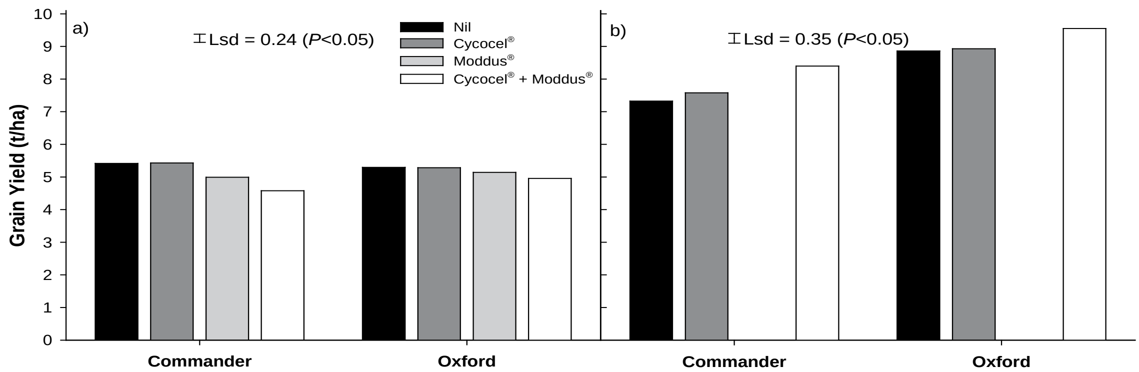

***Figure 2:** Grain yield at a) Moree and b) Breeza for Commander$^{(\phi)}$ and Oxford$^{(\phi)}$ barley treated with either no PGR, Cycocel®, Moddus® or a Cycocel® + Moddus® mixture at stem elongation.*

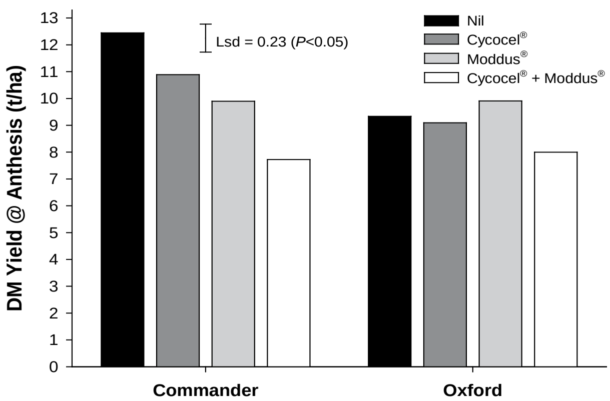

***Figure 3:** Dry matter yield at anthesis at Moree for Commander$^{(\phi)}$ and Oxford$^{(\phi)}$ barley treated with no PGR, Cycocel®, Moddus® or a Cycocel® + Moddus® mixture at stem elongation.*

The reduction in grain yield for treatments including Moddus® at Moree may be related to the significant reduction in dry matter accumulation by anthesis. The Moddus® only and Cycocel® + Moddus® treatment reduced antheseis biomass in Commander$^{(\phi)}$ by approximately 2.5 and 4.5 t/ha (Figure 3). This large reduction in biomass at anthesis may have limited the yield potential of Commander$^{(\phi)}$ in particular. Oxford$^{(\phi)}$ generally had 1.5 t/ha less canopy biomass at anthesis compared to Commander$^{(\phi)}$ at the Moree site. The same reductions in biomass at anthesis were not observed at Breeza, however, reductions in plant height were not as large either.

Summary

In all trials PGR treatments were shown to reduce lodging to some degree, which was most likely a function of the reduced plant height obtained from PGR applications. Reductions in plant height associated with PGR application were generally moderate (3 to 15 cm) with the exception of the Moree site in 2012 where height reductions up to 34 cm were recorded. Yield responses to PGR application ranged from –13% to +16% in Commander⍉ and Oxford⍉. Whether it be negative or positive, Commander⍉ usually was more responsive to the application of PGRs than Oxford⍉. The grain yield and plant height results highlight the variability in responses to PGR application, which makes it difficult to accurately predict the economic benefit of using PGRs within a cropping system. Of the PGR treatments the combined Cycocel® + Moddus® treatment resulted in the most consistent reduction in plant height, which is likely due to the two products blocking giberellin production at different parts of the synthesis pathway. Further research is needed to understand the influence that PGRs are having on crop structure, tiller formation, root growth and soil water extraction in winter cereal crops in the northern grains region.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Paul and Charles Tattam "Bonniedoon" and Scott Carrigan "Murray Cumummualah" are gratefully acknowledged for the provision of the trial sites. Technical assistance provided by Rod Bambach, Jan Hosking, Patrick Mortell and Peter Formann are also gratefully acknowledged.

Performance of some new malting barley varieties – Spring Ridge and Gurley 2012

Matthew Gardner NSW DPI, Tamworth

Key findings

Skipper⦶ and IGB1101 performed well at Gurley in a tough finish to the season and may provide options for a quick maturing malt variety in the future.

Despite yielding well at Spring Ridge, Grange⦶ was the lowest yielding variety at Gurley, while the variety appears to produce higher screening and lower retention levels than other varieties under high starting N conditions and a hot dry finish to the season.

Bass⦶ and Wimmera⦶ were the most protein responsive varieties to applied N producing 2.0% and 2.5% higher protein levels than Commander⦶, respectively, which achieved the lowest protein levels of the varieties examined.

All new varieties provided a straw strength advantage over Commander⦶ and Buloke⦶ under high lodging risk conditions (high plant populations, large residual soil N and large crop canopies) at Spring Ridge.

Introduction

The 2012 season highlighted the benefit of barley in a tight seasonal finish with yields generally being around 1–2 t/ha higher than with wheat at NSW DPI trial sites where both crop species were grown. There is still a large potential to increase the area of barley production across the region but this would be primarily dependent on improved receival prices and varieties that reliably achieve malt classification. Currently, there are a limited number of malt varieties, with Gairdner⦶ and Commander⦶ predominately grown throughout the northern grains region. However, some issues with low test weights and the higher susceptibility of Commander⦶ to lodging has been a hindrance to the wider adoption of this variety. Consequently, Gairdner⦶, which was released in 1998, is still the dominant malt variety grown in the northern region. Gairdner⦶ has been a good variety when grown in the right situations; however it does have a tendency to drop retention levels and increase screenings dramatically when under high N conditions when hot and dry conditions occur at the end of the season. In addition, Gairdner⦶ is a high protein achiever compared to other barley varieties such as Commander⦶, which can also jeopardise its potential to meet malt specifications under high starting soil N conditions. Potentially there may be some alternative malt varieties available for growers in the near future.

There are currently 14 varieties undergoing malt accreditation (a 3 year process), which are at varying stages of assessment. In an attempt to gauge how some of these new varieties will perform throughout the region under varying agronomy a national set of trials were established. There were three trials in the Western grains region, four trials in the Southern grains region and two trials in the northern grains region. This paper reports on the two Northern grains region trials conducted in 2012.

Site details

Spring Ridge

Location: **"Yoorooga"**

Co-operator: **Angus Murchison**

Previous Crop: **Long fallow out of cotton**

Starting N: **110 kg N/ha (0–120 cm)**

Sown: **15th June 2012**

Gurley

Location: **"Murray Cumummualah"**

Co-operator: **Scott Carrigan**

Soil: **Grey Vertosol**

Starting N: **91 kg N/ha (0–120 cm)**

Sown: **31st May 2012**

Treatments

At Spring Ridge six varieties were trialled including Commander⦶, Buloke⦶, Bass⦶, Wimmera⦶, Grange⦶ and Navigator⦶. In addition, Skipper⦶ and IGB1101 were included at the Gurley site to make eight varieties. Commander⦶ and Buloke⦶ were included in the trials as the check lines. All varieties were grown at plant populations of 75, 150 or 300 plants/m^2, which was in a factorial trial design with three N rates of 0, 30 and 90 kg N/ha, applied as Urea. All N treatments were side banded at planting and no further N applications were made throughout the season. This design was in accordance with the other seven trials conducted throughout the Australian grains belt in 2012.

Results

Spring Ridge yield

Commander⦶ and Grange⦶ were the highest yielding varieties at Spring Ridge, producing 6.3 and 6.2 t/ha, respectively when averaged across the different plant populations and N rates. Bass⦶, Navigator⦶ and Wimmera⦶ all had similar yields that were significantly higher than Buloke⦶, which yielded 5.6 t/ha. There were only limited N responses observed at Spring Ridge, which is probably not surprising given the starting soil N being over 100 kg N/ha between 0–120 cm. Despite this, the 90 kg/ha N application significantly increased grain yield for Commander⦶ and Grange⦶ compared to the 0 N rate (data not shown). There were no other significant differences observed as a result of N application at Spring Ridge in 2012 (data not shown).

Increasing plant population from 75 to 150 plants/m^2 increased grain yield for Bass⦶ and Commander⦶ by 0.42 and 0.34 t/ha, respectively at Spring Ridge (Figure 1). For all other varieties there was no significant increase in grain yield achieved from increasing plant populations. Increasing plant population from 150 to 300 plants/m^2 decreased grain yield in Navigator⦶, Commander⦶ and Buloke⦶ by 6, 9 and 7%, respectively. For both Commander⦶ and Buloke⦶ this increase in plant population also coincided with a significant increase in the severity of lodging, which may explain some of the yield decline. The same level of lodging was not observed in Navigator⦶ (data not shown).

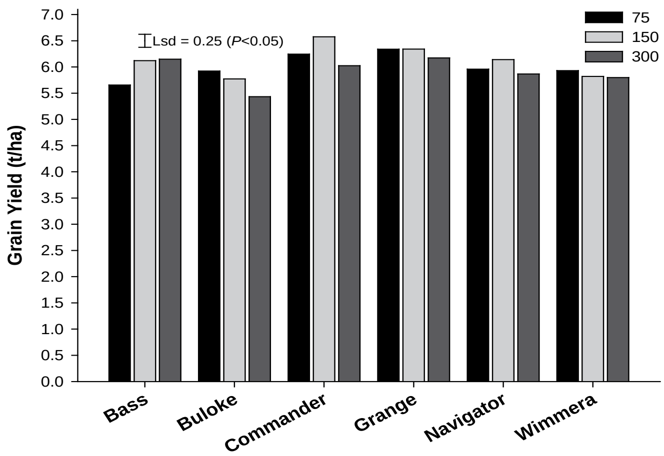

Figure 1: *Grain yield of six barley varieties grown at plant populations of 75, 150 and 300 plants/m^2 at Spring Ridge in 2012.*

Gurley yield

The quick season varieties Skipper⦶ and IGB 1101 had the greatest grain yields at Gurley, producing 4.0 and 3.9 t/ha, respectively, while Commander⦶ achieved 3.8 t/ha. Wimmera⦶ and Navigator⦶ achieved similar yields that were higher than Buloke⦶ and Bass⦶. Grange⦶ was the lowest yielding variety with an average yield 1.0 t/ha less than Commander⦶ (Figure 2).The actual plant populations achieved at Gurley were 70, 125 and 210 plants/m^2, which were lower than the levels targeted at sowing as a result of soil conditions during establishment. There was no variety interaction with plant population but 150 and 300 target plants/m^2 treatments resulted in a 0.4 and 0.6 t/ha increase in yield, respectively, compared to the 75 plants/m^2 treatment. Skipper⦶ and IGB 1101 were the only two varieties to have a significant yield improvement between the 0 and 90 kg N/ha treatments (Figure 2). There were no other significant responses in other varieties to N treatments (Figure 2).

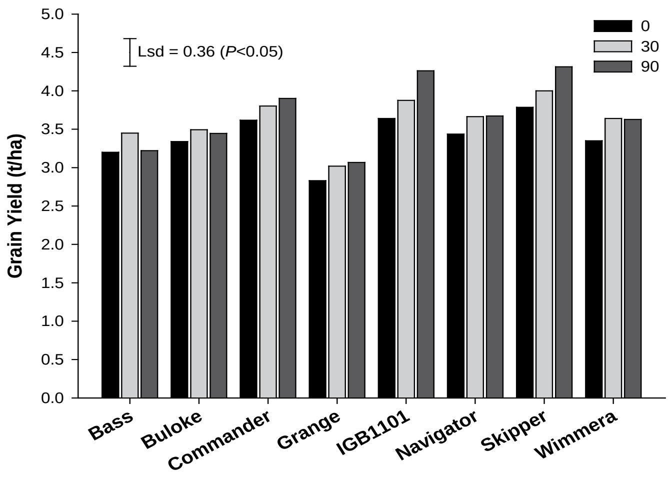

Figure 2: *The grain yield of eight barley varieties grown at three N rates of 0, 30 or 90 kg N/ha at Gurley in 2012.*

Grain quality

The high residual N at the Spring Ridge site meant that there were no varieties with protein values under 14%, which is above the malt specification of 12% (Table 1). Bass and Wimmera had the highest protein levels with 16%, which was 2% greater than the protein achieved by Commander. Although the protein values were approximately 3% lower at Gurley there were similar trends with Bass and Wimmera having the highest protein levels (Table 2). Commander and IGB 1101 both achieved proteins under 12% at Gurley. Navigator, Grange and Skipper appear to respond similarly in terms of the protein response to N application.

Screening levels were relatively low at both sites considering the receival requirement for malt barley is 7%. However, the Spring Ridge site had higher screenings than Gurley, with Grange and Wimmera actually exceeding 7% (Table 1). Grange also had the highest screenings at Gurley with 4.7%, which was significantly greater than all other varieties (Table 2). Under the conditions experienced at the Spring Ridge site, high residual N and a hot dry finish to the season, it could reasonably be expected that the screening levels in a variety such as Gairdner (not included in trial), which has an inherently smaller grain size may have exceeded 10%.

Bass (80.6%) had the highest retention at Spring Ridge, whilst Skipper (93.7%) had the best retention at Gurley (Table 1 and 2). Grange and Wimmera had the lowest retention at both sites. At the Spring Ridge site the retention levels in Grange and Wimmera were both below 70%. There was little variation between the other varieties. Commander and Navigator had the lowest test weights at Spring Ridge and Gurley, respectively but they were above 65 kg/hL in both instances. The test weights were similar between the two sites with the better varieties ranging between 70 and 72 kg/hL, which is above the target test weight of 65 kg/hL to meet malt specifications.

Table 1: *The average grain quality for six barley varieties grown across three nitrogen rates (0, 30 and 90 kg N/ha) and at three populations (75, 150 and 300 plants/m²) at Spring Ridge in 2012*

Variety	Protein (%)	Screenings (%)	Retention (%)	Test Weight (kg/hL)
Bass	16.1 a	2.2 d	80.6 a	72.4 a
Buloke	14.6 c	4.7 c	66.1 d	71.3 b
Commander	14.0 d	4.3 c	75.7 b	69.3 c
Grange	15.2 b	7.5 a	62.5 e	71.1 b
Navigator	15.3 b	5.5 b	70.6 c	71.1 b
Wimmera	16.0 a	7.7 a	62.1 e	70.8 b
Lsd (P=0.05)	0.3	0.4	1.3	0.5

Table 2: *The average grain quality for eight barley varieties grown across three nitrogen rates (0, 30 and 90 kg N/ha) and at three plant populations (75, 150 and 300 plants/m²) at Gurley in 2012*

Variety	Protein (%)	Screenings (%)	Retention (%)	Test Weight (kg/hL)
Bass	13.4 a	2.6 c	89.1 b	71.3 ab
Buloke	12.8 b	2.0 d	88.5 b	71.3 ab
Commander	11.0 d	2.4 cd	89.1 b	70.3 c
Grange	12.5 bc	4.7 a	82.9 d	70.1 cd
IGB1101	11.7 c	2.2 d	89.3 b	72.3 a
Navigator	12.1 c	2.3 d	87.9 b	69.6 d
Skipper	12.1 c	1.3 e	93.7 a	72.0 a
Wimmera	13.2 ab	2.9 b	85.2 c	71.6 a
Lsd (P=0.05)	0.4	0.3	1.7	0.6

Summary

Commander⁽ᴰ⁾ performed well at both sites in terms of grain yield and quality. Grange⁽ᴰ⁾ was comparable in terms of yield at Spring Ridge, however, it produced high screenings and low retention. These poor quality results were also observed at Gurley, where Grange⁽ᴰ⁾ was also the lowest yielding variety. All new varieties had significantly higher protein responses to applied N compared to Commander⁽ᴰ⁾, which should be a consideration when selecting paddocks with high levels of residual N. In terms of screenings, test weight and retention, Bass⁽ᴰ⁾ and Skipper⁽ᴰ⁾ were the best performing varieties in these two trials. IGB1101 and Skipper⁽ᴰ⁾ appear to have potential as possible quick malting varieties in the future. Currently there is no quick maturing malt variety available to growers. The results presented here will be combined with the results of the other trials throughout the Australian grains belt to get a better picture of overall variety performance.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Angus Murchison, "Yoorooga" and Scott Carrigan, "Murray Cumummualah" are gratefully acknowledged for the provision of the trial sites. Technical assistance provided by Rod Bambach, Jan Hosking, Patrick Mortell, Stephen Morphett, Jim Perfrement and Peter Formann are also gratefully acknowledged.

Impact of sowing time on crown rot in barley, bread and durum wheat – Walgett 2012

Matthew Gardner and Steven Simpfendorfer NSW DPI, Tamworth

Key findings

In durum, low plant populations coupled with an early sowing time halved the yield loss to crown rot (12%) compared to a later sowing time with a higher plant population (25% yield loss to crown rot).

A full profile of soil water at the start of the 2012 season at the trial site limited the yield losses from crown rot in durum to 15–30%, while losses were 7–15% for bread wheat and minimal for barley (<5%).

Variety selection had a significant impact on yield in the presence of crown rot infection in each of the winter cereal types (up to 1.4 t/ha in durum, 0.8 t/ha in bread wheat and 0.7 t/ha in barley).

Introduction

Crown rot caused by the fungus *Fusarium pseudograminearum (Fp)* is a major constraint to winter cereal production in the northern grains region. Yield loss from crown rot can be in excess of 70% in very susceptible crops such as durum wheat and where moisture stress occurs during grain-fill. Unfortunately for the industry there does not appear to be a genetic or agronomic 'silver bullet' that will negate the losses associated with crown rot or eliminate the build-up of inoculum within the system. Therefore, adapting our current practices and varieties to focus on managing the three key phases of crown rot (survival, infection and yield loss) will determine the impact this disease has on crops in the future.

The crown rot fungus survives on cereal and grass weed plants and residues, while infection occurs throughout the season and requires direct contact with infected residues. Yield loss is related to moisture stress post-flowering and the level of crown rot pressure. Moisture stress is believed to trigger the crown rot fungus to proliferate in the base of infected tillers, restricting water movement from the roots through the stems, and producing whiteheads that contain either no grain or lightweight shrivelled grain.

This trial aimed to determine the potential of sowing time to reduce the negative impacts of crown rot on yield and quality. It was hypothesised that an early sowing time allows grain-fill to occur under cooler conditions and less moisture stress which should reduce the impact of crown rot.

Site details

Location:	**"Wattle Plains", Walgett**
Co-operator:	**Dave and Fiona Denyer**
P. thornei:	**1,700 *Pt*/kg soil (0–30 cm)**
Soil type:	**Grey vertosol**
Fertiliser:	**60 kg/ha Granulock Supreme Z + 70 kg/ha granular Urea at sowing**
Soil moisture:	**~240 mm PAW to 1.5 m**

Treatments

- Two sowing dates: 30th April (TOS 1) and 28th May (TOS 2)
- 10 bread wheat, 4 barley and 4 durum wheat varieties
- Plus or minus added crown rot at sowing using sterilised durum grain colonised by five isolates of *Fp*.

Results

The yield loss in bread wheat and barley infected by crown rot were not affected by TOS at Walgett in 2012. However, in durum wheat the addition of crown rot inoculum resulted in a significant 12% and 25% yield reduction from TOS 1 and 2, respectively. The negative yield impact associated with infection was significantly greater for TOS 2 than TOS 1, which suggests that the earlier planting time enabled some of the yield loss from crown rot to be negated in the durum varieties.

Although it was expected that TOS 1 would have yielded better than TOS 2, there was no significant difference. This may be explained by differences in plant establishment with TOS 1 establishing on average 26 plants/m^2 compared to TOS 2 that established an average of 102 plants/m^2, which was the target population (100 plants/m^2). The poorer establishment of TOS 1 was a direct result of sub optimal sowing moisture but clearly the 4 week earlier sowing time allowed compensation for the 75% reduction in plant population compared to TOS 2.

There was a significant interaction between variety and the impact of crown rot (Figure 1). Yield losses were greatest for the durum wheat varieties, ranging from 14% for Hypernoᶲ to 31% for EGA Bellaroiᶲ. Significant yield losses in the bread wheats ranged from 7% for Sunguardᶲ to 15% for EGA Wylieᶲ (Figure 1). Wimmeraᶲ was the only barley variety to significantly lose yield from crown rot infection with a 0.32 t/ha loss (Figure 1). The average yields for barley, bread wheat and durum wheat in the absence of crown rot were 5.9, 4.4 and 4.0 t/ha. The fact that bread wheat and durum wheat yields were similar in the absence of crown rot inoculum suggests that background crown rot levels in the paddock did not confound the results. This will be confirmed through pathology assessment of stubble samples collected from the Walgett trial site after harvest.

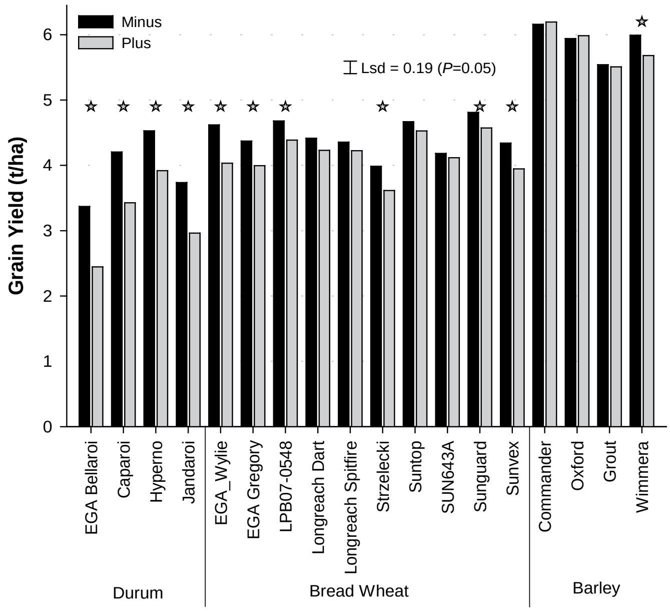

Figure 1: *Effect of crown rot on the yield of 18 different varieties averaged across two sowing times at Walgett in 2012. Varieties designated with a star represent a significant yield loss from crown rot infection.*

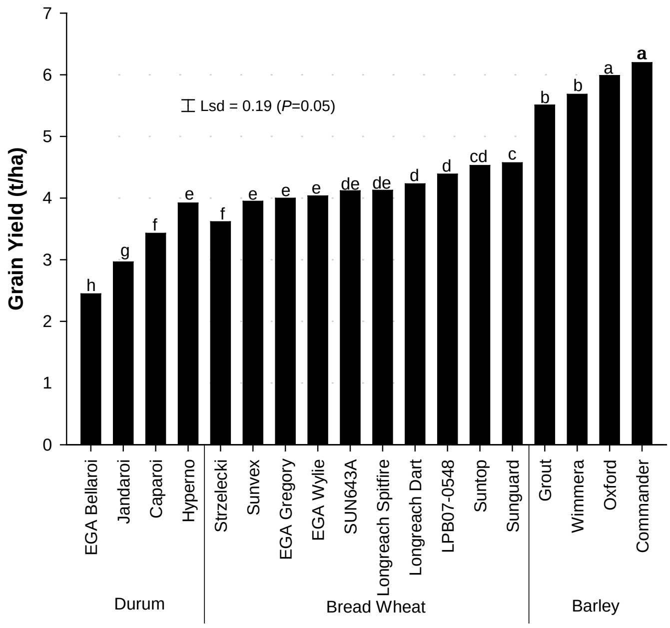

Figure 2: *The yield performance of 18 different varieties inoculated with crown rot averaged across two sowing times at Walgett in 2012. Bars designated with different letters indicates a significant difference between treatments (P=0.05).*

Yield achievement in the presence of crown rot (Figure 2) is perhaps a more useful means of comparing varieties rather than the extent of yield loss associated with infection (Figure 1) as a variety with the smallest yield loss may not always be the highest yield achiever. Although all durum wheat varieties are susceptible to crown rot there were significant differences in yields between varieties. Hypernoᶲ was the highest yielding durum variety in the presence of crown rot with a yield similar to that of the bread wheats Sunvexᶲ, EGA Wylieᶲ, EGA Gregoryᶲ, SUN643A and LongReach Spitfireᶲ (Figure 2). EGA Bellaroiᶲ and Jandaroiᶲ had yields 1.4 and 0.9 t/ha lower than Hypernoᶲ. The quicker bread wheats, LongReach Dartᶲ, LongReach Spitfireᶲ and SUN643A, which had negligible losses to crown rot (Figure 1), had lower yields than both Suntopᶲ and Sunguardᶲ (Figure 2). Selecting Strezleckiᶲ or EGA Gregoryᶲ over Sunguardᶲ in 2012 at the trial site cost 0.8 or 0.5 t/ha in yield where crown rot infection was present. Similarly growing Commanderᶲ as opposed to Groutᶲ increased yields from 5.5 to 6.2 t/ha (Figure 2). These examples highlight that variety choice in each of the winter cereal types can have a significant impact on final grain yield in the presence of crown rot infection (tolerance).

Conclusions

TOS 1 achieved the same yield as TOS 2 with approximately 25% of the plant establishment, which highlights the potential for early planting and low populations to be used in the western environment. This supported results of previous NSW DPI trials across seasons and sites. In durum wheat the yield loss caused by crown rot was approximately half for TOS 1 (12%) compared to TOS 2 (25%). Despite being planted four weeks apart TOS 1 only flowered 5–10 days earlier than TOS 2 and matured at the same time, which is consistent with other studies where low plant populations have been shown to delay development. Given the similar development for both sowing times it is likely that the low plant population has had a large influence on reducing yield loss from crown rot infection observed with TOS 1. Results from a row spacing x plant population trial conducted at the same site in 2012, showed that a plant population of 80 plants/m^2 used significantly less soil water than 160 plants/m^2 to a depth of 120 cm. Therefore, it would be expected in TOS 1, which had 25% of the plant population of TOS 2, there would have also been less soil water used throughout the season which may have reduced moisture stress during grain-fill and consequently yield loss from crown rot.

Yield losses to crown rot were greatest for durum wheat (15–30%), while only minimal for bread wheat (7–15%) and not significant for barley (<5%), which suggests that crown rot expression was not extreme at this site in 2012. This is primarily due to a combination of a full profile of soil moisture at the start of the season, with approximately 240 mm PAWC and average rainfall early in the season and a low background level of crown rot. If the stored moisture was lower, which is a possible scenario in 2013, yield losses would have been expected to be much more severe given the crown rot infection levels. Regardless this trial reinforces the need to avoid growing durum wheat where there is a high risk of crown rot.

It is important to determine a varieties performance under crown rot pressure and not necessarily just on relative yield loss to infection. Sunguard⟨D⟩, which had a significant 7% yield loss from crown rot infection, and Suntop⟨D⟩ yielded highest of the bread wheats in the presence of crown rot, however, the quick varieties (LongReach Dart⟨D⟩, LongReach Spitfire⟨D⟩ and SUN643A) that had no significant yield loss from crown rot infection were lower yielding in the presence of this disease.

Encouragingly, the durum wheat variety Hyperno⟨D⟩ also produced equivalent yield in the presence of crown rot to some of the bread wheat varieties indicating that further research into adapting durum production in this western environment is warranted.

Acknowledgements

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Dual purpose oats – Somerton 2012

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Introduction

Winter forage oats are the most popular dual purpose cereal sown in northern NSW. In northern NSW sowing of oats usually commences in early February and is spread out until June depending on the end use.

Forage oats provide a large amount of quality feed during the winter months when the majority of pastures in northern NSW are dormant and the remaining dry standing feed is of poor quality.

Typically oats are used for grazing only but where seasonal conditions permit, are usually harvested for grain for the next years seed supply or made into hay.

Key findings

Dry matter production was similar across most varieties with the exception of Mannus⊕ which performed poorly. Total dry matter production was on average 4.26 t/ha.

Grain yields were poor, on average 0.88 t/ha, which was expected particularly in the forage only types.

Trial details

The trial was located at:

Location:	**"Clermont Park", Somerton**
Co-operators:	**Andrew and Belinda Davidson**
Sowing date:	**20th April, 2012**
Fertiliser:	**70 kg/ha Nitrogen as Urea** **75 kg/ha Supreme Z Extra**
Dry Matter Assessment 1:	**22nd June**
Grazing 1:	**24th June**
Dry Matter Assessment 2:	**19th July**
Grazing 2:	**22nd–26th July**
Grain Harvest:	**13th November, 2012**

Treatments

The trial included 18 varieties of oats of which 7 were commercial and the remaining 11 entries were experimental lines.

Two dry matter assessments were conducted, with each assessment being followed by a 'crash' grazing with sheep to remove the dry matter evenly across all plots. Following the second grazing the animals were excluded for the remainder of the season to allow grain recovery to be assessed in mid November. The trial was harvested using a KEW plot header.

Results

Dry Matter Assessment 1

The first dry matter assessment produced on average 2.20 t/ha of dry matter (DM). In this assessment the top performer was Genie⊕ at 2.66 t/ha. However there was no significant difference in the DM produced from the top 9 varieties, meaning Eurabbie⊕ and Outback⊕ performed comparably. Mannus⊕ was the poorest at 1.51 t DM / ha.

Dry Matter Assessment 2

The second dry matter assessment produced on average 2.06 t/ha of dry matter (DM); slightly less than the first assessment. There was no significant difference in the DM production between all varieties except Mannus⊕ which produced significantly less.

Total Season Dry Matter Production

Across the two assessments the average dry matter production was 4.26 t/ha (Table 1).

The variety Genie⑂ produced the most dry matter across the two assessments of all included lines, in total 4.91 t/ha. The closest commercial variety was Eurabbie⑂ at 4.49 t/ha.

Yiddah⑂ and Mannus⑂ produced the lowest total dry matter production at 3.83 and 3.18 t/ha respectively.

Table 1: *Dry matter production and grain yield from Somerton 2012*

Variety	Dry Matter 1 (t/ha)	Dry Matter 2 (t/ha)	Total Dry Matter Production (t/ha)
Genie⑂	2.66	2.25	4.91
NSWO002	2.36	2.33	4.69
NSWO005	2.33	2.36	4.69
NSWO011	2.37	2.30	4.67
NSWO007	2.51	2.13	4.64
NSWO006	2.33	2.22	4.55
Eurabbie⑂	2.37	2.11	4.49
NSWO008	2.42	1.94	4.36
NSWO004	2.14	2.20	4.34
Outback⑂	2.32	1.96	4.28
NSWO010	2.05	2.21	4.26
Aladdin⑂	2.16	2.08	4.24
NSWO003	2.08	1.86	3.94
Cooee	2.04	1.90	3.94
NSWO009	1.95	1.93	3.88
NSWO001	1.96	1.88	3.84
Yiddah⑂	2.04	1.79	3.83
Mannus⑂	1.51	1.67	3.18
Mean (t/ha)	2.20	2.06	4.26
LSD (kg)	0.35	0.49	–
CV %	9.5	14.4	–

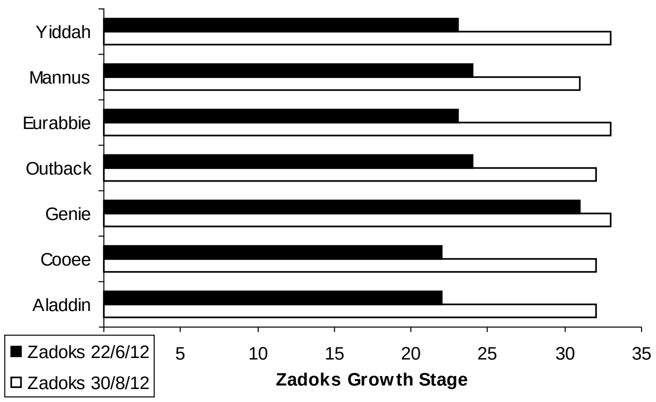

Figure 1: *Zadoks growth stages of commercial oat varieties*

Growth stage information

Grazing timing for dual purpose cereals is critical to achieving maximum dry matter production and grain yield. Growth stage information is shown in Figure 1.

The 7 commercial entries can be split into two groups:

1. Dual Purpose: Eurabbie⑂, Mannus⑂ and Yiddah⑂
2. Forage: Aladdin⑂, Cooee, Genie⑂ and Outback⑂.

The true dual purpose types had similar growth stages at Z23 or Z24 on the 22nd June for the first grazing assessment. By the 30th August, Mannus⑂ had only one node, while Yiddah⑂ and Eurabbie⑂ both had 3 nodes, and were thus significantly further advanced.

In comparison there was a high variation in the maturity of the forage types. On the 22nd June, Genie$^{\phi}$ had one node (Z31) while Aladdin$^{\phi}$, Cooee and Outback$^{\phi}$ were only early tillering. By the end of August they were all at a similar stage, Z32 or Z33.

Grain Yield

Oat recovery for grain yield was low on average across the trial. The average yield was 0.88 t/ha.

As would be expected the better performers were the true dual purpose varieties Eurabbie$^{\phi}$ and Yiddah$^{\phi}$.

Grain recovery from the forage types such as Genie$^{\phi}$, Aladdin$^{\phi}$, Outback$^{\phi}$ and Cooee were much less.

The yield data is not presented in this paper as the co-efficient of variation was too high at 22%.

Summary

The best performing oat varieties in 2012 for grazing only was Genie$^{\phi}$ followed by Eurabbie$^{\phi}$ and Outback$^{\phi}$, although they were generally not statistically better than some of the other varieties with the exception of Mannus$^{\phi}$ and Yiddah$^{\phi}$.

Total dry matter production in the 2012 season was on average 4.26 t/ha from two dry matter assessments. Several experimental lines also appear to be performing well and their progress should be monitored over seasons.

Grain recovery was generally disappointing from the trial with an average grain yield of 0.88 t/ha. It should be remembered however that half of the commercial entries in this trial are designed for forage or hay production only and not for grain yield.

Acknowledgements

This project is funded by NSW DPI and GRDC. Thanks to our co-operators Andrew & Belinda Davidson "Clermont Park", Somerton, for their generous provision of the trial sites, stock for grazing and support of the trials.

Thanks also to Ben Frazer for technical assistance.

Dry matter production from dual purpose cereals for the Northern Slopes and Plains – a summary of 5 years of trials

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Key findings

Oats and barley produced more grazing dry matter than wheat or triticale across sites and seasons.

Triticale produced the highest grain yield following grazing.

No one variety excelled in terms of ranking in the top 10 for dry matter production and grain yield. Urambie⟑ barley was the best overall performer, followed by El Alamein⟑ and Endeavour⟑ triticale and Tennant⟑, a winter wheat.

Dual purpose varieties should always be selected based on individual enterprise needs.

Introduction

Dual purpose cereal trials have been conducted by the NSW Department of Primary Industries for over 40 years. This paper contains the results from two trial sites in northern NSW during the period from 2008–2012.

These trials included a range of wheat, oat, barley, triticale and cereal rye varieties, both commercial and experimental lines, which amounted to 127 different entries over the five year period. For this paper the results from only 40 commercially available varieties have been presented, across four species, wheat, oats, barley and triticale.

Trial details

Somerton trial sites were located at "Clermont Park" in 2008–2012, while Purlewaugh sites where located at "Naparoo" in 2008, 2009, 2010, 2012 and "Kurrajong Vale" in 2011. The trials were sown each year in the first three weeks of April. In each year dry matter assessments were conducted around the end of June for dry matter 1 and at the beginning of August for dry matter 2. Dry matter assessments were followed by a 'crash' grazing using either sheep or cattle to remove the dry matter evenly across all plots. The second dry matter assessments did not occur at either site in 2008 or 2009 due to the dry seasons. Grazing was excluded once varieties started to change to the reproductive growth stages. Following the final grazing in each trial animals were excluded for the remainder of the season to allow grain recovery to be assessed in late November/ Early December. Trial plots were harvested using a KEW plot header. The data assessments made from each trial are presented in Table 1.

Table 1: *Measurements taken from dual purpose cereal trial sites in sequential years from 2008–2012*

Year	Site	No. of dry matter assessments	Harvested for grain yield
2008	Somerton	One	Yes
2009	Somerton Purlewaugh	One One	Yes Yes
2010	Somerton Purlewaugh	Two Two	Yes Yes
2011	Somerton Purlewaugh	Two Two	Yes Yes
2012	Somerton Purlewaugh	Two Two	Yes Yes

Data from each of the trial sites was collated and analysed to compare variety dry matter accumulation and grain yield across sites and seasons to give an indication of the most suitable varieties for Northern NSW.

Results

Which species provides the greatest dry matter and yield?

Dry matter and grain yield data for each of the four species, wheat, oats, barley and triticale were compared, across all varieties for an indication of their respective performance (Table 2).

Species and variety selection should be based on the priority end use for each individual paddock. The best early dry matter production was provided by oats. Oats were also comparable to barley by providing the best total dry matter production over the length of the grazing period. Triticale was significantly superior to all other species for final grain recovery. Wheat produced the least amount of dry matter but the second highest grain yield. Oats in comparison had the poorest grain recovery of all species. Barley appeared to give the best balance between dry matter production and grain recovery. It should be noted that wheat has a higher price for the sale of the grain.

Table 2: *Species mean dry matter and grain yields from 2008–2012 trials*

Species	Dry Matter 1 Yield (t/ha)	Dry Matter 2 Yield (t/ha)	Grain Yield (t/ha)
Barley	2.80	3.31	3.08
Oats	2.92	3.31	2.40
Triticale	2.50	3.07	3.97
Wheat	2.38	2.98	3.30

* Data for dry matter 2 was only available for 2010–2012.

Which variety should I grow for both high dry matter production and grain yield?

A total of 40 varieties were selected from the 127 varieties that data was collected for. The dry matter assessment and grain yield results for 8 barley, 13 oat, 5 triticale and 14 wheat varieties are presented in Table 3.

The number of times a variety was included in trials over the period of 2008–2012 varied, with the highest number of trials being nine such as for Urambie⟬, while other varieties were only entered once such as Dictator⟬.

Total dry matter production from the two assessments totalled over 8 t/ha for some varieties and 4.5 t/ha for grain recovery. Total dry matter production was calculated for all varieties with the exception of the varieties Dictator⟬, Genie⟬, Taipan⟬, Amarok⟬ and Whistler⟬ , which were only trialled in seasons where one dry matter assessment was possible.

No one variety was ranked in the top 10 for both dry matter production and grain yield. The barley variety Urambie⟬ was the most consistent performer for grazing and grain recovery ranking 11th for dry matter production at 6.1 t/ha and 5th for grain yield at 3.7 t/ha. Three other strong performers were the two triticale varieties; El Alamein⟬ (6.1 t/ha dry matter and 4.1 t/ha grain yield) and Endeavour⟬ (5.9 t/ha DM and 4.1 t/ha grain yield); and Tennant⟬, a winter wheat that produced 5. 8 t/ha DM and 3.6 t/ha.

Table 3: *Across sites and seasons variety performance of commercially available dual purpose cereal varieties tested in Somerton and Purlewaugh trials between 2008–2012*

Variety	Species	Dry Matter 1 Yield (t/ha)	Dry Matter 2 Yield (t/ha)	Total Dry Matter (t/ha)	Grain Yield (t/ha)	Trial Number
Dictator⒫	B	2.59	–	–	2.66	1
Gairdner⒫	B	2.42	3.72	6.14	2.78	3
Moby⒫	B	2.20	3.38	5.59	2.69	4
Oxford⒫	B	2.20	3.12	5.33	3.43	4
Urambie⒫	B	2.80	3.32	6.12	3.72	9
Westminster⒫	B	2.28	3.31	5.59	3.22	2
White Stallion⒫	B	2.28	3.10	5.38	2.85	2
Yambla⒫	B	3.27	2.96	6.23	3.26	5
Aladdin⒫	O	2.27	2.99	5.26	2.20	2
Bimbil	O	3.11	3.36	6.47	2.26	7
Cooba	O	4.39	3.69	8.08	2.03	2
Cooee	O	2.11	2.88	4.99	1.75	4
Dawson⒫	O	3.79	3.25	7.05	2.13	4
Drover⒫	O	3.79	3.35	7.15	2.20	4
Eurabbie⒫	O	3.20	3.39	6.59	2.63	7
Genie⒫	O	2.80	–	–	2.30	3
Graza 51⒫	O	1.95	3.26	5.22	1.56	2
Graza 80⒫	O	3.18	3.22	6.40	2.08	6
Outback⒫	O	2.11	2.93	5.04	1.72	4
Taipan⒫	O	2.86	–	–	2.10	2
Yiddah⒫	O	3.18	3.76	6.94	2.07	6
Crackerjack⒫	T	1.93	3.63	5.56	4.27	5
El Alamein (AT573)⒫	T	2.66	3.41	6.08	4.14	7
Endeavour⒫	T	2.50	3.41	5.91	4.08	9
Tobruk⒫	T	2.75	2.82	5.56	4.58	7
Tuckerbox⒫	T	1.79	3.05	4.84	3.49	4
Amarok⒫	W	1.81	–	–	3.20	3
Brennan⒫	W	2.50	2.80	5.30	3.27	7
EGA Eaglehawk⒫	W	2.38	2.91	5.30	3.30	9
EGA Gregory⒫	W	4.55	3.27	7.82	2.66	2
EGA Wedgetail⒫	W	2.38	3.15	5.53	3.43	9
Forrest (HRZ030086)	W	2.67	3.04	5.71	3.07	6
Mackellar⒫	W	2.50	2.52	5.02	3.39	7
Mansfield⒫	W	1.49	2.67	4.16	3.12	2
Marombi⒫	W	2.90	2.78	5.68	3.59	5
Naparoo⒫	W	2.38	3.24	5.62	3.55	9
SQP Revenue⒫	W	2.67	2.80	5.48	3.61	6
Tennant⒫	W	2.90	2.87	5.78	3.57	5
Whistler⒫	W	1.99	–	–	3.15	2
Wrangler⒫	W	1.53	2.94	4.47	3.26	4

* Species included are B = Barley, O = Oats, T = Triticale and W = Wheat

Which variety should I choose if dry matter production is the priority?

The majority of entries ranking in the top 10 for dry matter production were oat varieties (Table 4).

The top four varieties produced between 0.5 and 1.3 t/ha more dry matter than other varieties for the first dry matter assessment, whereas this same advantage was not evident for the second dry matter assessment. The public oat variety Cooba produced the most dry matter at 8.1 t/ha over the two dry matter assessments, however, this variety was only included in two trials at Somerton in 2009 and 2010.

The wheat variety EGA Gregory⁽ᵈ⁾ also performed very well, at 7.8 t/ha, and as a Prime Hard classified variety this is worth further consideration. Two barley varieties Yambla⁽ᵈ⁾, a designated dual purpose variety and the popular malting variety Gairdner⁽ᵈ⁾ also produced dry matter in excess of 6 t/ha.

None of the triticale varieties were ranked in the top ten, however El Alamein⁽ᵈ⁾ and Endeavour⁽ᵈ⁾ ranked 12 and 13 respectively.

Table 4: *The top 10 ranked varieties for total dry matter production from Somerton and Purlewaugh dual purpose cereal trials between 2008–2012*

Variety	Species	Dry Matter 1 Yield (t/ha)	Dry Matter 2 Yield (t/ha)	Total Dry Matter Production (t/ha)	Dry Matter Ranking
Cooba	O	4.39	3.69	8.08	1
EGA Gregory⁽ᵈ⁾	W	4.55	3.27	7.82	2
Drover⁽ᵈ⁾	O	3.79	3.35	7.15	3
Dawson⁽ᵈ⁾	O	3.79	3.25	7.05	4
Yiddah⁽ᵈ⁾	O	3.18	3.76	6.94	5
Eurabbie⁽ᵈ⁾	O	3.20	3.39	6.59	6
Bimbil	O	3.11	3.36	6.47	7
Graza 80⁽ᵈ⁾	O	3.18	3.22	6.40	8
Yambla⁽ᵈ⁾	B	3.27	2.96	6.23	9
Gairdner⁽ᵈ⁾	B	2.42	3.72	6.14	10

* Species included are B = Barley, O = Oats, T = Triticale and W = Wheat

Which variety should I choose if grain yield is the priority?

The triticale varieties came to the fore when grain yield was taken into consideration with all five triticale varieties ranking in the top 10 for grain yield. Only one barley variety, Urambie⁽ᵈ⁾ placed in the top 10; and none of the oat varieties. Of the wheat varieties, SQP Revenue⁽ᵈ⁾, Marombi⁽ᵈ⁾, Tennant⁽ᵈ⁾ and Naparoo⁽ᵈ⁾ were the best, producing over 3.5 t/ha following two grazing events.

Table 5: *The top 10 ranked varieties for grain yield from Somerton and Purlewaugh dual purpose cereal trials between 2008–2012*

Variety	Species	Grain Yield (t/ha)	Grain Yield Ranking
Tobruk^	T	4.58	1
Crackerjack^	T	4.27	2
El Alamein (AT573)^	T	4.14	3
Endeavour^	T	4.08	4
Urambie^	B	3.72	5
SQP Revenue^	W	3.61	6
Marombi^	W	3.59	7
Tennant^	W	3.57	8
Naparoo^	W	3.55	9
Tuckerbox^	T	3.49	10

* Species included are B = Barley, O = Oats, T = Triticale and W = Wheat

Summary

The selection of a dual purpose cereal should be based on the needs of the individual enterprise and property.

In general terms oat and barley varieties produce more dry matter in a season than wheat or triticale. Conversely triticale produces more grain yield than the other species.

The most ideal dual purpose variety ultimately depends on your end use. Only a small number of varieties produced both high dry matter and grain yield. Urambie^, El Alamein^, Endeavour^ and Tennant^ were the best dual purpose performers of the 40 varieties evaluated .

In all situations it is recommended to split the variety selection and sowing time of dual purpose cereals where possible. This will spread the period when grazing can occur and also the risk of crop failure due to dry conditions or disease.

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Thanks also to Peter Formann and Ben Frazer for technical assistance.

Managing dual purpose cereals – Somerton 2011

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Introduction

Dual purpose cereal trials have been conducted by the NSW Department of Primary Industries for over 40 years. One of these trials has been conducted at Somerton for the last 6 years, allowing extensive data to be collected on dry matter production, grain yield and growth rates of dual purpose cereals. For this paper the results from the 2011 trial have been presented, showing growth stages across four species, wheat, oats, barley and triticale.

Key findings

Typically barley and triticale are quicker to reach head emergence and flowering than most oat and wheat varieties.

The length of time taken to move between growth stages can vary dramatically within species.

Sow more than one variety or more than one dual purpose cereal species to split the timing of grazing.

Monitor the growth stages of dual purpose cereals, regularly, to ensure optimum grazing and grain/hay recovery.

Trial details

The trial was located at:

Location:	**"Clermont Park", Somerton**
Co-operators:	**Andrew & Belinda Davidson**
Sowing date:	**19th April, 2011**
Fertiliser:	**100 kg N/ha as Urea** **80 kg/ha Supreme Z Extra**
Growth stage assessment 1:	**27th June, 2011**
Growth stage assessment 2:	**16th August, 2011**
Growth stage assessment 3:	**14th September, 2011**

Dry matter assessments were conducted on the 27th June for dry matter 1 and 16th August for dry matter 2. At the same time, growth stages were recorded from one replicate using the Zadoks decimal code (Zadoks *et al*. 1974). Dry matter assessments were followed by a 'crash' grazing using sheep to remove the dry matter evenly across all plots. Following the second grazing animals were excluded for the remainder of the season to allow grain recovery to be assessed in late November/ Early December. Grain yield and quality were determined after plots were harvested using a KEW plot header. Dry matter and grain yield results are reported on separately.

Results

When to graze dual purpose cereals

Managing the timing and intensity of grazing dual purpose cereals is critical to achieving maximum dry matter and grain yield. In order to achieve this knowledge of an individual varieties development rate is useful. The rate of growth of each variety needs to be monitored carefully to ensure grazing is timely.

Identifying when to commence grazing is easier than identifying when to cease grazing. Grazing can commence once the plants are adequately anchored with secondary roots. This is to prevent stock from removing plants from the ground.

Identifying when to remove stock is largely dependent on being able to identify the start of stem elongation or the growth stage Zadoks 30 (Z30). At Z30 cereals are considered to be changing from the vegetative to the reproductive phase. Beyond this stage nodes may be felt inside the stem of the plant indicating that the developing head has now moved above ground level.

At this stage livestock should be removed and the paddock locked up for maximum grain recovery or hay production.

If livestock are allowed to continue grazing beyond this point, developing heads may be grazed off leading to significant reductions in grain yield and tiller death. Growth stage assessments should always be carried out on the primary tiller as it is the most advanced.

The time taken to reach growth stage Z30 varies depending on variety, temperature, grazing intensity and several other factors. Quick maturing varieties reach Z30 in a shorter period of time than longer season varieties, thus quicker varieties have a smaller grazing window, while long season varieties have more time to maximise grazing opportunity prior to Z30.

Across species barley tended to have a quicker development rate and run to head quicker than the other species. By the 16th August, there were 4 nodes on average across the 4 barley varieties, and by the 14th September they were close to starting to flower (Z61).

In comparison, triticale had an average of 5 nodes on the 16th of August, but by the 14th September was only at full head emergence, slightly slower than the barley.

Oats showed a much slower development rate than both barley and triticale, being at first node on the 16th August and only having progressed to mid boot stage by the 14th September. The exception to this was the variety Yiddah⟨PBR⟩, which had accelerated through to full head expression, demonstrating a much quicker development rate in the same 32 day period than all other oat varieties in this trial.

Wheat performed similar to oats, reaching Z30 on the 16th August, but only at mid booting by the middle of September.

Table 1 includes growth stage assessments for individual varieties. In this season the barley variety Moby⟨PBR⟩, had reached Z31 (one node present) by the 27th June, in comparison to a slower maturing variety such as Graza 51⟨PBR⟩ , which was at early tillering (Z24) on the same day.

Information about the development of different varieties enables better grazing management to maximise the length of time that stock can be allowed to graze paddocks and minimises any adverse effects on grain or hay recovery. This information also highlights the benefits of sowing more than one dual purpose variety to spread the availability of feed more evenly throughout the winter.

Table 1: *Somerton dual purpose cereal trial 2011 growth stage records in crop (planted 19th April, 2011)*

Variety	Species	Zadoks Growth Stage 27th June, 2011	Zadoks Growth Stage 16th August 2011	Zadoks Growth Stage 14th September 2011
Gairdner[Φ]	B	29	33	58
Moby[Φ]	B	31	39	67
Oxford[Φ]	B	29	34	57
Urambie[Φ]	B	29	32	56
Bimbil	O	26	31	48
Cooee	O	24	31	37
Graza 51[Φ]	O	23	33	37
Graza 80[Φ]	O	25	31	39
Outback[Φ]	O	26	32	37
Yiddah[Φ]	O	29	31	57
Crackerjack[Φ]	T	26	39	64
El Alamein (AT573)[Φ]	T	23	33	53
Endeavour[Φ]	T	24	32	51
Tuckerbox[Φ]	T	27	39	64
Brennan[Φ]	W	29	30	43
EGA Eaglehawk[Φ]	W	31	32	49
EGA Wedgetail[Φ]	W	26	31	51
Mackellar[Φ]	W	29	30	41
Mansfield[Φ]	W	28	30	37
Naparoo[Φ]	W	29	30	46
SQP Revenue[Φ]	W	29	30	37
Wrangler[Φ]	W	29	30	46

Species included are B = Barley, O = Oats, T = Triticale and W = Wheat

Summary

In general terms barley and triticale varieties tend to move quicker through the growth stages to reach flowering earlier than the other dual purpose species.

Within species there is also quite a bit of variation in the length of time taken to move between growth stages.

A good example is Yiddah[Φ], which is a much quicker maturity oat variety than Outback[Φ], Cooee, Graza 51[Φ] and Graza 80[Φ].

In all situations it is recommended to split the variety selection and sowing time of dual purpose cereals where possible. This will spread the period when grazing can occur and also the risk of crop failure due to dry conditions, frost or disease.

Acknowledgements

This project is funded by NSW DPI and GRDC. Thanks to our co-operators Andrew and Belinda Davidson “Clermont Park”, Somerton, for their generous provision of the trial sites, stock for grazing and support of the trials.

Thanks also to Ben Frazer for technical assistance.

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Row placement strategies in a break crop-wheat sequence

Andrew Verrell NSW DPI, Tamworth

Key findings

Sowing the following wheat crop *directly* over the row of the previous years break crop provided a 10–16% yield advantage

This system will only work for zero tillage systems where wheat stubble is kept intact

Introduction

Inter-row sowing has been shown to reduce the impact of crown rot and increase yield, by up to 9%, in a wheat-wheat sequence (Verrell *et al* 2009). Crop rotation reduces the incidence and severity of crown rot resulting in yield gains of 17–23% over continuous wheat (Verrell *et al* 2005). There was a need to examine whether row placement strategies coupled with a break crop – wheat rotation, would result in differences in grain yield over a five year crop sequence.

Treatments

A five year crop sequence experiment consisting of three winter sequences;

1. wheat-wheat-wheat-wheat-wheat
2. wheat-chickpea-wheat-chickpea-wheat
3. wheat-mustard-wheat-mustard-wheat

was established in 2008 at the Tamworth Agricultural Institute (TAI). The TAI site consists of a brown vertosol with an average summer and winter rainfall of 400 mm and 280 mm, respectively, and soil plant available water holding capacity of 120mm to a depth of 1.0m. Durum wheat (cv. EGA Bellaroi⁽ᴾ⁾) was sown in 2008 (40cm row spacing) and inoculated with a low level of the crown rot (CR) fungus, *Fusarium pseudograminearum* (*Fp*) at a rate of 0.5 g/m row. This resulted in a low incidence of *Fp* (25%) across the site.

In 2009, wheat, mustard or chickpea was sown either on or between the 2008 wheat rows using GPS guided autosteer. In subsequent seasons crops were sown either on or between the previous year rows resulting in sixteen different row placement combinations by the time the 2012 wheat crop was sown. All crops were sown with Janke coulter-tyne-press wheel parallelograms along with 100 kg N/ha (mustard and wheat) and 10 kg P/ha (all crops).

Results

The results presented here will focus solely on the mustard-wheat and chickpea-wheat systems and the last three years of the sequence trial (2010–2011-2012). Four row placement options are presented for both crop sequences and row placements are relative to the position of the 2010 wheat rows (Table 1).

Table 1: *Row placement options relative to the 2010 wheat rows*

Row Sequence	Row Placement		Abbreviation
	Year 2011	Year 2012	
1	Between 2010 rows	Between 2010 rows	BB
2	On rows 2010 rows	Between 2010 rows	OB
3	On rows 2010 rows	On rows 2010 rows	OO
4	Between 2010 rows	On rows 2010 rows	BO

The 2012 wheat yield, in the mustard-wheat sequence, was significantly higher for the BB row option (4.46 t/ha) compared to other placements (Table 2). Both the OB and OO options had similar yields which were lower than the BB treatment. The lowest yielding row placement option was BO (3.84 t/ha).

Table 2: *Row placement by year with grain yield, grain N removal and whiteheads for the 2012 wheat crop in a wheat-mustard-wheat sequence*

Row Placement Sequence	Row Placement × Crop			2012 Wheat Crop		
	2010 Wheat	2011 Mustard	2012 Wheat	Yield (t/ha)	Grain-N (kgN/ha)	Whiteheads (heads/m²)
BB				4.46a	87a	0.70a
OB				4.27b	88a	0.64a
OO				4.24b	86a	0.89ab
BO				3.84c	75b	1.53b

NB Values within a column with the same letter are not significantly different (P<0.05)

The BO row placement sequence had significantly lower grain nitrogen removal and the highest number of whiteheads compared to the other row placement options in the mustard-wheat sequence (Table 2).

Similar data for the mustard-wheat sequence is presented for the chickpea-wheat sequence (Table 3). In this sequence there was no difference between the BB, OB and OO row placements for the 2012 wheat yield. However, the BO sequence had significantly lower yield (4.03 t/ha) for the 2012 wheat crop compared to other options. The BO sequence also had the lowest grain nitrogen removal rate and the highest number of whiteheads under a chickpea-wheat rotation (Table 3).

Table 3: *Row placement by year with grain yield and grain N removal for the 2012 wheat crop in a wheat-chickpea-wheat sequence*

Row Placement Sequence	Row Placement × Crop			2012 Wheat Crop		
	2010 Wheat	2011 Chickpea	2012 Wheat	Yield (t/ha)	Grain-N (kg N/ha)	Whiteheads (heads/m²)
BB				4.46a	91a	0.92a
OB				4.45a	92a	0.92a
OO				4.36a	90a	0.83a
BO				4.03b	82b	1.63b

NB Values within a column with the same letter are not significantly different ($P<0.05$)

Whiteheads for the wheat-wheat sequence were 2.2, 0.8, 3.5 and 1.2 (heads/m²) for the BB, OB, OO and BO row placement options, respectively (rest of data not shown).

Summary

After five years, both break crop systems showed grain yield advantages in 2012, over continuous wheat, of 40% and 44%, for the mustard-wheat and chickpea-wheat systems, respectively. The chickpea-wheat system tended to have slightly higher wheat grain yields in 2012 for each of the four row placement strategies compared to the mustard-wheat sequence (Table 2 and Table 3).

The number of whiteheads/m² does not reflect the total level of incidence of *Fp* in a crop. Whitehead production is heavily influenced by the amount of water (rainfall + soil stored) available to the crop. Under high water levels, whitehead numbers can be very low or even non-existent even if the crop has a high incidence of *Fp*. The whitehead counts provide a trend and should not be considered as absolute values. In this experiment whitehead numbers are low due to high levels of crop available water, from zero-till fallowing and in-crop rainfall.

What this experiment has shown is that simply alternating row placement in consecutive years will not result in yield gains but a yield loss and increased CR (BO system). In the BO sequence the break crop was sown between standing cereal stubble which was kept intact. The following wheat crop was then sown between the previous years (break crop) rows but this put it directly over the old 2010 wheat row. The consequence of this sequence was that the wheat crop was sown into old infected wheat stubble hence the higher level of CR infection resulting in higher whitehead counts. The benefit of the break crop in breaking any disease cycle was reduced. This is supported by the wheat-wheat whitehead data which showed higher incidence of whiteheads/m² for row placements where wheat was sown directly over the previous row (BB=2.5, OO=3.5) compared to between row sequences (OB=0.8, BO=1.2).

Even the traditional on row system (OO) had a better yield and CR outcome than the BO system because the break crop was sown directly over the old wheat stubble row excavating the residue out of the row (tyne with spear points) and providing a direct break to the CR fungus (Table 2 and 3). This may not be the case however if a low disturbance disc system is used.

Based on these results the best option for row placement sequences in a break crop system is shown in Table 4.

Table 4: *Proposed row placement strategy to optimise crop yield in a wheat-break crop-wheat sequence.*

Year 1 Wheat	Year 2 Chickpea	Year 3 Wheat	Year 4 Canola	Year 5 Wheat

Following a wheat crop, the break crop (pulse or oilseed) should be sown between the standing stubble rows. In the next year, the wheat crop should be sown directly over the previous seasons break crop row. Then in the next year of the rotation the break crop should shift back and be sown between the standing wheat rows. Finally, in the fifth year, the wheat crop again should be sown directly over the previous years break crop row.

There are two simple rules that need to be followed;

- Sow break crops between standing wheat rows which need to be kept intact
- Sow the following wheat crop *directly* over the row of the previous years break crop

By following these two rules it ensures the following;

- Ensures four years occur between wheat crops being sown in the same row space (Table 4)
- Improved germination of break crops, especially canola, not hindered by stubble
- Chickpeas will benefit from standing stubble reducing the impact of virus
- Standing wheat stubble gives better protection to break crop seedlings

Acknowledgements

Thanks to Michael Nowland and Paul Nash for their assistance in the trial program.

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Response of current and future wheat varieties to three planting times at Tamworth in 2012

Matthew Gardner, Patrick Mortell and Jim Perfrement NSW DPI, Tamworth

Key findings

In 2012 the optimum sowing window appeared to shift forward 10 days compared to the traditional flowering window between 20th of September to October 5th. This shift in date resulted in the better performance of shorter season varieties from earlier planting times.

Suntop[⍬] and Sunguard[⍬] behaved similarly to EGA Gregory[⍬] in terms of maturity, while Suntop[⍬] had comparable yield across all planting times.

Longreach Dart[⍬] provides a quick option that was faster than any other variety examined with the main season planting time (TOS 2). Despite the quick time to reach anthesis, Longreach Dart[⍬] does not reach physical maturity any quicker than Longreach Spitfire[⍬], which suggests that it has a longer grain filling period.

Late season rainfall meant that longer season varieties were able to gain a yield advantage over quick maturing varieties from a late planting time (TOS 3).

Introduction

The autumn break in NSW occurs anywhere between March and June, with the reliability of the break being more inconsistent in northern NSW compared to the south. There a large number of wheat varieties available to growers across a wide range of maturities providing the opportunity to plant wheat crops from late March until late June and still have the crop flowering when the risks of frost and heat stress are acceptable. Between mid September to the first week in October is the optimum flowering window for cereal crops at Tamworth to avoid excessive frost risk (>10%) and limit exposure to heat stress later in the season. Varieties differ in the ability to achieve high yields from different sowing times. Trials were conducted at Tamworth to determine the yield and quality of a range of wheat varieties across three different sowing times. In addition, phenology information was collected throughout the season to assist in sowing time recommendations for the various varieties.

Site details

Tamworth Agricultural Institute

Location:	**Paddock 30**
Previous Crop:	**Canola**
Starting N:	**62 kg N/ha (0–120 cm)**
Sown:	**26th April, 20th May and 20th June**

Treatments

There were 20 varieties with varying maturities and agronomic traits used in the TOS trial in 2012 which included both commercially available varieties and advanced breeder lines (Table 1). The wheat TOS trial included 13 bread wheat varieties and 7 durum varieties (primarily experimental lines). These varieties were sown on three separate occasions 26th April (TOS 1), 20th May (TOS 2) and the 20th June (TOS 3).

Results

The 2012 season started with good subsoil moisture and had good rainfall through Autumn and early winter. After significant rainfall in mid July there was virtually insignificant fall of rain until after harvest.

The optimum flowering window at Tamworth in 2012 was between the 10th September and the 24th September (Figure 1), which supports the results of the barley TOS trial. The majority of wheat varieties from TOS 1 flowered in this window, hence TOS 1 had the highest yields of the three planting times (Figure 1). As flowering was delayed beyond September 24th there was a gradual yield decline. The exception was in TOS 3 where there was a group of varieties that flowered after mid October, which didn't suffer any more yield penalty compared to varieties that flowered in early to mid October (Figure 1). With TOS 3 nearly all varieties flowered outside what is typically the optimum flowering window for Tamworth of between the 20th of September and the 5th of October (Figure 1).

In 2012 there was a significant decline in grain yield for each delay in planting time. On average TOS 1 and 2 both flowered within the optimum window for Tamworth, while TOS 3 flowered 10 days past the optimum window (Table 1). Surprisingly, Longreach Spitfire⊕ had the highest yields from TOS 1 along with EGA Bounty⊕, which were both similar to Suntop⊕, Caparoi⊕ and Livingston⊕. All of these varieties attained grain yields of 6.0 t/ha or greater with TOS 1 (Table 1). Interestingly EGA Gregory⊕ was one of the lowest yielding varieties with the early sowing (TOS 1) which is in contrast to previous seasons where EGA Gregory⊕ had good comparative yields across all sowing times.

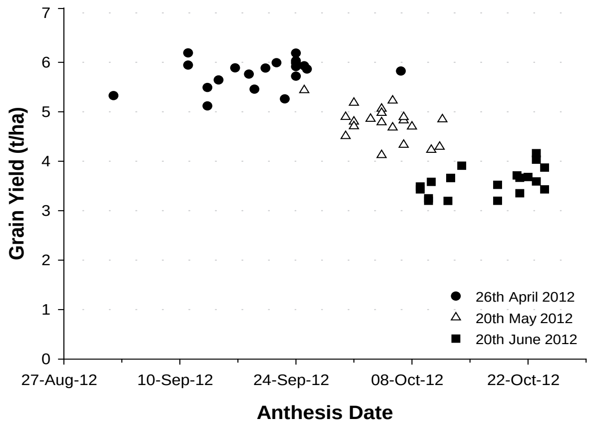

***Figure 1:** Relationship between grain yield and anthesis date for three sowing dates at Tamworth in 2012*

Longreach Dart⊕ had higher yield than all other varieties, except for EGA Gregory⊕ (5.23 t/ha), which was also similar to the experimental durum line TD280913 (5.18 t/ha) and Suntop⊕ (5.04 t/ha), from TOS 2 (Table 1). There were a further 10 varieties that had similar yields between 4.70 and 5.00 t/ha at TOS 2.

EGA Gregory⊕ and the experimental line QT16026 had the highest yields of all varieties in the latest sowing time (TOS 3), this is despite flowering after the 20th of October. Interestingly the remaining varieties in the top ten performing varieties for TOS 3 were all longer season varieties.

***Table 1:** Grain yield, yield rank and days to anthesis for 20 wheat varieties at three sowing times at Tamworth in 2012. Lsd's for TOS and variety were 0.41 t/ha and 0.24 t/ha, respectively (P<0.05).*

Variety	Yield (t/ha) and rank within sow time						Days from sowing to anthesis		
	26th April		20th May		20th June		26th April	20th May	20th June
Caparoi⊕	6.03	3	4.83	10	3.52	12	149	137	117
EGA Bounty⊕	6.19	2	4.89	7	3.68	6	149	137	121
EGA Eaglehawk⊕	5.82	12	4.85	9	3.87	4	162	142	123
EGA Gregory⊕	5.26	19	5.23	2	4.16	1	148	136	118
Jandaroi⊕	5.12	20	4.80	11	3.20	20	138	131	111
Livingston⊕	5.94	6	4.71	13	3.43	15	136	131	108
LongReach Dart⊕	5.32	18	5.44	1	3.58	11	127	125	109
LongReach Spitfire⊕	6.19	1	4.90	6	3.25	17	136	130	109
LPB07-0548	5.91	8	4.23	19	3.59	10	149	140	122
QT 16026	5.86	11	4.70	14	4.03	2	150	138	122
SUN643A	5.64	15	4.51	16	3.49	13	140	130	108
Sunguard⊕	5.46	17	4.68	15	3.67	7	144	136	120
Suntop⊕	5.99	4	5.06	4	3.71	5	147	134	120
Sunvale⊕	5.72	14	4.29	18	3.43	14	149	141	123
Sunvex⊕	5.93	7	4.33	17	3.35	16	150	137	120
TD280913	5.49	16	5.18	3	3.20	18	138	131	109
TD290491	5.89	9	4.86	8	3.91	3	142	133	113
TD290564	5.76	13	4.79	12	3.66	8	143	134	112
UAD0951096	5.88	10	4.98	5	3.66	9	145	134	112
Zulu	5.99	5	4.12	20	3.20	19	149	134	117
TOS Average	5.77		4.76		3.58		129 (3rd Sep)	121 (21st Sep)	108 (8th Oct)

Suntop$^{\phi}$ and Sunguard$^{\phi}$ had similar anthesis dates to EGA Gregory$^{\phi}$ across the three planting times. For TOS 1 and 2 Longreach Dart$^{\phi}$ was 17 and 10 days quicker than the average anthesis date, however, despite the earlier anthesis the time taken to reach physical maturity was the same as with Longreach Spitfire$^{\phi}$. For TOS 3, Longreach Dart$^{\phi}$ flowered at a similar time to Longreach Spitfire$^{\phi}$, and Livingston$^{\phi}$. The LPB07-0548 line was slightly longer maturity than EGA Gregory$^{\phi}$ in the 2012 trials but quicker than EGA Eaglehawk$^{\phi}$ (Table 1).

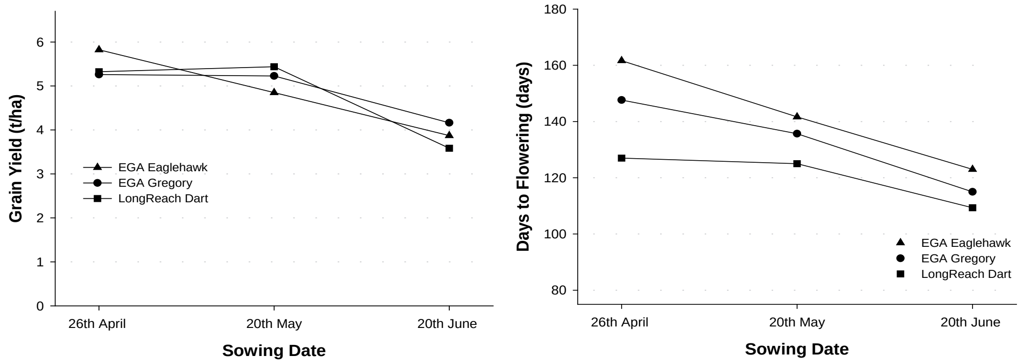

Figure 2: *Grain yield (a) and days from sowing to flowering (b) at three sowings dates for EGA Eaglehawk$^{\phi}$, EGA Gregory$^{\phi}$ and LongReach Dart$^{\phi}$ at Tamworth in 2012.*

When looking at the performance of a long season (EGA Eaglehawk$^{\phi}$), a main season (EGA Gregory$^{\phi}$) and a short season (LongReach Dart$^{\phi}$) variety, the longer season variety had an improved yield with an early season planting (26th April; Figure 2a). However, for the late plant (20th June) EGA Gregory$^{\phi}$ and EGA Eaglehawk$^{\phi}$ had similar yields to LongReach Dart$^{\phi}$. EGA Gregory$^{\phi}$ and LongReach Dart$^{\phi}$ obtained similar yield from the mid May planting time. The yield differences were relatively minor compared to the differences in flowering times. EGA Eaglehawk$^{\phi}$ flowered 36, 16 and 14 days later than LongReach Dart$^{\phi}$ from the first, second and third planting times, respectively (Figure 2b). This also highlights that the time taken to reach anthesis for LongReach Dart$^{\phi}$ may be approximately 127 days.

Summary

This trial allowed us to gauge how new varieties entering the market compare in their maturity and yield to existing variety benchmarks across sowing times. In the wheat, Suntop$^{\phi}$ appears to provide an alternative to EGA Gregory$^{\phi}$ in the market with similar yields and maturity, while Longreach Dart$^{\phi}$ provides a quick option that was faster than any other variety examined with the main season planting time (TOS 2). Despite the quick time to reach anthesis Longreach Dart$^{\phi}$ does not reach physical maturity any quicker than Longreach Spitfire$^{\phi}$, which suggests that it has a longer grain filling period.

The first sowing time provided the highest grain yields at this site in 2012, with a yield penalty incurred for every delay in planting date after that. Similar to what was observed for the barley TOS trial the optimum flowering window appeared to shift forward 10 days compared to the historical optimum flowering window of between 20th of September to October 5th for Tamworth. This shift explains why the quick maturing varieties performed well from early planting times (e.g. LongReach Spitfire$^{\phi}$ and LongReach Dart$^{\phi}$ in TOS 1 and 2, respectively). The other interesting interaction between maturity and planting time was the better performance of longer season varieties (all in top 10) with the last sowing time (TOS 3). The likely explanation is that the delay in maturity has actually enabled these varieties to take greater advantage of storms late in the season, compared to the quicker varieties that would have already matured. This interaction is likely to be totally dependant on seasonal conditions.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Technical assistance provided by Rod Bambach, Jan Hosking, Stephen Morphett and Peter Formann are also gratefully acknowledged.

Using row orientation, row spacing and variety selection as weed management tools – Bithramere 2012

Matthew Gardner, Patrick Mortell and Stephen Morphett NSW DPI, Tamworth

Introduction

When used appropriately herbicides are the most effective means of controlling weeds and minimising their competition with crops for resources. However, solely relying on herbicides for weed control comes with the risk of the quicker development of herbicide resistance in the cropping system. Mechanical methods of weed control are obvious options during the fallow, but there are other methods that can be used to manipulate the crop, which make it more competitive against weeds, hence reducing the impact of weeds of yield.

Manipulation of row spacing and orientation is one possible way reduce weed competition and maintain crop yield potential. An east-west crop row orientation has been reported to receive the greatest light interception and produce significantly higher yields for wheat and barley in the presence of weed competition. Having crop rows at an east-west orientation resulted in reduced biomass and light interception by weeds between crop rows. Reducing the space between rows also reduces the light interception by weeds as crops are quicker to achieve row closure. In addition species and variety selection can have a large bearing on the level of crop competition. Barley is generally more vigorous than wheat during the early growth stages making it more competitive with weeds. There is also a difference between varieties within a species that may make them more competitive with weeds.

The objective of this experiment was to investigate whether crop row orientation, row spacing and variety selection within barley could be used to minimise the effect of nil, low and high weed competition on grain yield.

Key findings

Row spacing did not significantly reduce the impact of weed competition on grain yield. However, row orientation and variety selection were found to be useful cost effective tools to reduce weed competition.

A vigorous variety such as Skipper⁽ᵈ⁾ reduced weed competition by potentially 30–40%, while an east-west row orientation was shown to reduce weed competition by approximately 40% compared to the north-south row orientation.

Although row spacing was not shown to reduce weed competition it was shown to limit yield potential by up to 11% when a 50 cm row spacing was used compared to a 30 cm spacing.

Site details

Bithramere

Location:	**"Hyland"**
Co-operators:	**Gavin Hombsch**
Sowing date:	**18th May 2012**
Fertiliser:	**80 kg/ha Nitrogen as Urea** **75 kg/ha Supreme Z Extra**
Starting Soil N:	**62 kg N/ha**
Grain Harvest:	**21st November, 2012**

Treatments

The trial design was fully factorial. Crop row orientation was either north-south (N-S) or east-west (E-W) and planted on either 30 or 50 cm row spacing's. Hindmarsh⁽ᵈ⁾ and Skipper⁽ᵈ⁾ were the two barley varieties used in the trial, which are both quick maturing. Skipper⁽ᵈ⁾ has a much more vigorous growth habit than Hindmarsh⁽ᵈ⁾ and produces a larger crop canopy. Nil, low and high weed competition was created in the form of canola. Pioneer® 44Y84, a vigorous Clearfield® hybrid canola variety, was planted at target plant populations or 0, 25 and 50 plants/m^2 for the nil, low and high weed competition treatments, respectively. The canola was planted both in the inter-row and in-row. The canola plants were allowed to grow until the barley crop reached anthesis (mid September) before they were manually removed from all plots. Prior to harvest the outside rows of each plot were removed using a sickle bar to eliminate any edge affects from the different row spacing treatments.

Results

Despite best attempts to establish the target weed populations the achieved populations were actually 0, 5 and 35 canola plants/m^2 for the nil, low and high weed competition treatments, respectively. Given the limited number of plants/m^2 for the low weed a competition treatment that individual data is not presented in this paper but was included in all statistical analyses. An E-W row orientation was shown to significantly reduce weed dry matter accumulation by 39% compared to the N-S row orientation that produced an average of 0.94 t/ha of weed biomass (Figure 1). The reduction in weed biomass could be further improved by using a more vigorous variety. Skipper$^{\phi}$ significantly reduced weed biomass by a further 30% and 42% for the N-S and E-W row orientations, respectively, compared to Hindmarsh$^{\phi}$. Row spacing did not have a significant effect on the accumulation of weed biomass (data not shown). The weed biomass produced represented between 5 and 17% of the total plot biomass achieved when the barley crop reached the anthesis growth stage (data not shown).

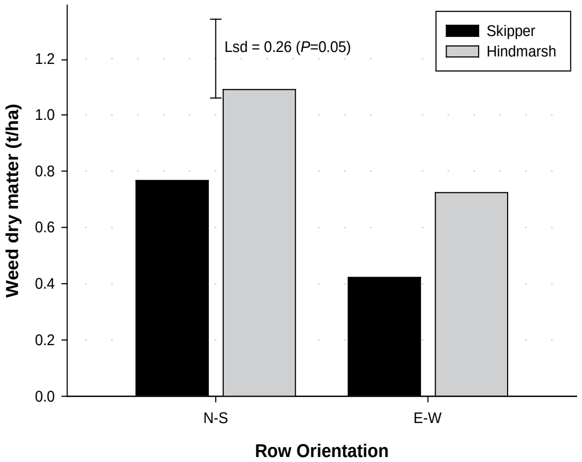

Figure 1: *Effect of north-south (N-S) or east-west (E-W) row orientations and variety selection (Skipper$^{\phi}$ or Hindmarsh$^{\phi}$) on weed dry matter accumulation by anthesis within a barley crop at Bithramere in 2012.*

Skipper$^{\phi}$ had an average grain yield of 5.02 t/ha across all treatments, which was significantly greater (0.33 t/ha) than Hindmarsh$^{\phi}$ (Figure 2). Row orientation, had no significant impact on grain yield under high weed competition. When no weeds were present, the N-S orientation had a 6% and 7% yield improvement, for the 30 and 50 cm row spacing treatments, respectively, compared to the E-W row orientation (Figure 2). Widening row spacing from 30 to 50 cm significantly reduced grain yield by 0.54 t/ha (11%) while the high weed competition reduced grain yield by 0.42 t/ha (8%) compared to no weed competition.

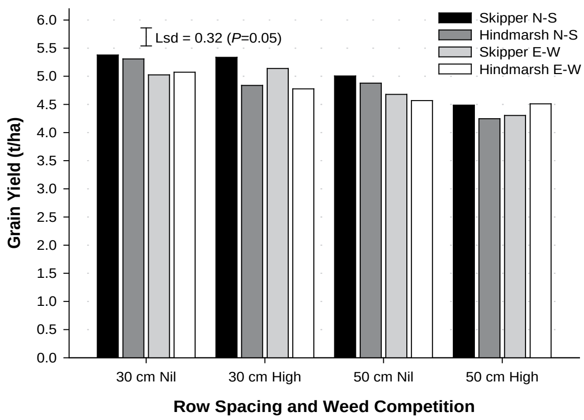

Figure 2: *Effect of row spacing and weed competition treatment on the grain yield of Hindmarsh$^{\phi}$ and Skipper$^{\phi}$ barley that was sown on either an east west or north south row orientation at Bithramere in 2012.*

Summary

Although the weed competition imposed in this trial was relatively light, 35 canola plants/m^2 and 5–17% of total biomass per hectare, it significantly reduced grain yield compared to the nil weed competition treatment. Row spacing did not significantly reduce the impact of weed competition on grain yield. As main treatments the wider row spacing and an E-W row orientation (in the absence of weeds) both significantly reduced grain yield. However in the presence of weeds row orientation had no significant effect on grain yield, which suggests that the difference between row orientations had been reduced. This may be a result of the low accumulation of weed biomass under the E-W row orientation. Lower weed competition from the E-W row orientation is likely a result of increased shading between crop rows as rows are at 90° to the sun.

Variety selection also had a large impact on weed competition with the more vigorous barley variety Skipper$^{\phi}$ reducing weed competition by potentially 30–40% compared to Hindmarsh$^{\phi}$. Given these results it would be expected that treatment differences may be increased at higher weed populations. This trial has demonstrated that weed competition can be reduced through the use of cost effective strategies such as row orientation and variety choice, which would complement any herbicide applications. Although row spacing was not shown to reduce weed competition, a wide row spacing of 50 cm did limit yield potential compared to a narrower 30 cm spacing.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Gavin Hombsch "Hyland" is gratefully acknowledged for the provision of the trial site. Technical assistance provided by Rod Bambach, Jan Hosking and Jim Perfrement are also gratefully acknowledged.

Dual purpose cereals – Somerton 2012

Loretta Serafin, Peter Formann and Matthew Gardner NSW DPI, Tamworth
Dougal Pottie NSW DPI, Gunnedah

AGRONOMY

Introduction

Dual purpose winter cereals have been evaluated by NSW Department of Primary Industries for the last 40 years. The Somerton site was one of two sites in northern NSW, the other located near Purlewaugh in the Coonabarabran district.

This paper includes the results of the 2012 season only. An across sites and seasons paper has been included in this book as well.

The dual purpose cereal trials are comprised of 5 species; wheat, oats, barley, triticale and cereal rye.

Key findings

For early season feed, the best DM production was from Moby⁽ᴾ⁾, White Stallion⁽ᴾ⁾ (barley), Outback⁽ᴾ⁾ (oats) and Southern Green⁽ᴾ⁾ (cereal rye).

By the time of dry matter assessment 2 there Southern Green⁽ᴾ⁾ (cereal rye), Tuckerbox⁽ᴾ⁾ and Endeavour⁽ᴾ⁾ (triticale) were the best performing varieties.

The highest grain yield was 3.58 t/ha which was achieved by the barley variety Urambie⁽ᴾ⁾. Tobruk⁽ᴾ⁾, triticale and Oxford⁽ᴾ⁾, barley were also high performers.

Trial details

Location:	**"Clermont Park", Somerton**
Co-operators:	**Andrew & Belinda Davidson**
Sowing date:	**20th April 2012**
Fertiliser:	**70 kg/ha nitrogen as Urea, 75 kg/ha Supreme Z Extra**
Dry Matter Assessment 1:	**22nd June**
Grazing 1:	**24th June**
Dry Matter Assessment 2:	**19th July**
Grazing 2:	**22nd–26th July**
Dry Matter Assessment 3:	**29th August**
Grain Harvest:	**13th November**

Treatments

The trial included 42 entries consisting of 8 barley, 4 oat, 8 triticale, 21 wheat and 1 cereal rye varieties and experimental lines. Only data from the named varieties is shown.

Two dry matter assessments were conducted, with each assessment being followed by a 'crash' grazing with sheep to remove the dry matter evenly across all plots. Following the second grazing the animals were excluded for the remainder of the season to allow grain recovery to be assessed in mid November. A third dry matter assessment was taken but was not followed by grazing. The trial was harvested using a KEW plot header.

Results

Dry Matter Assessment 1

Dry matter (DM) assessment 1 produced on average 1.59 t/ha of DM. The best DM production was from Moby⁽ᴾ⁾, White Stallion⁽ᴾ⁾ (barley), Outback⁽ᴾ⁾ (oats) and Southern Green⁽ᴾ⁾ (cereal rye).

Dry Matter Assessment 2

There was much larger variation in the dry matter production between varieties in the second assessment compared to the first. There was also more dry matter produced, with on average 2.67 t/ha DM recorded.

Southern Green⊕ (cereal rye), Tuckerbox⊕ and Endeavour⊕ (triticale) were the best performing varieties.

Dry Matter Assessment 3

A third dry matter assessment was conducted, but the trial was not grazed. These dry matter measurements were not included in the total dry matter production, because as a true dual purpose cereal recovery of this material would not be possible as the crop would have been locked up for grain recovery.

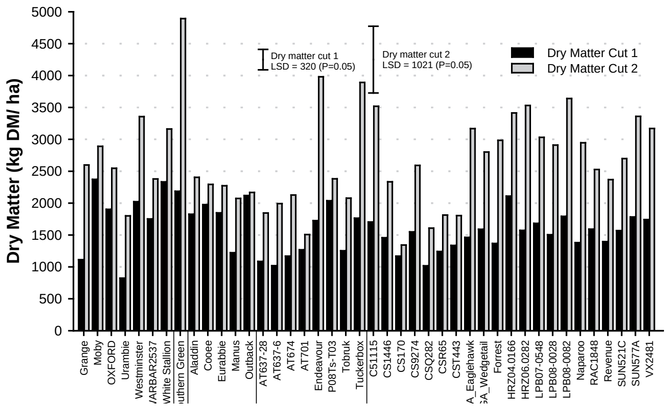

Figure 1: *Dry Matter Production from Mixed Cereals–Grazing 1 and 2*

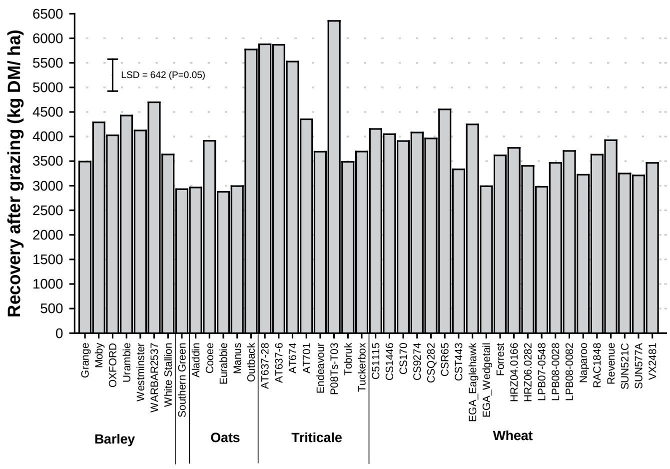

Figure 2: *Dry Matter Production from Mixed Cereals – Dry Matter Assessment 3*

However, the third dry matter assessment gave a good indication of a varieties ability to recover following a second grazing. The barley and triticale entries as a group recovered the best following grazing.

In contrast the recovery of oat varieties has been somewhat disappointing. Much of this was attributed to the combination of frosts and the heavy grazing which led to significant tiller death.

Total Season Dry Matter Production

In total across the season, the best variety was Southern Green⊕, a cereal rye which produced over 7 t/ha of DM.

Endeavour⊕ and Tuckerbox⊕, two triticale varieties were the next highest performers, delivering around 5.7 t/ha of DM.

Grain Yield

The highest grain yield was 3.58 t/ha which was achieved by the barley variety Urambie⊕. Tobruk⊕ (triticale) and Oxford⊕ (barley) were also high performers.

The majority of the oat varieties performed poorly for grain yield, including Outback⊕ which did not produce any grain at harvest.

Summary

There was a large variation in variety performance. Several of the barley varieties and the cereal rye produced the most dry matter. By the time of the second assessment it became obvious that some of the triticale varieties were also strong performers.

Acknowledgements

This project was funded by NSW DPI and GRDC under DAN 00135. Thanks to our co-operators Andrew & Belinda Davidson "Clermont Park" Somerton, for their generous provision of the trial sites, stock for grazing and support of the trials. Thanks also to Ben Frazer, Stephen Morphett and Jan Hosking for technical assistance.

Table 1: *Dry matter production and grain yield of the dual purpose cereal entries – Somerton 2012*

Variety	Species	DM 1 (t/ha)	DM 2 (t/ha)	Total DM (t/ha)	Grain Yield (t/ha)
Urambie⊕	B	0.82	1.80	2.62	3.58
CS170	W	1.17	1.34	2.51	3.04
Tobruk⊕	T	1.25	2.08	3.33	3.00
Oxford⊕	B	1.90	2.55	4.45	2.76
Naparoo⊕	W	1.38	2.95	4.33	2.67
Westminster⊕	B	2.02	3.36	5.38	2.58
Grange⊕	B	1.11	2.60	3.71	2.58
Endeavour⊕	T	1.73	3.98	5.71	2.53
EGA Eaglehawk⊕	W	1.46	3.17	4.63	2.51
EGA Wedgetail⊕	W	1.59	2.80	4.39	2.49
Southern Green⊕	CR	2.19	4.89	7.08	2.48
Moby⊕	B	2.37	2.89	5.26	1.93
White Stallion⊕	B	2.33	3.16	5.49	1.82
Tuckerbox⊕	T	1.76	3.89	5.66	1.79
Forrest⊕	W	1.37	2.98	4.35	1.59
SQP Revenue⊕	W	1.40	2.37	3.77	1.29
Eurabbie⊕	O	1.85	2.27	4.12	0.75
Mannus⊕	O	1.22	2.07	3.30	0.56
Aladdin⊕	O	1.83	2.41	4.23	0.14
Cooee	O	1.98	2.29	4.27	0.06
Outback⊕	O	2.12	2.17	4.29	n/a
Mean		1.59	2.67	4.26	2.17
L.s.d		0.32	1.05	1.24	0.47
CV %		12.4	24.3	–	13.4

B = Barley, O = Oats, T = Triticale, W = Wheat, CR = Cereal rye.

Effect of time of sowing and variety choice on chickpea yield – Trangie 2012

Leigh Jenkins NSW DPI, Warren **Rohan Brill** NSW DPI, Coonamble

Key findings

Chickpea time of sowing trials conducted at Trangie in 2011 and 2012 have shown that mid May to early June is the optimum period to plant current chickpea varieties with Jimbour⁽ᵇ⁾ type maturity. Early planting (early May) can increase the risk of exposure to disease infection events, as occurred in 2011 (resulting in lower yields) but not in 2012. Planting chickpeas in mid-late June has shown significantly lower yields in both the 2011 and 2012 trials.

Varieties with Jimbour⁽ᵇ⁾-type maturity (e.g. PBA HatTrick⁽ᵇ⁾ and PBA Boundary⁽ᵇ⁾) are ideal for the Central West region of NSW, with higher yields in both years. Within this maturity group, PBA Boundary⁽ᵇ⁾ had the highest yield in 2012; however in 2011 yield of PBA HatTrick⁽ᵇ⁾ was higher than PBA Boundary⁽ᵇ⁾ due to the effects of phytophthora root rot induced by wet conditions post sowing.

In 2012, targeting a higher plant population on PBA HatTrick⁽ᵇ⁾ (45 plants/m^2) had significantly higher yields than targeting a lower plant population (15 plants/m^2), regardless of sowing time.

Introduction

Disease and frost damage have previously been identified as the two major constraints to chickpea production in the northern cropping region. In both cases, sowing date can be used as a strategy to influence yield through avoidance of cold temperatures during flowering, and to reduce the exposure to disease infection events.

Chickpea time of sowing trials (TOS) have been conducted in 2010, 2011 and 2012 by NSW DPI at Trangie Agricultural Research Centre, to evaluate the impact of sowing date on phenology and yield of current and potential release cultivars. The 2010 trial succumbed to in-crop waterlogging and wet weather at harvest and was not harvested. Results of the 2011 trial were reported in the Autumn 2012 edition of the Northern Grains Region Trial Results publication.

This paper reports on the results of the 2012 trial investigating the effect of four times of sowing on the yield of seven chickpea varieties. A seeding rate component was also included in the trial (PBA HatTrick⁽ᵇ⁾ only) to compare the interactions between sowing time and plant population, chiefly to investigate if early sown low density crops yield comparably with late sown higher density crops.

Site details

Location:	**Trangie Agricultural Research Centre**
Soil type:	**Grey vertosol (cracking clay)**
2011 crop:	**Wheat**
Phosphorus:	**22 mg/kg (Colwell)**
PAW sowing:	**180 mm (estimate)**
In-crop rainfall:	**109 mm**

Fungicide strategy for foliar disease control was as per current best management practice, i.e. post emergence and prior to the first rainfall event for each individual time of sowing. In 2012 only four early applications of fungicide (cumulative for each TOS) were applied due to lack of rainfall events after July.

Treatments

4 sowing dates: TOS 1: 9 May; TOS 2: 21 May; TOS 3: 1 June; TOS 4: 20 June
5 desi varieties: CICA-0912 (potential release), Flipper⁽ᵇ⁾, PBA Boundary⁽ᵇ⁾, PBA HatTrick⁽ᵇ⁾, Sonali⁽ᵇ⁾ 2 kabuli varieties: Genesis™ 090, Genesis™ Kalkee
Target plant populations: 30 plants/m^2 (all varieties); 15 and 45 plants/m^2 (PBA HatTrick⁽ᵇ⁾ only)

Results

Effect of time of sowing on yield:

- Averaged across varieties, TOS 1 and TOS 2 were not significantly different in yield. However, TOS 2 was significantly higher yielding than TOS 3 (by 0.13 t/ha); and TOS 3 was significantly higher yielding than TOS 4 (by 0.31 t/ha).

Table 1: Grain yield (t/ha) of seven chickpea varieties sown at four sowing times at Trangie ARC 2012

Variety	Yield (t/ha)				
	9th May	21st May	1st June	20th June	Mean of variety
CICA-0912	1.44	1.56	1.50	1.24	1.43
Flipper(D)	1.65	1.55	1.45	1.13	1.44
Genesis™ 090	1.69	1.73	1.65	1.25	1.58
Genesis™ Kalkee	1.42	1.64	1.25	0.81	1.28
PBA Boundary(D)	1.60	1.71	1.76	1.42	1.62
PBA HatTrick(D)	1.51	1.68	1.46	1.35	1.50
Sonali(D)	1.55	1.52	1.41	1.09	1.39
Mean of sow time	1.55	1.63	1.50	1.18	1.46
l.s.d. $p < 0.001$	Variety = 0.108 t/ha, Sowing time = 0.08 t/ha				

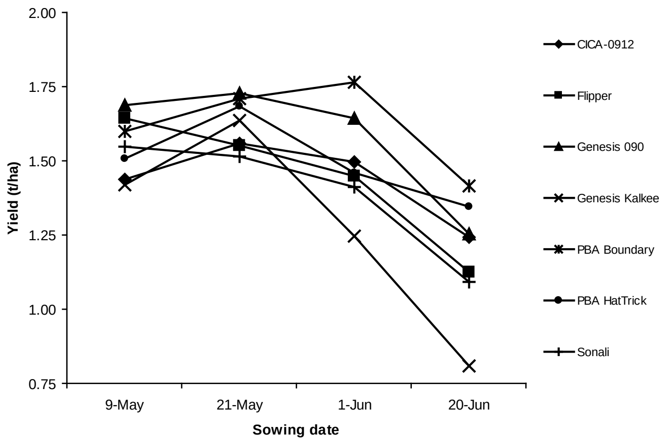

***Figure 1:** Grain yield (t/ha) of seven chickpea varieties sown at four sowing times at Trangie ARC 2012; l.s.d. ($p < 0.001$) Variety = 0.108 t/ha, Sowing time = 0.08 t/ha*

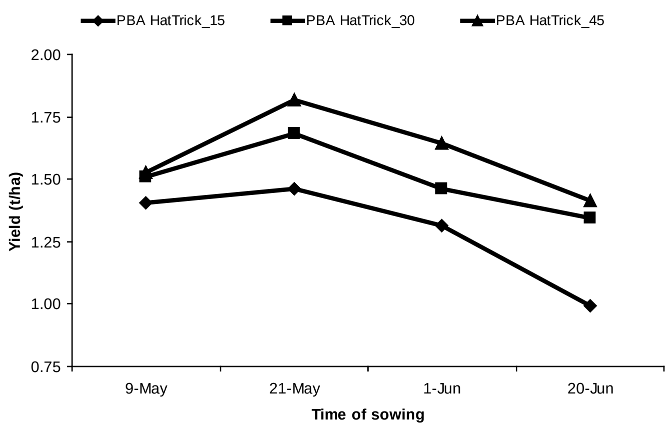

***Figure 2:** Grain yield (t/ha) of PBA HatTrick(D) sown with three target plant populations at four sowing times at Trangie ARC 2012; l.s.d. ($p < 0.001$) Seed rate = 0.118 t/ha*

- Averaged across sowing times, PBA Boundary(D) was the highest yielding variety (mean yield 1.62 t/ha), with significantly higher yield than all other varieties except Genesis™ 090 (1.58 t/ha). PBA HatTrick(D) yielded 1.5 t/ha averaged across sowing times.
- All varieties had a significant reduction in yield at TOS 4, with Genesis™ Kalkee having significantly lower yields than all other varieties at both TOS 3 and TOS 4.

Effect of seeding rate on yield:

- Across the four sowing dates and on the one variety PBA HatTrick(D), the 45 plants/m^2 target population (1.6 t/ha) and 30 plants/m^2 target population (1.5 t/ha) had significantly higher yield than the 15 plants/m^2 target population (1.29 t/ha) treatment.
- There was no interaction between seeding rate and sowing time, meaning that the advantage of the higher seeding rate was observed for all sowing times.
- There was no significant difference in yield between PBA HatTrick(D) sown early (TOS 1) at 15 plants/m^2 (1.41 t/ha) and PBA HatTrick(D) sown late (TOS 4) at 45 plants/m^2 (1.41 t/ha).

Table 2: Grain yield (t/ha) of PBA HatTrick(D) sown with three target plant populations at four sowing times at Trangie ARC 2012

Seed rate	Yield (t/ha)				Mean of seed rate
	9th May	21st May	1st June	20th June	
PBA HatTrick_15	1.41	1.46	1.32	1.00	1.29
PBA HatTrick_30	1.51	1.68	1.46	1.35	1.50
PBA HatTrick_45	1.53	1.82	1.64	1.41	1.60
Mean of sow time	1.48	1.65	1.47	1.25	1.47
l.s.d. $p < 0.001$	Seed rate = 0.118 t/ha				

Summary

Both the 2011 and 2012 chickpea time of sowing trials were conducted with a full soil moisture profile at planting. The 2011 season was characterised by wet conditions post-planting in May resulting in an increased incidence of phytophthora root rot, followed by a dry winter and spring. Chickpea foliar diseases did not impact on yield in either trial due to fungicide applications and the dry conditions from July–September.

The 2011 trial showed a significant yield penalty from early sowing (5 May) due to both the increased incidence of phytophthora root rot, and the effect of low temperatures on pod development. Optimum yields were achieved from mid-season sowing on 18 May and 9 June. The late sowing (27 June) in 2011 had lower yields than the two mid-season sowings, but still yielded higher than the first time of sowing.

The 2012 trial confirmed these results from 2011 that mid May to early June remains the optimum period to plant most current chickpea varieties with Jimbour type maturity, e.g. PBA HatTrick⫽ and PBA Boundary⫽ in the central western region. Early planting (early May) can increase the risk of exposure to disease infection events, as occurred in 2011 (resulting in lower yields) but not in 2012. Planting chickpeas in mid-late June has shown significantly lower yields in both the 2011 and 2012 trials.

In 2011, PBA HatTrick⫽ was the highest overall yielding variety (mean yield 1.37 t/ha), although not significantly higher than PBA Boundary⫽. In 2012 PBA Boundary⫽ was the highest yielding variety (mean yield 1.62 t/ha), and higher yielding than PBA HatTrick⫽ (1.5 t/ha). This reinforces the view that while Jimbour⫽-type maturities are ideal for the Central West region of NSW, each year will be slightly different in terms of variety response to the season. Knowledge of soil type and paddock disease risk would assist in choice of variety, with PBA Boundary⫽ not recommended in paddocks known to have a history of phytophthora root rot disease.

In 2012 the seeding rate component of the trial showed that targeting a lower plant population (15 plants/m^2) reduced yield potential, regardless of sowing time. Targeting a higher plant population (45 plants/m^2) had higher yields than the 15 and 30 plants/m^2 treatments at all sowing times.

Acknowledgements

This trial was funded by NSW DPI and GRDC through the Northern Pulse Agronomy Project in 2011 and 2012.

Thanks to Jayne Jenkins and Robert Pither (technical assistance), and Kelvin Appleyard (NSW DPI, Trangie) and Andrew Verrell (NSW DPI, Tamworth). Thanks also to Greg Miller (AusWest Seeds, Forbes) for supply of PBA HatTrick⫽ seed for associated chickpea trials.

Safflower – Yield responses to varying nitrogen and plant population

Craig Chapman NSW DPI, Narrabri
Matthew Gardner and Guy McMullen NSW DPI, Tamworth

Introduction

Safflower (*Carthamus tinctorius*) is a late winter sown oilseed which has been a commercial crop grown across north western NSW for many years. It has been shown previously to be a useful crop in cotton rotations and potentially as a later sowing option in seasons with very late breaks.

Safflower generally has yellow flowers and in most varieties thistle-like spines. Safflower is currently a relatively minor and underutilized crop due to a small domestic market for safflower oil and relatively lower yields and prices compared to other oilseeds.

Sironaria has been one of the mainstays of the safflower industry since its release in 1987 from the CSIRO breeding program. Sironaria combined resistance to Phytopthora root rot and Alternaria making it suitable for northern NSW and southern Qld.

Recently, safflower has been used as a platform crop for the Crop Biofactories Initiative a joint GRDC and CSIRO program developing crops with industrial uses. Genetic development by CSIRO has produced super high oleic safflower. Oleic acid is the starting point for valuable industrial oils and waxes.

Key findings

Yields of Sironaria were maximised at plant populations of 30–35 plants/m^2.

Yield responses to nitrogen were limited due to high starting soil levels and limited in crop rain.

Site details

Location:	**Tamworth Agricultural Institute**
Previous Crop:	**Fallow – Sorghum**
Sowing Date:	**6th July, 2012**
Variety:	**Sironaria**
Soil Type:	**Vertosol**
Starting soil N:	**121 kg N/ha (0–120 cm)**
Starting soil water:	**285 mm (PAWC 0–150 cm for canola)**
Fertiliser:	**Supreme Z® starter fertiliser was applied at 50 kg/ha at sowing.**
Insecticides:	**Karate® (Lambda-Cyhalothrin) was applied at 60 mL/ha to control Green Vegetable bugs and Rutherglen bugs after flowering.**

The trial was sown using flexicoil tynes with N fertiliser sidebanded 5 cm from the seed.

Treatments

3 target populations – 15, 30 and 45 plants/m^2

4 nitrogen rates – 0, 30, 60, 90, 120 kg N/ha applied as Urea.

Results 2012

Established populations were slightly higher than the target levels (Table 1). This reflected the good establishment conditions and rainfall received soon after planting resulting in lower then expected establishment losses.

The yield of Sironaria was maximised at 1.9 t/ha at populations above 30 plants/m^2 (Table 1). At the lowest population the yield was 12% lower than the other treatments.

Table 1: *Effect of plant population on grain yield*

Target Population (plants/m^2)	Established Population (plants/m^2)	Yield (t/ha)
15	20a	1.67b
30	33b	1.87a
45	47a	1.90a
F pr.	<0.001	<0.001

(Means followed by the same letter are not significantly different at the 5% LSD level)

Nitrogen had no significant effect on grain yield.

Grain samples are still being analysed for oil content.

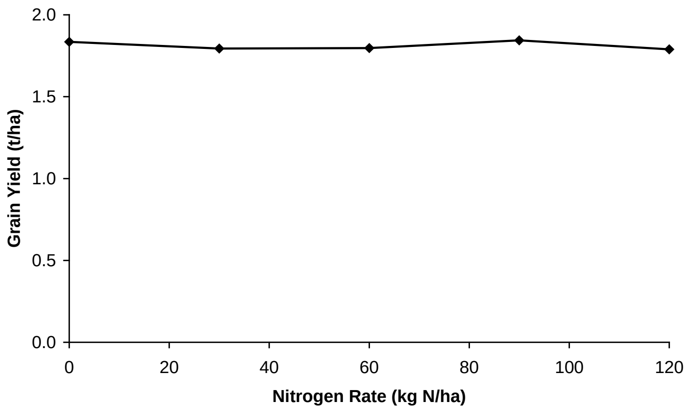

Figure 2: *Effect of applied nitrogen on grain yield of Sironaria safflower*

Plant samples taken at harvest are also being analysed to measure yield components (flower number, seeds per flower etc) to better understand yield development in safflower. This data was not available at the time of publication.

Summary

Sironaria yields were unaffected by applied N due to the high starting soil N and low yield potential due to low in-crop rainfall. Populations above 30 plants/m^2 maximised yield.

GRDC and CSIRO have developed new genetic methods to alter the oil quality of safflower allowing its use as an industrial oil crop. Any new varieties that come from this research are estimated to be available in 2018, this 'new' crop requires updated agronomy information to support its production.

Evaluation of possible new lines and updating agronomy packages for safflower is being conducted by NSW DPI and GRDC to support this potential new industry in the region.

Acknowledgements

This project is funded by NSW DPI and GRDC under DAN00153. Thanks for IPM advice to Loretta Serafin and Jim Perfrement, Rod Bambach and Jan Hosking for harvest.

Manipulating canola growth to conserve soil water – Tamworth and Blackville 2012

Matthew Gardner, Rod Bambach and Stephen Morphett NSW DPI, Tamworth

Introduction

Canola is highly vigorous and produces large amounts of biomass throughout the season (>10 t/ha in some cases), which is desirable for an effective break crop. The vigorous and large canopy helps breakdown previous crop stubble by creating an ideal micro-climate for decomposition, which can reduce the incidence of stubble born diseases in the rotation such as crown rot. The large canopies also require a large supply of nutrients and water to sustain them.

Canola has previously been shown under southern environments to be suitable for grazing and grain recovery. In these studies canola crops were grazed with sheep prior to bolting or stem elongation, before being allowed to regrow for grain recovery. In many cases the grazing had minimal impact on grain yield if grazing did not occur after stem elongation.

In the Northern Grains region winter crops typically have a heavy reliance on stored soil water. Therefore if the amount of water use could be reduced early in the season for canola it may increase the available water for late in the season during the critical grain fill stage. It was hypothesised that reducing the canopy size of canola early in the season may be a way of increasing grain yields through the conservation of soil water. The aim of these experiments was to determine whether defoliation through slashing or the use of plant growth regulators (PGRs) could be used to manipulate the canola canopy to conserve resources for later in the season.

Key findings

Defoliation of canola just prior to stem elongation has the capacity to conserve soil water in the surface 90 cm, while water use differences between varieties can extend to at least 180 cm.

Defoliation resulted in no yield loss at the Tamworth site but significant losses at Blackville, which may be a function of lower starting water and plant population compared to Tamworth.

The application of the PGR treatment, Cycocel and Moddus, significantly increased yield by an average of 0.27 and 0.36 t/ha at Blackville and Tamworth, respectively. This yield increase was not due to increased soil water availability or a reduced canopy size and requires further investigation.

Neither of these PGR products are registered for use in Canola.

Site details

Blackville

Location:	**"Parraweena"**
Co-operator:	**Joe Fleming**
Previous Crop:	**Wheat**
Starting N:	**41 kg N/ha (0–120 cm)**
Starting PAW:	**185 mm (estimate)**
Sown:	**16th May 2012**

Tamworth Agricultural Institute

Location:	**Paddock 19**
Previous Crop:	**Long fallow from sorghum**
Starting N:	**110 kg N/ha (0–120 cm)**
Starting PAW:	**265 mm**
Sown:	**20th May 2012**

Treatments

In the 2012 season two trials were conducted to investigate the capacity of defoliation or PGRs to be used to reduce canopy size in canola and reduce early water use. Two identical trials were established at Blackville, on the Liverpool Plains, and at Tamworth Agricultural Institute. In the trials two varieties were used, Pioneer® 44Y84 CL, which is one of the most vigorous hybrids on the market and is renowned for its large canopy and Hyola 555TT⁽ᵈ⁾, which has a smaller canopy and a lower vigour. Varieties were sown at a target population of 50 plants/m^2, although a poorer establishment at Blackville meant there were approximately 30 plants/m^2. Half the plots were defoliated to a height of approximately 5 cm just prior to stem elongation using mowers with the dry matter removed from the plot. There were 3 PGR treatments: nil PGR (Control), Cycocel® (0.2 L/ha) and a combination of Cycocel® (0.2 L/ha) + Moddus® (1.0 L/ha). PGRs were applied at each trial during stem elongation at 100 L/ha water rate. All treatments were in a complete factorial design with 3 replicates.

At the Tamworth site each plot had a neutron probe access tube installed to a depth of 1.8 m, while a rain out shelter and wet up site were set up adjacent to the trial to determine crop lower limit and plant available water. Soil moisture content was determined using a neutron probe, approximately every 3 weeks after treatments were implemented until crop maturity. Soil moisture data will be presented as volumetric moisture content.

Results

Grain yields were 0.8 to 1.5 t/ha greater at Tamworth compared to Blackville (Table 1). Pioneer® 44Y84 CL had significantly greater grain yield than Hyola 555TT$^{\phi}$ at both Blackville (14%) and Tamworth (10%) where no slashing treatment was imposed (Table 1). The slashing treatment significantly reduced grain yield at Blackville by 16 and 17% for Pioneer® 44Y84 CL and Hyola 555TT$^{\phi}$, respectively (Table 1). In contrast, there was no yield penalty for slashing at stem elongation for either variety at Tamworth.

Slashing significantly increased the harvest index for Pioneer® 44Y84 CL at Blackville from 25 to 29% (Table 1). There was no impact of slashing on harvest index for either variety at Tamworth or on Hyola 555TT$^{\phi}$ at Blackville (Table 1). None of the PGR treatments had a significant impact on harvest index.

Dry matter accumulation at mid anthesis (50% flowering) was 6.1 and 9.0 t/ha on average for Blackville and Tamworth, respectively (Table 1). Slashing significantly reduced dry matter production up until mid anthesis for all treatments (Table 1). At Blackville dry matter accumulation was reduced by 37 and 29% for Pioneer® 44Y84 CL and Hyola 555TT$^{\phi}$, respectively. Slashing lowered dry matter by 21 and 10% for Pioneer® 44Y84 CL and Hyola 555TT$^{\phi}$, respectively at Tamworth (Table 1).

The PGR treatments were also shown to have a significant effect on grain yield. The application of a Cycocel and Moddus mixture increased grain yield by an average of 0.27 and 0.36 t/ha across the two varieties where there was no slashing at Blackville and Tamworth, respectively. Where treatments were slashed there was no effect of PGRs on grain yield. The Cycocel treatment achieved similar grain yields to the control treatment at either site for the slashing treatments.

At Blackville PGR treatments significantly reduced dry matter accumulation from 8.2 t/ha for the control to 6.0 and 7.7 for the Cycocel and the Cycocel and Moddus mixture, respectively, where no slashing was implemented (data not shown). The Cycocel treatment reduced dry matter accumulation by a greater degree than the Cycocel and Moddus mixture at both Blackville and Tamworth. However at Tamworth the control treatment (9.7 t/ha dry matter) was similar to the Cycocel treatment (9.3 t/ha dry matter) but significantly lower than the Cycocel and Moddus mixture (10.3 t/ha dry matter) where no slashing was implemented (data not shown).

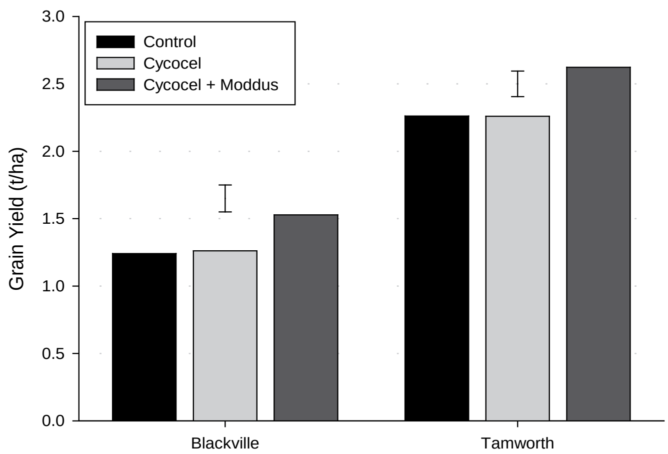

***Figure 1:** The effect of the application of three plant growth regulator (PGR) treatments on the grain yield of Pioneer® 44Y84 CL and Hyola 555TT$^{\phi}$ at Tamworth and Blackville.*

At Tamworth, when averaged across treatments, Pioneer® 44Y84 CL had use 4% more soil water (to 180 cm) compared to Hyola 555TT$^{\phi}$ by mid flowering. The difference in water use between varieties was observed at all depth intervals where soil moisture was measured. Slashing plots significantly increased the available water in the surface 60 and 90 cm for Hyola 555TT⁽ᵇ⁾ and Pioneer® 44Y84 CL, respectively. No PGR treatments caused a significant change in soil water compared to the control (data not shown).

Summary

Slashing significantly reduced the amount of dry matter production by mid flowering by approximately 33 and 15% at Blackville and Tamworth, respectively. At Tamworth this reduction in dry matter accumulation resulted in less water use in slashed plots to a depth of between 60 and 90 cm. Beyond 90 cm the slashing treatment had no impact on soil water. However the generally larger canopies associated with Pioneer 44Y84 dried the profile to a greater extent than Hyola 555TT⁽ᵇ⁾ with differences detected to 180 cm. It might be expected that the differences in water use may have been greater at Blackville where the differences in dry matter accumulation were greater. The larger reduction in dry matter accumulation incurred from slashing did reduce grain yields at the Blackville site. It is likely that the slightly lower plant plant population at Blackville (30 compared to 50 plants/m^2) would have reduced the capacity for the crop to compensate in both dry matter and yield. In addition, the lower starting soil moisture levels at the Blackville compared to a completely full profile at the Tamworth site. This difference is also likely to have had a large influence on the capacity of the crop to compensate from slashing given the heavy reliance of crops on stored moisture after July in 2012.

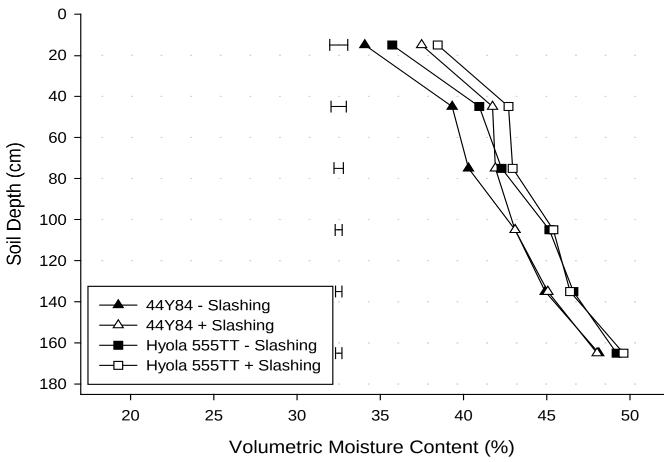

Figure 2: *The influence of slashing and variety, Pioneer® 44Y84 CL and Hyola 555TT⁽ᵇ⁾, on volumetric moisture content at mid flowering at Tamworth and Blackville.*

Interestingly, the Cycocel and Moddus mixture treatment significantly increased grain yields at both sites. However, this increase in yield was not related to savings in soil water early in the season as there was no significant difference measured. In addition, the dry matter response to the single PGR applications was variable between the two sites. It is not fully understood by what mechanism the PGR treatment has improved grain yield and this may require further investigation. Based on previous results with PGR applications the results can be highly variable with inconsistent results between sites and seasons.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is funded by NSW DPI and GRDC. The supply of the trial site by Joe Flemming at Parraweena", Blackville is gratefully acknowledge. Technical assistance provided by Rod Bambach, Jan Hosking, Patrick Mortell, Stephen Morphett, Jim Perfrement and Peter Formann are gratefully acknowledged.

Table 1: *The effect of slashing on grain yield, harvest index and dry matter yield (50% flowering) for Pioneer® 44Y84 CL and Hyola 555TT⁽ᵇ⁾ at Tamworth and Blackville. Values designated with a different letters within each row are significantly different (P= 0.05)*

Site	Pioneer® 44Y84 CL		Hyola 555TT⁽ᵇ⁾	
	– Slashing	+ Slashing	– Slashing	+ Slashing
	Grain Yield (t/ha)			
Blackville	1.43 a	1.21 b	1.23 b	1.03 c
Tamworth	2.54 a	2.35 ab	2.29 b	2.22 b
	Harvest Index (%)			
Blackville	25 a	29 b	29 b	31 b
Tamworth	34 a	36 a	35 a	37 a
	Dry Matter Yield at 50% Flowering (t/ha)			
Blackville	8.18 a	5.14 c	6.49 b	4.56 d
Tamworth	10.26 a	8.13 c	9.33 b	8.42 c

AGRONOMY

Can we establish canola from depth? – Moree, Blackville and Glasshouse studies 2012

Matthew Gardner, Jan Hosking and Rod Bambach NSW DPI, Tamworth

Key findings

The optimum establishment for all canola varieties was achieved with the 25 mm planting depth, with up to a 55 and 85% reduction in plant establishment when planting depths extended to 50 and 75 mm, respectively.

There were significant differences between varieties in establishment at the different depths with large seeded hybrid varieties being least affected by planting depth.

High stubble loads can significantly reduce canola establishment by 25–60% depending on planting depth.

A combination of hybrid vigour and seed size appeared to explain the better establishment results from Pioneer® 44Y84; however, the expression of hybrid vigour was not evident when seed diameter was less than 1.4 mm.

Introduction

Unlike the southern grains region, that receives a more typical Mediterranean climate, autumn rainfall in the northern region is far less reliable. This often requires growers to seek moisture when establishing winter crops within the optimum planting window. The optimum planting window for canola in the northern grains region is from mid April to mid May. The capacity to seek moisture with the sowing of canola has traditionally been very limited due to the small seed size of open pollinated varieties, however, the increasing availability of hybrid varieties may increase the potential to moisture seek due to their inherently larger seed size. Previously it has been reported that planting depths greater than 30 mm significantly reduce plant establishment under field conditions. Larger seed has been shown to improve establishment and have further influence throughout the season on increased pod numbers, seed weight per pod and yield. In theory, the use of hybrid varieties should facilitate canola establishment at depths greater than 30 mm.

Site details

Blackville

Location:	**"Parraweena"**
Co-operator:	**Joe Fleming**
Previous Crop:	**Wheat**
Starting N:	**41 kg N/ha (0–120 cm)**
Sown:	**16th May 2012**

Moree

Location:	**"Bonniedoon"**
Co-operator:	**Paul and Charles Tattam**
Previous Crop:	**Chickpeas**
Starting N:	**51 kg N/ha (0–120 cm)**
Sown:	**1st May and 20th May 2012**

Tamworth Agricultural Institute

Location:	**Glasshouse**
Soil:	**Grey Vertosol**
Starting N:	**Equivalent to 110 kg N/ha (0–120 cm)**
Sown:	**23rd August 2012**

Treatments

Field trials at Moree and Blackville were conducted to determine the affect of sowing depth on the establishment of six commercial canola varieties, both hybrid and open pollinated (OP). The six varieties were selected to ensure there were two from the conventional [Hyola 50 (hybrid), AV Garnet⍭ (OP)], Clearfield [Pioneer® 43C80 (OP), Pioneer® 44Y84 (hybrid)] and triazine tolerant [Hyola® 555TT (hybrid) and ATR Gem⍭ (OP)] classifications. Varieties were sown at 25, 50 and 75 mm depths using a Janke parallelogram tyne assembly. Sowing rates for each variety were adjusted for 1000 grain weight and germination to target 50 plants/m^2.

At the Moree site the trial was sown on two dates (1st and 22nd May) to capture any interactions with sowing time/soil temperature and sowing depth. The soil temperature at 50 mm was 14 and 11°C on the1st and 22nd May, respectively. The Blackville site had a single planting time on the 16th May, however, there was a plus and minus stubble treatment. The Blackville site had 6.2 t/ha of residual wheat stubble, which the canola trial was either sown directly into (plus) or the stubble was removed through raking and burning (minus) prior to sowing. Plant establishment counts were taken 16–24 days after planting. At physical maturity plant cuts were collected from a 1.1 m^2 area to assess dry matter accumulation and harvest index. Shortly following plant cuts a plot harvester was used to determine grain yield.

A glasshouse trial was conducted to complement the field trials and by using the same depth and variety treatments. In an attempt to separate hybrid vigour and seed size effects the seed for each variety was graded into two size categories large (2.00–2.36 mm diameter) and small (1.00–1.40 mm diameter). Soil from the 0–15 cm depth interval was collected from a black vertosol on the Tamworth Agricultural Institute. The soil was passed through a 5 mm sieve and weighed out equally into pots. Twenty seeds for each variety and seed size category were sown at the different planting depths in pots and grown in the glasshouse. The average minimum and maximum temperature recorded during the experiment was 12°C and 29°C. Seedling emergence date and numbers were recorded on a daily basis 3 days after planting. All plant shoots within each pot were harvested separately and dried to determine biomass (vigour) 15 days after emergence.

Results

Field trials

At Moree and Blackville the 25 mm sowing depth produced the best establishment for all varieties with an average of 40.3 and 48.2 plants/m^2, respectively (Figure 1). At Blackville Pioneer® 44Y84, Hyola® 50 and Hyola® 555TT had significantly higher establishment at the 25 mm sowing depth than the other three OP varieties, whereas, at Moree at the same depth Pioneer® 44Y84 had significantly higher establishment than all other varieties except AV Garnet⦷.

Increasing planting depth from 25 mm to 50 mm significantly reduced plant establishment by an average of 34% and 57% at the Moree and Blackville sites, respectively. Similar to the 25 mm depth Pioneer® 44Y84 had better establishment than all other varieties, while Pioneer® 43C80 had the lowest establishment for the 50 mm planting depth at Moree. Pioneer® 43C80 also had the lowest establishment at Blackville at 50 mm planting depth while Pioneer® 44Y84 and Hyola® 555TT had the best establishment with 35 and 34 plants/m^2, respectively (Figure 1b). Hyola® 50 also had significantly higher establishment than all the OP varieties at the 50 mm planting depth.

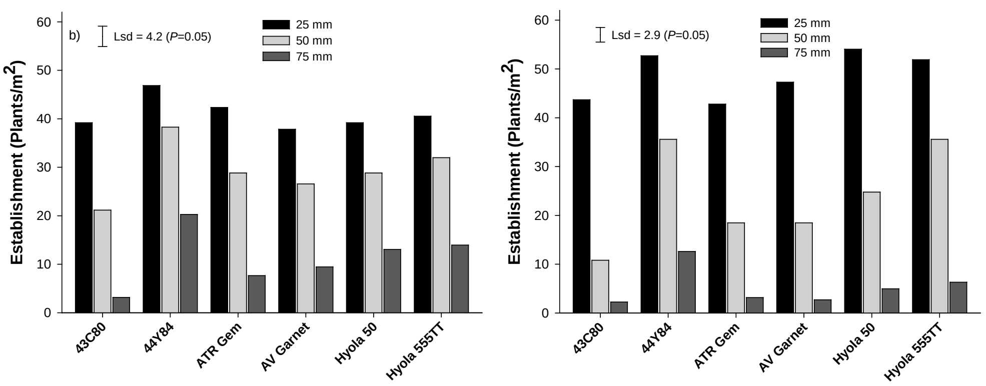

Figure 1: *Plant establishment of six canola varieties from planting depths of 25, 50 and 75 mm at a) Moree (average establishment across two planting times) and b) Blackville (one planting time).*

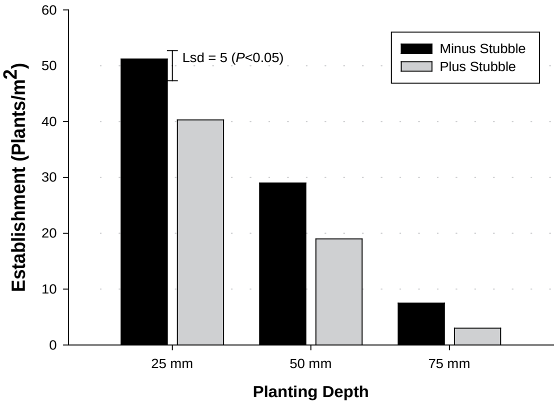

Figure 2: *Average establishment of six canola varieties at 25, 50 and 75 mm planting depths where previous wheat stubble residues were either removed (minus) or not (plus) at Blackville.*

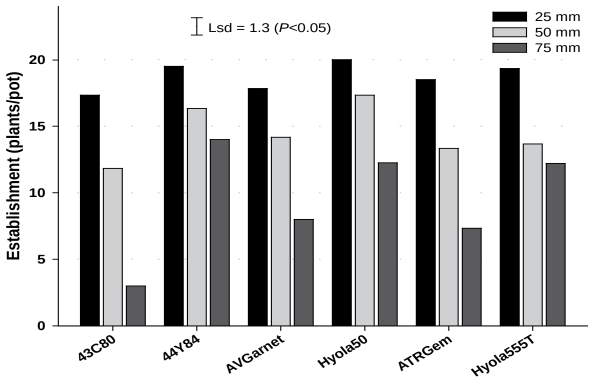

Figure 3: *Plant establishment of six canola varieties from planting depths of 25, 50 and 75 mm averaged across both small and large seed sizes – glasshouse 2012.*

The 75 mm planting depth had the lowest establishment for all varieties with an average 74% and 88% reduction in establishment compared to the 25 mm planting depth at Moree and Blackville, respectively (Figure 1). At Moree and Blackville Pioneer® 44Y84 had significantly higher establishment than all other varieties at the 75 mm planting depth.

There was no significant difference in establishment between the two plant times at Moree, which is most likely reflective of the optimum moisture conditions at both dates and only a minor (3°C) drop in soil temperature. The removal of stubble at Blackville did have a significant impact on canola establishment, although, there was no interaction with varieties. The removal of stubble significantly increased establishment by an average of 23, 35 and 60% across varieties for the 25, 50 and 75 mm planting depths, respectively (Figure 2).

Glasshouse trial

Similar to what was observed in the field trials, the 25 mm planting depth had the best establishment and increasing planting depth beyond that to 50 or 75 mm significantly reduced establishment by 32 and 51% on average across varieties, respectively (Figure 3). The three hybrid varieties had significantly better establishment from the 75 mm planting depth.

The small seeded OP treatment had the poorest establishment for each planting depth, however, all treatments took a similar time to emerge from their respective planting depths at 25 and 50 mm (Table 1). The large seeded Hybrid and OP treatments had significantly improved establishment compared to their respective small seeded treatments at both the 50 and 75 mm planting depths. The 100 plant weight 15 days after emergence compares treatments using equal plant numbers and gives an indication of early plant vigour. The large seeded hybrids had the highest early vigour. The early vigour of the small seeded treatments was more limited and more sensitive to increased planting

Table 1: *Plant establishment, days to emergence and 100 plant weights 15 days after emergence for three hybrid (Pioneer® 44Y84, Hyola® 50 and Hyola® 555TT) and three open pollinated (Pioneer® 43C80, AV Garnet⁽ᵇ⁾ and ATR Gem⁽ᵇ⁾) canola varieties segregated into large and small seed sown at three planting depths – glasshouse 2012.*

Planting Depth	Hybrid		Open Pollinated	
	Large seed	Small seed	Large seed	Small seed
		Establishment		
25 mm	19.4 a	19.8 a	19.4 a	16.3 b
50 mm	18.8 ab	12.8 c	17.4 b	8.8 d
75 mm	15.9 b	3.8 e	8.7 d	1.0 f
		Days to emergence		
25 mm	5.0 a	5.1 a	5.1 a	5.2 a
50 mm	5.9 ab	6.7 b	6.8 b	7.2 b
75 mm	7.4 b	11.3 e	8.7 c	10.0 d
		100 Plant weight 15 days after emergence		
25 mm	56.9 a	31.5 d	45.7 c	29.7 d
50 mm	51.8 b	24.5 e	44.9 c	23.5 e
75 mm	49.5 b	10.3 g	45.8 c	13.0 f

** Numbers within each section (Establishment etc.) designated with a different letter are significantly different (P=0.05).

depth than the large seed treatments (Table 1). Interestingly the small seeded hybrid treatments did not exhibit the same vigour advantage over the small seeded OP treatments that was observed between the respective large seeded treatments.

Summary

Not surprisingly increasing the planting depth significantly reduced establishment across all canola varieties. Establishment on heavy clay soils was reduced by 30–50% or 70–90% when shifting from 25 mm planting depth to 50 or 75 mm, respectively. However, this reduction in establishment was generally less severe for the hybrid varieties, in particular Pioneer® 44Y84. The better performance of Pioneer® 44Y84 in these trials may have been a result of either larger seed size or hybrid vigour. The pot trial indicated that seed size or hybrid vigour had little impact on the time taken to emerge. At the shallower planting depths (25 and 50 mm) large seeded hybrid and OP treatments established at similar levels, however, hybrids established much better at the deepest planting depth indicating a hybrid advantage. Small seed size increased the negative impact or risk associated with deeper planting depths on both establishment and seedling vigour. Interestingly, the large seeded hybrids had greater seedling vigour compared to the large seeded OP varieties but the same advantage was not observed under the small seeded scenario. This indicates that hybrid vigour may decrease as seed size is reduced. These trials indicate that in a moisture limited sowing situation a deeper than optimum planting depth (50 mm) may still establish an acceptable plant population. However, the risk of this deeper planting depth may be reduced by the selection of a large seeded hybrid canola variety.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is funded by NSW DPI and GRDC. The supply of the trial site by Joe Fleming at “Parraweena”, Blackville and assistance in locating the site from John Hoskings is gratefully acknowledged. Paul and Charles Tattam “Bonniedoon” are also gratefully acknowledged for the provision of the trial site at Moree. Technical assistance provided by Patrick Mortell, Stephen Morphett, Jim Perfrement and Peter Formann are gratefully acknowledged.

Response of fifteen canola varieties to three planting times at Tamworth in 2012

Matthew Gardner and Rod Bambach NSW DPI, Tamworth

Key findings

The highest yields were achieved at Tamworth in 2012 when the end of flowering occurred during the last 10 days of September.

Hyola® 50 and AV Garnet⊕ were the most consistent yielding varieties across all three planting times, whereas, the two quicker maturing varieties Pioneer® 43C80 and ATR Stingray⊕ were the poorest performing varieties.

Earlier planting (TOS 1) resulted in lower yield penalties (–8%) compared to delaying planting (TOS 3, –20% yield) compared to the main season planting window (TOS 2).

Introduction

Planting time is a compromise between planting too early, which increases the risk of frost damage and lodging, and planting too late that increases the risk of hot and dry conditions occurring during seed development. These hot and dry conditions reduce the yield potential and oil content of canola seed. As a general rule planting earlier in the planting window has a range of benefits including;

- generally have higher seed and oil yields as the crop finishes under cooler, moister, conditions
- temperatures at planting are usually warmer, which may allow for better establishment and quicker early growth and ground cover
- ensures that canola is harvested before cereals at the end of season

Canola is most susceptible to frost during late flowering/early pod fill as a heavy frost can destroy immature seeds. Canola usually tolerates frosts better than cereals. In western and northern zones of NSW, quick maturing varieties should not be sown early as September frosts may coincide with the pod-fill stage of crop development.

The optimum planting time depends on a range of factors. Mid and mid-late maturing varieties should be sown early in the recommended sowing window for a particular region, and early maturing varieties should be sown later. A trial at Tamworth was established in 2012 to further refine the planting window in the northern region for current commercially available canola varieties.

Site details

Tamworth Agricultural Institute

Sowing date:	**20th April, 16th May and 12th June 2012**
Fertiliser:	**75 kg N/ha as Urea** **200 kg/ha Superphosphate**
Staring N:	**121 kg N/ha (0–120 cm)**
Starting Water:	**285 mm (PAWC 0–180 cm)**

Treatments

There were 15 commercially available varieties with varying maturities and agronomic traits used in the TOS trial in 2012. The trial included 5 conventional, 5 triazine tolerant and 5 clearfield® varieties, with each group having a mix of open pollinated and hybrid varieties (Table 1). All varieties were sown on three separate occasions being the 20th April, 16th May and 12th June. Throughout the season development stages were recorded. For this paper the start and end of flowering are presented, which refers to there being 5% of the plot having flowers at the start or at the end of flowering.

Results

The relationship between yield and flowering time is presented in Figures 1a and 1b. The optimum time for flowering to begin in 2012 was difficult to predict as varieties started flowering between the 1st and 13th of August. Although, based on the flowering times available it is predicted that optimum yields were obtained when flowering started between the 27th July and the 30th August in 2012 at Tamworth, which is a wide window. There was only a narrow spread in the time taken for varieties to start flowering from each planting time, particularly with the second and third sowing dates. If the Juncea variety Xceed™ Oasis CLΦ is removed, the spread in the start of flowering dates was 14, 9 and 7 days for TOS 1, 2 and 3, respectively (Table 1).

The correlation between the end of flowering and yield gave a better indication of important dates by which flowering must cease. In 2012 at Tamworth the optimum yields were obtained when flowering finished between the 19th September and the 1st October (Figure 1b). Interestingly, these dates coincided with the optimum anthesis window for cereal crops at Tamworth in 2012 which was between the 20th September and 5th October. The end of flowering was more critical than the start of flowering as at this stage (5% flowers remaining) there are a large number of pods in the early stages of filling with immature seeds.

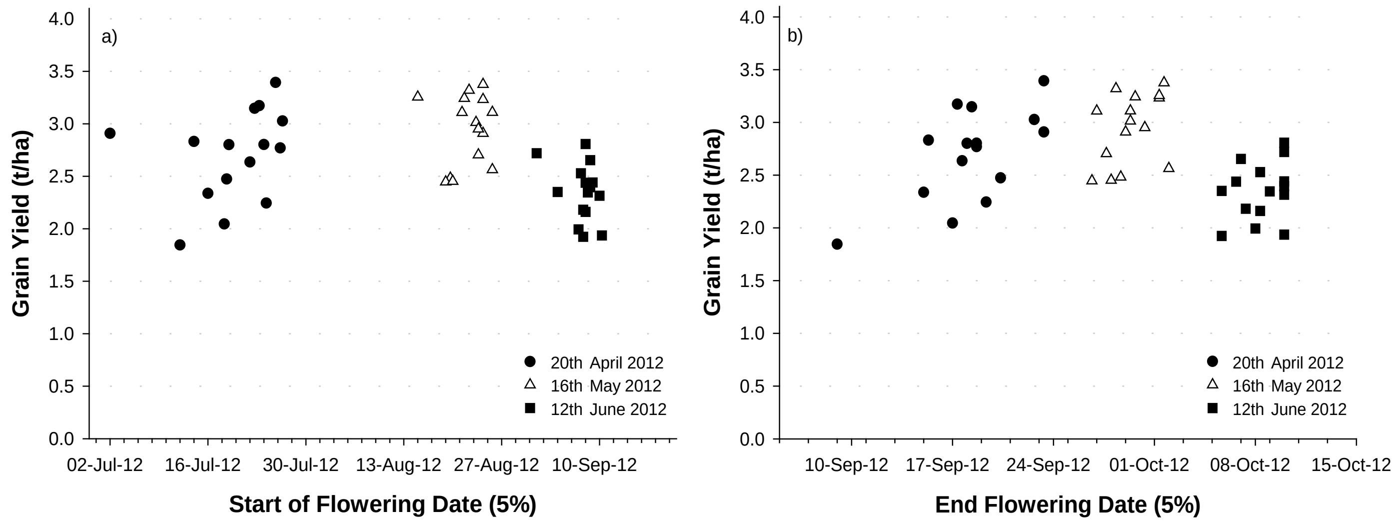

Figure 1: *Relationship between grain yield and (a) start of flowering (determined at 5% flowering) or (b) end of flowering (determined as 5% flowers remaining) date for three sowing dates at Tamworth in 2012*

The second TOS (16th May) had the highest grain yield with an average of 2.94 t/ha across all varieties. Planting on the 20th April (TOS 1) significantly reduce grain yields by 8% compared to TOS 2, whereas, delaying planting from the 16th May until the 12th June (TOS 3) significantly reduced grained by 20%. AV GarnetΦ, Hyola® 50 and CB Agamax, , which are all mid to long season varieties, were the best performing varieties for TOS 1 (Table 1). ATR StingrayΦ had the lowest yield from TOS 1 but was similar to that of to Pioneer® lines 43C80, 44Y84 and 43Y85. All these varieties were significantly lower yielding than the other varieties. Despite the Juncea variety Xceed™ Oasis CLΦ being almost 20 days quicker than the mid to long season canola varieties it was still one of the top five yielding varieties at TOS 1.

From the main season planting time (16th May) the top eight varieties yielded between 3.01 and 3.38 t/ha (Table 1). ATR StingrayΦ, Pioneer® 43C80 and CB Junee HT had the lowest yields (below 2.5 t/ha).

With the late planting (12th June) the top four yielding varieties (Hyola® 50, Xceed™ Oasis CLΦ, CB Agamax and Pioneer® 45Y82) all yielded above 2.5 t/ha. ATR StingrayΦ, Pioneer® 43C80 and ATR GemΦ had similar grain yields that were more than 15% below the average yield of other varieties at TOS 3 (Table 1).

Xceed™ Oasis CLΦ,was the quickest variety at all planting times to flower however it ended flowering above the average of all varieties suggesting it flowered for up to 20 days longer than all other varieties. ATR StingrayΦ was the quickest canola variety to end flowering with TOS 1 and was equally as quick as Pioneer® 43Y85 with TOS 2 and TOS 3. For the last two planting times the days taken to reach the end of flowering was remarkably close regardless of maturity with only 5 and 4 days separating varieties for TOS 2 and 3, respectively. This suggests that as planting moves later in the planting window the maturity length of varieties is compressed significantly.

Table 1: *Grain yield, yield rank and days to end of flowering (5% flowers remaining) for 15 canola varieties at three sowing times at Tamworth in 2012. Lsd for TOS x variety interaction is 0.43 t/ha (P<0.05).*

Variety	Yield (t/ha) and rank within sow time						Days from sowing to end of flowering		
	20th April		16th May		12th June		20th April	16th May	12th June
43C80 CL(PBR)	2.05	*14*	2.48	*13*	1.99	*13*	148	134	116
43Y85 CL(PBR)	2.34	*12*	3.11	*7*	2.35	*8*	146	132	114
44Y84 CL(PBR)	2.24	*13*	3.32	*2*	2.44	*6*	150	133	115
45Y82 CL(PBR)	2.80	*8*	3.24	*4*	2.53	*4*	149	135	116
ATR Gem(PBR)	3.03	*4*	2.56	*12*	1.94	*14*	154	137	118
ATR Stingray(PBR)	1.85	*15*	2.45	*15*	1.92	*15*	140	132	114
AV Garnet(PBR)	3.39	*1*	3.23	*5*	2.44	*5*	154	136	118
CB Agamax	3.17	*2*	2.91	*10*	2.65	*3*	148	134	115
CB Junee HT	2.47	*11*	2.45	*14*	2.18	*11*	151	133	115
Xceed Oasis CL	2.91	*5*	3.26	*3*	2.72	*2*	154	136	118
Hyola 50	3.15	*3*	3.38	*1*	2.81	*1*	149	137	118
Hyola 555TT(PBR)	2.64	*10*	3.01	*8*	2.35	*9*	149	134	117
Hyola 559TT	2.80	*7*	2.71	*11*	2.16	*12*	150	133	116
Hyola 575CL	2.83	*6*	2.95	*9*	2.40	*7*	146	135	118
Victory V3002	2.77	*9*	3.11	*6*	2.32	*10*	150	134	118
TOS Average	2.70		2.94		2.35		149 (16th Sep)	134 (27th Sep)	116 (6th Oct)

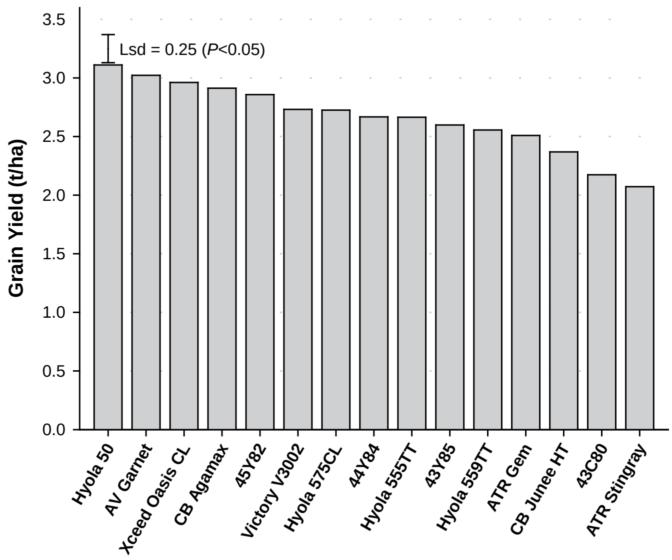

Figure 2: *Average grain yield of canola varieties for three planting times at Tamworth in 2012.*

Hyola® 50 and AV Garnet(PBR) had a yield of 3.11 and 3.02 t/ha averaged across all planting times, respectively. This was significantly higher than varieties that had an average yield across sowing dates less than Pioneer® 45Y82 (Figure 2). ATR Stingray(PBR) and Pioneer® 43C80 had average yields 33 and 33% lower than Hyola® 50 and were lower than all other varieties except for CB Junee HT.

Summary

When the end of flowering occurred during the last 10 days of September, the highest yields were achieved at Tamworth in 2012. This end of flowering window coincides with early pod fill and immature grains, which are the most sensitive to damage from either frost or hot and dry conditions. Hyola® 50 and AV Garnet(PBR) were the most consistent yielding varieties across all three planting times, whereas, the two quicker maturing varieties Pioneer® 43C80 and ATR Stingray(PBR) were the poorest performing varieties. Shifting planting time forward resulted in lower yield penalties (8%) compared to delaying planting from the main season window (20% penalty).

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Technical assistance provided by Jan Hosking, Patrick Mortell, Stephen Morphett, Jim Perfrement and Peter Formann are also gratefully acknowledged.

The effect of sowing depth on establishment and yield of six canola varieties – Coonamble, Nyngan and Trangie, 2012

Rohan Brill NSW DPI, Coonamble **Leigh Jenkins** NSW DPI, Warren **Tim McNee** NSW DPI, Nyngan

Introduction

In optimum conditions canola should be sown about 2–3 cm deep, targeting a population in western areas of NSW of around 20–30 plants/m². Producers in these regions know all too well that moisture conditions at sowing are rarely optimal and so practices need to be adapted.

As part of the GRDC supported Variety Specific Agronomy Packages (VSAP) project, three trials were established in the central-west region in 2012 to investigate the interaction between sowing depth and canola type (open-pollinated versus hybrid) on seedling establishment. Increasing sowing depth to greater than 3 cm is seen as a potential means of establishing canola in regions with variable autumn rainfall, while ensuring establishment occurs in the optimum window.

Site details

Coonamble

Soil type: **Sandy clay loam**

Sow date: **21st April**

Nyngan

Soil type: **Red clay loam**

Sow date: **17th April**

Trangie

Soil type: **Grey vertosol (cracking clay)**

Sow date: **20th April**

Treatments

6 varieties (seed size g/1000 seeds) – ATR Stingray⫚ (3.06), AV Garnet⫚ (3.78), Pioneer® 43C80 CL (3.68), Pioneer® 43Y85 CL (5.03), Pioneer® 44Y84 CL (5.34), Hyola 555TT⫚ (4.26). Each variety sown at 60 seeds/m².
3 sowing depths – 2.5, 5 and 7.5 cm

Results

- Each of the sites received rainfall on 3rd May, ranging from 8 mm at Nyngan, 14 mm at Trangie and 15 mm at Coonamble.
- Averaged across each of the three sites, increasing the depth of sowing from 2.5 cm to 5 cm and 7.5 cm reduced the average establishment of six canola varieties by 28% and 55% respectively (Figure 1).
- The reduced establishment as a result of deep sowing was greatest on ATR Stingray⫚ and AV Garnet⫚, and least on Pioneer® 43Y85 CL and Pioneer® 44Y84 CL.
- The effect of increasing sowing depth was more pronounced on the red soil sites at Coonamble and Nyngan compared with the grey clay soil site at Trangie.
- At the deep sowing treatments, canola establishment rate was closely related to seed size. The large seeded hybrid variety Pioneer® 44Y84 CL had consistently higher establishment rates than small seeded lines such as ATR-Stingray⫚ and AV-Garnet⫚.

Key findings

Increasing the depth of sowing from 2.5 cm to 5 cm and 7.5 cm reduced the average establishment of six canola varieties across three trials by 28% and 55% respectively.

Deep sowing caused a greater reduction in canola establishment on the red soil trial sites of Coonamble and Nyngan compared with the grey soil trial site at Trangie.

At Coonamble and Nyngan, there was a significant grain yield reduction from 7.5 cm sowing depth compared with both the 2.5 cm and 5 cm sowing depths. There was no effect of sowing depth on grain yield at Trangie.

Large seeded varieties had higher establishment rates at deep sowing depths than small seeded varieties. Large seed size was generally associated with non-TT hybrid canola varieties.

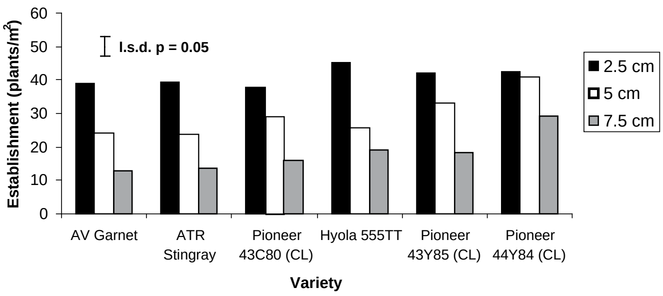

***Figure 1:** Effect of sowing depth on the establishment of six canola varieties, averaged across three trials at Coonamble, Nyngan and Trangie in 2012.*

- Increasing sowing depth affected grain yield to a lesser magnitude than it affected canola establishment.
- Increasing sowing depth from 2.5 to 5 cm had no effect on grain yield at any site. Increasing sowing depth further to 7.5 cm significantly reduced yield at Coonamble (0.25 t/ha) and Nyngan (0.25 t/ha).
- Averaged across all treatments and sites, Pioneer® 44Y84 CL was the highest yielding variety (2.1 t/ha). ATR Stingray⁽ᵈ⁾ was the lowest yielding variety (0.9 t/ha).

Summary

The trials support the general recommendation of planting depth of 2.5 cm for canola where conditions allow. These trials also show that where the soil surface is dry but moisture is available below the surface, it is possible to establish a commercially acceptable crop provided the variety planted has large seed (in this case greater than 5g/1000 seeds). When considering sowing depth of canola, ensure factors such as fertiliser rate, pre-emergent herbicide rates and machinery setup are factored in, as these may further impact on the ability to establish from deep sowing.

The trials also showed that while sowing depth had a significant effect on crop establishment, there is a much lesser effect on canola yield. In these trials there was sufficient follow up rain in early May to ensure all shallow treatments established on time. In seasons where autumn rainfall is low, deep sowing may be the only chance to establish canola on time.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

The effect of plant population on grain yield and oil concentration of four canola varieties – Nyngan 2012

Tim McNee NSW DPI, Nyngan **Rohan Brill** NSW DPI, Coonamble **Leigh Jenkins** NSW DPI, Warren

Introduction

Optimum seeding rates for canola are often discussed in western cropping areas like Nyngan.

In these low input farming regions, canola seed (which is generally purchased annually) is a major expense, particularly when hybrid varieties are being sown.

Improved seed placement and conservation farming techniques combined with improved vigour from new hybrids has led farmers to experiment with very low sowing rates (1.5–2 kg/ha) compared to traditional sowing rates (3–4 kg/ha).

Given that there is large variation in the seed size of commercial seed it is more appropriate to discuss plant population rather than actual seeding rate. Consequently this trial aimed to determine the response of canola to plant population in a western region of the NSW cropping belt (Nyngan), as well as distinguish any interactions between canola varieties and types.

Site details

Soil type:	**Red clay loam**
Sow date:	**17th April**
PAW at sowing:	**160 mm (approx)**
In-crop rainfall:	**97 mm**
Previous crops:	**Wheat (2011), chickpeas (2010)**
Soil tests (0–10cm):	**Nitrate Nitrogen 14 mg/kg, Ammonium Nitrogen 6 mg/kg, Colwell P 22 mg/kg, pH ($CaCl_2$) 5.0**

Treatments

Varieties:

Hybrids – Hyola 555TT⁽ᵈ⁾ and Pioneer® 43Y85 CL

Open pollinated – Pioneer® 43C80 CL and ATR Stingray⁽ᵈ⁾

Target plant populations:

10, 25, 40 and 60 plants/m^2

(assumes 80% germination, 60% establishment)

Key findings

The lowest plant population (10 plants/m^2) had reduced dry matter at flowering compared to 25 plants/m^2 for all varieties except Pioneer® 43Y85 CL. Dry matter was similar for all varieties where plant population was increased from 25 to 60 plants/m^2.

Grain yield for all varieties except ATR-Stingray⁽ᵈ⁾ was lower at 10 plants/m^2 than 25 plants/m^2, with no further yield increase where plant population was increased beyond 25 plants/m^2. The lack of grain yield increase in populations greater then 25 plants/m^2 indicates the high compensation capacity of canola plants.

Pioneer® 43Y85 CL (average yield 1.8 t/ha) was the highest yielding variety at all seed rates. ATR Stingray⁽ᵈ⁾ (average yield 0.4 t/ha) was the lowest yielding variety at all seed rates.

Oil concentration differences were less obvious; however the intermediate treatments (25 and 40 plants/m^2) were slightly higher than the 10 and 60 plants/m^2 treatments.

Table 1: Details of sowing rate and achieved plant populations at Nyngan in 2012.

Variety	1000 Seed Weight (g)	Sowing Rate (kg/ha)	Plant Population	
			Target (p/m²)	Actual (p/m²)
Hyola 555TT⁽ᵈ⁾	4.26	0.9	10	13
Hyola 555TT⁽ᵈ⁾	4.26	2.2	25	30
Hyola 555TT⁽ᵈ⁾	4.26	3.6	40	49
Hyola 555TT⁽ᵈ⁾	4.26	5.3	60	54
ATR Stingray⁽ᵈ⁾	3.06	0.6	10	10
ATR Stingray⁽ᵈ⁾	3.06	1.6	25	16
ATR Stingray⁽ᵈ⁾	3.06	2.6	40	38
ATR Stingray⁽ᵈ⁾	3.06	3.8	60	73
43Y85 CL	5.03	1.0	10	12
43Y85 CL	5.03	2.6	25	31
43Y85 CL	5.03	4.2	40	40
43Y85 CL	5.03	6.3	60	74
43C80 CL	3.68	0.8	10	8
43C80 CL	3.68	1.9	25	32
43C80 CL	3.68	3.1	40	34
43C80 CL	3.68	4.6	60	56

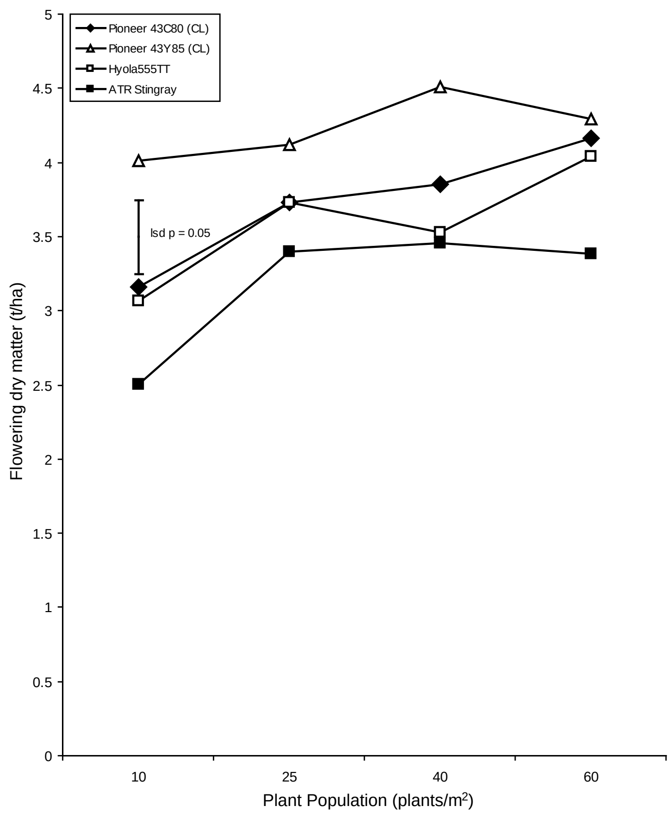

***Figure 1:** Effect of plant population on the dry matter at flowering of four canola varieties at Nyngan in 2012*

Results

- Increasing the plant population from 10 to 25 plants/m² increased dry matter at flowering in all varieties except Pioneer® 43Y85 CL (Figure 1).
- Increasing the plant population further from 25 to 40 and 60 plants/m² did not increase dry matter further in any varieties (Figure 1).
- Increasing the plant population from 10 to 25 plants/m² increased grain yield in all varieties except ATR-Stingray⁽ᵈ⁾ (Figure 2).
- Increasing the plant population further from 25 to 40 and 60 plants/m² did not affect grain yield in any varieties (Figure 2).
- Increasing the plant population from 10 to 25 and 40 plants/m² increased oil content by an average 0.7% in all varieties except 43C80 CL⁽ᵈ⁾, which had no change in oil content with plant population (Figure 3).

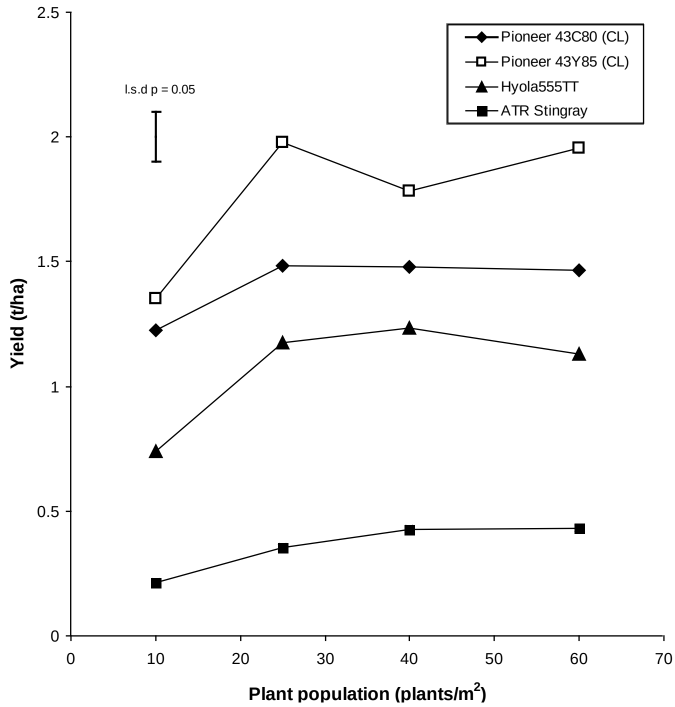

Figure 2: *Effect of plant population on the grain yield of four canola varieties at Nyngan in 2012*

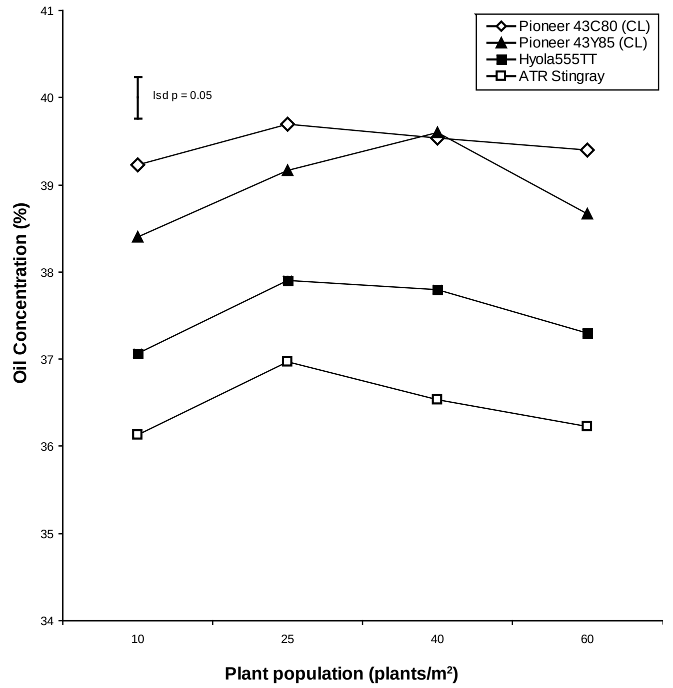

Figure 3: *Effect of plant population on the oil content of four canola varieties at Nyngan in 2012*

Summary

At Nyngan in 2012 it appeared that a plant population of 10 plants/m^2 was inadequate for optimum canola yield. Dry matter production was limited in all varieties when plant population was less than 25 plants/m^2, with the exception of Pioneer® 43Y85 CL. Dry matter was similar at 25, 40 and 60 plants/m^2 for all varieties. This suggests that at the populations from 25 to 60 plants/m^2 the canola plants were able to adjust adequately to suit the available resources.

In all varieties except ATR-Stingray⸰ grain yield was significantly lower at 10 plants/m^2 population compared to the higher populations, which were all similar. It is likely that the limited dry matter production observed for 10 plants/m^2 treatments reduced the capacity of the canopy to effectively utilise available resources, which in turn limited grain yield.

Oil concentration differences were quite marked between varieties; however differences between plant populations were less obvious with the intermediate treatments (25 and 40 plants/m^2) tending to have higher oil than the 10 and 60 plants/m^2 treatments.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

Evaluation of Indian Mustard varieties against Canola from a late planting time at Tamworth in 2012

Matthew Gardner and Rod Bambach NSW DPI, Tamworth

Key findings

There was no yield advantage observed for the Indian mustard varieties trialled in this experiment from a late planting time over canola, which may be a consequence of the full water profile at the start of the season.

The top six performing mustard varieties did perform similar to the canola varieties AV Garnet⁽ᵈ⁾ and Pioneer® 43Y85.

Indian mustards started flowering approximately 10 days earlier than the canola varieties, resulting in mustards flowering for 41 days compared to 31 days for the canola on average.

The use of Indian mustards will be solely dependent on marketing and processing opportunities.

Introduction

Well-adapted mustard varieties may have a role in the drier and warmer parts of the region with their superior drought resistance characteristics. Previously it has been reported that yields were lower and more stable across sowing dates and locations in Indian mustard compared to canola (Holland *et al.* 2001). The main reason for this increased yield stability was the low harvest index of the Indian mustard, which never exceeded 0.22, while in both cultivars of canola it varied between 0.14 and 0.38 (Holland *et al.* 2001). Results from the northern region (Holland *et al.* 2001) in conjunction with others (Wright *et al.* 1995) have shown that under low yielding situations Indian mustard varieties can potentially yield more than canola. However, when the conditions are more favourable the yield potential of Indian mustards is generally less than that of canola.

Despite the potential fit for Indian mustard production in the northern environment, the major limitation to adoption revolves around market. Indian mustard is a specialty commodity with a limited number of processors and markets, making it difficult to receive reliable returns.

In 2012 a small trial was sown to evaluate the performance of current canola varieties against previously trialled Indian mustard material.

Site details

Tamworth Agricultural Institute

Sowing date:	**12th June 2012**
Fertiliser:	**75 kg N/ha as Urea** **200 kg/ha Superphosphate**
Staring N:	**121 kg N/ha (0–120 cm)**
Starting Water:	**285 mm (PAWC 0–150 cm)**

Treatments

The three canola varieties included in the trial were Hyola® 50, AV Garnet⁽ᵈ⁾ and Pioneer® 43Y85, which are all mid to quick maturing varieties. There were two canola quality Juncea lines included, Xceed™ Oasis CL⁽ᵈ⁾ and Sahara⁽ᵈ⁾ that are both Clearfield® varieties and commercially available. The commercially available yellow mustard varieties were Micky, Kaye and Dune. Dune was the original variety released, which has been superseded, however was included for comparison of variety advancement. There were also a number of experimental yellow mustard lines sown including Selection 1, Selection 2 and Selection 3 (all made from Micky), 352, 99Y and 37-2. There were also two biodiesel types included, 887 and 397, which are both yellow mustards that are not suitable for human consumption. Finally there were two Brown mustards that were commercially available in the past, GG005 and BM11. All varieties were planted on the 13th June, which is beyond the optimum planting window for canola but a more traditional planting time for Indian mustards. Flowering times were monitored throughout the season. Unfortunately, at the time of writing oil contents were not available. Typically oil contents of Indian mustards are lower than canola.

Results

There was little variation between entries in the date which they reached the end of flowering (determined as 5% of flowers remaining), with all varieties ending between the 3rd and 8th October. However, the mustards started flowering approximately 10 days earlier than the canola varieties, resulting in mustards flowering for 41 days compared to 31 days for the canola on average (data not shown). The canola TOS trial in the same paddock indicated that varieties which ended flowering in early October in 2012 had reduce yields of around 20% compared to varieties which ended flowering in mid to late September. Although yield potential may be limited by hot dry conditions during early pod fill in canola, this should be advantageous to the mustards.

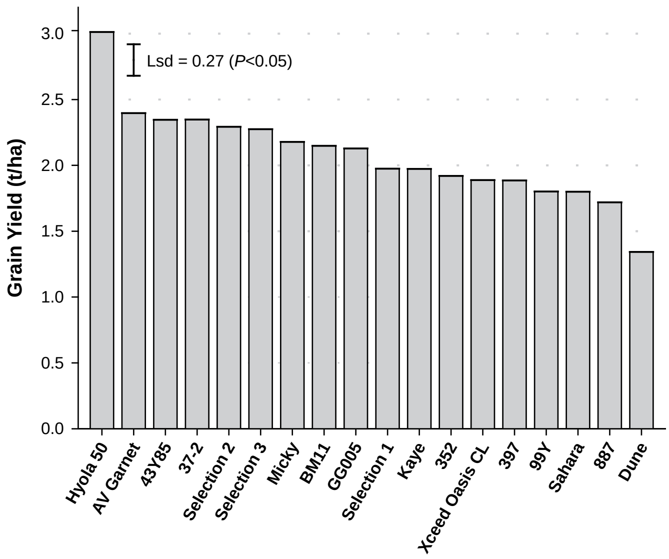

Figure 1: *Grain yield of three canola and fifteen Indian mustard varieties sown on the 14th June at Tamworth in 2012.*

Hyola® 50 had significantly higher grain yield than all other varieties, which supports the canola TOS trials where it averaged over 3 t/ha across a 7 week spread in planting times (Figure 1). AV Garnet⁽ᵇ⁾ and Pioneer® 43Y85 yielded 2.40 and 2.34 t/ha, respectively, which was similar to all mustard entries which produced yields greater than 2 t/ha (Figure 1). Of the mustards 37-2 and Selections 2 and Selection 3 produced yields similar to Micky, BM11 and GG005, but had improved yield over all other mustard entries. Although Selection 1 yielded lower than Selections 2 and 3 it was still similar to Micky from which it was originally selected. The bio-diesel type 887 was similar to other mustard entries which yielded less than 2 t/ha, with the exception of Dune that had the lowest grain yield (1.34 t/ha) of all varieties.

Summary

The end of flowering for all mustard and canola varieties was compressed into a five day period at the start of October. Varieties in the canola TOS study in the same paddock that ended flowering during this same period appeared to have up to a 20% reduction in yield potential compared to an earlier finish in flowering. Despite this Hyola® 50 still yielded 3 t/ha, which was 0.6t/ha more than any other canola or mustard entry. The top six performing mustard entries did however perform similar to the canola varieties AV Garnet⁽ᵇ⁾ and Pioneer® 43Y85. All mustard varieties had a yield advantage over Dune (22–43%), while Micky yielded 13% more than Xceed™ Oasis CL⁽ᵇ⁾ and 17% more than Sahara⁽ᵇ⁾. There was no yield advantage observed for the Indian mustard varieties trialled in this experiment from a late planting time. This may reflect the full profile of moisture at the start of the season, which limited moisture stress during flowering and grain-fill. Yield advantages of mustard over canola may be observed in a more western environment where the seasonal conditions are typically hotter and drier than the Tamworth environment during these critical late stages of development.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Technical assistance provided by Jan Hosking, Patrick Mortell, Stephen Morphett, Jim Perfrement and Peter Formann are gratefully acknowledged.

Effect of time of sowing and variety choice on canola establishment and yield – Trangie 2012

Leigh Jenkins NSW DPI, Warren **Rohan Brill** NSW DPI, Coonamble

Key findings

In western NSW moisture seeking canola (sowing seed deeper than 3 cm) in early-mid April into marginal moisture conditions may result in lower plant establishment rates than sowing just prior to or just after a rainfall event.

Waiting until there is adequate moisture for sowing (early May), or dry sowing (late April) with a reliable forecast of follow up rain, achieved higher yields in 2012 than sowing earlier in mid-April. However the yield loss from early sowing in 2012 was assumed to be due to more than just lower establishment rates.

In 2012 a high number of frost events contributed to the reduced yield potential of early planted (mid-April) canola in this trial at Trangie Agricultural Research Centre.

Introduction

In western NSW canola time of sowing is a compromise between ideal sowing conditions and the appropriate maturity cultivar to suit. Early sowing maximises vegetative growth (biomass) and the length of flowering period, but can predispose the crop to yield-damaging frosts at flowering and early grain fill. Later sowing may reduce frost risk but can result in poor vigour due to cold and/or wet soils at planting time, and an inability to complete seed maturity before the onset of high temperatures and moisture stress, reducing both yield and oil content.

This paper reports on the results of a trial conducted in 2012 to investigate the effect of three times of sowing on yield and oil content of seven canola varieties (hybrid and open pollinated). A seeding rate component was also included in the trial (two varieties only) to compare the interactions between sowing time and plant population, especially to investigate if early sown low density crops (less than 15 plants/m²) yield comparably with early sown higher density crops (more than 20 plants/m²).

Site details

Location:	**Trangie Agricultural Research Centre**
Soil type:	**Grey vertosol (cracking clay)**
2011 crop:	**Wheat**
Phosphorus:	**22 mg/kg (Colwell)**
Deep N:	**112 kg/ha (0–90 cm)**
PAW sowing:	**180 mm (estimate)**
In-crop rainfall:	**109 mm**

Treatments

3 sowing dates: TOS 1: 13 April – moisture seeked into marginal moisture, sown 5 cm deep; TOS 2: 26 April – dry sown, 2 cm deep (14 mm rainfall 3 May); TOS 3: 14 May – moderate moisture, sown 3–4 cm deep
7 canola varieties: 43C80 CL, 43Y85 CL, 44Y84 CL, ATR-Stingray⚫, Jackpot TT⚫, Hyola 555 TT, AV-Garnet⚫
2 target plant populations: 40 plants/m² (all varieties); 15 plants/m² (44Y84 CL and AV-Garnet⚫ only)

Results

Effect of time of sowing on establishment:

Table 1: *Establishment (plants/m²) of seven canola varieties with two target plant populations sown at three sowing times, Trangie ARC 2012*

Variety	Target plant population (plants/m²)	Number of seeds planted/m²	Seed weight (g/1000 seeds)	Actual sowing rate (kg/ha)	Actual plant population (plants/m²)		
					13th April	26th April	14th May
43C80 CL	40	80	3.68	2.94	17.19	49.13	47.57
AV-Garnet⁽ᵖ⁾	40	80	3.47	2.78	11.63	48.26	50.17
Jackpot TT⁽ᵖ⁾	40	80	3.76	3.01	19.62	48.96	47.57
ATR-Stingray⁽ᵖ⁾	40	80	3.44	2.75	17.71	46.70	51.22
Hyola 555TT⁽ᵖ⁾	40	80	3.41	3.41	21.70	55.90	55.90
43Y85 CL	40	80	5.03	4.02	22.05	51.56	59.20
44Y84 CL	40	80	5.38	4.3	20.14	60.07	74.65
44Y84 CL_Low	15	30	5.38	1.61	8.51	21.35	24.13
AV-Garnet_Low	15	30	3.47	1.04	5.03	14.41	15.45
Mean of 7 varieties sown at high seeding rate (40 plants/m²)					18.58	51.51	55.18
Mean of 44Y84 and AV-Garnet⁽ᵖ⁾ sown at high seeding rate (40 plants/m²)					15.89	54.17	62.41
Mean of 44Y84 and AV-Garnet⁽ᵖ⁾ sown at low seeding rate (15 plants/m²)					6.77	17.88	19.79

- All varieties had reduced establishment from TOS 1. Only two hybrid varieties (Hyola 555TT⁽ᵖ⁾ and 43Y85 CL⁽ᵖ⁾) achieved greater than 25% establishment; all other varieties including the two sown at low seeding rates achieved less than 25% establishment.
- Establishment for all varieties at TOS 2 and TOS 3 achieved greater than the target plant population, because plant establishment was greater than the assumed 50% on which seed rates were calculated. Both TOS 2 and TOS 3 achieved over 60% establishment at the standard (40 plants/m²) sowing rate.
- The three hybrids with seed size greater than 4 g/1000 seed weight (Hyola 555TT⁽ᵖ⁾, 43Y85 CL and 44Y84 CL) averaged 74% establishment, compared to the four open-pollinated varieties with seed size of less than 4 g/1000 seed weight, which averaged 61% establishment.

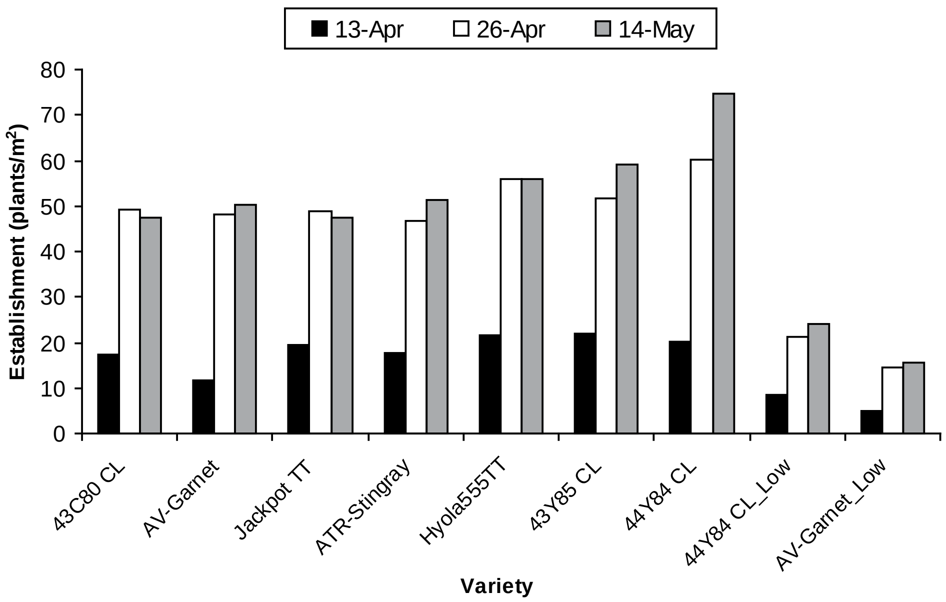

Figure 1: *Establishment (plants/m2) of seven canola varieties with two target plant populations at three sowing times, Trangie ARC 2012*

Effect of time of sowing on yield:

Table 2: *Grain yield (t/ha) and oil content (%) of seven canola varieties with two target plant populations sown at three sowing times, Trangie ARC 2012; l.s.d. (p = 0.05) Variety = 0.16 t/ha, Sowing time = 0.1 t/ha, Seed rate = 0.14 t/ha, Oil = 0.6%*

Variety	13th April		26th April		9th May		Mean	
	Yield (t/ha)	Oil (%)	Yield (t/ha)	Oil (%)	Yield (t/ha)	Oil (%)	Yield (t/ha)	Oil (%)
43C80 CL	0.99	41.83	1.51	41.73	1.47	41.70	1.32	41.76
43Y85 CL	1.25	39.67	1.71	41.07	1.90	41.57	1.62	40.77
44Y84 CL	1.41	42.30	1.91	42.13	1.86	41.87	1.72	42.10
AV-Garnet⁽ᴰ⁾	1.13	41.83	1.27	42.00	1.74	41.70	1.38	41.84
Hyola 555TT⁽ᴰ⁾	1.00	40.17	1.56	41.17	1.66	40.37	1.41	40.57
Jackpot TT⁽ᴰ⁾	0.87	42.90	1.29	43.53	1.29	43.27	1.15	43.23
ATR-Stingray⁽ᴰ⁾	0.79	41.03	1.16	41.03	1.28	41.70	1.07	41.26
44Y84 CL_Low	1.32	42.83	1.68	42.20	1.50	41.47	1.50	42.17
AV-Garnet_Low	0.76	41.27	1.20	41.43	1.43	41.43	1.13	41.38
Mean of 7 varieties sown at high seeding rate (40 pl/m^2)	1.06	41.39	1.49	41.81	1.60	41.74	1.38	41.65
Mean of 44Y84 and AV-Garnet⁽ᴰ⁾ sown at high seeding rate (40 pl/m^2)	1.27	42.07	1.59	42.07	1.80	41.78	1.55	41.97
Mean of 44Y84 and AV-Garnet⁽ᴰ⁾ sown at low seeding rate (15 pl/m^2)	1.04	42.05	1.44	41.82	1.47	41.45	1.32	41.77

- Averaged across varieties, TOS 3 was significantly higher yielding than TOS 1 (0.54 t/ha) and TOS 2 (0.11 t/ha). TOS 2 was significantly higher yielding than TOS 1 (0.43 t/ha). The lower yield of TOS 1 was likely due to a combination of factors including reduced plant establishment, frost damage as a result of early flowering and potentially higher rates of vegetative water use.
- Averaged across sowing times, the hybrids 44Y84 CL and 43Y85 CL were the highest yielding varieties, with an average yield of 1.72 t/ha and 1.62 t/ha respectively. Jackpot TT⁽ᴰ⁾ and ATR Stingray⁽ᴰ⁾ were the lowest yielding varieties, with an average yield of 1.15 t/ha and 1.07 t/ha respectively.
- The seeding rate treatment had a significant effect on yield. Averaged for the two varieties 44Y84 CL and AV-Garnet⁽ᴰ⁾, the high seeding rate targeting 40 plants/m^2 yielded 0.24 t/ha more than the low seeding rate targeting 15 plants/m^2 There was no interaction between seeding rate and sowing time, meaning that the advantage of the higher seeding rate was observed for all sowing times.

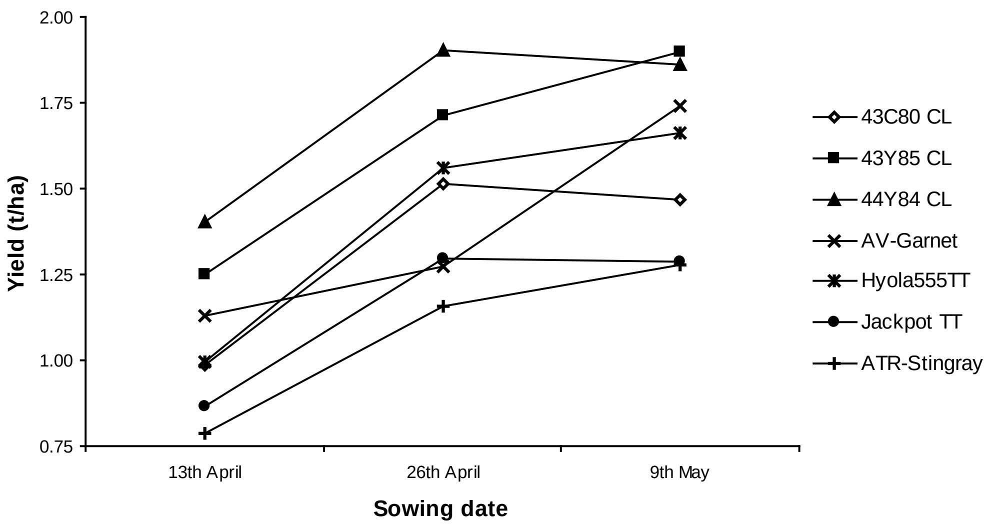

Figure 2: *Grain yield (t/ha) of seven canola varieties sown at three sowing times at Trangie ARC 2012; l.s.d. (p = 0.05) Variety = 0.16 t/ha, Sowing time = 0.1 t/ha*

Effect of time of sowing on oil content:

- There was no significant effect of time of sowing on oil content in this trial.
- Jackpot TT[(b)] had the highest average oil content (43.2%) of all varieties, with 44Y84 CL also higher than the other five varieties (42.1%). All other varieties averaged less than the minimum base oil content of 42%, meaning discounts would apply at delivery. The lowest of these were 43Y85 CL at 40.8% and Hyola 555TT[(b)] at 40.6%.
- There was no significant effect of seeding rate treatments on oil content in this trial.

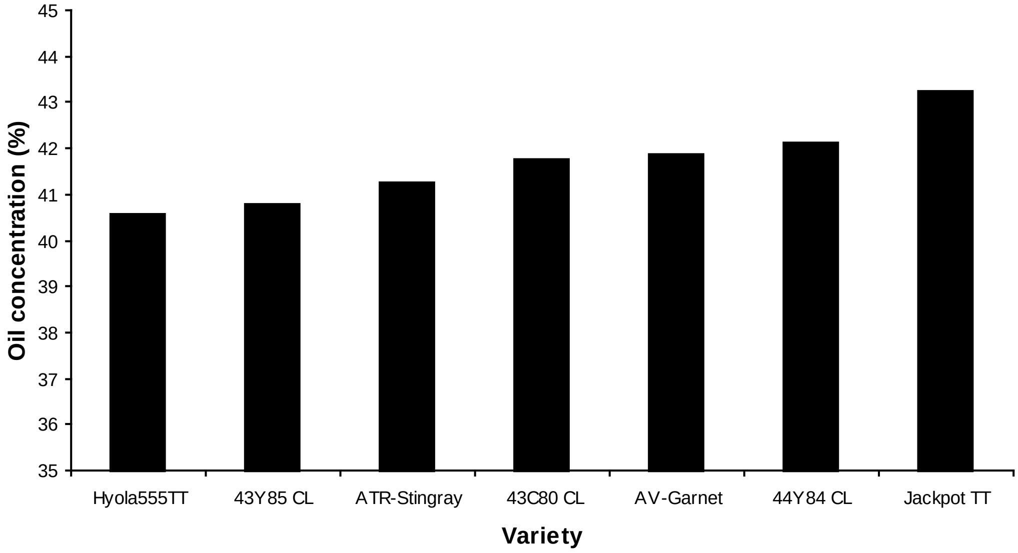

Figure 3: *Oil content (%) at 6% moisture of seven canola varieties averaged across three sowing times at Trangie ARC 2012; l.s.d. (p = 0.05) Variety = 0.6%*

Summary

Conditions at sowing obviously can have a large impact on crop establishment rates. Moisture seeking early (mid-April) into marginal moisture conditions may result in established populations well below those being targeted. Delaying sowing until there are better moisture conditions after an autumn break (early May), and even dry sowing (at a shallow depth) prior to the autumn break can be acceptable for canola provided adequate rainfall (15–20 mm) is received soon after sowing. In the 2012 trial if May had remained dry, the early deep sown treatment may still have resulted in a better outcome than not planting canola at all. Seeding rates that target a lower plant population may reduce yield potential. However the greatest risk associated with early sowing is the impact of frost which may significantly reduce the yield potential of early planted (mid-April) canola in western NSW.

Acknowledgements

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Sorghum in the western zone – Row Configuration x Population x Hybrid – "Morialta", Mungindi 2012

Guy McMullen, Loretta Serafin and Ben Frazer NSW DPI, Tamworth
Tim Burley (formerly NSW DPI) and Russell Carty NSW DPI, Moree **Fiona Scott** Trade & Investment NSW

Key findings

Highest yields at around 4 t/ha were achieved with plant populations between 50 and 70, 000 plants/ha.

Yields declined as row spacing widened in this above average season. The same result would not be expected from more typical seasonal conditions for this environment.

Gross margins were driven by final grain yield. Solid, single skip and superwide achieved the highest gross margin. Double skip gross margins were poor in comparison.

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 yields.

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 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 three sites planted across northern NSW in the 2011/12 season, the other two sites being Garah and Rowena. Results from the Rowena site are presented in another paper. The Garah site suffered inundation with water and could not be used.

Trial details

Co-operator:	**Tom Greentree, "Morialta", Mungindi**
Sowing Date:	**24th and 25th October, 2011**
Planter:	**Monosem double disc**
Fertiliser:	**100 kg of Urea pre-drilled**
	46 kg/ha Supreme Z at sowing

Treatments

Hybrids

- 2436 (low tillering and high SG) experimental hybrid
- MR43 (moderate SG and tillering)
- MR Bazley (PAC2437) (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.

- 30,000 plants/ha
- 50,000 plants/ha
- 70,000 plants/ha

Results

Establishment

The site established well with the 3 and 5 plants/m^2 populations (30,000 and 50,000 plants/ha) close to the targeted populations. The higher target population, 7 plants/m^2 was more difficult to achieve with only 5.8 plants/m^2 (Figure 1).

Two hybrids 2436 and MR 43 established similarly while MR Bazley achieved lower plant populations across all target populations.

Tillers

The number of tillers per plant reduced as the plant population increased. This is expected as greater competition for light and water affect the plants tillering capacity.

MR Bazley produced the most tillers per plant across all populations, followed by MR43 and then 2436. This corresponded with the expected tillering of each of the hybrids.

Increasing effective row spacing also reduced the number of tillers per plant (Figure 2). Single skip developed the highest number of tillers per plant for MR Bazley (Figure 2).

Head numbers

The number of heads per square metre and number of heads per plant both declined as the effective row spacing increased (Figure 3). Differences between hybrids across row configurations were apparent.

As was found for the tiller numbers, increasing plant population increased the number of heads per square metre, while the number of heads per plant decreased.

MR Bazley produced greater head numbers per plant when compared to MR43, which had more heads than 2436 across all populations and configurations (Figure 4). However, the differences in head numbers per plant became less substantial as the population increased.

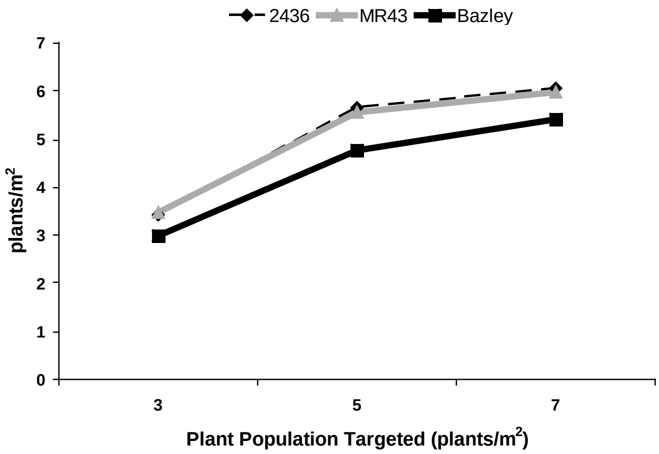

Figure 1: *Plant Establishment at "Morialta"*

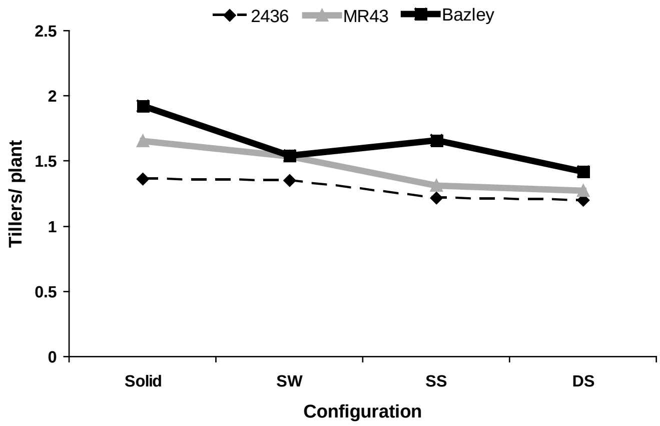

Figure 2: *Effect of row configuration and hybrid on tillers per plant (including the mainstem)*

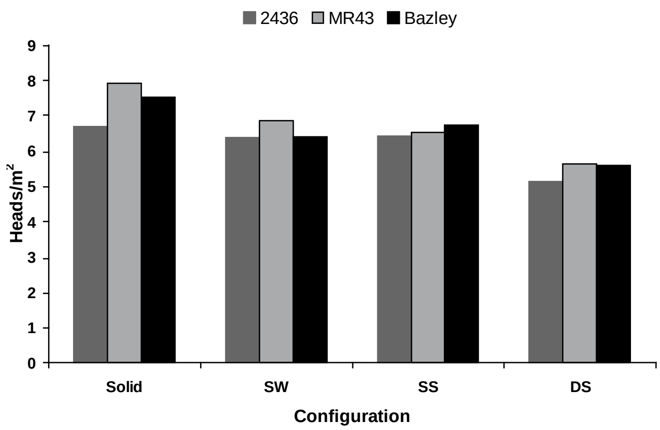

Figure 3: *Effect of configuration on heads per* m^2

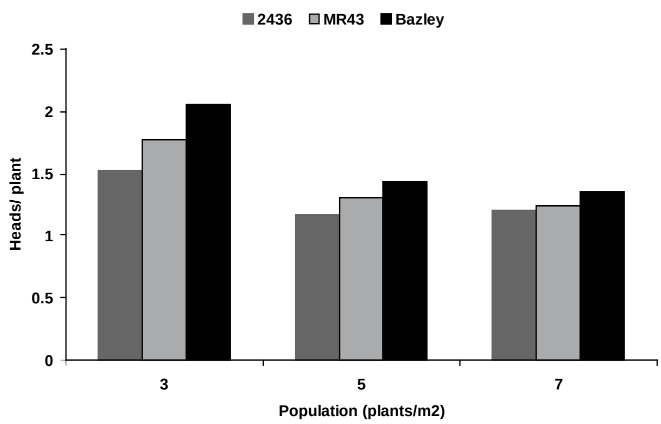

Figure 4: *Effect of population and hybrid on heads per plant*

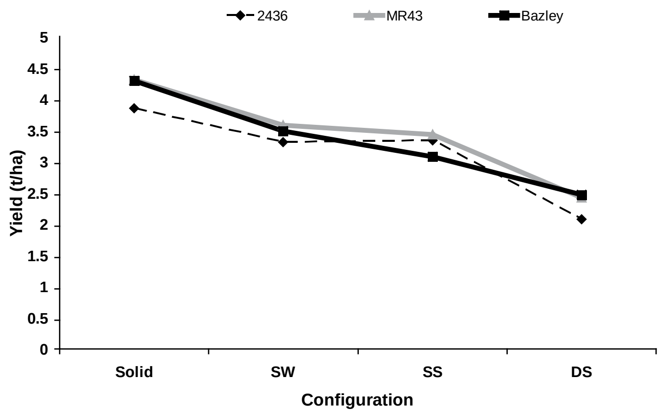

Figure 5: *Grain yield of different sowing configurations averaged across plant populations*

Yield

Yields reached a maximum of just over 4 t/ha with the solid plant configuration and decreased as row spacing increased. This was a similar trend to the high yielding 2010/11 season. There was no significant difference in the yield of single skip and superwide configurations. Double skip yielded the lowest but it was not significantly different to the superwide configuration.

Yields increased as the plant population increased however, the differences were not statistically significant.

The yields of MR43 and MR Bazley were similar across all configurations. 2436 yielded less than the other two hybrids across all configurations except single skip.

Yields of hybrids across populations showed no clear trends; however MR 43 significantly out yielded MR Bazley and 2436 at the low population. At the middle population MR Bazley out yielded MR 43, which out yielded 2436.

At the high population yield differences were less, with MR 43 yielding highest.

Higher populations yielded more across all configurations except double skip (Figure 5). Yield differences between hybrids became less as row spacing widens.

Grain Quality

Grain samples were tested to determine the effects of hybrid, row configuration and plant population on 1000 grain weight, screenings and hectolitre weight. 1000 Grain weight varied little across populations or configurations (Table 1).

2436 had the highest 1000 grain weight at 35 g across all populations and configurations, followed by MR Bazley and then MR 43.

Table 1: *Effect of population and Hybrid on 1000 Grain weight*

Hybrid/Population	30,000	50,000	70,000
2436	35	36	35
MR Bazley	32	32	31
MR43	30	30	28

Hectolitre weights were all well above the 71 kg/hL receival standard for high grade sorghum, generally in the range of 76–78 kg/hL (Table 2).

Hectolitre weight generally increased as population increased and row spacing widened.

Overall hectolitre weights were highest for 2436 followed by MR 43 and then MR Bazley across all populations and configurations.

Table 2: *Effect of Configuration and Hybrid on Grain Quality*

Configuration	Hybrid	Average of 1000 Grain Weight	Average of Hectolitre Weight	Average of % Screenings
Solid	2436	34.8	77.5	3.4
	MR Bazley	32.6	76.4	2.3
	MR43	28.6	77.3	2.3
SW	2436	34.8	78.4	3.0
	MR Bazley	31.0	76.6	2.7
	MR43	29.2	77.8	2.7
SS	2436	37.0	78.4	2.4
	MR Bazley	32.5	76.5	1.8
	MR43	30.1	78.2	2.0
DS	2436	35.4	79.3	2.6
	MR Bazley	30.9	76.6	1.9
	MR43	28.2	78.5	2.7

All screenings were well below the 11% receival standard for high grade sorghum with the highest being 3.5%.

Screenings generally decreased as population increased and row spacing widened.

2436 had the highest screenings followed by MR43 and then MR Bazley.

Gross Margins

Gross margins varied dramatically depending on the treatment in the trial. As expected, higher gross margins were achieved with higher yields.

Gross margins increased substantially as population increased. There was little difference between the gross margin for the different hybrids as the only difference in input cost was for the purchase of seed (Table 3).

Table 3: *Effect of Population and Hybrid on Gross Margin*

Hybrid	30,000	50,000	70,000
2436	1249.1	2700.3	3533.8
MR Bazley	982.4	3325.0	3527.6
MR43	1323.7	2653.6	3445.3

Row configuration was a much stronger driver of gross margin. Gross margins showed grain sorghum in these more favourable years to be an attractive proposition for growers who used solid, single skip and superwide configurations (Table 4).

Table 4: Effect of configuration and hybrid on gross margin

Config	Hybrid	Average of Gross Margin ($/ha)
Solid	2436	217.8
	MR Bazley	291.0
	MR43	256.7
SW	2436	339.4
	MR Bazley	296.2
	MR43	329.0
SS	2436	267.9
	MR Bazley	241.1
	MR43	244.1
DS	2436	6.4
	MR Bazley	42.3
	MR43	–5.1

Conclusions

Hybrid tiller and head production can be strongly influenced by the row configuration and plant population. In this trial, a similar trend to our previous research was evident, where as row spacing widened and plant population increased the number of tillers and heads reduced.

Yield at this site was again above what is considered typical of this environment at just over 4 t/ha. In this above average yielding season higher yields were achieved from narrower row spacings such as solid plant. However this is also a more risky row configuration in years of plant stress.

While there were differences in grain quality across treatments, there were no impacts on classification across all treatments.

As would be expected the GM were strongly influenced by grain yield. Gross margins showed grain sorghum in these more favourable years to be an attractive proposition for growers who used solid, single skip and superwide configurations at plant populations of 50,000 plants/ha.

Acknowledgements

This project is funded by the GRDC under project DAN00150 with support from Pacific Seeds.

Thanks to Jan Hosking, Peter Formann and Jim Perfrement for technical assistance.

Sorghum in the western zone – Row Configuration x Population x Hybrid – "Glendara", Rowena 2012

Loretta Serafin, Guy McMullen and Ben Frazer NSW DPI, Tamworth
Tim Weaver NSW DPI, ACRI, Narrabri **Fiona Scott** NSW Trade & Investment, Tamworth

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 yields.

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 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 three sites planted across northern NSW in the 2011/12 season, the other two sites being Garah and Morialta. Results from the Morialta site are presented in another paper. The Garah site suffered inundation with water and could not be used.

Key findings

Hybrid tiller and head production can be strongly influenced by the row configuration and plant population.

Yield at this site was again above what is considered typical of this environment with the best treatments reaching close to 6 t/ha. In this above average yielding season higher yields were achieved from narrower row spacings and hybrids with higher tillering capacity.

Gross margins showed grain sorghum in these more favourable years to be a more attractive proposition for growers who used solid configurations, in this season. As would be expected the higher the grain yield the higher the resulting gross margin.

Trial details

Co-operator:	**Philip and John Harris**
Property:	**"Glendara", Rowena**
Sowing Date:	**29th and 30th September, 2011**
Planter:	**Monosem double disc**
Fertiliser:	**46 kg/ha Supreme Z at sowing**

Starting Soil Water

The site was cored at sowing to establish starting soil water. PAWC was estimated to be 167 mm.

Treatments

Hybrids

- 2436 (low tillering and high SG)
- MR43 (moderate SG and tillering)
- MR Bazley (PAC2437) (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.

- 30,000 plants/ha
- 50,000 plants/ha
- 70,000 plants/ha

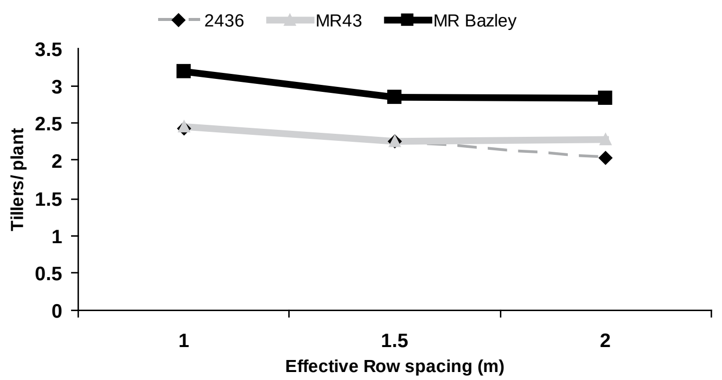

Figure 1: *Effect of row configuration on tillers per plant*

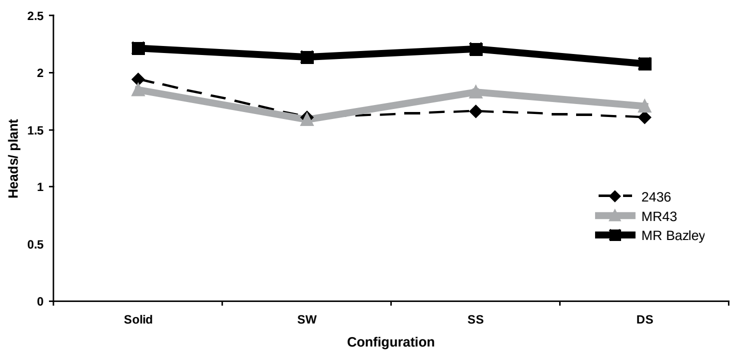

Figure 2: *Effect of row configuration on the number of heads per plant.*

Results

Establishment

Establishment counts were taken for each plot. This site had a good establishment for all hybrids. Target population was achieved for 30,000 plants/ha. However for the 50,000 plants/ha and 70,000 target populations, only 46,000 and 54,000 plants/ha respectively were established.

MR Bazley populations were established around 12% lower than 2436 and MR43, which established at similar populations.

Tillers

As population increased tiller production per square metre increased, whilst tiller production per plant decreased across all hybrids.

There was no significant difference in tillering between 2436 and MR43. MR Bazley produced significantly more tillers than the other two hybrids both per square metre and per plant.

Head numbers

As plant population increased the number of heads per square metre also increased. The trends between hybrids were the same for head numbers as they were for tillers, there was no significant difference between 2436 and MR43 while MR Bazley produced significantly more tillers.

Heads per plant decreased as plant population increased.

Across configurations, the solid plant produced significantly more heads per square metre than all other configurations. The trend was for decreasing head number as row spacing increased.

Yield

Rowena was the highest yielding of three sites in the 2011/12 season, with an average site yield of 4.5 t/ha. There was quite a large range in yields across the different treatments though, with the best (solid plant) yielding 5.2 t/ha and the worst (double skip) 3.5 t/ha.

Yield decreased as row spacing increased in the 2011/12 season (Figure 3).

Solid plant yielded the best at all 3 sites in the 2010/11 season and also in the 2011/12 season, however both seasons have been wetter than average.

Superwide and single skip configurations were not statistically different in their final yield. Single skip and superwide yielded 88 and 91% respectively of the solid plant.

The double skip configuration resulted in 1.7 t/ha less or 67% of the yield of the solid plant.

Yields across the three hybrids were significantly different. 2436 was the lowest yielding hybrid by far, 0.5 t/ha less than MR43, while the yield difference between MR43 and the highest yielding MR Bazley was less at only 0.2 t/ha.

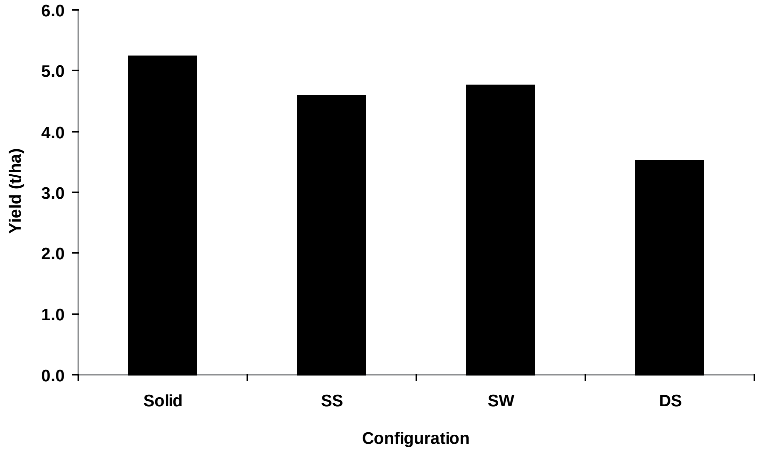

***Figure 3:** Grain yield across sowing configurations*

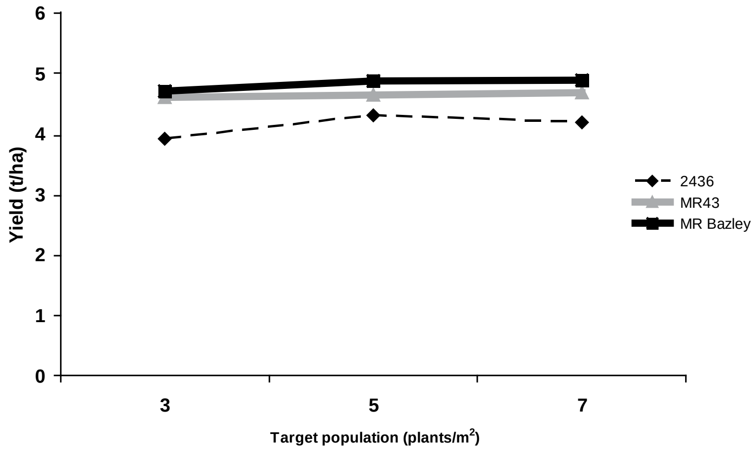

***Figure 4:** Grain yield across hybrids and plant populations*

Grain Quality

There was no significant difference in 1000 grain weight or hectolitre weight across configurations, populations or hybrids.

There were significant differences in screenings across row configurations and hybrids. Screenings reached up to 13.5% in the solid plant configuration but declined to around 8% for double skip. There were also significant differences in hybrids, with MR Bazley showing lower screenings than MR43 and 2436.

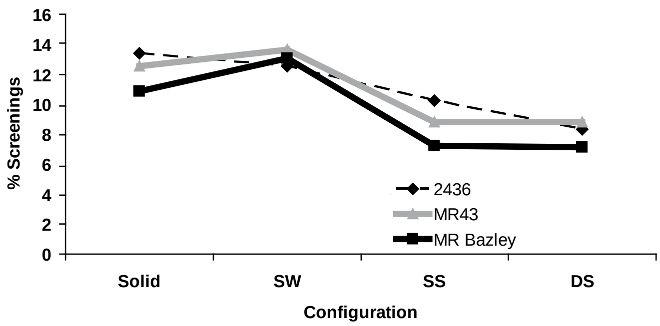

***Figure 5:** Effect of Row configuration and Hybrid on Screenings*

Finishing Soil Water

Finishing soil moisture across configurations for the hybrid MR43 was measured at harvest. These measurements were taken both on row and mid row for all configurations except double skip where an extra core was taken in the middle of the skip area.

Differences in the finishing soil water were detected at the surface, whilst moisture was similar at depth for all configurations with the exception of the middle of the skip area in the double skip plots.

The middle of the skip area for the double skip configuration shows more moisture remaining at all depths below 50 cm.

No significant difference was observed between on row and mid row soil moisture in any configuration.

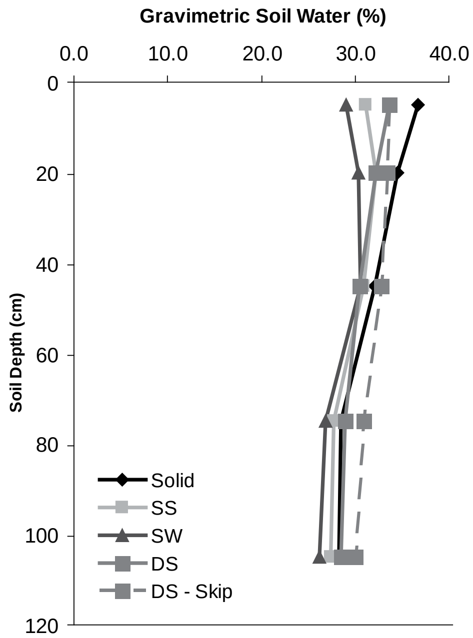

Figure 6: *Gravimetric soil water in between plant rows across all sowing configurations*

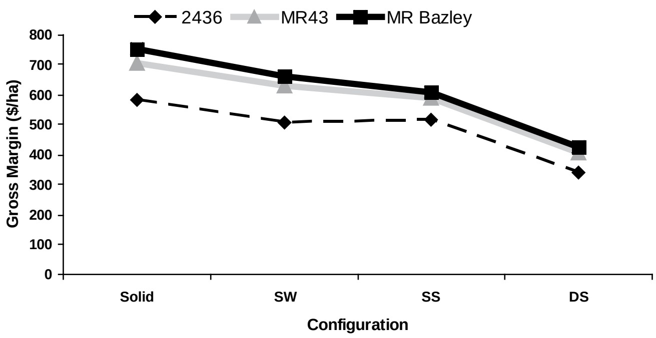

Figure 7: *The effect of sowing configuration and variety on gross margin*

Gross Margins

Gross margins follow the same trend as grain yield. Gross margin decreased as row spacing increased.

There was no significant difference between the gross margin for single skip and super wide configurations.

There was a difference in gross margin between hybrids, with 2436 having a lower gross margin as a result of its lower yield.

Conclusions

Hybrid tiller and head production can be strongly influenced by row configuration and plant population. High tillering hybrids can be made to perform like a low tillering hybrid if plant population and effective row spacing are increased.

In this trial, a similar trend to our previous research was evident, where as row spacing widened and plant population increased the number of tillers and heads reduced. Under above average seasonal rainfall this resulted in lower yields.

Yield at this site was again above what is considered typical of this environment with the best treatments reaching close to 6 t/ha. In this above average yielding season higher yields were achieved from narrower row spacings and hybrids with more tiller production. However, this is also a more risky row configuration in years of stress.

Gross margins showed grain sorghum in these more favourable seasons to be a more attractive proposition for growers who used solid configurations. As would be expected the higher the grain yield the higher the resulting gross margin.

Acknowledgements

This project is funded by the GRDC under project DAN00150 with support from Pacific Seeds.

Thanks to Jan Hosking, Peter Formann, and Jim Perfrement for technical assistance. Thanks to Phillip and John Harris and family “Glendara”, Rowena for hosting the trial site. The assistance of Brad Coleman, Coleman Ag is also gratefully acknowledged.

Sorghum – Irrigation management and hybrid selection

Loretta Serafin, Ben Frazer and Guy McMullen NSW DPI, Tamworth

Introduction

Irrigated grain sorghum research in northern NSW has been extremely limited since the early 1980's. During that era, research focused on hybrid performance and plant population, however the suite of hybrids and standard planting configurations (narrow rows of around 33 cm) have changed extensively.

Independent comparative trials of hybrids under irrigation have not been performed by NSW DPI since the early 1980's and limited comparisons have been conducted in either NSW or Qld by other organisations.

Typically hybrids targeted for irrigation are suggested on the basis of performance under high yielding dryland conditions.

Key findings

In the above average rainfall season at this site in 2011/2012 there was no interaction between irrigation management and hybrid selection. Hybrids that performed well without additional irrigation also performed well with two waterings.

Even in a wet season there was over a 1.6 t/ha yield response to two waterings across all sorghum hybrids.

Grain yield varied across hybrids with Enforcer achieving the highest yields of 7.3 t/ha. Other good yield performers included 86G56 and MR Maxi.

Site details

Location:	**Liverpool Plains Field Station, Breeza**
Sowing Date:	**4th November 2011**
Fertiliser:	**200 kg/ha Urea (92 kg N/ha)** **48 kg/ha Supreme Z**
Herbicides:	**1.5 L/ha Dual Gold® applied PSPE** **2 L/ha Atrazine applied 30th December 2011**

Sowing Details:

Trials were sown with a double disc monosem precision planter. Starter fertiliser was placed with the seed while Urea was pre-applied by spreading and then incorporated. Planting configuration was 2 rows/bed, at 90 cm spacing.

Bare beds were left between irrigation treatments to minimise lateral movement of water with additional sown buffers also sown outside experimental beds to reduce edge effects.

Harvest Details:

The trial was desiccated with 2 L/ha of RoundupMax® on the 29th March 2012. All plots were harvested on the 10th April 2012 with a KEW small plot header and subsamples taken for grain quality analysis.

Treatments

3 Irrigation treatments:

I-0 Dryland

I-1 1 irrigation near end of flowering

I-2 2 irrigations – One near the end of flowering and again during grain-fill.

12 Hybrids:

Eclipse, Enforcer, 85G08, 85G22, 86G56, 84G99, MR Bazley, MR Buster, MR Maxi, MR43, Tiger and Venture

Results

There was no interaction between irrigation and hybrid for either yield or grain quality. There was a significant affect of the main treatments across both yield and quality.

Irrigation

Irrigation had a significant affect on both yield and hectolitre weight (Table 1). Even in a season with above average rainfall there was a 1.6 t/ha increase in yield with two irrigations. The difference between one and two irrigations was 1 t/ha which was not significant at the 5% level.

Table 1: *Effect of irrigation management on sorghum grain yield and quality (average across 12 hybrids)*

Water	Yield (t/ha)	Screenings (%)	Hectolitre weight (kg/hL)	Grain weight (g/1000)
I-0	5.6 b	5.4	78.4 c	35.7
I-1	6.2 ab	4.4	78.9 b	34.8
I-2	7.2 b	4.0	79.4 a	34.1
F. pr	0.04	0.06	0.005	nsd
5% lsd	1.1	–		

Means followed by the same letter are not significantly different.

Hectolitre weight had small but significant increases with additional irrigations. Screenings were well below the receival standard of 11% for Sorghum. Additional irrigations did result in a trend for reduced levels of screenings.

Hybrid Performance

Hybrid yields ranged from 7.3 and 5.3 t/ha for Enforcer and 85G22 respectively (Table 2). The top yielding hybrids included Enforcer, 86G56 and MR Maxi.

Differences in grain quality were all highly significant. All hybrid screenings were less then 11%. The highest level of screenings was 6.8% in 85G22 and the lowest in MR Bazley of 3%.

Hectolitre weights where all high as was grain size. Overall there was a trend for smaller grain size at higher yields.

Table 2: *Hybrid grain yield and quality (averaged across irrigation treatments)*

Hybrid	Yield (t/ha)	Screenings (%)	Hectolitre Weight (kg/hL)	Grain Weight (g/1000 seeds)
Enforcer	7.3 a	4.9 cde	79.0 cd	30.7 a
G56	6.8 ab	4.0 ef	79.2 c	33.8 ab
MR Maxi	6.7 ab	3.4 fg	78.3 e	36.9 bc
MR Buster	6.5 b	4.0 efg	78.0 e	36.6 bcd
Tiger	6.5 b	5.4 bcd	78.5 e	38.1 bcde
Venture	6.5 b	4.6 cde	79.9 b	34.6 cde
G99	6.4 bc	5.5 bc	78.5 de	33.5 def
Eclipse	6.4 bc	4.4 de	79.9 ab	35.7 efg
MR43	6.1 bcd	3.3 fg	80.4 a	34.9 fg
MR Bazley	5.7 cde	3.0 g	79.2 c	36.1 gh
G08	5.7 de	5.9 ab	77.5 f	35.3 h
G22	5.3 e	6.8 a	78.1 e	32.2 i
F. pr.	<0.001	<0.001	<0.001	<0.001
5% lsd	1.2	1.9	0.8	2.5

Means followed by the same letter are not significantly different.

Summary

The 2011/12 summer season had greatly above average rainfall. Despite this there were still significant increases in yield and small differences in grain quality with additional irrigation in this trial.

Hybrids performed the same under both dryland and irrigated situations in this trial.

There has been a lack of agronomic work done on sorghum, especially under irrigation. Further work is required for robust recommendations for irrigated sorghum production.

Acknowledgements

This project is funded by NSW DPI. Thanks to Peter Formann, Rod Bambach and Jan Hosking for technical assistance. Thanks also to Scott Goodworth, LPFS for his assistance with the site.

AGRONOMY

Sowing time response of 12 wheat varieties – Trangie 2012

Rohan Brill NSW DPI, Coonamble **Leigh Jenkins** NSW DPI, Warren

Key findings

Across the twelve wheat varieties included, optimum yield was achieved where anthesis occurred in the window from 10th September to 24th September

EGA Gregory^{⁽ᵇ⁾}, Suntop⁽ᵇ⁾ and LongReach Impala⁽ᵇ⁾ were relatively high yielding at each of the three sowing dates

These relatively high yielding varieties also achieved the lowest grain protein concentration

Introduction

Sowing time is a balance between avoiding frost and heat at anthesis and also ensuring that water is available for the critical grain fill period post-flowering. Early sowing of quick flowering lines can lead to frost damage, while late sowing of slow flowering lines can lead to excessive heat stress. Even where heat and frost are avoided, excessive early vegetative growth from early sowing may reduce the amount of water available for grain fill. Conversely, late sowing of quick varieties may reduce yield potential by not utilising all water and nutrients available.

These results are a continuation of trials which have been reported in previous editions of the Northern Grains Region Trial Results Book.

Site details

Location:	**Trangie**
Soil type:	**Grey vertosol (cracking clay)**
2011 crop:	**Canola**
2010 crop:	**Wheat**
RLN:	**Nil**
PAW (sowing):	**180 mm**
Nitrogen:	**177 kg/ha (0–90 cm)**
Phosphorus:	**22 mg/kg (Colwell)** **40 mg/kg (BSES)**

Treatments

3 sowing dates – 30 April (dry sown, 12 mm recorded 3 May), 21 May, 12 June
10 bread wheat varieties – LongReach Crusader⁽ᵇ⁾, LongReach Dart⁽ᵇ⁾, Gauntlet⁽ᵇ⁾, EGA Gregory⁽ᵇ⁾, Livingston⁽ᵇ⁾, LongReach Spitfire⁽ᵇ⁾, Sunguard⁽ᵇ⁾, Suntop⁽ᵇ⁾, Sunvale⁽ᵇ⁾, Sunzell⁽ᵇ⁾
1 durum variety – Caparoi⁽ᵇ⁾
1 soft wheat variety – LongReach Impala⁽ᵇ⁾

Results

- Grain yield was optimised from treatments that flowered between 10 September and 24 September.
- Early sowing of the very quick variety LongReach Dart⁽ᵇ⁾ resulted in frost damage that reduced yield. At the anthesis stage, 20% of heads of LongReach Dart⁽ᵇ⁾ displayed some level of frost damage, which occurred before the head had emerged. No other treatment had more than 5% of heads damaged by frost. LongReach Dart⁽ᵇ⁾ flowered 7 days earlier than the next quickest varieties Livingston⁽ᵇ⁾ and LongReach Spitfire⁽ᵇ⁾.
- There was a sharp drop off in yield when flowering was delayed beyond 26 September.

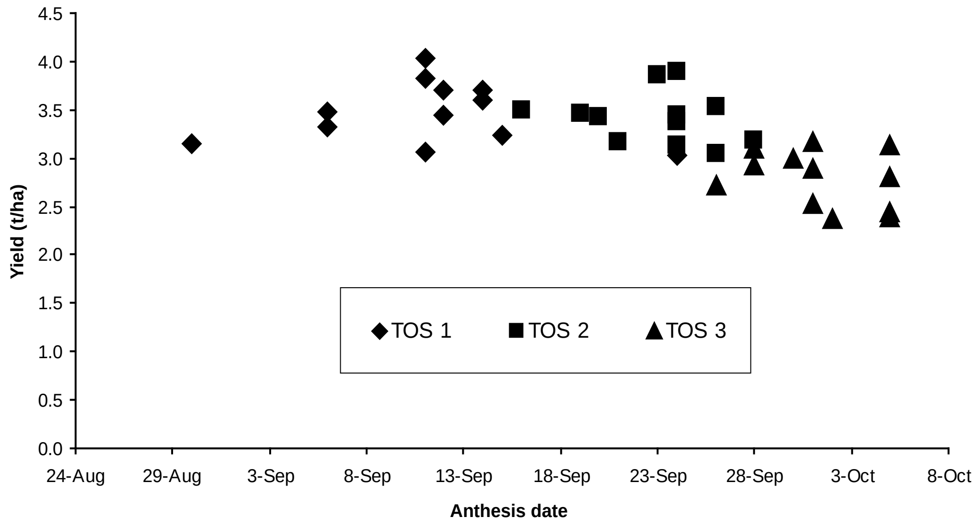

***Figure 1:** Effect of flowering date on yield of 12 wheat varieties sown at three sowing dates at Trangie in 2012*

- Grain yield of EGA Gregory$^{\Phi}$, Suntop$^{\Phi}$ and LongReach Impala$^{\Phi}$ was relatively high at all three sow times. These varieties also had the lowest grain protein concentration.
- LongReach Spitfire$^{\Phi}$ generally achieved at least 1% greater protein than most other varieties for a given yield level. Yield of LongReach Spitfire$^{\Phi}$ was close to average for each of the three sowing dates.
- Sunguard$^{\Phi}$ and Sunvale$^{\Phi}$ had at least average yield at the first sow date, but had significant yield reduction of approximately 0.5 t/ha for each of the subsequent sow dates.

***Table 1:** Grain yield, grain protein concentration and anthesis date of 12 wheat varieties sown at three sow dates at Trangie in 2012*

Variety	Yield (t/ha) and protein (%)						Anthesis date		
	30th April (dry)		21st May		12th June		30th April	21st May	12th June
Caparoi$^{\Phi}$	3.24	12.5	3.14	12.8	2.37	11.7	15-Sep	24-Sep	2-Oct
LongReach Crusader$^{\Phi}$	3.06	13.5	3.17	12.8	2.52	12.9	11-Sep	21-Sep	1-Oct
LongReach Dart$^{\Phi}$	3.15	13.0	3.50	12.6	2.71	11.9	30-Aug	16-Sep	26-Sep
LongReach Gauntlet	3.44	12.8	3.44	12.6	2.81	12.2	12-Sep	24-Sep	5-Oct
EGA Gregory$^{\Phi}$	3.71	12.1	3.53	12.1	3.13	11.5	14-Sep	26-Sep	5-Oct
LongReach Impala$^{\Phi}$	3.70	11.7	3.86	11.8	3.10	11.7	12-Sep	23-Sep	28-Sep
Livingston$^{\Phi}$	3.48	12.8	3.47	12.6	2.92	12.2	6-Sep	19-Sep	28-Sep
LongReach Spitfire$^{\Phi}$	3.32	14.1	3.43	13.6	3.00	13.2	6-Sep	20-Sep	30-Sep
Sunguard$^{\Phi}$	3.82	12.0	3.37	12.5	2.89	12.3	11-Sep	24-Sep	1-Oct
Suntop$^{\Phi}$	4.03	11.9	3.90	12.0	3.17	11.9	11-Sep	24-Sep	1-Oct
Sunvale$^{\Phi}$	3.60	13.0	3.04	13.7	2.44	12.6	14-Sep	26-Sep	5-Oct
Sunzell$^{\Phi}$	3.03	13.7	3.18	13.6	2.39	12.9	24-Sep	28-Sep	5-Oct
Mean of sow time	3.47	12.8	3.42	12.7	2.79	12.3			
l.s.d. p = 0.05	yield	0.29	protein	0.34					
c.v. (%)		7.2		1.5					

Summary

In the past two seasons of sowing time trials at Trangie (with a full moisture profile), EGA Gregory$^{\phi}$ and Suntop$^{\phi}$ have been relatively high yielding across all sow times. Yield of both of these varieties has been maximised where anthesis has occurred around 14th to 21st September. On average these varieties should be sown in the period from early May to mid-May to target this anthesis date. Earlier sowing (April) of EGA Gregory$^{\phi}$ may escape frost, but yield is often reduced (such as in 2011) because more water is used pre-flowering, leaving less water for grain fill.

From the late sowing dates over the past two seasons (with a full profile of moisture), EGA Gregory$^{\phi}$ and Suntop$^{\phi}$ have been higher yielding than quicker maturing varieties, such as Livingston$^{\phi}$, LongReach Crusader$^{\phi}$ and LongReach Spitfire$^{\phi}$.

In a season with only a moderate soil profile (Trangie 2009) coupled with a dry spring, the quicker maturing lines (such as mentioned above) yielded consistently more than slower varieties such as EGA Gregory$^{\phi}$, even when quicker varieties flowered at the same time from a later sow date. Therefore there may be opportunities to alter the mix of fast and slow maturing varieties depending on the amount of stored soil water at sowing.

Both EGA Gregory$^{\phi}$ and Suntop$^{\phi}$ have been close to the highest yielding varieties from all sow times of the past two seasons, but have also achieved the lowest grain protein concentration. This is primarily due to the yield dilution of protein by starch. LongReach Spitfire$^{\phi}$, while achieving moderate yields, again was able to achieve a high protein for its yield level. For example in sow time 2, where yield of LongReach Spitfire$^{\phi}$ was similar to the varieties LongReach Gauntlet$^{\phi}$, Livingston$^{\phi}$, LongReach Crusader$^{\phi}$ and LongReach Dart$^{\phi}$, protein was on average 1% higher.

Acknowledgements

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VSAP Broadacre Variety Trial – Walgett

Tim Weaver NSW DPI, Walgett **Greg Rummery and Sarah Groat** Greg Rummery Consulting Pty Ltd

Introduction

A Variety Specific Agronomy Package (VSAP) trial evaluating 6 varieties on a broadacre scale was established near Walgett (Plate 1). Broadacre trials are similar to national variety trials (NVT), however on a larger scale. The varieties sown in the trial were EGA Gregory$^{\phi}$, Sunco$^{\phi}$, Sunguard$^{\phi}$, LongReach Spitfire$^{\phi}$, LongReach Crusader$^{\phi}$ and the newly released variety Suntop$^{\phi}$. The site was soil cored prior to sowing to a depth of 1.2 metres and the results are listed in Table 1. Plant available water content (PAWC) was calculated using CSIRO's Soil Mapp App using the gravimetric moisture content (Figure 1). An EM38 survey in vertical and horizontal mode was completed on the 18th May just after sowing to assess the site for uniformity (Figure 2).

A normalized difference vegetation index (NDVI) image (Figure 3) was taken of the trial site on the 20th August and a correlation with the EM38 survey was completed. A header fitted with yield mapping technology was used to harvest the trial on the 31st October.

A temperature data logger was also installed at the site as well as a rain gauge to capture all in-crop rainfall (Table 2 and Figure 4).

Plate 1: *Trial site on the 30th October 2012*
Photo: G Rummery

Site details

Location:	**"Brooksdale", Walgett**
Co-operator:	**Greg Rummery**
Soil Type:	**Grey Vertosol**
Sown/Rate:	**16th May at 30 kg/ha**
Urea:	**3rd August at 46 units N/ha**
Harvest:	**31st October**

Key findings

EGA Gregory$^{\phi}$ yielded higher (3.6 t/ha) then the other 5 varieties, while having the lowest protein of all varieties.

LongReach Crusader$^{\phi}$ was the opposite of EGA Gregory$^{\phi}$ having the lowest grain yield (1.9 t/ha) and highest protein (12.4%) of all the varieties. However, an early planting time may have resulted in some frost damage in LongReach Crusader$^{\phi}$.

Extremely dry conditions from August to November meant that applied N (3rd August) would have had a limited influence on results.

Table 1: Soil properties at 'Brooksdale'.

Depth (cm)	0–10	10–30	10–30	60–90	90–120
Ammonium Nitrogen mg/kg	8	2	3	2	4
Nitrate Nitrogen mg/kg	<1	< 1	1	2	< 1
Colour	GR				
Gravel %	0				
Texture	3.5				
Phosphorus Colwell mg/kg	26				
Potassium Colwell mg/kg	494				
Sulfur mg/kg	8.6				
Organic Carbon %	1.41				
Conductivity dS/m	0.213				
pH Level ($CaCl^2$) pH	7.9				
pH Level (H^2O) pH	8.9				

Table 2: Rainfall received in-crop at 'Brooksdale'.

	Rain (mm)
May	18
June	19.4
July	34.2
August	7.8
September	14
October	2
Total	95.4

Results

The approximate starting plant available water content (PAWC) was estimated to be 300 mm using the gravimetric moisture content (Figure 1) and bulk density from CSIRO's SoilMapp. This would suggest a full profile of moisture and adequate for a wheat crop.

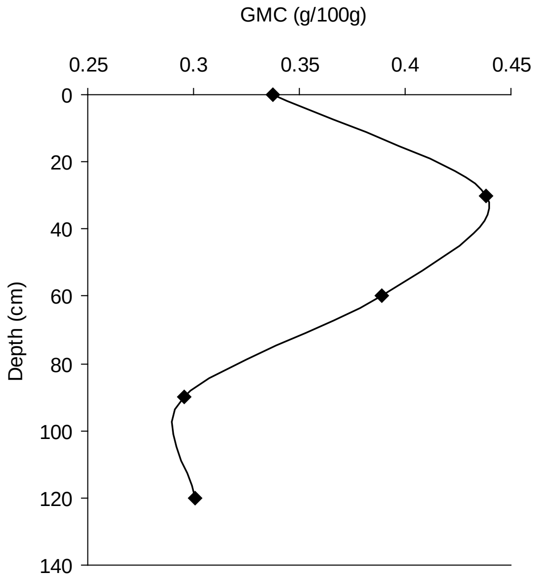

Figure 1: *Gravimetric moisture content to 120 cm at 'Brooksdale' (mS/m)*

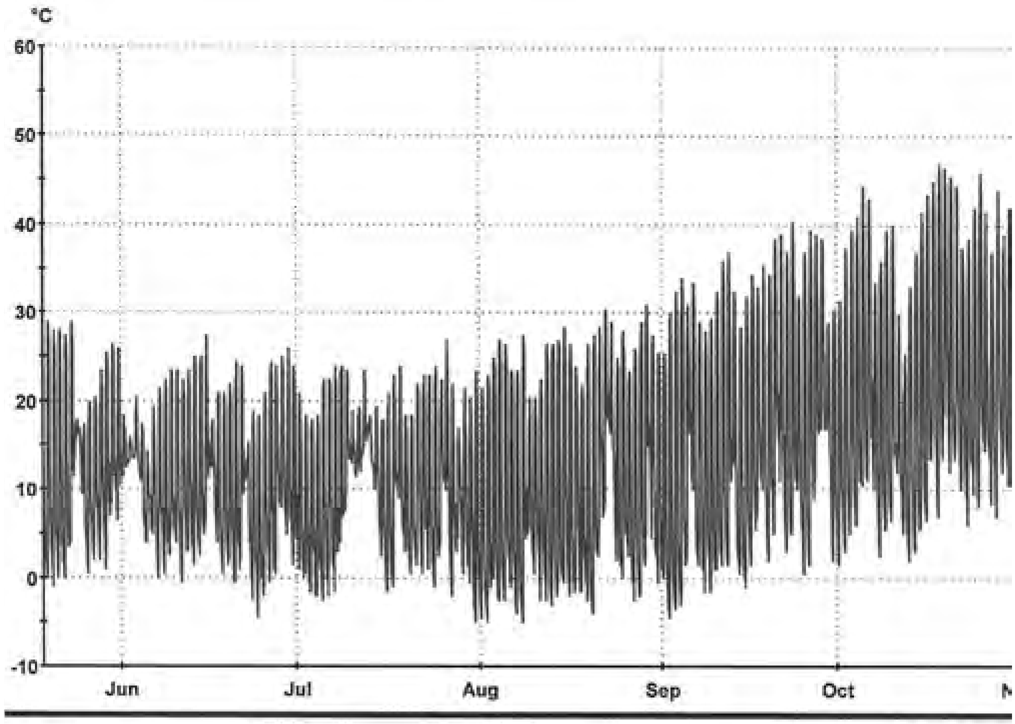

Figure 2: *EM(vertical) survey of VSAP Broadacre Trial at 'Brooksdale'.*

Figure 3: *NDVI of VSAP Broadacre Trial at 'Brooksdale' on 20th August 2012*

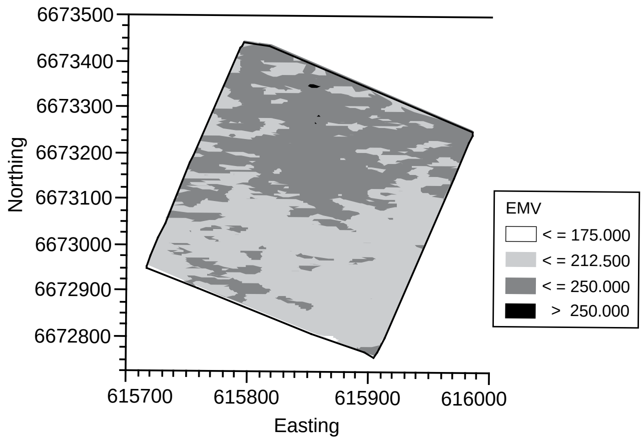

Figure 4: *Temperature logged at 'Brooksdale' from May to November 2012.*

The majority of rainfall fell in the first three months of the crops growth (71.6 mm).
In the last three months the crop only received 23.8 mm. The side dressing of the wheat with Urea on the 3rd August and then no significant follow-up rain may explain the low protein in EGA Gregory.

There were a total of 40 days where the temperature was below zero (Figure 2).
The coldest temperature recorded was –5°C and was experienced regularly throughout June, July, and August (Figure 2). A temperature of –4.5°C was also recorded in early September (Figure 2) and the last frost was on the 10th September. There was evidence of frost damage in LongReach Crusaderⓓ and this significantly reduced the yield, producing only 1.9 t/ha. LongReach Crusaderⓓ was sown mid May and anthesis was 11th September when temperatures were still reaching 4.5°C. As this variety is quick maturing a late May to June sowing is recommended.

The NDVI image taken on the 20th August highlighted uniform growth at the southern half of the trial, however there were high readings at the northern half as shown in Figure 3. On closer inspection of the areas of higher NDVI readings, the wheat was very lush and green. A comparison with the EM38 (in vertical mode) survey (Figure 2), confirmed higher conductivity at the northern end of the trial indicating.

The elevation of the trial site corresponds with the $EM38_V$ data, ie the northern end of the trial is higher than the southern end, and although the north end was inundated in the 2012 February floods it drained earlier and therefore the loss of N was possibly not as great, hence better crop growth. Further, the previous crop in 2011 was poorly established in the northern end due to a dryer seedbed as a result of flooding partially covering the north end of the trial site from the 2010/11 floods. The NDVI and EM38 readings are a clear indication of high variability that can exist in a single paddock. It good to know the past history of the paddock as this can help when applying fertiliser. Higher rates of fertiliser would need to be applied in the southern end of the paddock in this trial as the northern end did not seem to be as deficient. It would be suggested that soil samples be analysed from both parts of the paddock to address the deficiencies more accurately.

Yield

The higher (P<0.001) yielding variety was EGA Gregoryⓓ at 3.6 t/ha. LongReach Spitfireⓓ (2.5 t/ha), Suntopⓓ (2.8 t/ha), Suncoⓓ (2.8 t/ha) and Sunguardⓓ (3 t/ha) yields were not significantly different. LongReach Crusaderⓓ was the lowest (P<0.001) yielding variety at 1.9 t/ha. The yields and LSD are shown in Figure 5.

Protein

The highest (P<0.001) protein was produced by LongReach Crusaderⓓ (12.4%), while the lowest (P<0.001) protein was EGA Gregoryⓓ (8.8%). Suntopⓓ (9.6%), Suncoⓓ (9.5%) and Sunguardⓓ (9.6%) all had similar proteins. LongReach Spitfireⓓ had the second highest protein at 11.3%.

Discussion

The highest yield and lowest protein was achieved by EGA Gregory⊕. The lowest yield and highest protein was achieved by LongReach Crusader⊕. The other varieties were significantly different (P<0.001) to these varieties and were on average between these two varieties.

The newest variety in the trial (Figure 6) was commercially released in 2012 as Suntop⊕; previously known as SUN595B. Suntop⊕ is a main season wheat with a similar maturity to Janz and quicker than EGA Gregory⊕, however slower than Livingston⊕. It has an APH quality classification. The protein achieved in the Broadacre trial was only 9.6% and the yield was less than EGA Gregory⊕ at 2.8 t/ha.

Considering the constraints of the soil, lack of rainfall and severe climate the variety most notable is EGA Gregory⊕ for yield. Under the adverse conditions of low nitrate-N and low rainfall in August, September and October, EGA Gregory's⊕ high yield was surprising compared to other varieties. If significant rainfall had followed the 3rd August side dressing of Urea (46 units N/ha) it would have been an interesting result in regard to yield and protein for all the varieties and how EGA Gregory⊕ would respond. The mid may (16th May) planting was ideal for EGA Gregory⊕ and anthesis was 19 September missing the early September frosts that LongReach Crusader⊕ experienced.

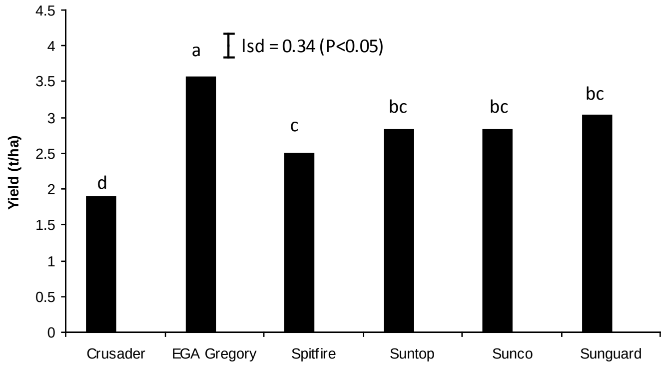

Figure 5: *Grain yield of the six varieties at 'Brooksdale' Walgett. LSD bar indicates significant differences between treatments (P=0.05). Means with different letters are significantly different (p<0.05)*

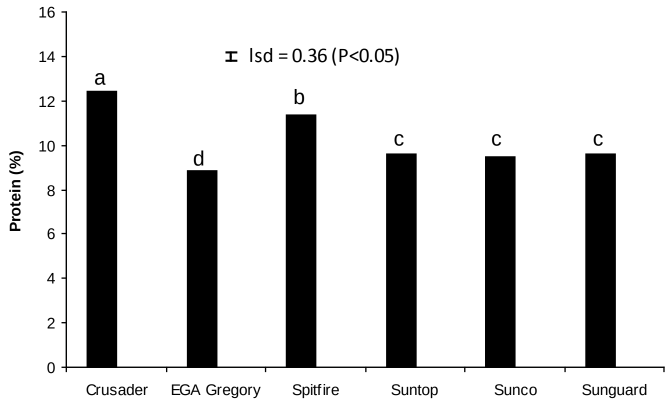

Figure 6: *Grain protein of the six varieties at 'Brooksdale' Walgett. LSD bar indicates significant differences between treatments (P=0.05). Means with different letters are significantly different (p<0.05)*

LongReach Spitfire⊕ was the second highest achiever of protein (11.3%), however it was also the second lowest yield (2.5 t/ha). LongReach Spitfire⊕ and LongReach Crusader⊕ have recommended planting commencing the 4th week in May for the northwest plains (Winter crop variety sowing guide 2012). Both varieties are short season and the anthesis of LongReach Spitfire⊕ in this trial was 12 September. The below zero temperatures experienced in early September could have impacted on LongReach Spitfire⊕ yield due to the 16th May planting.

The other three varieties Suntop⊕, Sunco⊕ and Sunguard⊕ have suggested planting from the second week in May and all yielded very similarly and produced almost identical protein.

Considering the protein results of all the varieties, none of them reached 13% and made APH grade. LongReach Crusader⊕ was the only variety that reached a H2 grade and at present market value at writing was $317/t. With a yield of 1.9 t/ha it had a potential return of $602/ha. EGA Gregory⊕ at 8.8% protein would be at FED1 grade and presently at writing was $270/t. With a yield of 3.6 t/ha it had a potential return of $972/ha. These prices for feed grade do not normally occur. Using these very rough calculations and not taking into account cost of production, EGA Gregory⊕ was the best variety to plant for the 2012 winter season. However, this would vary from season to season depending on prices and whether you are targeting yield or protein.

Planting LongReach Crusader⊕ and LongReach Spitfire⊕ in the 3rd Week of May is only a week earlier than the recommended planting window of the 4th week in May as suggested in the winter crop variety sowing guide 2012 (published by NSW DPI). Frost damage was evident in LongReach Crusader⊕, which may have been avoided by planting a week later. It does suggest though that for the Walgett district it may need to even be planted first week in June. LongReach Spitfire⊕ also may or may not have been less affected by planting a week later. However, a later planting date may have produced a different result.

Knowing your variety and having a target for yield or protein will ensure better decisions are made that will hopefully result in a higher return. It is important to have soil tests done and check the nutrient status so that deficiencies can be addressed if the season looks promising, providing the chosen variety with every possible chance of meeting yield and protein targets.

Summary

- Know your paddock history, as this will help address nutritional issues.
- EGA Gregory⁽ᴰ⁾ yielded the highest (3.6 t/ha), while also having the lowest protein (8.8%) of all varieties
- In contrast, LongReach Crusader⁽ᴰ⁾ had the highest protein (12.4%) and lowest yields (1.9 t/ha) of all varieties, which may have been influenced by planting time.

Acknowledgements

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Life Cycle Assessment of greenhouse gas emissions during wheat production: initial studies

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Introduction

Wheat production inevitably generates greenhouse gas (GHG) emissions. The relative contribution of each emission and total emissions from wheat production can be determined using Life Cycle Assessment (LCA). LCA is an internationally agreed approach that is used to assess environmental impacts from production systems, using methodology described by International Standards ISO14040 series.

NSW DPI has chosen to conduct LCA calculations using SimaPro (Pré International), an internationally recognised and validated modelling tool. Specific data used in the calculation of emissions from wheat production, such as yields, fertiliser rates and machinery types are mainly obtained from Australian commercial and research sources. Other data are embedded in inventory databases used by SimaPro to provide environmental outputs from each of the activities in a process flow, such as carbon dioxide emissions from diesel combustion by farm machinery. These data are modified to be specific to the study in question. Emission factors are applied from Australian field research, such as into nitrous oxide emissions from N fertiliser applied in particular regions.

GHG emissions, determined as CO_2-equivalents (CO_2-e), which arise from all fossil fuel inputs used to grow a crop of wheat, are considered to be major contributors to the warming of the global atmosphere and lead to climate variability and change. Energy from fossil fuels used to manufacture fertiliser, fuel, chemicals and machinery contributes to crop emissions during the 'pre-farm' stage of a 'cradle-to-farm-gate' LCA for a tonne of grain, in addition to transport of these inputs from manufacturer to farm.

Fuel use by field machinery during crop production adds to overall emissions of GHGs during the 'on-farm' stage. Burning and rotting of crop residues contribute methane and carbon dioxide. Nitrogen fertiliser may also release nitrous oxide, which can be calculated as CO_2-e for inclusion in total emissions. Nitrous oxide and methane have 298 and 25 times more global warming potential than CO_2 per molecule, respectively.

Expected outcomes of modelling GHG emissions during LCAs for cropping operations in northern NSW are that the grains industry will be able to:

- demonstrate environmental stewardship
- identify practice change to reduce GHG emission in cropping operations
- translate nitrous oxide emissions and carbon sequestration data into accurate information for carbon footprint labelling
- understand the influence of carbon price and input costs on emissions.

There are a number of studies currently examining the emissions from various crop, livestock and forestry production systems in NSW. A recent study of wheat production in Central NSW showed greenhouse gas emissions were 200 kg CO_2-e per tonne of wheat based on a grain yield of 3.5 t/ha. The main sources of emissions were pre-farm production and transport of fertilisers (30%) and from the nitrous oxide (26%) emitted directly on-farm from the N fertiliser applied to the crop.

The following information is from a preliminary LCA for a new project that is focussed on GHG emissions from wheat in various cropping systems in northern and southern NSW. The example is for a no-till, short fallow wheat crop grown west of the Newell Highway in north-west NSW.

Key findings

Life Cycle Assessment (LCA) of no-till wheat production after short fallow in the North West NSW region using averaged district data has demonstrated that major sources of greenhouse gas (GHG) emissions are the manufacture and use of Urea fertiliser.

There is a need to extend LCA to examine the effects of replacing N fertiliser with legumes in cropping systems and provide other economically viable options to reduce GHG emissions.

Crop production details

Dryland wheat under no-till with short fallow

District:	**Moree-Walgett**
Source:	**NSW DPI Farm Enterprise Budget Series – North West NSW, Winter 2012**
Yield base:	**1.7 t/ha after prior wheat crop**

LCA data and inventories

The LCA is based on data from regional-level production collected annually over many years by NSW DPI and from recent field trials measuring nitrous oxide emissions during a range of crop sequences at Tamworth.

The quantities of chemicals and fertiliser applied were taken from the calendar in NSW DPI Farm Enterprise Budget Series – North West NSW, Winter 2012 (Table 1). Machinery options were selected from this budget as described below.

The emission outputs from each input were calculated mostly from the Australasian Life Cycle Inventory v3 database to which SimaPro is linked. Some chemical inputs were considered to be imported from global markets but their emissions are not yet available in the Australasian inventory. In these cases accredited European inventories were used for such inputs.

Data sources for transport of inputs to farm and farm machinery

Trucks used to transport the fertiliser, chemicals and fuel were selected to represent average cartage from city to farm. Most of the journey from point of manufacture or import into Australia (Brisbane or Sydney) to a regional centre (Walgett) is assumed to occur by articulated truck of >20 t and by smaller rigid trucks from the regional centre to farm. Fuel usage by these trucks and emissions from the energy used in their manufacture contributes to pre-farm emissions.

Fuel consumption by a tractor with implements was estimated from 'Guide to Tractor and Implement Costs' for a tractor with 180 kW PTO/217 kW engine (NSW Trade & Investment). Harvesting was based on use of a Class 8 combine harvester with data from Kondinin publications. Farm machinery data were used to also calculate contributions to emissions as pre-farm 'embodied energy' used for production of all machinery, based on a 10 year life.

Chemicals used for production

- Fertilisers: Urea (40 kg N/ha) at sowing as indicated in Table 1.
- Herbicides: Glyphosate, 2,4-D amine and triclopyr with surfactant were used for general and broadleaf weed control. Fenoxaprop-p-ethyl was included as a 1 in 4 year option for wild oats.
- Fungicides: Tebuconazole was used in the short fallow program. This may not be required in all years.

Table 1: *Calendar of on-farm operations*

Time	Farm operation
Nov Yr 1	Previous wheat crop harvest
Dec Yr 1	Weed control – herbicide spray
Jan Yr 2	Weed control – herbicide spray
Feb Yr 2	Weed control – herbicide spray (twice)
Apr Yr 2	Weed control – herbicide spray
May Yr 2	Sowing: Seed (45 kg/ha) with Urea (87 kg/ha to supply 40kg/ha of N).
Jun Yr 2	Wild oat control (1 in 4 years)
Jul Yr 2	Broadleaf weed control and foliar fungicide application
Nov Yr 2	Harvest

Results

- Emissions from the production of 1 tonne of wheat grown in this short fallow system were 193.3 kg CO_2-e, of which 88.9 kg CO_2-e, or 46% of emissions were from on-farm use of Urea and direct soil emissions of carbon dioxide and nitrous oxide (N_2O direct) (Table 2). Emissions from the pre-farm production of Urea added 33.8 kg CO_2-e or 17.5% of the emissions profile per tonne of wheat.
- Diesel combustion from spraying operations and production of pesticides contributed a further 32.2 kg CO_2-e or 16.7% of total emissions.
- Minor emissions occurred from transport of fertiliser, diesel and other chemicals, embodied energy in machinery, seed used for sowing the crop and other on-farm operations. Low levels of indirect nitrous oxide emissions occur from ammonia volatilisation from soil and redeposition.

Table 2: *GHG emissions pre- and on-farm operations during wheat production*

Inputs for production of 1.7 tonne wheat /ha	kg CO_2-e emitted per tonne
Manufacture of herbicides	16.9
Manufacture of fungicide	0.5
Manufacture of Urea	33.8
Production of seed for sowing	6.1
Transport of fertiliser and inputs other than diesel	3.6
Production and transport of diesel	0.47
Embodied energy	6.8
'Pre-farm' subtotal per tonne	68.2
'Pre-farm' per ha @1.7t/ha	115.9
Diesel combustion (spraying)	14.8
Diesel combustion (sowing)	6.8
Diesel combustion (harvesting)	3.4
N_2O direct	51.1
N_2O indirect	11.1
CO_2 emissions from use of Urea	37.8
'On-farm' subtotal per tonne	125.1
'On-farm' sub total per ha	212.7
Total emissions per tonne	193.3
Total emissions per ha	328.7

Discussion

- Total emissions of 193 kg CO_2-e per tonne of wheat in North West NSW were similar to those calculated for wheat in Central NSW at 200 kg CO_2-e per tonne.
- Manufacture and use of N fertiliser contributed approximately the same GHG emissions per tonne of wheat in both regions. Urea and MAP combined (65.7 kg total fertiliser or 21.2 kg N per tonne wheat) emitted a total of 125.1 kg CO_2-e per tonne of wheat (manufacture, N_2O direct and CO_2) in Central NSW, compared with 122.7 kg CO_2-e emitted from 23.5 kg N in 51 kg Urea per tonne of wheat in North West NSW. The yield in Central NSW was assumed to be 3.5 t/ha.
- Replacement of N fertiliser applications with leguminous crops in rotation systems is an option to reduce emissions. Research trials currently being undertaken at Tamworth will provide data for further LCA studies to examine how N_2-fixing chickpeas and other pulses may reduce emissions.
- Diesel combustion during spraying is expected to be larger than other operations because it is repeated several times during a season. The single sowing operation produces more emissions than harvesting or a single spraying run (2 kg CO_2-e per run). Ongoing improvements in machinery efficiencies may contribute to some future reduction in emissions. Other LCA studies into varying tractor and implement combinations may also show reductions in diesel use.
- Further LCA studies on farming system combinations of wheat with canola, sorghum and chickpeas across NSW over the next 2 years will incorporate data from grower about their practices and from other commercial sources, as well as research trials. These data will supplement the general averaged sources being currently used for LCA conducted by NSW Department of Primary Industries. Additionally, economic analysis of the farming systems within the LCAs will indicate potential changes to profitability.

Summary

- Life Cycle Assessment of no-till wheat production after short fallow in North West NSW using averaged district data has demonstrated that major sources of emissions are the manufacture and use of Urea fertiliser.
- LCA can be used to study cropping systems with a view to identifying major opportunities for reducing GHG emissions and linking them to economic outcomes.
- There are opportunities to advise on alternative farm operation efficiencies to reduce on-farm emissions, such as use of legumes to replace N fertiliser.

Acknowledgements

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Breeding durum wheat for crown rot tolerance

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Introduction

Crown rot (CR) is the most important disease of durum wheat and is a significant factor limiting expansion of the durum industry. With the wide adoption of minimum tillage based production systems, CR disease pressure is expected to increase in future and hence it is important to develop genetic resistance and tolerance to the disease. This study describes our initial examination of genetic variation for CR resistance and tolerance, and, development of a breeding approach based on these results.

Treatments

A set of durum lines containing released varieties and advanced breeding lines, with the inclusion of bread wheat check varieties, was evaluated for CR tolerance in a yield trial at Tamworth Agricultural Institute in the 2010 season containing inoculated (2g inoculum/m row) and uninoculated treatments as described by Dodman and Wildermuth (1). Disease severity was visually assessed at harvest on 25 random plants from each plot as the extent of basal browning.

The same set of lines was also put through a glasshouse CR pot test (2) at Cobbitty to obtain additional CR resistance data (based on a 0–4 scale incorporating basal browning and whiteheads/deadheads).

Results and discussion

All entries, including 2-49, showed reduced yield in inoculated plots relative to the untreated checks (Figure 1). This is despite the 2010 season not being overly conducive to the expression of CR as whiteheads. Yield loss due to CR was highest in EGA Bellaroi$^{\phi}$ and lowest in BO4-17. Lines 241000, 241046 (both NSWDPI) and Hyperno$^{\phi}$ (released SA variety) also showed low levels of relative yield loss from CR infection. Caparoi$^{\phi}$ showed significantly better tolerance to CR relative to EGA Bellaroi and this is consistent with the observation that Caparoi$^{\phi}$ performs well under both dry and wet conditions. Five lines including 241046 (NSWDPI), BO4-17 (CIMMYT) and three from University of Adelaide node of ADWIP (WID052, Yawa$^{\phi}$ and WID091) produced good yields under the inoculated treatment (Table 1).

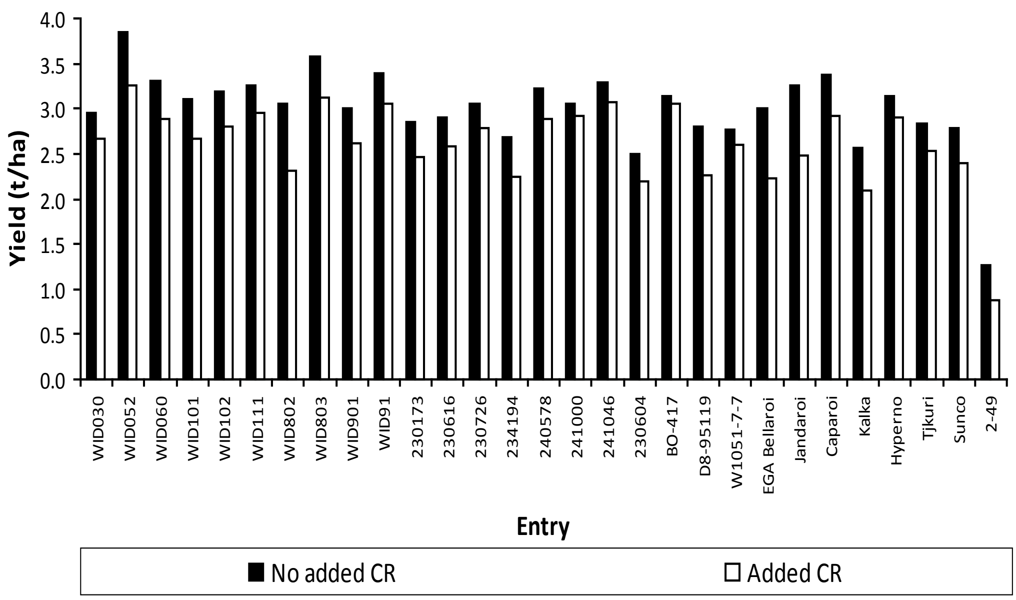

Figure 1: *Performance of durum lines in presence of CR relative to uninoculated plots in 2010 in Tamworth.*

Key findings

There was significant variation in the level of crown rot (CR) tolerance in durum wheat assessed under low levels of yield loss in the field in 2010

Durum entries also varied in their levels of CR resistance assessed using a glasshouse pot test.

Lines such as BO4-17, Hyperno$^{\phi}$ and 241046, which had good yield in presence of CR inoculum combined with low yield loss from infection, appear useful for developing new CR tolerant varieties.

Correlation between CR severity data from the field and glasshouse tests was low (0.26). However, both tests detected significant variation among durum lines.

On the basis of these results we conclude there is useful genetic variation for CR tolerance in durum wheat which can be characterised using resistance and tolerance criteria.

Table 1: *CR tolerance and resistance data for selected durum lines.*

Lines	Yield (added CR – t/ha)	Yield loss (%)	Field CR severity (%)	Pot test CR severity
WID052	3.25	15.5	39.6	3.9
Yawa⊕	3.12	12.9	39.2	3.7
BO4-17	3.06	2.8	44.7	3.2
WID091	3.05	10.1	40.8	2.8
241046	3.00	9.0	37.7	4.0
Caparoi⊕	2.91	13.6	42.7	3.8
EGA Bellaroi⊕	2.23	25.4	45.5	3.6

Breeding approach

We are working to characterise the material generated by GRDC-funded durum CR pre-breeding project (NSWDPI/USQ) for CR resistance and agronomic traits. Best selections from this material and other durum germplasm that have shown CR tolerance in our work will be crossed to advanced durum lines to incorporate the trait into high yielding and high grain quality backgrounds. In early stages (up to S1), evaluation would be based on performance in disease nursery, marker information and/or glasshouse tests. For lines in intermediate stages (S2/S3), evaluation will be in CR prone trial sites and disease nursery. Advanced (S4) lines will be assessed in inoculated trials to provide CR tolerance data.

Summary

Durum wheat is generally susceptible to CR as shown by many studies but a detailed examination of the response of durum germplasm to the disease in glasshouse and field experiments has revealed significant variation between varieties for yield loss due to CR under field conditions as well as disease severity in glasshouse pots. We hope to make crosses between the CR tolerant lines from this work and high grain quality genotypes to develop commercially useful CR tolerant varieties.

Acknowledgements

This work was partially funded by the Grains Research and Development Corporation.

References

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2. Raju, T.N. and Turner, M. A. (2008) A brief note on crown rot pot test developed at Plant Breeding Institute, University of Sydney. In "Collated screening methodologies", *Proceedings of GRDC Crown Rot Screening Workshop*, 15–16 October, 2008. The University of Sydney, Australia.

Resistance of eleven barley varieties to the root lesion nematode *Pratylenchus thornei* – Trangie 2011

Rohan Brill NSW DPI, Coonamble and **Steven Simpfendorfer** NSW DPI, Tamworth

Introduction

The root lesion nematode (RLN) *Pratylenchus thornei* (*Pt*) is widespread in cropping soils through central and northern NSW including much of the farmed grey clay soils on Trangie Agricultural Research Centre (TARC). This nematode can cause significant yield loss in certain susceptible crops, especially wheat and chickpeas. Barley varieties generally tend to have moderate levels of ***tolerance*** to *Pt* which allows them to maintain relatively high yield in the presence of this nematode species. However, barley varieties can also vary in their levels of ***resistance*** to *Pt* which is related to the extent which they build-up *Pt* populations in the soil, which dictates their 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 then has the potential to increase the negative impact of *Pt* on yield of subsequent crops.

A barley variety sowing time experiment was conducted at TARC in 2011 (yield results reported in Autumn 2012 Northern Grains Region Trial Results). The harvested plots were left intact and soil cores were taken in March 2012 to assess the effect of barley variety choice on the build-up of *Pt* in the soil under the 2011 crop. This type of testing determines the ***resistance*** of barley varieties to *Pt*.

Key findings

Barley variety choice can have a moderate impact on the build-up of the RLN, *Pratylenchus thornei* in the soil.

Pratylenchus thornei populations were approximately double in the most susceptible variety Gairdner⍉ compared to the most resistant varieties Urambie⍉ and Oxford⍉.

Sowing time did not have a significant effect on the build-up of *Pt* populations in barley.

Site details

Location:	**Trangie Agricultural Research Centre**
Previous crop:	**Faba beans**
RLN (*P. thornei*):	**10,200 *Pt*/kg soil (0–30 cm)**
Soil type:	**Grey vertosol**

Treatments in 2011

Three sowing times of:

1. 6th May
2. 18th May
3. 9th June

Eleven varieties, ranging in maturity from the long season, dual purpose winter type Urambie⍉ to the quick variety Grout⍉.

Nematode testing

Ten small soil cores were taken from the 0–30cm zone from each harvested plot of the second sowing time (18th May 2011) in March 2012. Three varieties (Commander⍉, Buloke⍉, and Hindmarsh⍉) were also sampled across the three sowing times. The cores from each plot were bulked and sent to the South Australian Research and Development Institute (SARDI) for PreDictaB analysis of *Pt* numbers within each soil sample based on this sensitive and selective DNA test.

Results

The barley varieties differed in their levels of resistance to *Pt* (Figure 1). Six varieties reduced the *Pt* population to below the starting level of 10,200 *Pt*/kg soil.

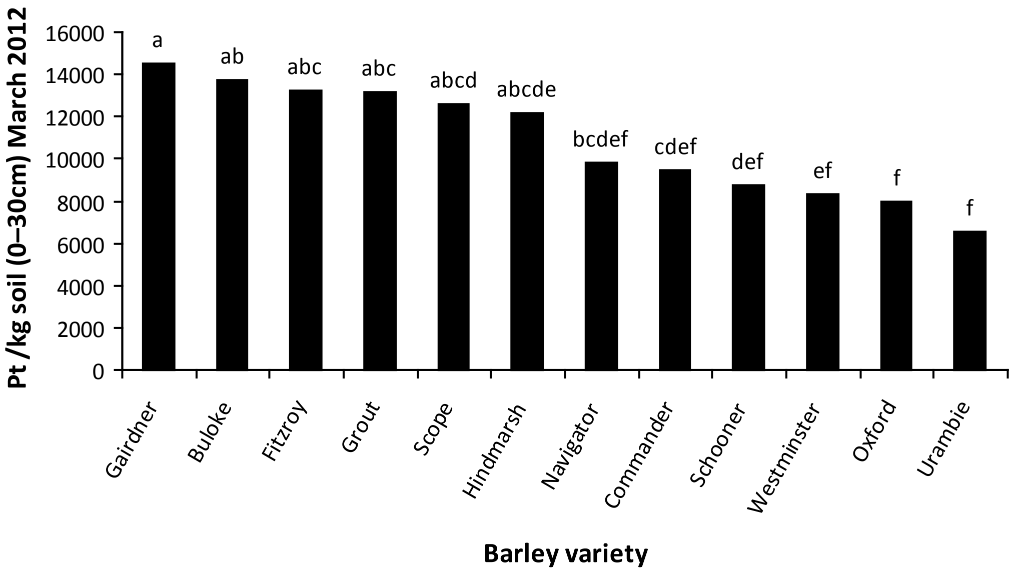


Figure 1: *Resistance of 11 barley varieties to* Pratylenchus thornei *– Trangie 2011*
Starting Pt *population at sowing 2011 of 10,200 Pt/kg soil (0–30cm). Bars followed by the same letter are not significant at the 95% confidence level.*

At the more susceptible end of the resistance ratings, the barley varieties only resulted in a modest build-up in *Pt* populations (max. 14,500 *Pt*/kg soil with Gairdner$^{\phi}$) over the starting population (Figure 1).

Sowing time did not have a significant effect on the build-up of *Pt* populations under the various barley varieties over the 2011 growing season.

Conclusions

Barley variety choice had a moderate effect on the build-up of *Pt* soil populations over the 2011 season. In 2012, remaining *Pt* populations were approximately double after the most susceptible variety Gairdner$^{\phi}$ compared to the most resistant varieties Urambie$^{\phi}$ and Oxford$^{\phi}$. However, even though the most resistant varieties reduced the actual levels of *Pt* compared to what was present at sowing in 2011, the populations were still above the threshold (2,000 *Pt*/kg soil) for yield loss in intolerant varieties at sowing in 2012.

This trial was conducted in the same paddock as the wheat variety sowing time experiment. Although not statistically comparable the barley varieties appear to have similar levels of resistance to *Pt* as the majority of the wheat varieties, with the exception of Lincoln$^{\phi}$ and Axe$^{\phi}$ which appear very susceptible.

Barley is an option for growers in situations where *Pt* is a concern as all varieties generally have moderate levels of tolerance to *Pt* which maximises yield in the presence of this nematode. However in these situations it would be recommended to choose a relatively resistant variety to. Several barley varieties do appear to have a moderate level of resistance to *Pt* which will also limit the build-up of populations within the soil. However, variety choice can still influence the build-up of *Pt* populations in the soil as significant differences (although smaller than seen in wheat) still exist in the resistance of barley varieties to *Pt*.

Acknowledgements

This project was funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169) and Northern Integrated Disease Management Project (DAN00143). Thanks to Trangie staff Jayne Jenkins and Rob Pither along with Tamworth staff Finn Fensbo, Rod Bambach and Zeb Taylor for technical support.

Effect of row spacing and plant population on soil water use and the impact of crown rot – Walgett 2012

Matthew Gardner, Steven Simpfendorfer and Jim Perfrement NSW DPI, Tamworth

Introduction

Crown rot caused by the fungus *Fusarium pseudograminearum* (*Fp*) is a major constraint to winter cereal production in the northern grains region. Yield loss is related to moisture stress post-flowering. Moisture stress is believed to trigger the crown rot fungus to proliferate in the base of infected tillers, restricting water movement from the roots through the stems, and producing whiteheads that contain either no grain or lightweight shrivelled grain.

This trial aimed to determine the effect of row spacing and plant population on the impact of crown rot in durum, bread wheat and barley. It was hypothesised that wider row spacing's and/or a lower plant population may provide the capacity to conserve moisture for use later in the season. This has the potential to reduce moisture stress during grain-fill therefore potentially decreasing the negative impacts of crown rot on yield and quality.

Key findings

In this trial using wider row spacing's (500 mm) actually increased soil water use in the 0–60 cm depth interval and therefore did not reduce the extent of yield loss from crown rot.

There was no difference between the 300 and 400 mm row spacing's in terms of water use and grain yield for Commander⁽ᴾ⁾ and LongReach Spitfire⁽ᴾ⁾.

The 160 plants/m^2 plant population used significantly more water over the season compared to the 80 plants/m^2 to a depth of 120 cm but this did not impact on final grain yield.

Infection with crown rot significantly reduced soil water use during the last 3 weeks of grain-fill.

Site details

Location:	**"Wattle Plains", Walgett**
Co-operator:	**Dave and Fiona Denyer**
P. thornei:	**1,700 Pt/kg soil (0–30 cm)**
Soil type:	**Grey vertosol**
Fertiliser:	**60 kg/ha Granulock Supreme Z + 70 kg/ha granular Urea at sowing**
Soil moisture:	**~240 mm PAWC to 1.5 m**

Treatments

- Sowing date: 28th May
- Caparoi⁽ᴾ⁾ durum, LongReach Spitfire⁽ᴾ⁾ bread wheat and Commander⁽ᴾ⁾ barley
- Three row spacing's: 300, 400 and 500 mm
- Two target plant populations: 80 or 160 plant/m^2
- Plus or minus added crown rot at sowing using sterilised durum grain colonised by five isolates of *Fp*
- Neutron probe access tubes installed in each plot to 1.8 m. Soil moisture measured ~every 21 days from GS31 to maturity in 0–30, 30–60, 60–90, 90–120, 120–150 and 150–180 cm depth intervals
- Two outside rows of each plot were removed just before harvest to reduce edge effects on yield

Results

Commander⊕ had the highest yield whereas Caparoi⊕ had the lowest yield across all row spacing's. Caparoi⊕ was the only variety that experienced a significant yield reduction shifting from 300 to 400 mm row spacing, while all varieties had a yield reduction between the 400 mm and 500 mm row spacing (Figure 1a). The presence of crown rot did not cause a yield reduction in Commander⊕ or LongReach Spitfire⊕ at any of the row spacing's (data not shown). In contrast, yield loss associated with crown rot infection in Caparoi⊕ was 15, 22 and 23% at the 300, 400 and 500 mm row spacing's, respectively (Figure 1b).

Row spacing had a significant impact on plant available water content (PAWC) in the surface 60 cm over the season, with 500 mm having lower PAWC compared to the other two row spacing's (Figure 2a). On average the 500 mm row spacing used an additional 14 mm of soil water between stem elongation and maturity. Below 60 cm there was no difference in PAWC between the different row spacing's. There was also a significant affect of plant population with the 160 plants/m^2 using significantly more water over the season compared to the 80 plants/m^2 to a depth of 120 cm (Figure 2b), despite there being no significant difference in final grain yield.

LongReach Spitfire⊕ left significantly more soil water in the profile compared to both Caparoi⊕ and Commander⊕ at crop maturity, particularly in the surface 90 cm. Commander⊕ dried the soil profile to the greatest degree but was similar to Caparoi⊕ in the surface 90 cm. Caparoi⊕ and LongReach Spitfire⊕ used similar quantities of water from the 90 to 150 cm depth intervals (Figure 3a). The WUE of Caparoi⊕, Commander⊕ and LongReach Spitfire⊕ equated to 14.2, 21.4 and 17.9 kg grain/mm

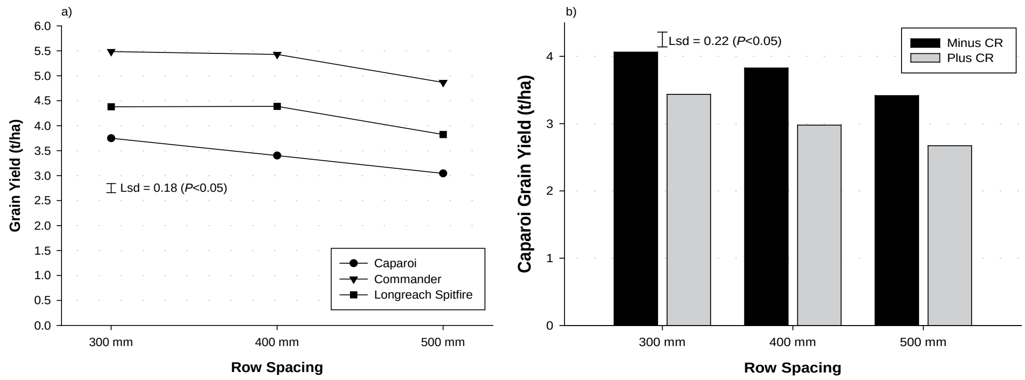


Figure 1: *(a) The effect of 300, 400 and 500 mm row spacing's on the grain yield of Caparoi⊕, Commander⊕ and LongReach Spitfire⊕ and(b) the impact of plus or minus crown rot on the yield of Caparoi⊕ at 300, 400 and 500 mm row spacing's at Walgett in 2012.*

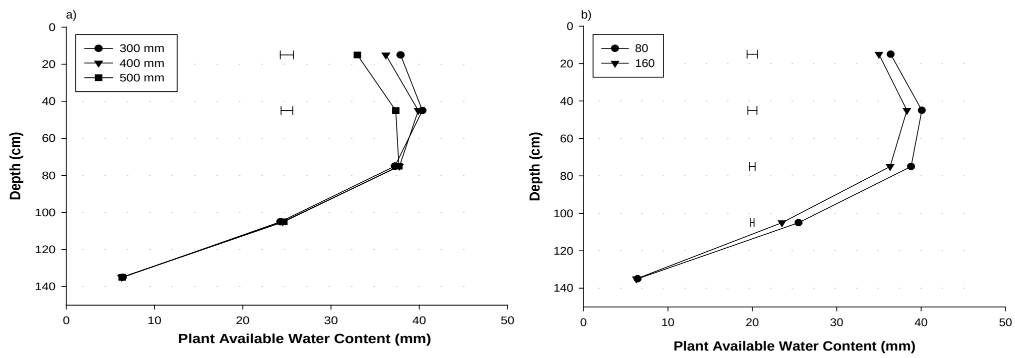


Figure 2: *The effect of 300, 400 and 500 mm row spacing's (a) and plant populations of 80 and 160 plants/m^2 (b) on plant available water content (PAWC) from stem elongation to maturity at Walgett in 2012. Bars represent Lsd (P=0.05).*

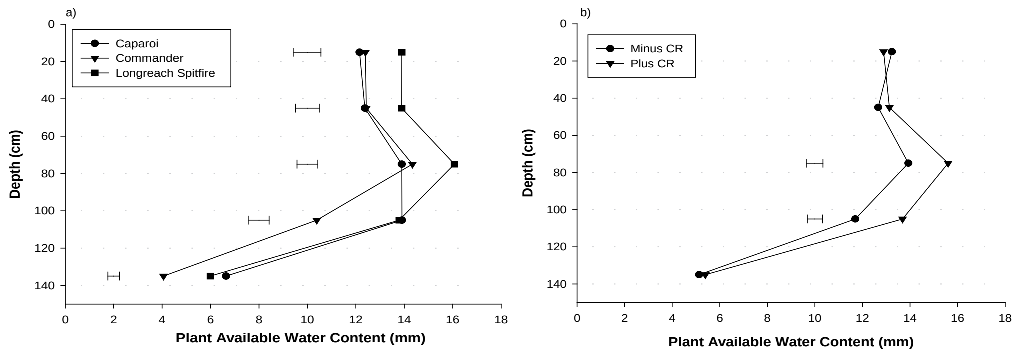


Figure 3: *The effect of variety (a) and the presence of crown rot (b) on plant available water content (PAWC) at physical maturity of the crop on the 27 October at Walgett in 2012. Bars represent Lsd (P=0.05).*

water, respectively. The final measurement of soil water at crop maturity was the only sampling time where crown rot had a significant impact on PAWC. Less water was used between the 60 and 120 cm depth interval where plots were inoculated with crown rot (Figure 3b).

Conclusions

It was hypothesised that increasing row spacing would conserve moisture in the profile for late in the season, which would reduce the yield loss from crown rot. However, the results suggest the opposite, with the 500 mm row spacing consistently having less PAWC in the surface 60 cm throughout the season. Yield loss to crown rot at the 500 mm row spacing was 12% worse than the 300 mm row spacing. It is not fully understood why there was greater water use for the 500 mm row spacing, but potentially there were greater evaporation losses as crop row closure was never achieved, particularly with Caparoi⑪ and LongReach Spitfire⑪. This requires further investigation.

Interestingly, there was no yield penalty for shifting from a 300 to 400 mm row spacing in barley (Commander⑪) or the bread wheat (LongReach Spitfire⑪), consistent with previous research in this environment. However, increasing yield loss was associated with each widening of the row spacing in the durum wheat (Caparoi⑪). The agronomy of durum production has not been extensively evaluated in such a western environment due to limited commercial production in the region primarily based around concerns over the high susceptibility of this crop to crown rot. However, this research indicates that agronomy in this environment could potentially be different to that normally used for bread wheat and barley production. Further research into adapting durum production in this environment appears warranted.

Surprisingly crown rot significantly reduced soil water use during the three weeks prior to maturity in the 60–120 cm depth interval, which supports that the crown rot fungus proliferates in the base of infected tillers, restricting water movement from the roots through the stems at the onset of moisture stress. This again highlights that if the starting soil water was lower than at sowing in 2012, then the moisture stress would have been initiated well before the final three weeks of crop development with greater negative impacts from crown rot infection on yield likely. Furthermore, it will be important to determine the impact of this lower water use and disease interactions on grain quality.

Acknowledgements

The authors would like to thank Dave & Fiona Denyer, "Wattle Plains", Walgett for providing the trial site. Technical assistance provided by Rod Bambach, Jan Hosking, Patrick Mortell, Stephen Morphett and Ben Frazer are gratefully acknowledged. This research was co-funded by NSW DPI and GRDC under projects DAN00169 and DAN00143.

Resistance of barley, durum and bread wheat varieties to the root lesion nematode *Pratylenchus thornei* – Coonamble 2011

Steven Simpfendorfer and Matthew Gardner NSW DPI, Tamworth **Rohan Brill** NSW DPI, Coonamble

Key findings

Winter crop type and variety choice has a large effect on the build-up of nematode populations in the soil due to differences in their ***resistance*** to *Pt*.

This was most pronounced in bread wheat where variety choice increased the *Pt* population by between 1.8 to 3.6 times (9,737 up to 19,719 *Pt*/kg of soil).

The build-up of *Pt* populations in this field trial are broadly in line with published resistance ratings but discrepancies appear to exist, especially with LongReach Spitfire⏀ which appears better than its current very susceptible (VS) rating.

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 winter cereal time of sowing trial examining the interaction between *Pt* and crown rot was conducted near Coonamble in central western NSW in 2011. Yield outcomes from this trial were reported in the Autumn 2012 Northern Grains Region Trials Results. The harvested plots were left intact and soil cores were taken in March 2012 to assess the effect of winter cereal crop type and variety choice on the build-up of *Pt* in the soil under the 2011 plots. This type of testing determines the ***resistance*** of each variety to *Pt* under field conditions.

Site details

Location:	**"Woolingar", Coonamble**
Grower:	**Lindsay Meers**
Manager:	**Jason Peters**
TOS 1:	**20th May 2011**
TOS 2:	**22nd June 2011**
Pt at sowing:	**5,522 *Pt*, 0 *Pn*/kg soil at 0–30 cm**

Treatments in 2011

- Five barley varieties (Oxford⏀, Commander⏀, Hindmarsh⏀, Shepherd⏀ and Grout⏀).
- Four durum wheat varieties (Caparoi⏀, Hyperno⏀, EGA Bellaroi⏀ and Jandaroi⏀).
- Nine bread wheat varieties (EGA Gregory⏀, SUN627A, LongReach Spitfire⏀, EGA Bounty⏀, Livingston⏀, LongReach Crusader⏀, Sunvex⏀, Ellison⏀ and Strzelecki⏀).
- All plus and minus crown rot inoculum at each sowing time.

Nematode testing

Ten small intact soil cores were then taken from the 0–30 cm zone from each harvested plot in March 2012. The cores from each plot were bulked and sent to the South Australian Research and Development Institute (SARDI) for PreDicta B analysis of *Pt* numbers within each soil sample based on this sensitive and selective DNA test.

Results

Sowing time had little effect on the build-up of *Pt* populations at this site in 2011. The difference between sowing times was only significant in two varieties. The *Pt* population increased from 6,211 *Pt*/kg soil with the May sowing to 11,129 *Pt*/kg soil with the June sowing in Grout$^{\phi}$ barley. Conversely, with the bread wheat Ellison$^{\phi}$ the population decreased from the first (18,747 *Pt*/kg soil) to the second sowing (14,599 *Pt*/kg soil).

The addition of crown rot inoculum at sowing also had little impact on the build-up of *Pt* populations with significant differences in only three varieties. Shepherd$^{\phi}$, LongReach Crusader$^{\phi}$ and LongReach Spitfire$^{\phi}$ all had lower (19 to 34% reduction) *Pt* populations in the presence of added crown rot (data not shown).

Winter crop type and variety significantly impacted on the build-up of *Pt* populations over the season. Every variety across all winter cereal types increased the *Pt* above the starting population at sowing in 2011. Barley (av. x1.6 multiplication) and durum (av. x1.3) generally had better resistance than bread wheat (av. x2.7; Figure 1).

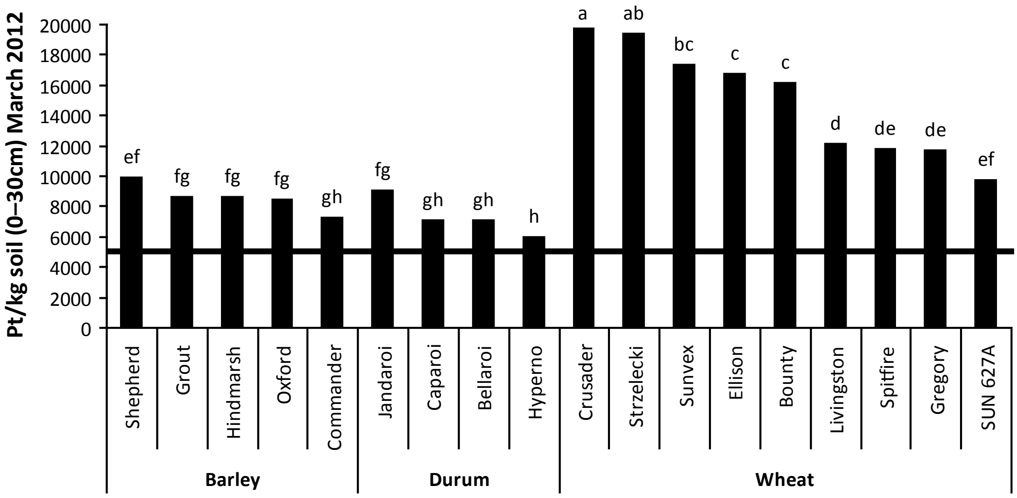


Figure 1: *Resistance of 5 barley, 4 durum and 9 bread wheat varieties to Pratylenchus thornei averaged across two sowing dates – Coonamble 2011 Starting Pt population at sowing 2011 of 5,522 Pt/kg soil (0–30 cm) indicated by solid line. l.s.d (95% confidence level) = 2,255 Pt/kg soil.*

The only significant difference between barley varieties was that Commander$^{\phi}$ (x1.3) was more resistant (i.e lower *Pt* population) than Shepherd$^{\phi}$ (x1.8). In durum, Hyperno$^{\phi}$ (x1.1) was significantly more resistant than Jandaroi$^{\phi}$ (x1.6), which is in line with their published resistance ratings for *Pt*. Hyperno$^{\phi}$ is rated moderately resistant (MR) while Jandaroi$^{\phi}$ is moderately susceptible-susceptible (MS-S).

Considerably more variation appears to exist in the resistance of bread wheat varieties to *Pt*. The breeding line SUN627A produced half the *Pt* population (9,737 *Pt*/kg soil) of the most susceptible varieties LongReach Crusader$^{\phi}$ (19,719 *Pt*/kg soil) and Strzelecki$^{\phi}$ (19,388 *Pt*/kg soil; Figure 1). All bread wheat varieties multiplied the *Pt* population above the starting level present at sowing in 2011 but variety choice had a huge impact on the extent of build-up (x1.8 to x3.6).

Conclusions

Pt populations were roughly in line with published resistance ratings but some discrepancies appear to exist. The most noticeable is the current very susceptible (VS) rating of LongReach Spitfire$^{\phi}$. *Pt* populations at both sowing times with LongReach Spitfire$^{\phi}$ were equivalent to Livingston$^{\phi}$ and EGA Gregory$^{\phi}$ which are rated MR-MS and MS-S, respectively. The *Pt* population following LongReach Spitfire$^{\phi}$ was around 40% lower than those following the S-VS varieties LongReach Crusader$^{\phi}$ and Strzelecki$^{\phi}$ (Figure 1).

The resistance ratings also do not appear to maintain good relativity across winter cereal crop types. Jandaroi$^{\phi}$ durum and the bread wheat varieties EGA Bounty$^{\phi}$ and EGA Gregory$^{\phi}$ are all rated MS-S yet *Pt* populations varied significantly from 9,072 up to 16,194 *Pt*/kg soil.

Breeding programs need to focus on developing and releasing winter cereal varieties with good levels of ***tolerance*** to *Pt* to limit yield impact on crops. However, released varieties also need to have improved levels of ***resistance*** to *Pt* to limit the build-up of this widespread pest within cropping systems in the northern region.

Acknowledgements

This project was funded by NSW DPI and GRDC under the Northern Integrated Disease Management Project (DAN00143) and Variety Specific Agronomy Package Project (DAN00169). Thanks to Lindsay Meers and Jason Peters for hosting the trial on his property at Coonamble. Technical assistance provided by Amy Alston, Rod Bambach, Zeb Taylor, Jayne Jenkins and Tim Weaver is gratefully acknowledged. Nematode numbers were assessed using PreDicta B, which was developed by SARDI with funding support from GRDC.

Resistance of barley, durum and bread wheat varieties to the root lesion nematode *Pratylenchus thornei* – Mungindi 2011

Steven Simpfendorfer and Matthew Gardner NSW DPI, Tamworth

CROP PROTECTION

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 they 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 winter cereal time of sowing trial examining the interaction between *Pt* and crown rot was conducted near Mungindi in north-western NSW in 2011. Yield outcomes from this trial were reported in the Autumn 2012 Northern Grains Region Trials Results. The harvested plots were left intact and soil cores were taken in March 2012 to assess the effect of winter cereal crop type and variety choice on the build-up of *Pt* in the soil under the 2011 plots. This type of testing determines the ***resistance*** of each variety to *Pt* under field conditions.

Key findings

Winter crop type and variety choice has a large effect on nematode populations in the soil due to differences in their ***resistance*** to *Pt*.

This was most pronounced in bread wheat where variety choice decreased the *Pt* population by 64% between the most susceptible (25,448 *Pt*/kg soil) and most resistant (9,050 *Pt*/kg soil) variety.

The build-up of *Pt* populations in this field trial are broadly in line with published resistance ratings but discrepancies appear to exist, especially with LongReach Spitfire⚬ which appears better than its current very susceptible (VS) rating.

Reliable ***resistance*** ratings appear to be produced under both high and moderate starting *Pt* populations. Hence, NVT are potentially a useful source of reliable field based assessments.

Site details

Location:	**"Jabiru", Mungindi**
Co-operator:	**Bruce Longworth**
Manager:	**Joe Robinson**
Agronomist:	**Rob Holmes (HMAg)**
TOS 1:	**10th May 2011**
TOS 2:	**2nd June 2011**
Pt at sowing:	**18,515 *Pt*, 0 *Pn*/kg soil at 0–30cm**

Treatments in 2011

- Five barley varieties (Oxford⚬, Commander⚬, Hindmarsh⚬, Shepherd⚬ and Grout⚬).
- Four durum wheat varieties (Caparoi⚬, Hyperno⚬, EGA Bellaroi⚬ and Jandaroi⚬).
- Nine bread wheat varieties (EGA Gregory⚬, SUN627A, LongReach Spitfire⚬, EGA Bounty⚬, Livingston⚬, LongReach Crusader⚬, Sunvex⚬, Ellison⚬ and Strzelecki⚬).
- All plus and minus crown rot inoculum at each sowing time.

Nematode testing

Ten small intact soil cores were then taken from the 0–30cm zone from each harvested plot in March 2012. The cores from each plot were bulked and sent to the South Australian Research and Development Institute (SARDI) for PreDicta B analysis of *Pt* numbers within each soil sample.

Results

Sowing time did impact on *Pt* populations at this site in 2011 but the interaction appeared to be crop type and variety specific. There was no significant difference in *Pt* populations between the two sowing dates with any of the barley varieties. In durum wheat the *Pt* populations increased by 43% from the 1st (5,815 *Pt*/kg soil) to the 2nd (8,303 *Pt*/kg soil) sowing time when averaged across the four varieties. In the bread wheat varieties *Pt* populations all significantly increased between the first and second sowing time in EGA Bounty⁽ᵈ⁾ (+27%), Sunvex⁽ᵈ⁾ (+34%), EGA Gregory⁽ᵈ⁾ (+68%) and Ellison⁽ᵈ⁾ (+81%).

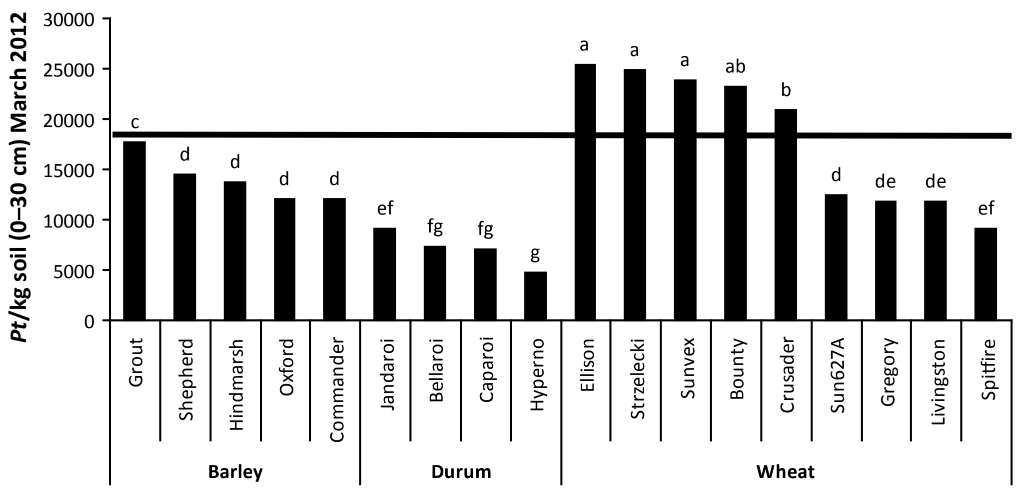
The addition of crown rot inoculum at sowing did not have a consistent impact on *Pt* populations with numbers significantly increased in the presence of added crown rot with EGA Bounty⁽ᵈ⁾ and Ellison⁽ᵈ⁾ but decreased with Hindmarsh⁽ᵈ⁾, Strzelecki⁽ᵈ⁾ and Sunvex⁽ᵈ⁾ (data not shown).

Winter crop type and variety significantly impacted on *Pt* populations which developed over the season. Mungindi had a very high starting *Pt* population of 18,515 *Pt*/kg soil in the 0–30 cm layer. This is over nine times the threshold for yield loss in intolerant varieties. At this high starting population only five of the bread wheat varieties increased the *Pt* population beyond this level over the 2011 season (Figure 1). All four durum varieties had better resistance than the five barley varieties. The better bread wheat varieties were generally equivalent to barley while the more susceptible bread wheats produced higher *Pt* populations than both barley and durum (Figure 1). However, even the best variety, Hyperno⁽ᵈ⁾ (4,786 *Pt*/kg soil), did not reduce the *Pt* population below the 2,000 *Pt*/kg soil threshold for yield loss in a following intolerant crop.

The only significant difference between barley varieties was that Grout⁽ᵈ⁾ left higher *Pt* populations than the other four varieties. In durum, Hyperno⁽ᵈ⁾ (4,786 *Pt*/kg soil) was significantly more resistant than Jandaroi⁽ᵈ⁾ (9,125 *Pt*/kg soil), which is in line with their published resistance ratings for *Pt*. Hyperno⁽ᵈ⁾ is rated moderately resistant (MR) while Jandaroi⁽ᵈ⁾ is moderately susceptible-susceptible (MS-S).

More variation appears to exist in the resistance of bread wheat varieties to *Pt*. LongReach Spitfire⁽ᵈ⁾ produced almost a third the *Pt* population (9,050 *Pt*/kg soil) of the most susceptible varieties Ellison⁽ᵈ⁾ (25,448 *Pt*/kg soil), Strzelecki⁽ᵈ⁾ (24,879 *Pt*/kg soil) and Sunvex⁽ᵈ⁾ (23,804 *Pt*/kg soil; Figure 1).

***Figure 1:** Resistance of 5 barley, 4 durum and 9 bread wheat varieties to* Pratylenchus thornei *averaged across two sowing dates – Mungindi 2011 Starting* Pt *population at sowing 2011 of 18,515* Pt*/kg soil (0–30 cm) indicated by solid line. l.s.d (95% confidence level) = 2,907* Pt*/kg soil.*



Conclusions

Pt populations were roughly in line with published resistance ratings but some discrepancies appear to exist. The most noticeable is the current very susceptible (VS) rating of LongReach Spitfire⊕. *Pt* populations at both sowing times with LongReach Spitfire⊕ were equivalent to Livingston⊕ and EGA Gregory⊕ which are rated MR-MS and MS-S, respectively. The *Pt* population following LongReach Spitfire⊕ was 64% lower than that following the S-VS variety Strzelecki⊕ (Figure 1). In fact the only variety across the three crop types which produced a significantly lower *Pt* population than LongReach Spitfire⊕ at Mungindi in 2011 was the durum variety Hyperno⊕ which is rated MR.

Mungindi had a starting *Pt* population 3.4 times higher than that at Coonamble where this same trial was conducted in 2011. Despite this the relative ranking of varieties, based on final *Pt* populations, was quite consistent between the two sites. Interestingly, the varieties produced quite similar final *Pt* numbers at both sites even though they all increased from the starting population at Coonamble but generally decreased from the higher starting population at Mungindi. This indicates that the starting *Pt* population (high or moderate) does not appear to compromise field based ***resistance*** assessments as long as it focuses on relative final *Pt* numbers.

The impact of sowing time on *Pt* populations appears to vary with crop type, variety and potentially the starting population when comparing findings from Mungindi and Coonamble in 2011. In terms of resistance, at this stage there does not appear to be a clear recommendation based around sowing time. However, with regards to ***tolerance*** these same trials clearly demonstrated that delayed sowing exacerbated yield loss from *Pt*.

Breeding programs need to focus on developing and releasing winter cereal varieties with good levels of ***tolerance*** to *Pt* to limit yield impact on crops. However, released varieties also need to have improved levels of ***resistance*** to *Pt* to limit the build-up of this widespread pest within cropping systems in the northern region. National Variety Trials (NVT) funded by GRDC could be a potentially useful source of reliable field based ***resistance*** ratings as relative rankings between varieties appear to be maintained under either high (9x threshold) or moderate (2.5x threshold) starting *Pt* populations. Uniformity of the population across a trial site is more likely to be a compromising factor which could be a greater risk with lower starting populations below the threshold.

Acknowledgements

This project was funded by NSW DPI and GRDC under the Northern Integrated Disease Management Project (DAN00143) and Variety Specific Agronomy Package Project (DAN00169). Thanks to Bruce Longworth and Joe Robinson for hosting the trial. Assistance of their agronomist Rob Holmes (HMAg) was also greatly appreciated in co-ordinating the trial site and soil coring. Technical assistance provided by Amy Alston, Rod Bambach, and Zeb Taylor is gratefully acknowledged. Nematode numbers were assessed using PreDicta B which was developed by SARDI with funding support from GRDC.

Desi chickpea varieties differ in their resistance to the root lesion nematode *Pratylenchus thornei* – Come-by-Chance 2010

Steven Simpfendorfer, Matthew Gardner and Guy McMullen NSW DPI, Tamworth

Key findings

Chickpea variety choice can have a large effect on the build-up of the Root Lesion Nematode (RLN), *Pratylenchus thornei* (*Pt*) in the soil.

Desi chickpea lines increased *Pt* populations by between 1.8 times (CICA1009) up to 8.4 times (CICA0907) compared to the starting soil population at sowing in 2010.

National variety trials (NVT) are a potential source of reliable field assessment of nematode ***resistance*** levels.

Introduction

The root lesion nematode (RLN) *Pratylenchus thornei* (*Pt*) is widespread in cropping soils through central and northern NSW. Although mainly considered an issue in wheat crops, *Pt* also infects chickpeas with yield losses of between 20–30% previously recorded in intolerant varieties. Chickpeas are also susceptible to *Pt* which means that this nematode colonises their root systems and builds up their numbers in the soil. This is a particular issue in the northern region where chickpea remains the main winter break crop grown in rotation with winter cereals. However, chickpea varieties can vary in their levels of ***resistance*** to *Pt*, which is related to the extent that they build-up *Pt* populations in the soil which then dictates their 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 following chickpeas the greater the potential for a negative impact on the yield of subsequent crops.

A chickpea variety trial was conducted at Come-by-Chance in north-west NSW in 2010 under the National Variety Trial (NVT) network funded by the Grains Research and Development Corporation (GRDC). The harvested plots were left intact and soil cores were taken in March 2011 to assess the effect of chickpea variety choice on the build-up of *Pt* in the soil under the 2010 crop. This type of testing determines the ***resistance*** of chickpea varieties to *Pt*.

Site details

Location:	**Come-by-Chance Chickpea NVT 2010**
Collaborating agronomist:	**Greg Rummery**
Collaborating grower:	**Bill Buchanan**
P. thornei at sowing:	**2,172 Pt/kg soil (0–30 cm)**
Sowing date:	**28th May 2010**

Treatments in 2010

Six commercially released desi chickpea varieties (Jimbour⊕, Flipper⊕, Yorker⊕, Kyabra⊕, PBA HatTrick⊕ and PBA Boundary⊕) and 18 advanced numbered lines were grown in a randomised block design (3 replicates) for yield evaluation at Come-by-Chance in 2010.

Nematode testing

Eight small cores (0–30 cm) were taken around the edge of the NVT chickpea trial at sowing in 2010 to establish the starting background population of *Pt* across the site. The plots were left intact over the summer fallow after harvest in 2010. Ten small intact soil cores were then taken from the 0–30cm zone from each harvested plot in March 2011. The cores from each plot were bulked and sent to the South Australian Research and Development Institute (SARDI) for PreDictaB analysis of *Pt* numbers within each soil sample based on this sensitive and selective DNA test.

Results

The desi chickpea entries differed in their levels of resistance to *Pt* (Figure 1). All entries were susceptible to *Pt* and increased the soil population above the starting background level of 2,172 *Pt*/kg soil.

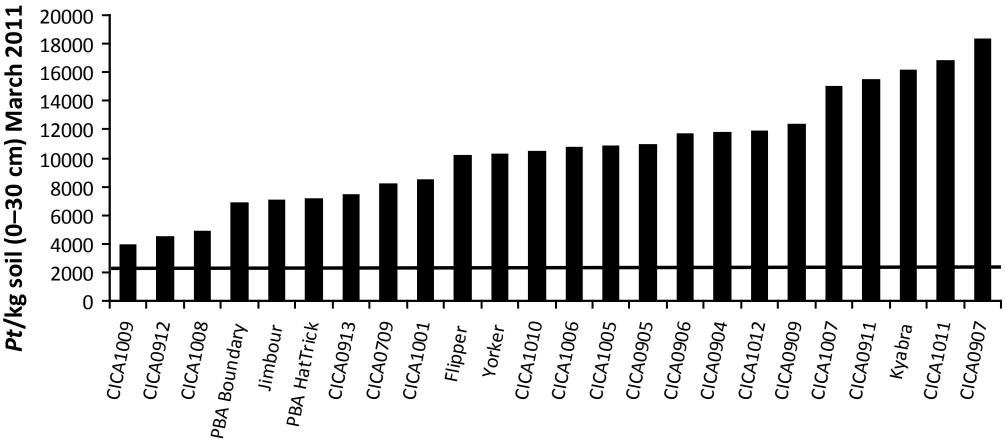


Figure 1: *Resistance of 24 desi chickpea entries to* Pratylenchus thornei *– Come-by-Chance 2010 Starting* Pt *population at sowing 2010 of 2,172* Pt*/kg soil (0–30 cm) indicated by solid line. l.s.d (95% confidence level) = 7,888* Pt*/kg soil.*

CROP PROTECTION

Conclusions

Desi chickpea entries varied significantly in their effect on the build-up of *Pt* soil populations over the 2010 season (i.e. ***resistance*** level). *Pt* populations multiplied 1.8 times under the most resistant entry CICA1009, and up to 8.4 times under the most susceptible entry CICA0907. Variety choice can also have a significant impact on the build-up of *Pt* populations within the soil with numbers around 2.3 times greater after the very susceptible variety Kyabra⁽ᴰ⁾ compared to moderately susceptible varieties such as PBA Boundary⁽ᴰ⁾, Jimbour⁽ᴰ⁾ or PBA HatTrick⁽ᴰ⁾ (Figure 1).

All current desi chickpea varieties and advanced lines are susceptible to *Pt* and will build-up soil populations within the rotation. However, variety choice can still influence the extent of build-up of *Pt* as significant differences exist in the ***resistance*** of chickpea varieties to *Pt*.

As highlighted in this study, the NVT network appears to be a valuable potential source of reliable field assessments of nematode ***resistance*** levels in varieties and near release lines across a range of crop types.

Breeding programs need to focus on developing and releasing chickpea varieties with good levels of ***tolerance*** to *Pt* to limit yield impact on chickpea crops. However, released varieties also need to have improved levels of ***resistance*** to *Pt* to limit the build-up of this widespread pest within cropping systems in the northern region.

Acknowledgements

This project was funded by NSW DPI and GRDC under the NVT network and Northern Integrated Disease Management Project (DAN00143). Thanks to Bill Buchanan for hosting the trial on his property at Come-by-Chance and Greg Rummery for collaboration in co-ordinating sampling of the site. Thanks to Alan Bowring, Rod Bambach, and Tiffany Biggs for technical support.

Seed and in-furrow (fertiliser) fungicides are not effective for early season management of chickpea Ascochyta – Tamworth 2012

Kevin Moore, Steve Harden, Paul Nash and Gail Chiplin NSW DPI, Tamworth

CROP PROTECTION

Key findings

There is no evidence to support growers using seed or fertiliser fungicides to control early season foliar infection by Ascochyta.

Growers and advisors are urged to continue with current recommendations for managing chickpea Ascochyta.

Introduction

Ascochyta blight, caused by the fungus *Ascochyta rabiei*, is the major chickpea disease in the GRDC Northern region. When Ascochyta first caused widespread losses across the region, all chickpea varieties were so susceptible that foliar fungicides were recommended before the first post-emergent rainfall event, before the 3 leaf stage or 3 weeks after emergence, whichever occurred first. This first spray is the most important one because it delays or reduces the establishment of Ascochyta in the lower canopy. Whilst newer varieties have improved resistance to Ascochyta, none are immune and under conditions conducive to Ascochyta they will sustain damage if not protected. This has led many agronomists to recommend the early fungicide spray on these varieties as they do for the older susceptible ones. Growers are reluctant to do this as the plants are only a few centimetres tall. Further, in seasons where there are two emergences, growers are even more reluctant to spray the first plants to emerge as this means spraying the entire paddock twice.

A seed or in-furrow (fertiliser) treatment that would protect young chickpea plants from foliar infection has the benefits of:

- applied at sowing
- cheaper than the first foliar fungicide spray
- eliminates the early season spray so that growers do not feel they are wasting fungicide by spraying 'bare ground"
- insurance against growers not logistically being able to apply the first spray
- In 2011 we evaluated a range of commercial and experimental fungicides for efficacy against foliar infection by Ascochyta when applied to seed or fertiliser. No treatment protected against foliar infection. We do not know if that was because no treatment was effective or because it was 8 weeks between planting and inoculation with Ascochyta. Further research was needed.

2012 Site details

Location: **Tamworth Agricultural Institute**

Treatments

There were 20 treatments including a high disease control (Nil – no seed or fertiliser treatment), a low disease control (industry standard seed treatment with P Pickel-T® plus foliar sprays with 1.0L/ha Unite720®); 17 treatments (P Pickel-T® alone plus 16 experimental products) were applied to seed and one (experimental – SIFI) was applied to fertiliser. Plots measured 2 m x 11 m and there were four replicates.

The trial was sown on 31 May 2012 with the variety Kyabra⟮ⁱ⟯ (very susceptible) and inoculated with Ascochyta @ 320,000 spores/mL in 100 L/ha water through a spray boom on 10 July during a rain event.

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Results

- Ascochyta infection was lower than expected but sufficient to warrant data capture. On 31 July, plants infected with Ascochyta were counted. The only plots that had no Ascochyta were those in the low disease control (P Pickel-T® + Unite720®). However, there were significant differences amongst the other treatments (Table 1) although none was as effective as the seed treatment plus foliar spray.

Table 1: *Predicted means for number of plants infected with Ascochyta on 31 July 2013 for 17 experimental fungicides plus the industry standard (PPT) and the high disease control (Nil). Treatments sharing a common letter are not significantly different (P=0.05, LSD = 5.64)*

Treatment	Predicted	Comparison	% Infected
Nil	18.89	a	7.2
STF7	14.11	ab	5.3
STF13200	12.28	bc	4.7
NU38L25	11.81	bcd	4.5
NU38L80	11.78	bcd	4.5
NU94L100	11.67	bcd	4.4
9F600	10.83	bcde	4.1
PPT	10.38	bcdef	3.9
9F300	10.12	bcdef	3.8
SIF1	8.58	bcdefg	3.3
NU94L150	6.65	cdefgh	2.5
STF13400	6.60	defgh	2.5
5F75	6.35	defgh	2.4
5F150	5.98	efgh	2.3
NU38L40	5.08	fgh	1.9
5F225	5.01	fgh	1.9
9F150	4.78	fgh	1.8
NU94L300	4.28	gh	1.6
B50	1.14	h	0.4

Whilst it is tempting to conclude that some of the treatments eg NU94L300 and B50, offer promise for early season protection, the incidence of disease across the trial was disappointingly low. In the 2011 trial, 100% of plants in the Nil treatment were infected with Ascochyta. In 2012 only 7.2% of plants in the Nil plots were infected. If this 7.2% infection is adjusted upwards to 100%, and the others are adjusted according to their predicted values, even the 'best' treatments referred to above, have infection rates of 23% and 6% respectively. These rates so early in the life of the crop would render subsequent management difficult on a susceptible variety in a season conducive to disease. It would have been interesting to have included in the trial a chickpea variety with improved resistance to Ascochyta.

Summary

The effectiveness of seed or fertiliser fungicides for controlling early season foliar infection by Ascochyta remains unresolved. There is no evidence to support growers experimenting with such treatments. Indeed, growers and advisors are urged to continue with current recommendations for managing chickpea Ascochyta.

This work will continue for another season using the 'better' treatments from the 2012 trial and will be expanded to include a second variety with improved resistance to Ascochyta.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Northern NSW Integrated disease management project (DAN00143). Thanks to Richard Heath who originally asked the question and to Alan Bowring for help with selecting treatments. Thanks to chemical companies for products.

The effects of sowing date and plant density on virus symptoms in chickpea

Andrew Verrell NSW DPI, Tamworth

Key findings

Sow at optimal seeding rate allowing for potential losses due to seed quality and sowing conditions – irrespective of sowing date, to ensure early canopy closure.

Plant on time – to suit your environment and minimise the impact of aphid flights.

Retain standing stubble – this deters aphids from landing on the crop.

Sow between standing cereal rows – use precision agriculture techniques to sow between the stubble rows. This assists generating a uniform crop canopy which makes the crop less attractive to aphids.

Introduction

There are over 14 species of virus that naturally infect chickpeas. These viruses are spread by airborne insects with aphids being the predominant vector.

The aphids that fly into chickpea crops do not stay long and do not normally colonise plants. Typical virus symptoms are bunching, reddening, yellowing, death of shoot tips and early death of whole plants. However, it should be remembered that none of these are diagnostic for virus.

The occurrence of virus in chickpeas is episodic and varies dramatically from season to season and location. Clovers, medics, canola/mustard, weeds, and other pulses can host viruses that infect chickpea.

The best control strategies to reduce risk of viruses are agronomic. These include; retaining cereal stubble, sowing on time, establishing a uniform closed canopy and controlling weeds (Schwinghamer *et al.* 2009). Seed and foliar insecticides are not recommended for chickpea viruses.

Treatments

A survey of 17 chickpea crops in northern NSW by Moore *et al* (2013) found a high incidence of Beet western yellows virus (BWYV) and lower incidences of Alfalfa mosaic virus (AMV) and Cucumber mosaic virus (CMV). Observations by Moore *et al* (2013) suggest 3 major infections with the 1st flight of aphids in the 1st week of September. Chickpea trials at Tamworth Agricultural Institute (TAI) had a high incidence of plants with virus symptoms. These trials were within 300 m of lucerne and approximately 500 m of canola paddocks. Three trials; sowing date, plant density and nutrient omission, were selected and plants exhibiting virus symptoms were counted on the 15th of October (see Table 1).

Table 1: *Trial details for the TAI trials assessed for virus in chickpeas*

Trial	Varieties	Treatments	Sowing Date
Sowing Date	PBA Boundary^{⁽ᵇ⁾}, Flipper⁽ᵇ⁾, Genesis™ 090, Kalkee, Sonali⁽ᵇ⁾, Cica-912 PBA HatTrick⁽ᵇ⁾	30 plants/m^2 7, 15, 30, 45 plants/m^2	7/5/2012 13/6/2012 6/7/2012 7/8/2012
Density	PBA Boundary⁽ᵇ⁾, Cica-912, PBA HatTrick⁽ᵇ⁾, Genesis™ 090, Kyabra⁽ᵇ⁾	5, 10, 15, 20, 30, 45 plants/m^2	31/5/2012

All trials were sown at 40 cm row spacing into standing wheat residue and chickpea rows were sown between the standing wheat stubble. Both the sowing date and density trials had 5.5 kg N/ha, 11 kg P/ha, 2 kg S/ha and 0.5 kg Zn/ha applied at sowing.

Results

Plant density and virus

Varieties showed no significant difference in the incidence of plants with virus symptoms (%) but there was a highly significant effect with plant density (see Figure 1).

Very low plant density (5 plants/m^2) exhibited the highest incidence of virus symptoms (62%) with the incidence declining in a curvilinear fashion as plant densities increased. There was no significant difference in the proportion of plants exhibiting virus symptoms for 20, 30 and 45 plant/m^2 densities with virus symptom incidences of 13, 6 and 4%, respectively.

Sowing date and virus

Seven varieties were sown (30 plants/m^2) across 4 sowing dates along with PBA HatTrick(b) at 4 plant densities (see Table 1). The proportion of plants with virus symptoms was highly significant for sowing date, variety and sowing date x variety (Figure 2).

In Figure 2, varieties are listed in order of average proportion of plants with virus symptoms across the 4 sowing dates. The order of varieties is consistent with current published virus ratings (Hawthorne, 2008) with Flipper(b) rated as MS-MR, PBA HatTrick(b) MS and Sonali(b) VS.

The 2nd and 3rd sowing dates had the highest incidence of virus with average values of 2, 12, 14 and 5% for the 1st, 2nd, 3rd and 4th sowing dates, respectively. By the time of the first reported aphid flights the 1st sowing date had developed tall dense uniform canopies with complete row closure (1st flower range, 21/8–7/9). The 2nd and 3rd sowing dates were behind in terms of growth and development (1st flower range, 7/9–24/9, 24/9–4/10, respectively). The 4th sowing date was still in vegetative mode, very short with the cereal stubble still visible and standing above the chickpea plants (1st flower range, 9/10–13/10). Optimum sowing time in this environment is in the last week of May.

This trial also allowed the effect of sowing date x density to be examined in PBA HatTrick(b) (see Table 1 and Figure 3). Similar trends in the effect of sowing date on virus symptoms were evident, with

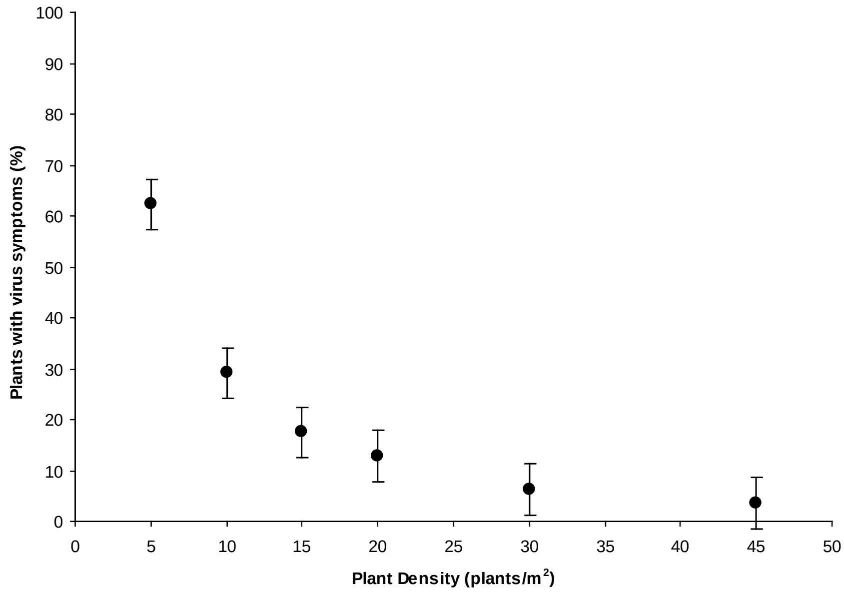

Figure 1: *Plants exhibiting virus symptoms (%) related to plant density (plants/m^2). (Error bars represent se ± 5.0)*

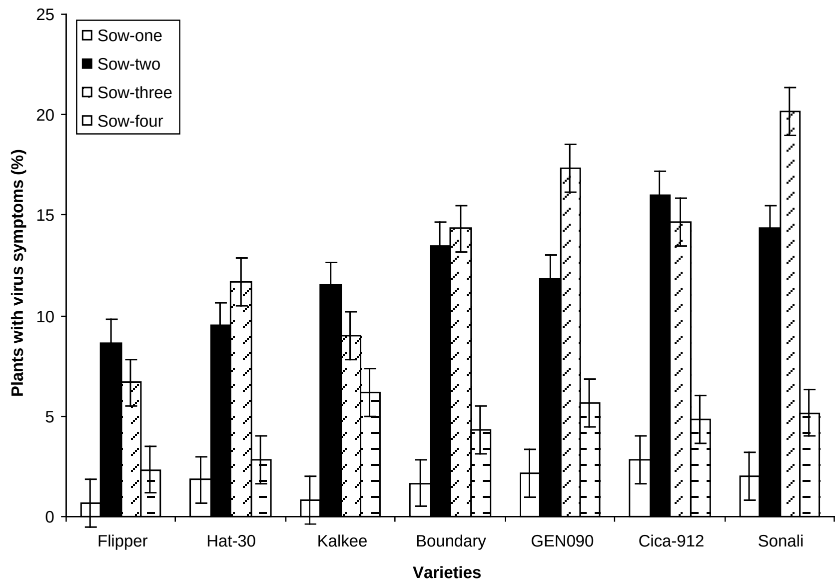

Figure 2: *Proportion of plants with virus symptoms (%) for sowing date by variety. (Error bars represent se ± 1.17)*

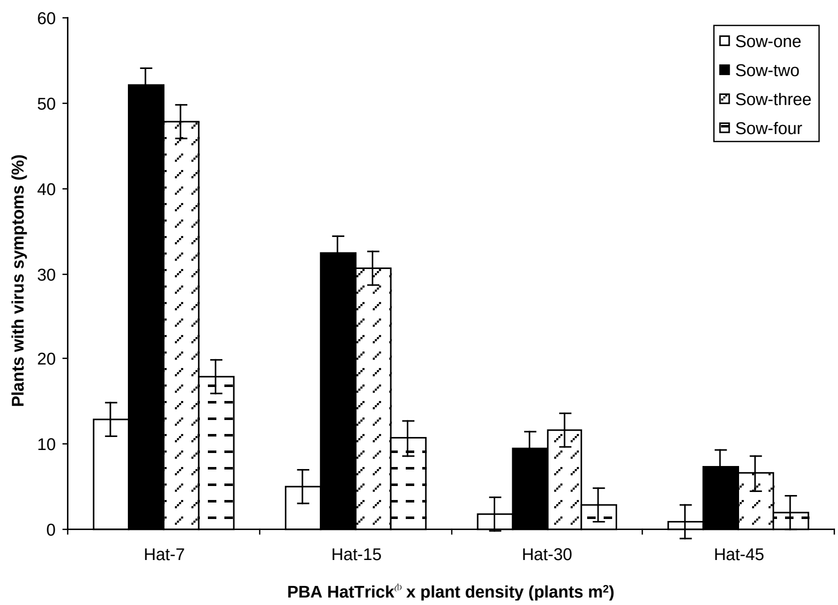

Figure 3: *Proportion of plants with virus symptoms (%) for sowing date by plant density for PBA HatTrick(b) (Error bars represent se ± 2.01)*

the 2nd and 3rd sowing dates having the highest incidence. Importantly, across all 4 sowing dates, the trend for plant density is the same with the proportion of plants with virus symptoms declining as plant density increases.

Summary

- Sow at the optimal seeding rate – irrespective of sowing date, to ensure early canopy closure to reduce aphid attraction to plants next to bare soil.
- Plant on time – to suit your environment and minimise the impact of aphid flights.
- Retain standing stubble – this deters aphids from landing on the crop.
- Sow between standing cereal rows – use precision agriculture techniques to sow between the stubble rows. This assists generating a uniform crop canopy which makes the crop less attractive to aphids.

Acknowledgements

Thanks to Michael Nowland and Paul Nash for their assistance in the trial program.

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Response of chickpea genotype to Phytophthora root rot (*Phytophthora medicaginis*) – Warwick Qld 2012

Kevin Moore, Kristy Hobson, Steve Harden, Paul Nash and Gail Chiplin NSW DPI, Tamworth
Mal Ryley DAFFQ, Toowoomba **William Martin and Kris King** DAFFQ, Warwick

CROP PROTECTION

Introduction

Phytophthora root rot (PRR) of chickpea is endemic and widespread in northern NSW and southern QLD and can cause total yield loss as it did in 2012 in a crop of PBA Boundary⁽ᴾ⁾ near Moree.

As there are no in-crop control measures for PRR, avoidance of high risk paddocks and varietal selection are the only cost effective management tools available to growers.

Current commercial varieties differ in their resistance to *P. medicaginis*, with Yorker⁽ᴾ⁾ having the best resistance (MR), PBA HatTrick⁽ᴾ⁾, Flipper⁽ᴾ⁾, Jimbour, Kyabra⁽ᴾ⁾ having a lower level (MR-MS) and PBA Boundary⁽ᴾ⁾ having the least resistance (MS).

Since 2007, trials have been conducted to quantify losses caused by PRR in current and advanced breeding lines. In 2012 we also included elite germplasm incorporating very high levels of resistance from a wild relative of chickpea, *Cicer echinospermum*.

Key findings

Chickpea Phytophthora root rot (PRR) caused yield losses of between 14% to 85%

PBA Boundary⁽ᴾ⁾ is more susceptible to PRR than other varieties currently grown in northern NSW/southern QLD and should not be planted into paddocks with any level of risk of PRR

Hybrid breeding lines have significantly improved levels of resistance to PRR than the moderately resistant variety Yorker⁽ᴾ⁾, which has the highest resistance available in current commercial varieties

2012 Site details

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

Treatments

- Five released varieties, three advanced breeding lines and three hybrid crosses with *C. echinospermum* (Table 1).
- All plots inoculated with oospores of *P. medicaginis* at sowing on 9 July 2012.
- Half the plots were treated with metalaxyl to stop PRR infection; metalaxyl was applied to seed plus regular soil drenches. Yield loss from PRR is the difference between metalaxyl treated plots and untreated plots.

Results

- Seed and soil treatment with metalaxyl controlled PRR.
- PRR caused yield losses from between 14% to 85% (Table 1).
- Of the commercial varieties, Yorker⁽ᴾ⁾ sustained the least yield loss whilst PBA Boundary⁽ᴾ⁾ lost the most yield from PRR.
- Of the advanced breeding lines, CICA0912 was as resistant as Yorker⁽ᴾ⁾ sustaining a 34% loss in yield to PRR
- The elite hybrid lines, generated by crossing chickpea (Jimbour or Howzat) with *Cicer echinospermum*, have significantly (P<0.0001) higher levels of resistance to *P. medicaginis* than the most resistant variety, Yorker⁽ᴾ⁾ (Table 1).
- Although the yield of the hybrid lines in the absence of PRR in this trial were slightly lower than some commercial varieties such as PBA HatTrick⁽ᴾ⁾ and PBA Boundary⁽ᴾ⁾ , their improved resistance will compensate for that lower yield in wet years if PRR is present.
- The trial also confirms that PBA Boundary⁽ᴾ⁾ (85% yield loss from PRR) is more susceptible to PRR than PBA HatTrick⁽ᴾ⁾ (64% yield loss).

Table 1: *Yield of commercial chickpea varieties and breeding lines in the absence of PRR and % yield losses due to PRR from a 2012 trial at Warwick QLD (P Yield<0.014; lsd Yield = 0.31; P %yield loss<0.001, lsd Yield loss = 24)*

Variety / Line[A]	Yield (t/ha) without PRR	% yield loss due to PRR
D06318	2.40	14
D06344	2.47	22
D06321	2.41	26
CICA0912	2.49	34
Yorker⁽ᵈ⁾	2.52	35
CICA0709	2.42	59
CICA1007	2.87	60
PBA HatTrick⁽ᵈ⁾	2.56	64
Jimbour	2.70	66
Kyabra⁽ᵈ⁾	2.83	78
PBA Boundary⁽ᵈ⁾	2.58	85

[A] D lines are hybrid crosses between chickpea and a wild *Cicer* species.

Summary

- Phytophthora root rot (PRR) caused yield losses from between 14% to 85%.
- Yorker is still the most resistant commercial variety.
- Some advanced breeding lines are just as resistant to PRR as Yorker⁽ᵈ⁾ or even appear to have improved levels of resistance.
- PBA Boundary⁽ᵈ⁾ is more susceptible to PRR than PBA HatTrick⁽ᵈ⁾.

Acknowledgements

This project is funded by NSW DPI, DAFFQ and GRDC under the Northern NSW Integrated disease management project (DAN00143) and the Northern Integrated disease management project (DAQ00154).

⁽ᵈ⁾ Varieties displaying this symbol beside them are protected under the *Plant Breeders Rights Act 1994.*

Increasing numbers of the root lesion nematode *Pratylenchus thornei* did not affect yield of six chickpea varieties – Coonamble 2012

Kevin Moore and Steve Harden NSW DPI, Tamworth **Rohan Brill** NSW DPI Coonamble
Neil Coombes NSW DPI, Wagga Wagga

Introduction

Root-lesion nematodes (RLN) pose a serious threat to the farming systems of the northern grains region and can reduce yield in intolerant cereal and pulse crops. A recent survey by Simpfendorfer *et al* (2012) showed *Pratylenchus thornei* (*Pt*) to be the major RLN species in the region.

Cereal varieties differ in their tolerance to *Pt* (Simpfendorfer *et al*, 2012). However, little is known about the relative tolerance of individual chickpea varieties to *Pt.* An opportunity to address this was available at a site used in 2011 to capture similar data for cereals (Simpfendorfer *et al*, 2012). Tolerance is the ability to maintain yield in the presence of a constraint.

Key findings

Chickpea variety had no effect on grain yield at a trial site in which pre-sow numbers of *Pt* nematodes ranged from ~ 2,500 to ~ 30,000/kg soil.

Pre-sow *Pt* numbers had no effect on yield of any of the six varieties – yield did not decline as nematode numbers increased and this was true for all varieties.

In chickpeas, resistance to *Pt* may not be linked to tolerance.

Site details

Location: **Coonamble**

Co-operator: **Lindsay Meers**

Treatments

- Six desi chickpea varieties were selected based on preliminary data on *Pt* reproduction rates from a 2010 NVT trial at Come-By-Chance (Simpfendorfer *et al*, 2013).
- The varieties were, in increasing resistance to *Pt*: Kyabra$^{\phi}$, Yorker$^{\phi}$, PBA HatTrick$^{\phi}$, Jimbour, PBA Boundary$^{\phi}$ (CICA0511) and CICA0912. Resistance is the effect on nematode reproduction – reproduction decreases as resistance increases.
- PreDicta B results from 2012 pre-sow soil samples showed *Pt* numbers across the trial ranged from ca 2,500/kg soil to ca 30,000. The experimental design ensured each variety occurred across the same range of *Pt* numbers.
- There were 4 replicates with six occurrences of each variety per rep. This gave 24 regression points per variety to test impact of nematode population on yield.

Results

- There were no significant (P=0.067) differences in grain yield among the six chickpea varieties (Table 1).
- There was no significant effect of pre-sow number of *Pt* on yield (Figure 1).

Table 1: *Predicted means for yield of six chickpea varieties at Woolingar Coonamble 2012. Variety had no significant effect on yield (P=0.067)*

Variety	Yield t/ha
PBA Boundary$^{\phi}$	1.83
Kyabra$^{\phi}$	1.79
PBA HatTrick$^{\phi}$	1.72
Yorker$^{\phi}$	1.71
Jimbour	1.69
CICA0912	1.68

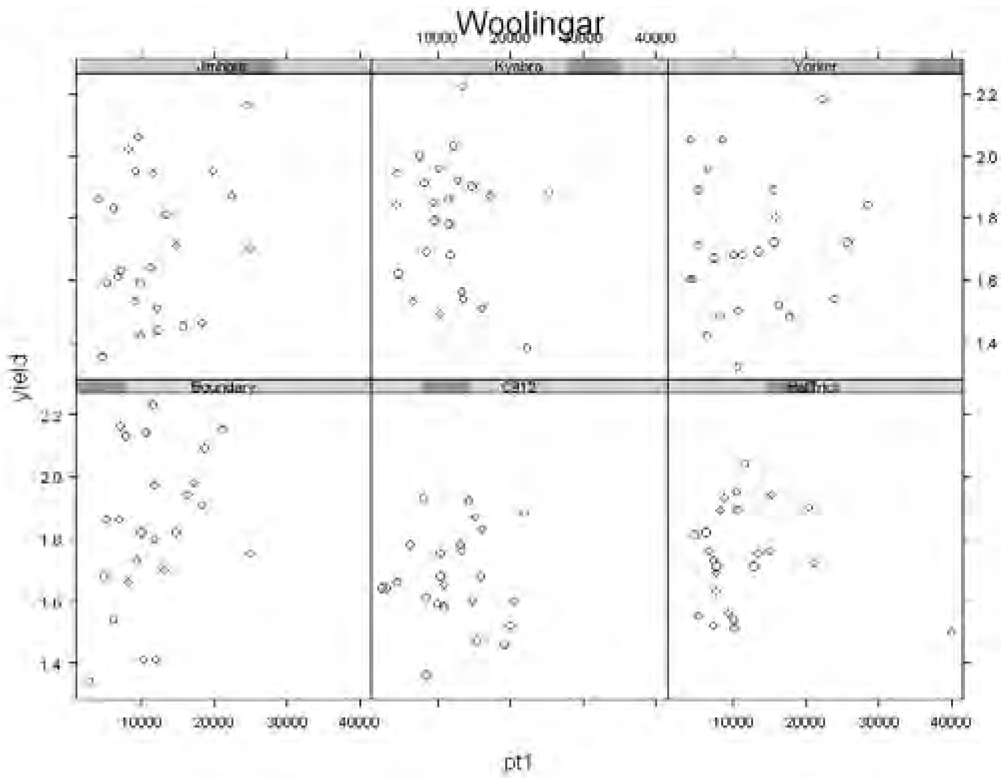

***Figure 1:** Relationship between yield of six chickpea varieties and numbers of pre-sow* Pratylenchus thornei *at Woolingar, Coonamble 2012*

- The grain yields in this trial were somewhat lower than expected. The most likely reasons are: (i) a very dry August and spring and (ii) although September rainfall was about the same as the Long Term Average (LTA), September was considerably colder than the LTA.
- It is not known why there was no significant effect of pre-sow number of *Pt* on yield. The answer may lie in the effect of nematodes on growth and yield of the previous crop. The 2011 trial examined the impact of nematodes on yield of cereal variety (barley, durum, wheat) with and without added crown rot. Is it reasonable to propose that residual soil moisture and soil nitrogen would increase as nematode numbers also increased because plant growth and yield would have been lower? Another explanation is that current chickpea varieties are not as intolerant of *Pt* as is commonly thought. Our results are consistent with another RLN trial conducted in northern NSW in 2012 by Northern Grower Alliance that also found no significant difference in yield among five chickpea varieties under 'low' and 'high' *Pt* numbers. However, a trend towards yield loss with some chickpea varieties was evident under 'high' *Pt* numbers in their work.

Summary

- Chickpea variety had no effect on grain yield at a trial site in which pre-sow numbers of *Pt* ranged from ca 2,500 to ca 30,000/kg soil.
- There was no effect of pre-sow *Pt* numbers on yield of any of the six varieties, suggesting that the varieties are equally tolerant to *Pt*, be that a low, moderate or high tolerance.
- The varieties in this trial were selected based on their effect on *Pt* reproduction in the 2010 Come-By-Chance trial i.e. they were chosen based on their resistance to *Pt*. Our 2012 data suggests that resistance may not be a good predictor of tolerance at least among the varieties in the trial.
- We await with interest the post-harvest PreDicta B results to see the impact of chickpea variety on *Pt* reproduction during the course of the trial.

References

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Acknowledgements

Special thanks to Lindsay Meers (owner) and Jason Peters (manager) who allowed access to Woolingar and provided valuable assistance throughout the season. This work is funded by NSW DPI and GRDC under the Northern NSW Integrated disease management project (DAN00143). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

Effect of the root lesion nematode *Pratylenchus thornei* on chickpea yield – Coonamble & Trangie 2012

Kevin Moore, Kristy Hobson and Steve Harden NSW DPI, Tamworth
Leigh Jenkins NSW DPI, Warren **Rohan Brill** NSW DPI, Coonamble

Key findings

Yield varied significantly with chickpea genotype at these two sites under high starting numbers of *Pt*

There was no evidence that an experimental biological agent had any beneficial effect on yield.

Interspecific hybrids with purported improved resistance to *Pt* did not consistently perform better than commercial varieties or advanced breeding lines in terms of tolerance (i.e. yield).

Introduction

Current strategies to minimise the impact of Root Lesion Nematodes (RLN) on northern region farming systems are based on: (i) growing resistant crops and varieties to reduce the reproduction of nematodes, (ii) growing tolerant varieties to reduce the impact of nematodes on growth and yield and (iii) hygiene to limit spread.

As a crop, chickpea is considered susceptible (and intolerant) to both *Pratylenchus thornei* (*Pt*) and *P. neglectus* (*Pn*) which are the main RLN species in the region. However, varieties differ in their level of resistance i.e. effect on nematode reproduction. Thompson *et al* (2011) found, under glasshouse conditions and artificial inoculation, that Australian and international chickpea cultivars possessed a similar range of susceptibilities through to partial resistance.

This paper reports on the tolerance of 16 chickpea genotypes under field conditions with natural populations of *Pt*. The potential of an experimental biological agent to limit yield loss from *Pt* was also included with two genotypes.

Site details – Netherway

Location:	**Coonamble**
Co-operator:	**Burrabogie pastoral company**
Manager:	**Mark Meers**

Site details – Trangie

Location:	**Trangie Agricultural Research Centre**

Treatments

- Nine desi varieties: PBA Boundary⁽ᴰ⁾, PBA HatTrick⁽ᴰ⁾, Jimbour, Kyabra⁽ᴰ⁾, Flipper⁽ᴰ⁾, Yorker⁽ᴰ⁾, CICA0709, CICA1007, CICA0912
- Four kabuli varieties: Genesis™ 090, Genesis™ 425, Genesis™ Kalkee (at Trangie replaced by Genesis™ 114), Almaz⁽ᴰ⁾
- Three interspecific hybrids with a wild relative of chickpea purported to have improved resistance to *Pt*, designated D5222, D5253, D5288
- The trial also included a biological agent claimed to have activity against *Pratylenchus* spp. This was applied to the seed of Kyabra⁽ᴰ⁾ (the least *Pt* resistant entry in the trial) and CICA0912 (most resistant entry)
- There were 4 replicates in each trial

Results

- At Netherway, post sow PreDicta B *Pt* numbers varied from 2,789 to 18,652, mean 9,230 *Pt*/kg soil and at Trangie from 3,421 to 15,267, mean 7,667 *Pt*/kg soil in the 0–30 cm layer.
- At both sites genotype had a highly significant (P<0.001) effect on yield (Table 1, Table 2)
- There was no significant effect of the biological agent on yield of CICA0912 at either sites and no effect on yield of Kyabra⁽ᴰ⁾ at Netherway. At Trangie, untreated Kyabra⁽ᴰ⁾ out yielded Kyabra⁽ᴰ⁾ plus biological (Table 1, Table 2).

***Table 1:** Predicted means for yield of 16 chickpea genotypes at Netherway Coonamble 2012. Entry had a significant effect on yield (P<0.001, LSD = 0.15)*

Entry	Predicted	Comparison
D5288	1.73	a
C1007	1.69	ab
G090	1.63	abc
C912	1.58	bcd
BOU	1.58	bcde
KYB+BIO	1.56	bcde
HAT	1.51	cdef
KAL	1.48	defg
C912+BIO	1.47	defg
C709	1.46	defg
D5222	1.44	defg
KYB	1.44	defg
D5253	1.43	efg
G425	1.41	fgh
FLI	1.39	fgh
JIM	1.34	gh
ALM	1.33	gh
YOR	1.26	h

***Table 2**. Predicted means for yield of 16 chickpea genotypes at Trangie 2012. Entry had a significant effect on yield (P<0.001, LSD = 0.14)*

Entry	Predicted	Comparison
BOU	1.74	a
C1007	1.66	ab
KYB	1.59	bc
G090	1.57	bcd
HAT	1.55	bcd
C709	1.53	cde
JIM	1.51	cdef
C912	1.45	defg
KYB+BIO	1.43	efg
FLI	1.42	efg
G425	1.41	efg
D5288	1.40	fg
C912+BIO	1.35	gh
D5253	1.34	gh
D5222	1.24	hi
ALM	1.18	i
YOR	1.17	i
G114	1.16	i

- The interspecific hybrids did not stand out either as a group or as individual entries with improved tolerance to *Pt*. At Netherway, D5288 had the highest yield but at Trangie it was well down the list along with the other two hybrids (Table 1, Table 2). This may reflect their inherent lower yield rather than any interaction with *Pt*

Summary

- Yield was significantly (P<0.001) affected by chickpea genotype at both sites although the ranking of genotypes varied between sites.
- There was no evidence that the biological agent had any beneficial effect on yield.
- The interspecific hybrids with purported improved resistance to *Pt* did not consistently perform better than the other entries indicating that they do not appear to also contain improved tolerance to *Pt*.
- We await with interest the post-harvest PreDicta B results to see the impact of chickpea variety on *Pt* reproduction (i.e. resistance) during the course of the trial.

References

Thompson, Reen, Clewett, Sheedy, Kelly, Gogel & Knights (2011) Hybridisation of Australian chickpea cultivars with wild *Cicer* spp. increases resistance to root-lesion nematodes (*Pratylenchus thornei* and *P. neglectus*). Australasian Plant Pathol. (2011) 40:601–611

Acknowledgements

Special thanks to Burrabogie pastoral company and its manager Mark Meers who allowed access to Netherway and provided valuable assistance throughout the season. This work is funded by NSW DPI and GRDC under the Northern NSW Integrated disease management project (DAN00143). Thanks to Jayne Jenkins Rob Pither, Paul Nash, Gail Chiplin and Rod Bambach for technical assistance.

Resistance of eighteen wheat varieties to the root lesion nematode *Pratylenchus thornei* – Trangie 2011

Rohan Brill NSW DPI, Coonamble **Steven Simpfendorfer** NSW DPI, Tamworth

Key findings

Wheat variety choice can have a large effect on the build-up of the RLN, *Pratylenchus thornei* in the soil.

Pratylenchus thornei populations were six times higher in the most susceptible variety Lincolnᶲ compared to the most resistant variety Gauntletᶲ.

Earlier sowing generally increased the build-up of *Pt* populations, especially in the most susceptible variety.

Introduction

The root lesion nematode (RLN) *Pratylenchus thornei* (*Pt*) is widespread in cropping soils throughout central and northern NSW including much of the farmed grey clay soils on Trangie Agricultural Research Centre (TARC). This nematode can cause significant yield loss in certain crops, especially wheat and chickpeas. Wheat varieties with a moderate level of ***tolerance*** of *Pt* are available which allows them to maintain relatively high yield in the presence of this nematode species. Wheat varieties also vary in their level of ***resistance*** to *Pt* which is related to the extent that they build-up *Pt* populations in the soil, which subsequently dictates their effect on subsequent crops. 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 then has the potential to have a greater negative impact on the yield of subsequent crops.

A wheat variety by sowing time experiment was conducted at TARC in 2011 (yield results reported in Autumn 2012 Northern Grains Region Trial Results). The harvested plots were left intact and soil cores were taken in March 2012 to assess the effect of wheat variety choice on the build-up of *Pt* in the soil under the 2011 crop. This type of testing determines the ***resistance*** of wheat varieties to *Pt*.

Site details

Location:	**Trangie Agricultural Research Centre**
Previous crop:	**Faba beans**
RLN (*P. thornei*):	**10,200 *Pt*/kg soil (0–30 cm)**
Soil type:	**Grey vertosol**

Treatments in 2011

Three sowing times of:

1. 30th April 2011
2. 16th May 2011
3. 9th June 2011

Eighteen varieties, broadly grouped into three maturities

Early: Axeᶲ, LongReach Crusaderᶲ, LongReach Lincolnᶲ, Livingstonᶲ, Merindaᶲ, LongReach Spitfireᶲ

Mid: EGA Bountyᶲ, Bolacᶲ, LongReach Gauntletᶲ, Suntopᶲ, EGA Gregoryᶲ, SUN627A, Sunguardᶲ, Sunvaleᶲ

Late: EGA Eaglehawkᶲ, QT15047, Sunzellᶲ, EGA Wedgetailᶲ

Nematode testing

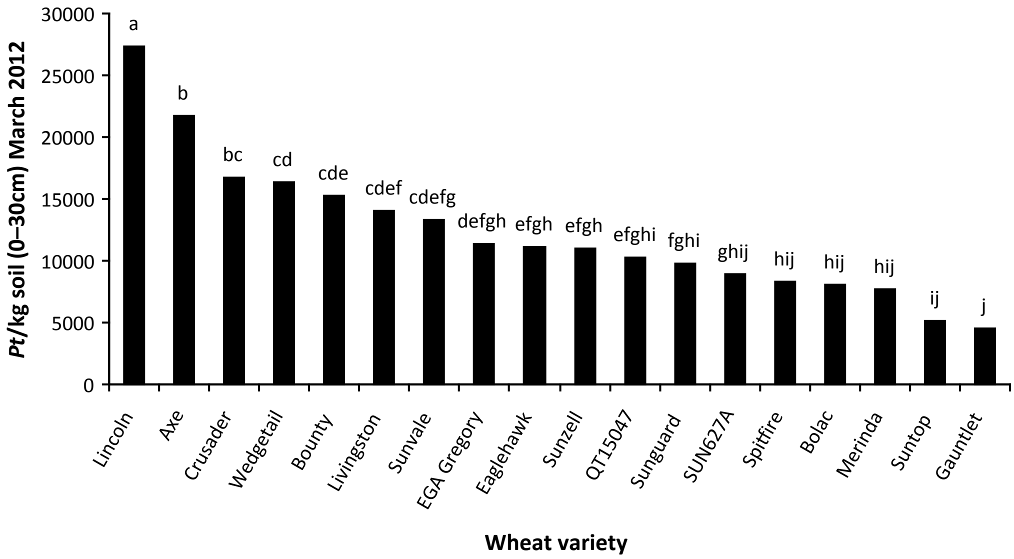
Ten small intact soil cores were taken from the 0–30 cm depth from each harvested plot on the second sowing time (16th May 2011) in March 2012. Four varieties (EGA Gregoryᶲ, LongReach Lincolnᶲ, LongReach Spitfireᶲ and Sunguardᶲ) were also sampled across the three sowing times. The cores from each plot were bulked and sent to the South Australian Research and Development Institute (SARDI) for PreDictaB analysis of *Pt* numbers within each soil sample based on this sensitive and selective DNA test.

Results

The wheat varieties differed greatly in their levels of resistance to *Pt* (Figure 1). Seven varieties reduced the *Pt* population to below the starting level of 10,200 *Pt*/kg soil at sowing in 2011 with both Suntop⊕ and LongReach Gauntlet⊕ roughly halving the soil population.

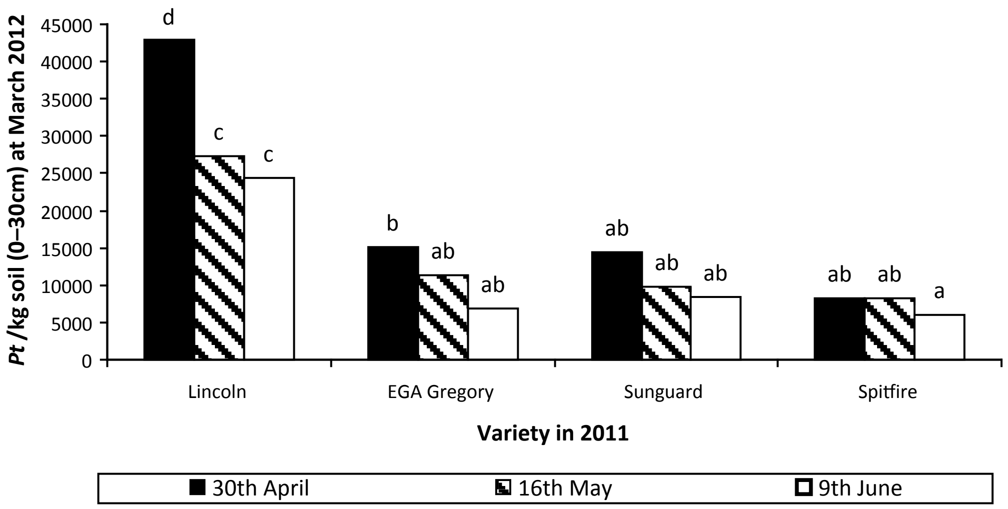
At the other extreme both LongReach Lincoln⊕ and Axe⊕ appear quite susceptible to *Pt* with both roughly doubling the *Pt* population over the season leaving 27,340 and 21,742 *Pt*/kg soil, respectively. The remaining varieties had intermediate levels of resistance to *Pt* (Figure 1).

Figure 1: *Resistance of 18 wheat varieties to* Pratylenchus thornei *– Trangie 2011. Starting Pt population at sowing 2011 of 10,200 Pt/kg soil (0–30cm). Bars followed by the same letter are* ***not*** *significant at the 95% confidence level.*



Sowing time had a significant effect on the build-up of *Pt* populations over the growing season. The 1st sowing on the 30th April 2011 (20,154 *Pt*/kg soil in Mar 2012) resulted in significantly higher *Pt* populations than the later two sowing times (14,176 and 11,389 *Pt*/kg soil, respectively) when averaged across the four wheat varieties. At the individual wheat variety level the effect of sowing time was only significant in the variety LongReach Lincoln⊕ which was the most susceptible of these four varieties to *Pt* (Figure 2).

Figure 2: *Effect of sowing time in 2011 on resistance of four wheat varieties to* Pratylenchus thornei. *Bars followed by the same letter are* ***not*** *significantly different at the 85% confidence level.*



Conclusions

Wheat variety choice had a large effect on the build-up of *Pt* soil populations over the 2011 season. Remaining *Pt* populations were six times higher after the most susceptible variety LongReach Lincoln⁽ᵈ⁾ compared to the most resistant variety LongReach Gauntlet⁽ᵈ⁾. However, even though the most resistant varieties reduced the actual levels of *Pt* compared to what was present at sowing in 2011, the populations were still above the threshold (2,000 *Pt*/kg soil) for yield loss in intolerant varieties at sowing in 2012.

Early sowing of the very susceptible variety LongReach Lincoln⁽ᵈ⁾ resulted in a *Pt* population 1.6 times higher than mid-May sowing (43,000 *Pt*/kg soil compared to 27,000 *Pt*/kg soil), suggesting that the combination of early sowing and very susceptible varieties may lead to a large increase in *Pt* populations.

The effect of the various wheat varieties on *Pt* populations in this trial broadly support reported resistance ratings. However, a discrepancy appears to exist between these trial results and with reported ratings of very susceptible (VS) for both LongReach Spitfire⁽ᵈ⁾ and Sunguard⁽ᵈ⁾. In this trial, across three separate sowing dates, these two varieties did not produce *Pt* populations significantly different from EGA Gregory⁽ᵈ⁾ which is rated MS-S to this nematode.

Growers need to choose wheat varieties with good levels of ***tolerance*** to *Pt* to maximise yield in the presence of this nematode. However, they also need to ensure that the variety also has a decent level of ***resistance*** to *Pt* to limit the build-up of populations within the soil.

Acknowledgements

This project was funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169) and Northern Integrated Disease Management Project (DAN00143). Thanks to Trangie staff Jayne Jenkins and Rob Pither along with Tamworth staff Finn Fensbo, Rod Bambach and Zeb Taylor for technical support.

Control of *Fusarium* head blight in durum wheat using the fungicide Prosaro®

Steven Simpfendorfer NSW DPI, Tamworth

Key findings

A preventative application of Prosaro® at the start of flowering is a viable strategy to minimise the impact of FHB on yield and grain quality under high risk situations in northern NSW.

Alternatively, Prosaro® can still be applied ideally within three days of an FHB infection event during flowering or up to 7 days later and still provide disease control and yield benefits.

Introduction

Previous research conducted by NSW DPI in 2004 demonstrated the superiority of a fungicide combination of tebuconazole + prothioconazole in the control of Fusarium head blight (FHB) caused by the fungus *Fusarium graminearum* (*Fg*). This fungicide combination has subsequently been released by Bayer CropScience® as the product Prosaro®.

Timing of fungicide application in relation to crop flowering (anthesis) and the length of protection if adopting a preventative spray program are two practical concerns raised by growers and advisors in the Liverpool Plains region of northern NSW. This region has a high proportion of durum wheat grown in the winter cropping phase and a moderate area of maize grown in summer. Maize is a preferred host of *Fg* and durum wheat is highly susceptible to FHB worldwide. When this is combined with the higher probability of wheat crops on the Liverpool Plains receiving rainfall during flowering compared to the rest of northern NSW this situation represents a high risk for the development of FHB. Primary infections of FHB occur through the anthers (flowers) of wheat plants. Hence, timing fungicide application around this stage is critical to efficacy. Furthermore, growers and advisors were keen to determine whether a preventative fungicide application at the start of flowering (GS61) would provide protection against FHB infection at that stage but also if the infection period is delayed to later in crop development.

The aim of this experiment was to evaluate the efficacy of Prosaro® in relation to the timing of both fungicide application and occurrence of FHB infection.

Site details

Location:	**Tamworth Agricultural Institute**
Sowing Date:	**16th June 2009**
Harvest Date:	**30th November 2009**

Treatment details

- One durum variety; EGA Bellaroi⊕.
- Conducted in the field under a screenhouse (21 × 6 m) with overhead mist irrigation to favour disease development.
- One metre long plots with four rows of EGA Bellaroi⊕ at 38 cm row spacing.
- Three replicates of each treatment.
- Two fungicide treatments were used within the experiment with all applications at the same fungicide rates which were:
  1. Prosaro® (210 g/L Prothioconazole + 210 g/L Tebuconazole) at 300 mL/ha + 1% Hasten
  2. Folicur® (430 g/L Tebuconazole) at 290 mL/ha + 1% Hasten

  The experiment essentially had two aspects, the first was to examine the importance of timing of fungicide application in relation to FHB infection at the start of flowering (GS61). Treatments were:
  1. Prosaro® applied 7 days before GS61 (–7 days, i.e. heading) with FHB inoculation at GS61.
  2. Prosaro® applied at GS61 (0 days, ~25% flowering) with FHB inoculation at GS61.

3. Prosaro® applied 3 days after GS61 (+3 days) with FHB inoculation at GS61.
4. Prosaro® applied 7 days after GS61 (+7 days) with FHB inoculation at GS61.
5. Prosaro® applied 7 days before GS61 (–7 days) with FHB inoculation at GS61.
6. Prosaro® applied at GS61 (0 days) with FHB inoculation at GS61.
7. Prosaro® applied 7 days after GS61 (+7 days) with FHB inoculation at GS61.

The second aspect to the experiment was examining the length of protection provided by Prosaro® if applied preventatively at the start of flowering (~25%; GS61). Treatments were:

8. Prosaro® applied at GS61 with FHB inoculation at GS61 +5 days.
9. Prosaro® applied at GS61 with FHB inoculation at GS61 +10 days.
10. Prosaro® applied at GS61 with FHB inoculation at GS61 +15 days.

There needed to be four nil fungicide control treatments to assess the severity of FHB at the four different inoculation timings to allow determination of the extent of control achieved by the various fungicide treatments above. Control treatments were:

11. Nil fungicide with FHB inoculation at GS61.
12. Nil fungicide with FHB inoculation at GS61 +5 days.
13. Nil fungicide with FHB inoculation at GS61 +10 days.
14. Nil fungicide with FHB inoculation at GS61 +15 days.

- All fungicide applications were in a water volume of 150 L/ha with a pressurised 1 L spray unit.
- Each plot was inoculated with a spore suspension of *Fusarium graminearum* (*Fg*) at the appropriate timing for the various treatments.
- All plots were overhead misted every night for 35 days after the first treatment (–7 days GS61) was imposed to encourage infection and FHB development.
- FHB severity was visually assessed around the end of grain-fill, just prior to head senescence (17th November).
- All heads in each plot were hand harvested, bulked, threshed and weighed to obtain grain yield.
- A total of 400 random grains from each plot were plated in the laboratory to determine the percentage of grains colonised by Fusarium (% Fusarium infected grain).

Results

FHB severity

Prosaro® was clearly superior to Folicur® in controlling FHB when applied at GS61 (+ 0 days) with an 81% decrease in the number of bleached spikelets compared to the Nil fungicide control. Folicur® by comparison only resulted in a 56% reduction when applied at GS61 (+0 days; LHS Figure 1).

Timing of fungicide application affected the efficacy of both products. Application 7 days before anthesis (–7 days) reduced the level of FHB control to 44% with Prosaro® and 38% with Folicur® with the difference between the two fungicides not being significantly different at this application timing.

Delaying application of Prosaro® by + 3 days did not significantly reduce efficacy compared to application at GS61 (+ 0 days).

However, delaying application by 7 days past anthesis reduced the efficacy of both fungicides but the penalty was much greater with Folicur® (26% control) than Prosaro® (58% control). Appling Prosaro® at 7 days past anthesis gave equivalent visual control of bleached spikelets as applying Folicur® at GS61 (+ 0 days; LHS Figure 1).

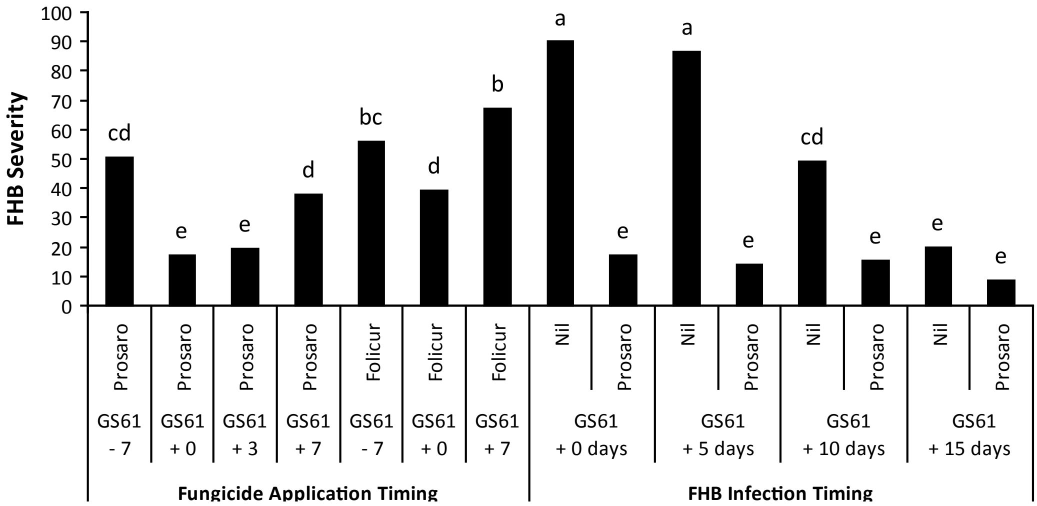


Figure 1: *Effect of timing of fungicide application and FHB infection on visual severity of spikelet bleaching in heads. (Bars with the same letter are not significantly different at 95% confidence level).*

Timing of FHB infection had a big impact on the severity of disease symptoms with infection at GS61 or five days later (GS61 + 5 days) resulting in 90% and 87% of spikelets being visually bleached, respectively. Delaying infection by + 10 days significantly reduced FHB severity to 49% with + 15 days infection timing causing only 20% of spikelets in heads to appear bleached (RHS Figure 1).

Application of Prosaro® at GS61 resulted in similar levels of disease severity whether FHB infection was at GS61 (+0 days), + 5 days, + 10 days or + 15 days (RHS Figure 1). Prosaro® did have reduced efficacy as FHB infection was delayed by 10 days or more with 81% control at + 0 days and 84% control at + 5 days infection timing. Control was reduced to 69% at + 10 days and 57% (not significantly different from Nil) at + 15 days infection timing. However, the reduced efficacy of a preventative Prosaro® application at GS61 on later infections (10 and 15 days after GS61) was accompanied by reduced disease severity in the absence of fungicide application anyway so that the final disease levels across all Prosaro® treatments were not significantly different (RHS Figure 1).

% Fusarium infected grain

FHB infection can cause white grains but less severe or later infection can result in normal coloured and sized grain that can still be infected with *Fusarium*. This can be an issue at sowing if retaining seed from FHB infected crops as these infected grains can result in seedling death.

Application of Prosaro® at GS61 (+ 0 days) reduced the number of grains infected by *Fusarium* by 48% compared to the Nil fungicide control (LHS Figure 2).

Prosaro® was superior to Folicur® in reducing *Fusarium* infection of grain at the + 0 day and + 7 day application timings.

The timing of fungicide application affected efficacy of both products. Application 7 days before anthesis (–7 days) reduced the level of control with both Prosaro® and Folicur® with the two fungicides not being significantly different at this application timing.

Delaying application of Prosaro® by + 3 days did not significantly reduce efficacy compared to application at GS61 (+ 0 days).

Delaying application by + 7 days reduced efficacy of both fungicides but the penalty was much greater with Folicur® than Prosaro® (LHS Figure 2).

Timing of FHB infection had a big impact on the percentage of grains infected with Fusarium with levels steadily decreasing from 62% with infection at GS61 (+ 0 days) down to 24% when infection was delayed by + 15 days (RHS Figure 2).

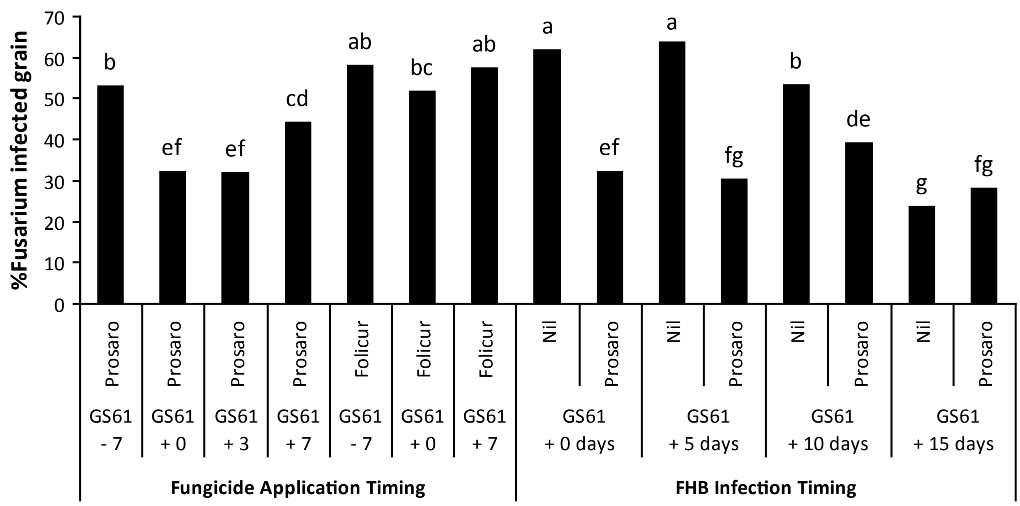


***Figure 2:** Effect of timing of fungicide application and FHB infection on percentage of grain infected with Fusarium.*

(Bars with the same letter are not significantly different at 95% confidence level).

A preventative application of Prosaro® at GS61 resulted in similar levels of grain infection when FHB infection occurred at GS61 (+0 days), + 5 days, or + 15 days (RHS Figure 2). However, an anomaly occurred with FHB infection was delayed + 10 days with higher grain infection levels than the other Prosaro® treatments.

Prosaro® application at GS61 did have reduced efficacy as FHB infection was delayed by 10 days or more with 48% reduction in infected grains at + 0 days and 52% reduction at + 5 days infection timing but was reduced to 27% at + 10 days and 0% (not significantly different from Nil) at + 15 days infection timing.

Grain yield

FHB infection had a large impact on grain yield resulting in around 59% yield loss compared to the highest yielding treatment (Prosaro® applied at GS61 with FHB infection + 15 days, Figure 3).

Prosaro® was clearly superior to Prosaro® at all application timings.

The yield benefit from fungicide application was 2.37 t/ha with Prosaro® compared to 1.20 t/ha with Folicur® when applied at GS61 (+ 0 days; LHS Figure 3).

Delaying Prosaro® application by + 3 days after GS61 did not significantly reduce the yield benefit (2.25 t/ha) compared to spraying Prosaro® at GS61 (+ 0 days).

Spraying – 7 days before flowering reduced efficacy but still produced a yield benefit of 1.47 t/ha with Prosaro® and +0.76 t/ha with Folicur® compared to the Nil fungicide treatment.

Delaying fungicide application by 7 days post anthesis also reduced efficacy with a 1.90 t/ha yield gain with Prosaro® and only 1.00 t/ha with Folicur®.

The impact of FHB infection on grain yield decreased as infection timing was delayed by 10 days post anthesis. FHB infection at GS61 (+ 0 days) resulted in 59% yield loss compared to a loss of 54% at 5 days post anthesis, 29% at 10 days post anthesis and only 5% (not significantly different) at 15 days post anthesis (RHS Figure 3).

A preventative application of Prosaro® at GS61 maintained yield to a similar level with all FHB infection timings.

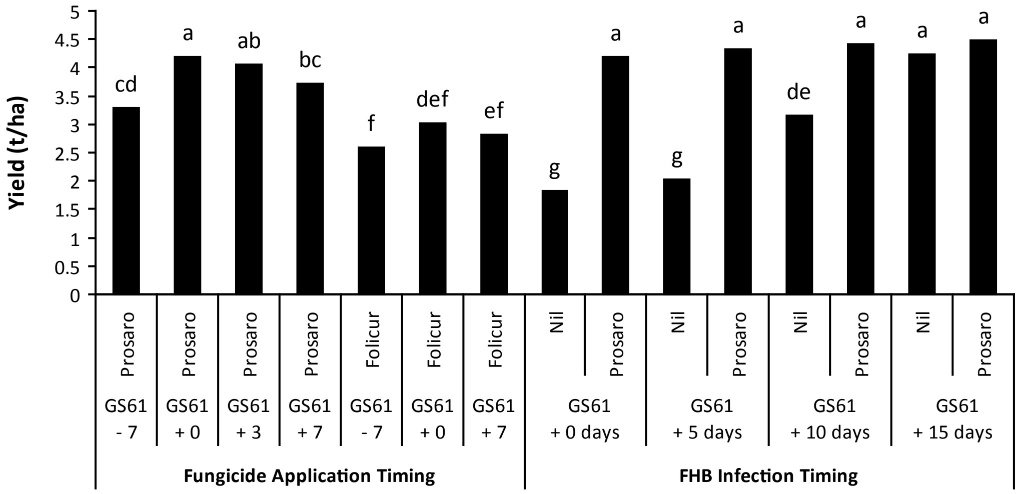


Figure 3: *Effect of timing of fungicide application and FHB infection on grain yield. (Bars with the same letter are not significantly different at 95% confidence level).*

Conclusions

Although Folicur® still provided measurable suppression of FHB, the product Prosaro® clearly provided superior levels of control. Prosaro® application at GS61 reduced FHB severity by 81% compared to only 56% control with the application of Folicur® at the same timing. This translated into a 130% yield benefit (2.37 t/ha) with Prosaro® compared to 66% (1.20 t/ha) with Folicur® compared to the Nil fungicide control treatment.

The timing of fungicide application was critical to the efficacy of both fungicides. Spraying 7 days before flowering (GS61) reduced control levels and the associated yield benefit compared to application at GS61 (+ 0 days). The anthers (flowers) are the primary infection site for *Fg* so spraying before flowering provides reduced protection of these plant structures.

Delaying the application of Prosaro® by 3 days after FHB infection at GS61 did not significantly reduce efficacy compared to application at GS61 (+ 0 days). However, delaying application of both fungicides by 7 days after FHB infection at GS61 did reduce levels of disease control and associated yield benefit with the penalty being much greater with Folicur® than Prosaro®. This provides growers with some flexibility in disease management in that they can apply Prosaro® ideally within 3 days of a rainfall event around flowering (i.e. FHB infection event) and maintain efficacy. Even though applying Prosaro® up to 7 days after an infection event had reduced efficacy it still provided a significant reduction in FHB severity and a good yield benefit.

A preventative application of Prosaro® at the start of flowering (GS61) provided equivalent levels of control if FHB infection occurred at GS61 (+ 0 days) or + 5 days later. Efficacy of a preventative Prosaro® application at GS61 did start to decline when FHB infection occurred 10 days or more after the start of flowering. However, this was accompanied by reduced negative impacts of FHB with later infections even in the absence of Prosaro® application. A preventative application of Prosaro® at GS61 did not provide any measurable benefit over no fungicide application (Nil treatment) when infection occurred + 15 days after GS61. However, a preventative application of Prosaro® at GS61 still maximised disease control and yield benefits at all other FHB infection timings.

Although not examined in this study, overseas research has demonstrated the importance of spray coverage in FHB control with twin nozzles (forward and backward facing) angled to cover both sides of a wheat head and high water volumes (≥100 L/ha) as being critical to efficacy. Aerial application also has reduced efficacy on FHB control based on overseas studies.

Acknowledgements

This project was funded by Bayer CropScience®. Thanks to NSW DPI staff, Paul Nash for field assistance, Robyn Shapland for laboratory assistance and Guy McMullen for statistical analysis.

Seed-borne *Fusarium* threatens crown rot control strategies – Tamworth 2011

Steven Simpfendorfer NSW DPI, Tamworth

Introduction

There were several commercial wheat crops in northern NSW in 2011 that experienced high levels of crown rot even though they had come out of good rotations, such as canola and double-cropped chickpeas after sorghum. Seed-borne infection with *Fusarium* was suspected in these situations and was able to be traced back, in some cases, by culturing grain that growers had retained from their 2011 plantings. The planting seed had high levels of colonisation by *Fusarium* as a result of head blight (FHB) infection that occurred as a result of wet conditions during flowering and grain-fill in 2010.

FHB relates to the symptoms of head infection which appears as premature ripening of infected spikelets and white and/or pink grain. FHB in the northern region in 2010 was caused predominantly by *F. graminearum* and/or *F. pseudograminearum*. Wet weather during flowering and/or grain-fill is required for FHB infection and disease development.

One issue with grain infection by *Fusarium*, as a result of FHB in wet seasons, is if it is sown the next year it can lead to seedling death which reduces crop establishment. Seedling death (also called seedling blight) results from a severe infection of seedlings as they germinate with most dying before or shortly after they emerge (up to 5 leaf stage). This early infection by *Fusarium* introduced from the seed is effectively similar to a very severe early infection with crown rot. Hence, we were also concerned whether seed infected with *Fusarium* may also be introducing crown rot into surviving plants.

A replicated small plot field trial was conducted at Tamworth in 2011 to investigate the effect of grain infection with *Fusarium* on crop establishment and whether crown rot was introduced into surviving plants. The trial also examined the potential of five fungicide seed treatments to improve establishment and reduce any crown rot levels introduced into surviving plants when sowing seed infected by *Fusarium.*

Key findings

Sowing *Fusarium* infected seed significantly reduces crop establishment.

Sowing *Fusarium* infected seed can also introduce seed-borne crown rot into surviving plants which potentially diminishes any break crop benefits on inoculum levels.

The seed treatments examined in this study had limited activity on improving establishment and reducing seed-borne crown rot levels when sowing seed with high levels of *Fusarium* infection.

Growers should sow seed free of *Fusarium* or with as low a level as possible.

Site details

Location:	**Tamworth Agricultural Institute**
Sowing date:	**1st August 2011**
Fertiliser:	**50 kg/ha Granulock Supreme Z and 100 kg/ha of granular Urea at sowing**

Treatments

- Four grower seed lots of durum with 0 to 73% infection by *Fusarium* from 2010 harvest.
- Six seed treatments: Nil, Dividend® 260 mL, Dividend® 130 mL, Rancona C® 100 mL, Raxil Pro® 15 mL and Jockey 450® mL. All rates are per 100 kg of seed.
- Sown as 1 m plots with five rows at 38 cm spacing.
- Sowing rate adjusted based on 1000 grain weight of each seed lot to target 120 plants/m^2.
- Establishment measured at 5 leaf stage.
- Plots grown through to harvest and incidence of surviving plants infected with crown rot determined through visual assessments and confirmed by plating.

Results

Establishment

Untreated grain infected with *Fusarium* (nil treatment) had reduced emergence of between 53% down to 15% with the severely infected EGA Bellaroi(b seed lot (Table 1). None of the five seed treatments affected establishment in the Jandaroi(b seed lot which was free of *Fusarium* infection. Hence, establishment differences evident in the three *Fusarium* seed lots with some of the fungicide seed treatments appears related to reduced levels of seedling blight rather than improved germination and/or vigour.

Dividend® at the 260 mL/100 kg seed application rate was the only seed treatment to significantly improve establishment in all three seed lots infected with *Fusarium* over the untreated control (nil treatment, Table 1). Dividend®, at the 260 mL rate, increased establishment by 11% to 28% with the benefit lowest in the most heavily infected seed lot. However, even the best seed treatment in this trial could not improve establishment to even 80%. This was particularly evident in the heavily infected EGA Bellaroi(b seed lot. In this situation, Dividend® (260 mL) significantly improved establishment by 11% over the untreated seed. However, this still only raised establishment with this seed lot to 26%.

Table 1: *Effect of five fungicide seed treatments on establishment (%) of four durum seed lots ranging in levels of Fusarium infection.*

Seed treatment	Jandaroi(b 0% *Fusarium*	EGA Bellaroi(b 25% *Fp* only	Jandaroi(b 30% *Fp* + *Fg*	EGA Bellaroi(b 73% *Fp* + *Fg*
Nil	95.4 a	50.7 c	53.0 c	14.7 bc
Dividend® 260	93.2 a	78.7 a	69.0 a	25.7 a
Dividend® 130	94.8 a	54.3 a	62.7 ab	19.7 abc
Rancona C®	95.0 a	60.0 b	58.7 bc	20.3 ab
RaxilPro®	92.8 a	60.0 b	53.3 c	16.0 bc
Jockey®	90.1 a	54.0 c	59.7 bc	11.3 c

Establishment numbers followed by the same letter are not significantly different (P=0.05) within each seed lot. Variety, percentage of seed infected with *Fusarium* and species (*Fp* = *Fusarium pseudograminearum* and *Fg* = *F. graminearum*) are outlined in the column heading for each seed lot.

Crown rot at harvest

Sowing untreated seed infected with *Fusarium* resulted in 24 to 63% of surviving plants being infected with crown rot at harvest depending on the seed lot (data not shown). The uninfected Jandaroi(b seed lot only averaged 1% crown rot infection indicating that the trial was not compromised by background inoculum levels in the paddock. Averaged across the three *Fusarium* infected seed lots, Jockey® was the only seed treatment that did not reduce the incidence of crown rot in surviving plants compared to untreated seed (Nil treatment, Figure 1). However, the reduction in seed-borne crown rot levels was only modest with a maximum average reduction from 35% in untreated seed down to ~27% with Dividend® (260 mL), Rancona C® or Raxil Pro® (Figure 1). In the most heavily infected seed lot these same seed treatments reduced seed-borne crown rot levels at harvest from 63% down to between 43 to 48% (data not shown).

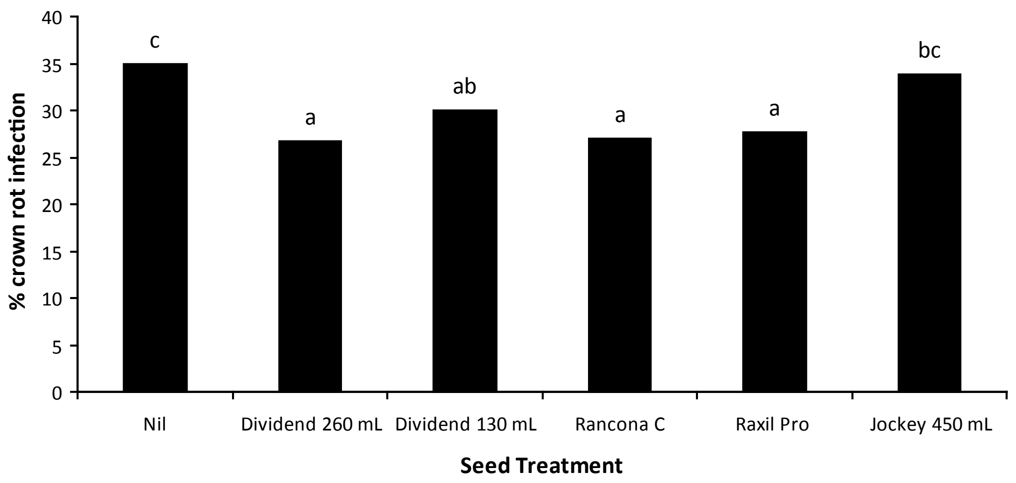


Figure 1: *Effect of five seed treatments on crown rot levels at harvest arising from sowing Fusarium infected seed. Data is average of three Fusarium infected seed lots. Bars with the same letter are not different at the 95% confidence level.*

Conclusions

Sowing seed infected with *Fusarium* significantly reduces crop establishment due to seedling blight. Seed treatments can improve emergence by 10 to 30% but this effect is insufficient if grain is heavily infected with *Fusarium*. In severely infected grain the seed becomes filled with mycelium of *Fusarium* which dramatically reduces germination and vigour. Even the most active seed treatments examined in this trial cannot restore such severely damaged grain to make it suitable for planting.

This study also demonstrated that sowing *Fusarium* infected grain can also introduce high levels (average 35%) of seed-borne crown rot infection into surviving plants. The seed treatments examined in this study had limited effect on reducing levels of seed-borne crown rot infection.

Grain infection with *Fusarium* only occurs as a result of FHB infection, which is favoured by wet conditions during flowering. Crown rot alone cannot directly result in grain infection, as the fungus does not develop up the entire stem and into heads within a season.

Ideally growers should plant wheat seed that is free of *Fusarium* infection by targeting crops which were not infected with FHB in the previous season. Grain infected with FHB is usually white and, if prolonged wet conditions occurred during grain-fill, infected grains will take on a pink appearance. However, it should be noted that if any white or pink grains are evident, then the levels of *Fusarium* infection can be significantly higher than what may be indicated by visual inspection. This is because FHB infections that occur later during grain-fill may not cause any visual discolouration of the seed.

Seed-borne crown rot affects yield in the current crop and introduces infected stubble back into the paddock. Sowing *Fusarium* infected seed, therefore, undoes any break-crop benefits that may have been obtained from growing non-host crops (such as chickpea, canola, faba bean, sorghum) within the rotation sequence.

No seed treatments are registered in Australia for the disinfection of grain infected with *Fusarium*. Even so, those treatments examined in the current study appear to have limited activity anyway.

Acknowledgements

This research was co-funded by NSW DPI and GRDC under project DAN00143. Thanks to Derek Gunn (Agromax consulting) and Jim Hunt (Hunt Ag Solutions) for co-ordinating grower seed lots used in this study. Technical assistance provided by Paul Nash, Robyn Shapland, Karen Cassin and Kay Warren is gratefully acknowledged.

Seed-borne *Fusarium* levels in the northern region in 2010 and 2011

Steven Simpfendorfer NSW DPI, Tamworth

Key findings

Fusarium infection levels in grain are heavily dependent on seasonal conditions during flowering and grain-fill with much higher levels from the 2010 than the 2011 harvest.

Even the lower levels in 2011 may still be introducing small amounts of seed-borne crown rot into paddocks, potentially compromising any break crop benefits on inoculum levels.

Visual assessment of white and/or pink grain, charactertistic of FHB infection, potentially underestimates the actual extent of seed-borne *Fusarium* in the seed.

Introduction

The 2010 season was characterised by widespread rainfall during flowering and grain-fill throughout much of the northern grains region. These conditions favoured the development of Fusarium head blight (FHB) predominantly in bread and durum wheat crops. *Fusarium graminearum* and *F. pseudograminearum* were the two main species which caused the FHB epidemic in 2010 but the dominant species varied considerably between regions.

The 2011 season experienced less rainfall during flowering and grain-fill, compared to 2010, but low levels of FHB were still evident.

FHB has negative impacts on yield and quality but also results in grain becoming infected with *Fusarium.* Seed-borne *Fusarium* has implications in regards to reduced plant establishment and the introduction of crown rot into surviving plants if the infected seed is used for sowing (Simpfendorfer 2013 *Northern Grains Region Trials Results*).

Evidence of seed-borne *Fusarium* levels in the northern grains region has raised concerns whether seed transmission will be an on-going issue or is seasonally dependent. Levels of *Fusarium* infection in grower retained bread and durum wheat seed harvested in 2010 and 2011 from across the northern region was measured to determine the extent of this issue.

Site details

Location: **Various throughout central/northern NSW and southern Queensland**

Treatments

- Growers and/or advisers submitted seed sub-samples from bread and durum wheat crops targeted for sowing the next season.
- Sixty-nine samples were submitted from the 2010 harvest and 60 from the 2011 harvest.
- Grain samples were visually assessed for the percentage of white and/or pink grain.
- Two lots of 100 random grains from each sample were plated to determine the level of *Fusarium* infection.

Results

Seed-borne *Fusarium* levels were considerably higher from the 2010 than the 2011 harvest which reflected the extent of FHB evident in each season. In 2010, grain infection levels were as high as 75% with a fifth of samples having infection levels greater than 10% (Figure 1). The majority of samples in 2010 (49%) had low seed-borne *Fusarium* levels of between 0.5 to 5%. Only 13 of the 69 samples (19%) from the 2010 harvest had no detectable level of *Fusarium* infection.

The highest level of Fusarium detected in grain from the 2011 harvest was only 5.5%. The majority of samples in 2011 (74%) had low seed-borne *Fusarium* levels of between 0.5 to 5%. Only 11 of the 60 samples (18%) from the 2011 harvest had no detectable level of *Fusarium* infection.

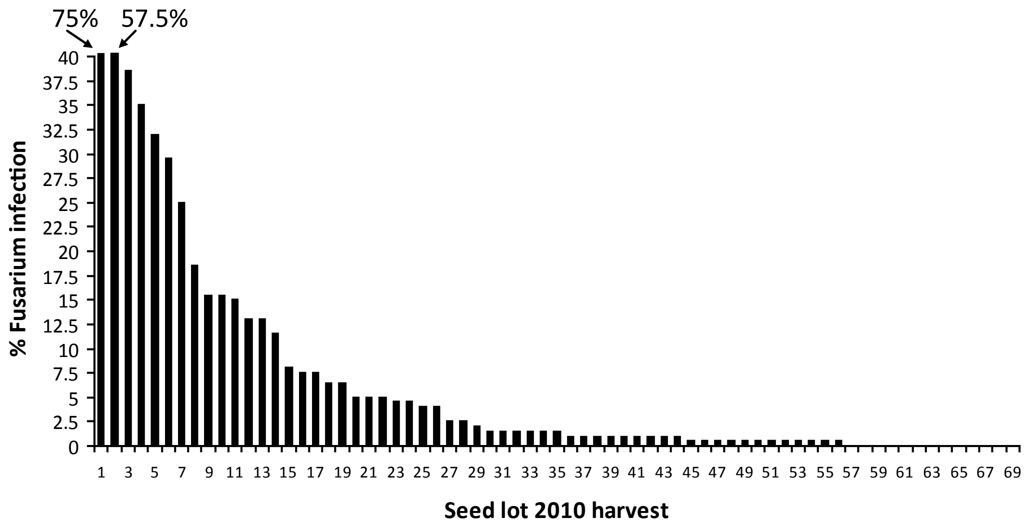


Figure 1: *Seed-borne Fusarium levels from 2010 harvest. First two samples greater than 40% infection as listed above bars.*

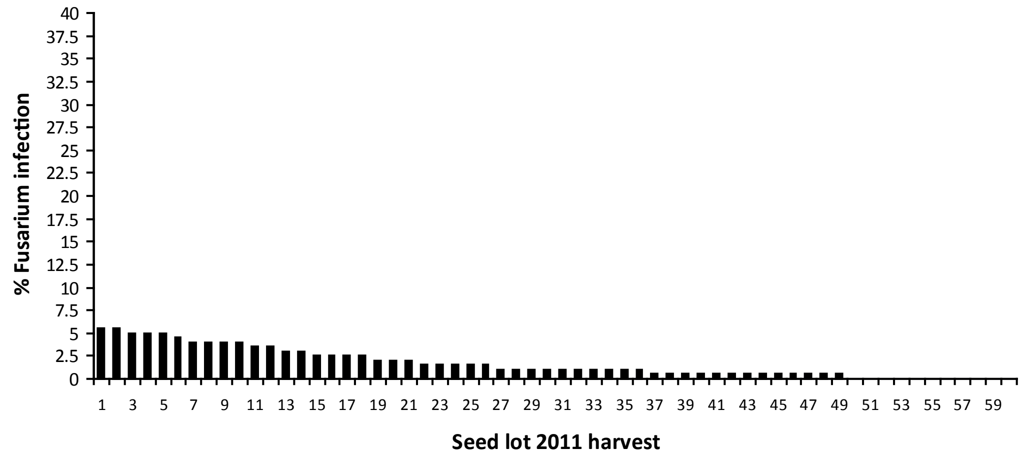


Figure 2: *Seed-borne Fusarium levels from 2011 harvest.*

Seed-borne Fusarium levels, based on plating, were considerably higher than was often indicated by visual assessment of white and/or pink grain (Table 1). Increasing infection levels, assessed either visually or from plating for Fusarium levels, had a negative impact on seed germination (Table 1).

Table 1: *Percentage visual infected grain, seed-borne Fusarium and germination level of six grain samples from the 2010 harvest.*

% White/Pink grains	% Fusarium	% Germination
1	4	81
2	8	74
11	32	59
12	39	40
14	35	36
18	58	25

Conclusions

As with the actual occurrence of FHB, grain infection with *Fusarium* appears to be heavily dependent on seasonal conditions during flowering and grain-fill. Grain infection with *Fusarium* only occurs as a result of FHB infection, which is favoured by wet conditions during flowering. Crown rot alone cannot directly result in grain infection, as the fungus does not develop up the entire stem and into heads within a season. Hence, seed-borne *Fusarium* is likely to be a bigger issue for industry following wet seasonal conditions during flowering and grain-fill such as in 2010 which favoured the development of FHB.

However, even though 2011 had lower rainfall during flowering and grain-fill which resulted in lower levels of seed-borne *Fusarium*, only 18% of samples were free of infection. Low levels of seed-borne *Fusarium* infection may therefore still be potentially introducing crown rot into 'clean' paddocks and compromising break crop benefits.

Ideally growers should plant wheat seed that is free of *Fusarium* infection by targeting crops which were not infected with FHB in the previous season. Grain infected with FHB is usually white and, if prolonged wet conditions occurred during grain-fill, infected grains will take on a pink appearance. However, visual assessment of white or pink grain is not a great indicator of the actual levels of *Fusarium* infection within the seed. *Fusarium* infection levels can be significantly higher than what may be indicated by visual inspection. This is because FHB infections that occur later during grain-fill may not result in any visual discolouration of the seed. Visual observation of white and/or pink grain should only be used to indicate that FHB has occurred and grain should be plated to determine the actual level of seed-borne *Fusarium* if that seed is being considered for sowing in the following season.

Acknowledgements

This research was co-funded by NSW DPI and GRDC under project DAN00143. Thanks to all growers and advisers who submitted samples for analysis. Technical assistance provided by Robyn Shapland, Karen Cassin and Kay Warren is gratefully acknowledged.

Impact of increasing *Pratylenchus thornei* numbers on wheat yield – Come-by-Chance 2011

Steven Simpfendorfer and Matthew Gardner NSW DPI, Tamworth

Key findings

Growing the MT variety EGA Gregory⟃ rather than the I–VI variety Strzelecki⟃ provided a 46% yield benefit at a threshold (~2,000 *Pt*/kg soil) starting level of *Pt* and an 86% yield benefit at a 20x threshold level (~40,000 *Pt*/kg soil).

However, yield loss (~20%) still occurred at high *Pt* populations in the MT variety EGA Gregory⟃.

There needs to be a greater focus on the ***resistance*** of all crops and varieties within the rotation sequence to avoid the build-up of high *Pt* populations within paddocks.

Introduction

The root lesion nematode (RLN) *Pratylenchus thornei* (*Pt*) is widespread in cropping soils throughout the northern grains region. Wheat varieties differ in their level of tolerance to *Pt*. Tolerance relates to the ability of a variety to maintain yield in the presence of *Pt*, with an intolerant variety suffering greater yield loss than a moderately tolerant variety at the same *Pt* population. An indicative threshold of 2,000 *Pt*/kg soil is used widely by industry as the level at which yield loss starts to occur in intolerant varieties. However, it is not clear whether this threshold is a 'cliff-face' or does a progressively greater level of yield loss occur as the starting *Pt* population rises? Equally, what impact does an increasing *Pt* population at sowing have on the yield response of varieties with different levels of tolerance to this nematode?

A chickpea variety trial was conducted at Come-by-Chance in north-west NSW in 2010 under the National Variety Trial (NVT) network funded by the Grains Research and Development Corporation (GRDC). The harvested plots were left intact and soil cores were taken in March 2011 to assess the effect of chickpea variety selection on the build-up of *Pt* in the soil under the 2010 crop. The chickpea varieties differed in their resistance to *Pt* as reported elsewhere in this edition of the Northern Grains Region Trial Results. Consequently, *Pt* populations in individual chickpea plots from 2010 ranged from 2,292 up to 39,194 *Pt*/kg soil in the 0–30 cm layer.

The opportunity was therefore taken to split each plot randomly in 2011 and sow a moderately tolerant (MT) wheat variety, EGA Gregory⟃ and an intolerant–very intolerant (I–VI) variety, Strzelecki⟃ across the site.

Site details

Location:	**Come-by-Chance**
Collaborating agronomist:	**Greg Rummery**
Collaborating grower:	**Bill Buchanan**
Sowing date:	**31st May 2011**
Fertiliser:	**50 kg/ha of Granulock 12Z at sowing**

Treatments in 2011

- Two wheat varieties: EGA Gregory⟃ (MT) and Strzelecki⟃ (I-VI)
- 102 plots of each wheat variety with starting *Pt* populations ranging from just over 2,000 (threshold) up to nearly 40,000 (20x threshold) *Pt*/kg soil.

Nematode testing

Even though we already had *Pt* numbers for each 10 m chickpea plot collected in March 2011 (102 plots) we decided to re-core each 5 m split plot separately immediately after sowing at the end of May 2011 (204 plots) to obtain more accurate starting numbers. Ten small soil cores (0–30 cm) over the newly planted wheat row were collected from each split-plot on the 1st June 2011. The ten cores from each split plot were bulked and sent to the South Australian Research and Development Institute (SARDI) for PreDicta B analysis of *Pt* numbers within each soil sample based on this sensitive and selective DNA test.

Results

The yield of both varieties decreased with increasing starting populations of *Pt*. The yield of the I-VI variety Strzelecki⁽ᵖ⁾ ranged from an average of 4.17 t/ha at low *Pt* populations (threshold) down to around 2.61 t/ha at the highest populations (20x threshold). This was an average yield loss of around 37% (or 1.56 t/ha) between the lowest and highest *Pt* populations at sowing (Figure 1).

The yield of the MT variety EGA Gregory⁽ᵖ⁾ was higher across all starting *Pt* populations than with the I-VI variety Strzelecki⁽ᵖ⁾. However, the yield of EGA Gregory⁽ᵖ⁾ still dropped from an average of 6.10 t/ha under low (threshold) levels down to 4.85 t/ha at the highest (20x threshold) *Pt* population. This still represented a 20% (or 1.25 t/ha) yield decline in a MT variety between threshold and 20x threshold *Pt* populations (Figure 1).

Choosing an MT over an I-VI variety has a large impact on profitability. At a low starting *Pt* population, around the 2,000 *Pt*/kg of soil indicative threshold, there was a 46% (or 1.93 t/ha) yield benefit of growing EGA Gregory⁽ᵖ⁾ over Strzelecki⁽ᵖ⁾. The impact of variety choice was even more dramatic at a much higher *Pt* population of around 40,000 *Pt*/kg soil with a yield benefit of 86% (2.24 t/ha) of EGA Gregory⁽ᵖ⁾ over Strzelecki⁽ᵖ⁾ (Figure 1).

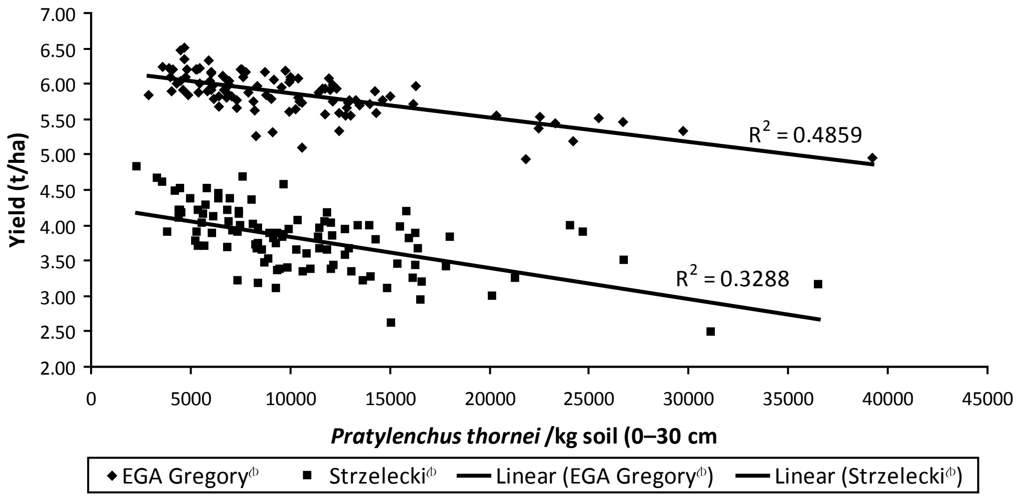


Figure 1: *Impact of* Pratylenchus thornei *population on the yield of a moderately tolerant (EGA Gregory⁽ᵖ⁾) and intolerant-very intolerant (Strzelecki⁽ᵖ⁾) wheat variety – Come-by-Chance 2011.*

Conclusions

Differences in the ***tolerance*** level of wheat varieties to *Pt* have a large impact on yield in the presence of this nematode. Choosing to grow a MT over an I-VI variety had a 46% to 86% yield benefit under threshold or 20x threshold *Pt* numbers, respectively.

The current industry accepted threshold of 2,000 *Pt*/kg soil does not appear to be a 'cliff-face' in that increasing yield loss still progressively occurred in both the MT and I–VI variety as the *Pt* population at sowing rose above this level. Unfortunately, the lowest population in this study was just above threshold (2,292 *Pt*/kg soil) so we could not determine what the yield curves for both varieties looks like as *Pt* populations move below 2,000 *Pt*/kg. Further research is required to determine if yield loss still occurs at even lower *Pt* levels below the accepted threshold and the interaction with variety tolerance.

Clearly yield loss still occurs in MT varieties such as EGA Gregory⁽ᵖ⁾ under high *Pt* populations. This was not surprising as it fits with the definition of moderate yield loss with a MT variety. Current pre-breeding efforts have developed material which appears tolerant (T) of *Pt*. It would be interesting to test such material under a similar range of starting *Pt* populations, at the one site in the one season, as in this study to confirm if the yield response is effectively flat (i.e. no yield loss).

Growing MT varieties is a useful tool to minimise yield loss to *Pt*. However, high *Pt* populations still have a negative impact on yield in a MT variety such as EGA Gregory⁽ᵖ⁾. Hence, there needs to be a focus on the **resistance** of all crops and varieties within the rotation sequence to avoid the build-up of high *Pt* populations within paddocks.

Acknowledgements

This project was funded by NSW DPI and GRDC under the Northern Integrated Disease Management Project (DAN00143). Thanks to Bill Buchanan for hosting the trial on his property at Come-by-Chance and Greg Rummery for collaboration in co-ordinating sampling of the site. Thanks to Alan Bowring, Rod Bambach, Stephen Morphett, Jim Perfrement and Tiffany Biggs for technical support.

Improved tolerance of new wheat varieties to crown rot and *Pratylenchus thornei* – Gurley 2012

Steven Simpfendorfer and Matthew Gardner NSW DPI, Tamworth

Key findings

Both *Pt* and crown rot cause significant yield loss in intolerant/susceptible varieties alone or in combination.

Pt and crown rot **did not** reduce grain protein levels.

Some recently released varieties appear to combine improved tolerance to *Pt* with increased resistance to crown rot which provided up to a 109% yield advantage at this site in 2012.

Introduction

Both crown rot and root lesion nematodes (RLN) are important pathogens of winter cereals in the northern grains region. Wheat varieties are known to vary in their ***resistance*** (build-up of nematode numbers in soil) and ***tolerance*** (yield in the presence of nematodes) to the two main RLN species *Pratylenchus thornei* (*Pt*) and *P. neglectus* (*Pn*). Within the northern grains region *Pt* is more widespread and generally at higher populations in soil then *Pn*, however this can vary between individual paddocks. RLN feed on root systems causing lesions and reduced lateral branching. Intolerant varieties infested with RLN are often stunted and can appear yellow because the feeding of the nematodes has restricted root development and their ability to extract nutrients from the soil. High soil populations of RLN can cause yield loss in intolerant varieties in both 'wet' and 'dry' seasons but losses are potentially greater in drier years as limited soil moisture restricts a plants ability to compensate for RLN feeding by producing more roots.

Crown rot, caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to winter cereal production in the northern grains region. The expression of crown rot infection as whiteheads is heavily influenced by moisture/heat stress during flowering and/or grain-fill. The 2010 and 2011 seasons in the northern region generally had quite wet and mild conditions during grain-fill which has masked the expression of crown rot and limited yield loss from this disease. However, moist conditions favour infection by the crown rot fungus and generally produce higher biomass crops. The 2010 and 2011 seasons in the northern region have favoured the build-up of stubble infected by the crown rot fungus within paddocks. Unfortunately this build-up has largely gone unnoticed by many growers and advisers as the seasons have not favoured the expression of whiteheads.

A range of new wheat varieties have been released over the last few years but due to the seasons their relative tolerance to crown rot has been difficult to determine. Any management strategy that limits storage of soil water or constraint (e.g. RLN) which reduce the ability of roots to access this water increases the probability and/or severity of moisture stress during grain-fill and therefore exacerbates the impact of crown rot. The relative tolerance of a wheat variety to *Pt* is therefore also an important consideration within the northern grain region as RLN can impact directly on yield but can further increase the expression of crown rot.

A variety trial was conducted at Gurley in northern NSW in 2012 which was initially aimed at stripe rust management. No stripe rust developed at the site throughout the whole season even in moderately susceptible varieties. However, the trial paddock happened to have a high background level of *Pt* and a moderate level of crown rot inoculum, even though it came out of a faba bean break crop in 2011. Faba bean is generally a good break for crown rot but unfortunately are susceptible to *Pt* so build-up their populations within the soil. The opportunity was therefore taken to examine the relative impact of *Pt* tolerance and crown rot resistance within the different varieties on yield and quality.

Site details

Location:	**"Murray Cummumualah", Gurley**
Co-operator:	**Scott Carrigan**
Nematodes:	**9,183 Pt, 0 Pn/kg soil (0–30 cm)**
Crown rot:	**140 pg *Fp*/kg soil (medium risk)**
Soil type:	**Grey vertosol**
Rotation:	**Faba bean 2011, Barley 2010**
Stubble mgt:	**Kelly-chain prior to sowing 2012**
Starting N:	**91 kg N/ha to 1.2 m**
Fertiliser:	**50 kg/ha Granulock Supreme Z + 45 kg/ha N as Urea at sowing**

Treatments

- Ten bread and one durum variety (Table 1).
- Two fungicide treatments: nil and full (Flutriafol 400 mL/ha on starter + 145 mL/ha tebuconazole at GS32 and GS39) primarily aimed at stripe rust management.
- Plots harvested using a KEW small plot header to obtain yield and sub-samples used to determine grain quality (protein, screenings and 1000 grain wt).

Table 1: Pratylenchus thornei tolerance and crown rot resistance rating of 10 bread and 1 durum wheat variety evaluated at Gurley in 2012

Variety	*Pt* tolerance	Crown rot resistance
Suntop⟨PBR⟩	MT	MS
Sunguard⟨PBR⟩	T-MT	MR-MS
LongReach Spitfire⟨PBR⟩	MT	MS
Baxter⟨PBR⟩	MT-MI	MS
Livingston⟨PBR⟩	MT-MI	MS-S
Ventura⟨PBR⟩	MT-MI	MS-S
LongReach Crusader⟨PBR⟩	MI-I	MS
EGA Gregory⟨PBR⟩	MT	S
Sunzell⟨PBR⟩	MT-MI	S
Ellison⟨PBR⟩	I-VI	S-VS
Caparoi⟨PBR⟩	MT-MI	VS

Results

Grain yield

When looking at the yield of each variety it is difficult to determine the relative contribution of both diseases to the final outcome as a lack of tolerance to *Pt* can also increase the severity of crown rot expression (yield loss). However, it is evident that varieties which have good levels of tolerance to *Pt* combined with some level of resistance to crown rot (even MS) had a significant improvement in yield in the presence of both of these diseases.

Within the bread wheat varieties Suntop⟨PBR⟩ was 1.54 t/ha (109%) higher yielding than Ellison⟨PBR⟩ which has poorer resistance/tolerance to both *Pt* and crown rot. Suntop⟨PBR⟩ and EGA Gregory⟨PBR⟩ are both moderately tolerant (MT) of *Pt* but the improved resistance of Suntop⟨PBR⟩ (MS) to crown rot over EGA Gregory⟨PBR⟩ (S) appears to have provided a 1.05 t/ha (55%) yield advantage at this site in 2012 (Figure 1).

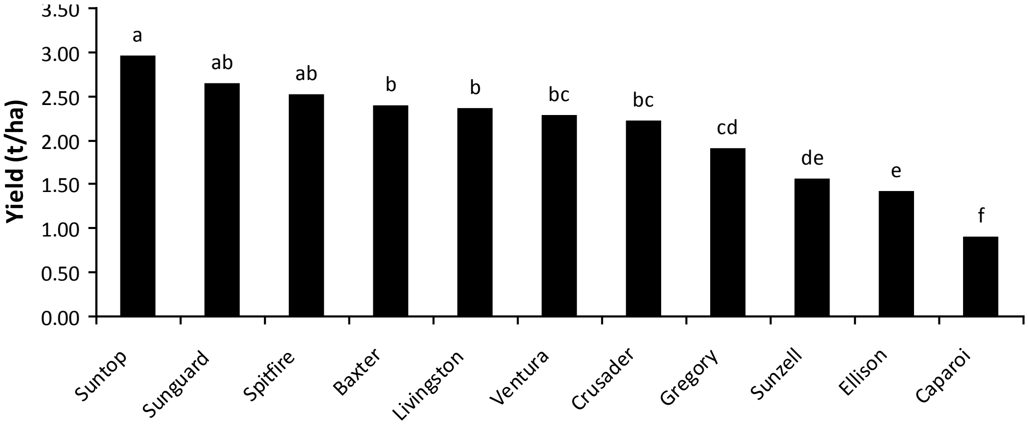


***Figure 1:** Yield (t/ha) of 10 bread and 1 durum wheat variety in presence of* Pratylenchus thornei *and crown rot – Gurley 2012*

Whitehead expression

The expression of crown rot infection as whiteheads was visually assessed during early to mid grain-fill on only one date (11th October). Whitehead assessments can potentially be compromised by differences in the maturity of varieties so ideally multiple assessments should be made a week or more apart to capture maximum expression in each variety. The single assessment date in this trial may have underestimated the extent of whitehead formation in the slower maturity varieties Sunzell⊕ and EGA Gregory⊕ as they were probably not fully expressed at the time of assessment.

The durum variety Caparoi⊕ expressed around twice as many whiteheads as the worst bread wheat variety Ventura⊕ (Figure 2). Suntop⊕, Sunguard⊕ and Baxter⊕ were the only varieties to produce less than 10% whiteheads.

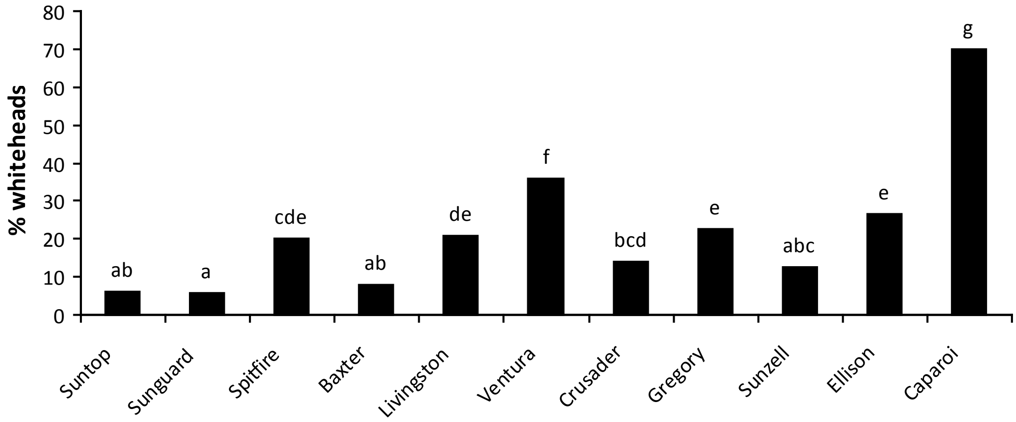


***Figure 2:** Percentage of whiteheads at early to mid grain-fill. Bars with the same letter are not different at the 95% confidence level.*

Grain protein

Grain protein levels ranged from 11.6% in Suntop⊕ up to 13.6% in Ellison⊕ (Figure 3). Grain protein across varieties was in the order Suntop/Ventura/Gregory<Sunguard/Livingston⊕/Crusader<Spitfire/Baxter/Caparoi⊕<Sunzell/Ellison.

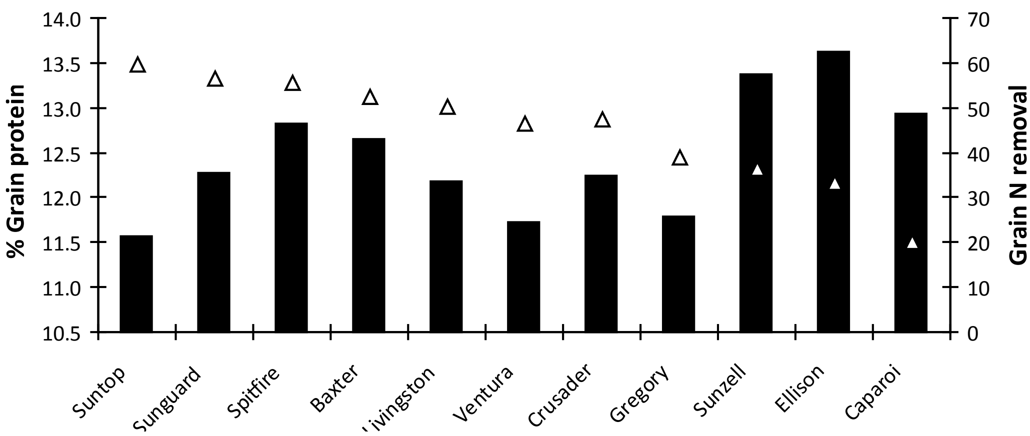


***Figure 3:** Grain protein (bars) and grain N removal (triangles). Lsd (P=0.05) = 0.3 for protein and 8.8 for grain N removal.*

Grain N removal

Removal of nitrogen from the soil profile in grain was calculated for each variety as yield x protein x 1.75. Suntop⊕ had as high a grain N removal level as the top varieties even though it had the equal lowest grain protein concentration (Figure 3). Reduced grain protein in Suntop⊕ therefore appears associated with yield dilution rather than any inefficiency in protein formation in grain. Varieties that had reduced yield due to poor tolerance to *Pt* and/or resistance to crown rot generally had reduced levels of grain N removal. Sunzell⊕, Ellison⊕ and Caparoi⊕ had the lowest levels of grain N removal even though they had amongst the highest grain protein levels. These varieties removed between 23.2 (Sunzell⊕) to 39.3 kg N/ha (Caparoi⊕) less N in grain compared to Suntop⊕.

Conclusions

Grain protein levels at this site ranged between 11.6% to 13.6% with the different varieties. This was not a low protein site as there was roughly 142 kg/ha N (in profile + added at sowing) available to the crop. Low grain protein levels were a widespread issue in parts of the northern grains region in 2012. This trial found that neither *Pt* or crown rot were associated with decreasing protein levels. Sunzell⊕, Ellison⊕ and Caparoi⊕ were generally the three varieties with the lowest ratings for *Pt* and/or crown rot which consequently experienced the greatest negative impacts on yield from these diseases. However, these varieties were the highest protein achievers with levels ranging from 12.9% (Caparoi⊕) up to 13.6% (Ellison⊕).

Interestingly, these varieties had the lowest levels of N removal in grain through reduced yield rather than lower grain protein. The question is where has that extra nitrogen ended up in the paddock? In theory, a lack of tolerance to *Pt* means greater impact of the nematodes on root systems which would reduce the uptake of soil moisture and nutrients. Hence, in *Pt* intolerant varieties the N is likely to have largely remained in the soil. Conversely, crown rot is not a root pathogen so does not restrict the plants ability to extract soil water and nutrients. Rather crown rot, when expressed under moisture stress during grain-fill, restricts water movement at the base of infected tillers. Hence, in theory in crown rot susceptible varieties the N may have been taken up from the soil but become trapped in the stubble as the transport system to move it into grain late in the season became compromised by the infection.

Recent seasons in the northern grains region (2010 and 2011) have limited the expression of crown. At the same time research into the impact of *Pt* has increased dramatically with an associated strong extension effort. Unfortunately some have formed the conclusion from this information that *Pt* is a more important pathogen restricting winter cereal production in the northern region than crown rot. However, this trial at Gurley in 2012 clearly highlights that ***both*** *Pt* and crown rot have significant impact alone and in combination.

The relative impact of the two pathogens on yield can be inferred by comparing varieties with the same level of tolerance/resistance for one disease but different ratings for the other. For example, the impact of *Pt* alone can be inferred by comparing Suntop⊕ and LongReach Crusader⊕ which are both rated MS to crown rot. The yield penalty of going from a MT (Suntop⊕) to MI-I (LongReach Crusader⊕) variety for *Pt* was 0.73 t/ha (25% yield loss from *Pt*).

Similarly the impact of crown rot alone at this site can be inferred by comparing Suntop⊕ with EGA Gregory⊕ which are both MT of *Pt*. The yield penalty of going from a MS (Suntop⊕) to an S (EGA Gregory⊕) variety for crown rot was 1.05 t/ha (36% yield loss from crown rot).

The impact of crown rot was painfully obvious with Caparoi$^{\phi}$ which was the only durum variety in the trial and the most susceptible (VS) to crown rot. Caparoi$^{\phi}$ expressed around 70% whiteheads during grain-fill in mid October and subsequently yielded only 0.89 t/ha. Caparoi$^{\phi}$ is rated MT-MI to *Pt* which is the same rating given to Baxter$^{\phi}$, Livingston$^{\phi}$ and Ventura$^{\phi}$. Hence, the yield difference of 1.45 t/ha (62% yield loss) between Caparoi$^{\phi}$ and the average of these other three varieties can be argued to be associated with crown rot.

Such debates however, are academic and somewhat distracting from the key message that clearly varieties which are very susceptible or intolerant of **either** of these two pathogens should not be grown in medium to high risk situations. Varieties need to incorporate high levels of tolerance and resistance to **both** *Pt* and crown rot as they are both widespread in the northern grains region and can impact significantly on production either alone or in combination. Encouragingly, some of the more recently released bread wheat varieties appear to have done this which provided significant yield improvements under pressure from both *Pt* and crown rot at this site in 2012.

Acknowledgements

The authors would like to thank Scott Carrigan, "Murray Cummumualah", Gurley for providing the trial site. Technical assistance provided by Robyn Shapland, Rod Bambach, Stephen Morphett, Peter Formann, Kay Warren, Finn Fensbo and Jim Perfrement are gratefully acknowledged. This research was co-funded by NSW DPI and GRDC under project DAN00143.

Impact of stripe rust on wheat yield and role of up-front vs in-crop fungicide management – Gilgandra 2012

Steven Simpfendorfer NSW DPI Tamworth **Kathi Hertel** NSW DPI, Dubbo

CROP PROTECTION

Introduction

Stripe rust, caused by the fungus *Puccinia striiformis*, has re-emerged as a significant issue for wheat production in eastern Australia since 2002. Yield and quality losses are related to reductions in green leaf area, which results from pustule formation on infected leaves. Variety resistance is ultimately the best option for managing stripe rust in the long term. However, in the short to medium term growers planting moderately susceptible varieties are reliant on the use of fungicides either at sowing (in-furrow on fertiliser or seed treatment) or in-crop (application of foliar fungicides), or a combination of both options. The development of new pathotypes of the stripe rust fungus, which reduce the resistance of selected commercial varieties, can make fungicide intervention necessary in other situations.

This study evaluated a range of at sowing (up-front) and in-crop fungicide strategies on the control of stripe rust in a moderately susceptible (MS) bread wheat variety, LongReach Crusader⊕ and a moderately resistant (MR) variety, LongReach Spitfire⊕ at Gilgandra in central NSW in 2012. The trial further examined the relative yield loss from stripe rust in 12 varieties (11 bread and 1 durum) by comparing nil and full disease control treatments.

Key findings

Stripe rust reduced the yield of moderately susceptible varieties by between 12–20% at this site in 2012.

There was **no** yield benefit from applying fungicide(s) in varieties rated MR or better.

Fungicide application(s) **did not** impact on grain protein levels in any variety.

The up-front treatment of Flutriafol® at the 400mL/ha rate on starter fertiliser provided good disease control and yield benefit (33%) in the MS variety LongReach Crusader⊕.

Site details

Location:	**"Inglewood", Gilgandra**
Co-operator:	**Kevin Kilby**
Nematodes:	**0 *Pt*, 0 *Pn*/kg soil (0–30 cm)**
Fertiliser:	**50 kg/ha Granulock 12Z at sowing**

Treatments

- Two bread wheat varieties LongReach Spitfire⊕, which is moderately resistant (MR), and LongReach Crusader⊕ which is moderately susceptible (MS) to the Yr17+ pathotype of stripe rust.
- Nine fungicide treatments:
  1. Nil control treatment with no fungicide application either at sowing or in-crop.
  2. Full disease control treatment of Flutriafol on Granulock® 12Z (400 mL/ha) + Tebuconazole (145 mL/ha) at growth stages Z32 (2nd Node) + Z39 (flag leaf emergence)
- Four at sowing (up-front) fungicide options for controlling stripe rust:
  3. Flutriafol (Intake®) on Granulock® 12Z (400 mL/ha)
  4. Flutriafol (Intake®) on Granulock® 12Z (200 mL/ha)
  5. Triadimefon (Triad®500WP) on Granulock® 12Z (200 g/ha)
  6. Fluquinconazole (Jockey Stayer®) on seed (450 mL/100 kg seed)
- Three in-crop foliar fungicide options of:
  7. Tebuconazole (Folicur®, 145 mL/ha) at Z32
  8. Tebuconazole (Folicur®, 145 mL/ha) at Z25 + Z39
  9. Tebuconazole (Folicur®, 145 mL/ha) at Z32 + Z39
- Nil vs full disease control treatments for 8 other bread wheat and one durum variety (Figure 1).

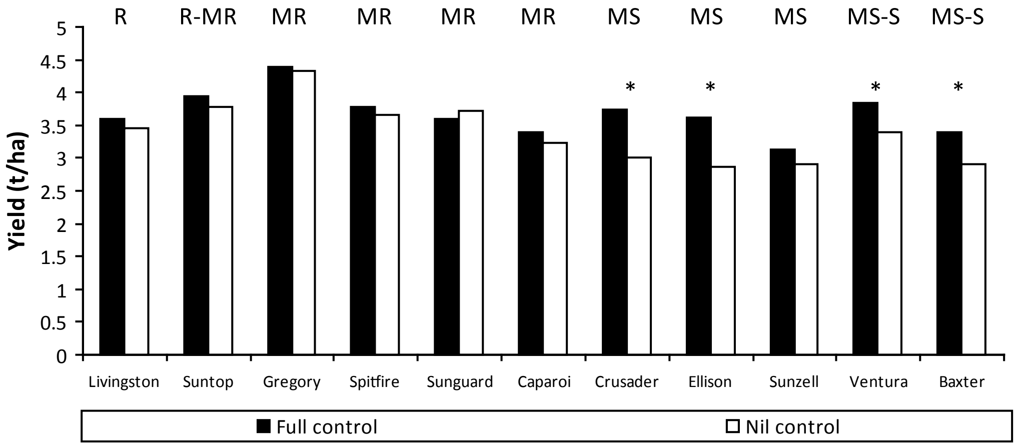
Results

Impact of varietal resistance

The Gilgandra site experienced moderate pressure from stripe rust in 2012. Stripe rust infection only caused a significant reduction in yield in four of the 11 varieties evaluated. The greatest yield loss (Full vs nil control) occurred in the MS varieties Ellison⁽ᴾ⁾ (–20%), LongReach Crusader⁽ᴾ⁾ (–19%) and the MS-S varieties Baxter⁽ᴾ⁾ (–15%) and Ventura⁽ᴾ⁾ (–12%) (Figure 1).

The full disease control treatment (Flutriafol® at sowing + Folicur® at GS32 + Folicur® at GS39) did not increase yield in any of the varieties rated MR or better for the WAYr17+ pathotype of stripe rust. It is important to note that Livingston⁽ᴾ⁾ does have reduced resistance (MR-MS) to the WAYr17+Yr27+ pathotype of stripe rust, which was not present at this site in 2012.

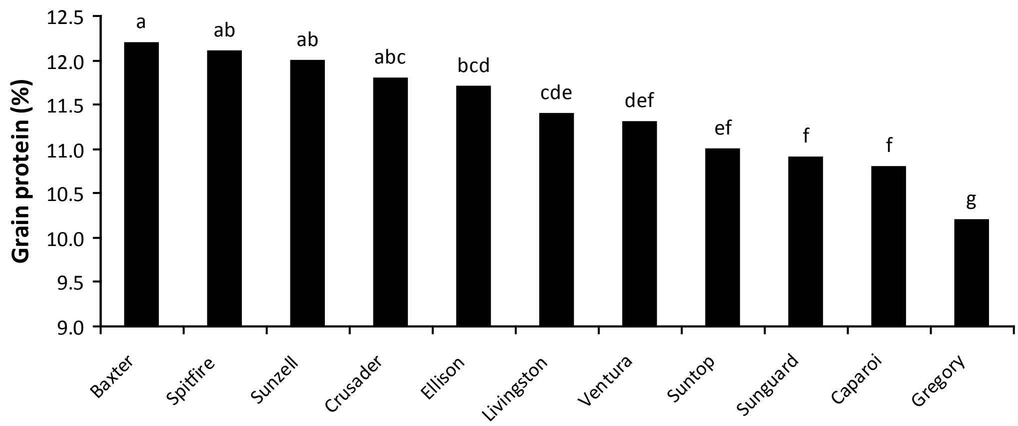
__Figure 1:__ Impact of stripe rust control on the yield of 10 bread and 1 durum variety with varying levels of resistance – Gilgandra 2012. Stripe rust resistance ratings along top of graph are to the WAYr17+ pathotype of stripe rust. Bars with asterix (*) denote a significant increase in yield with the full stripe rust control treatment compared to nil control for that variety. Lsd (P=0.06) = 0.39 t/ha.



Grain protein

The full fungicide treatment did not significantly affect the grain protein levels in any of the 11 varieties irrespective of the resistance level of that variety to stripe rust. However, there were inherent differences between the grain protein levels achieved by the different varieties at this site in 2012. EGA Gregory⁽ᴾ⁾ had the lowest level of grain protein (10.2%), which was 2% behind the highest variety Baxter⁽ᴾ⁾ (12.2%) (Figure 2) The lower protein level of EGA Gregory⁽ᴾ⁾ appears to be a function of yield dilution as it was the highest yielding variety in this trial.

__Figure 2:__ Grain protein levels – Gilgandra 2012. Bars with the same letter are not different at 95% confidence level.



CROP PROTECTION

Up-front vs in-crop fungicides

There was no significant difference between the nil control treatment and any of the up-front or in-crop fungicide treatments in MR variety LongReach Spitfireⓓ (data not shown).

In the MS variety LongReach Crusaderⓓ, the 400 mL/ha of Flutriafol® provided a 33% (1.0 t/ha) yield benefit over the nil fungicide control treatment (Figure 3). The other three up-front fungicide treatments did not significantly change yield compared to the nil control. All three in-crop fungicide treatments provided a significant yield benefit over the nil control of between 12% (GS32 only) and 16% (GS32 + GS39) which was around half the benefit seen with Flutriafol® (400mL/ha) on the starter fertiliser at sowing.

None of the nine fungicide treatments had a significant impact on grain protein levels in either LongReach Crusaderⓓ or LongReach Spitfireⓓ (data not shown).

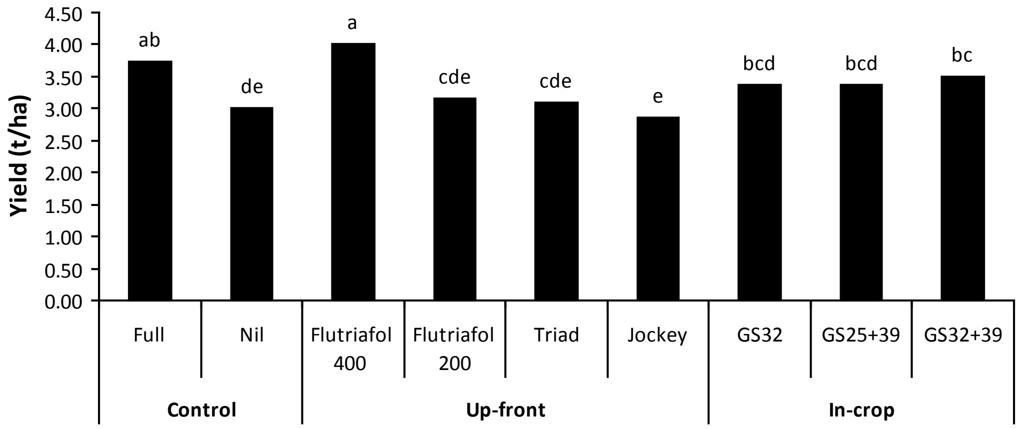


Figure 3: *Effect of fungicide treatments on the yield of LongReach Crusaderⓓ in the presence of stripe rust – Gilgandra 2012. Bars with the same letter are not different at 95% confidence level.*

Conclusions

The 2012 season in much of the northern grains region was less conducive to the development of leaf diseases such as stripe rust compared to the previous two seasons. However, moderate levels of stripe rust still developed at this Gilgandra site in moderately susceptible varieties in 2012.

There was a 12% to 20% yield benefit from controlling stripe rust in moderately susceptible varieties. However, there was no yield benefit from applying fungicide to any variety that was rated MR or better. Fungicide application in MR is not warranted. Fungicide application did not affect grain protein levels in any of the varieties.

The up-front fungicide treatment of Flutriafol® (400 mL/ha) provided a 33% yield benefit over the nil control treatment compared to 12% to 16% with in-crop treatments in the MS variety LongReach Crusaderⓓ.

Acknowledgements

The authors would like to thank Kevin Kilby, "Inglewood", Gilgandra for providing the trial site. Technical assistance provided by Zeb Taylor, Peter Formann, Robyn Shapland, Rod Bambach, Kay Warren, Finn Fensbo and Karen Cassin are gratefully acknowledged. Trial was sown, maintained and harvested by NSW DPI mobile trial unit operated by Scott Boyd. This research was co-funded by NSW DPI, University of Sydney and GRDC under project DAN00143 and US53.

Breeding durum wheat for crown rot tolerance

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Raju Tokachichu University of Sydney, Narrabri

Key findings

There was significant variation in the level of crown rot (CR) tolerance in durum wheat assessed under low levels of yield loss in the field in 2010.

Durum entries also varied in their levels of CR resistance assessed using a glasshouse pot test.

Lines such as BO4-17, Hyperno and 241046, which had good yield in presence of CR inoculum combined with low yield loss from infection, appear useful for developing new CR tolerant varieties.

Introduction

Crown rot (CR) is the most important disease of durum wheat and is a significant factor limiting expansion of the durum industry. With the wide adoption of minimum tillage based production systems, CR disease pressure is expected to increase in future and hence it is important to develop genetic resistance and tolerance to the disease. This study describes our initial examination of genetic variation for CR resistance and tolerance, and, development of a breeding approach based on these results.

Treatments

A set of durum lines containing released varieties and advanced breeding lines, with the inclusion of bread wheat check varieties, was evaluated for CR tolerance in a yield trial at Tamworth Agricultural Institute in the 2010 season containing inoculated (2 g inoculum/m row) and uninoculated treatments as described by Dodman and Wildermuth (1). Disease severity was visually assessed at harvest on 25 random plants from each plot as the extent of basal browning.

The same set of lines was also put through a glasshouse CR pot test (2) at Cobbitty to obtain additional CR resistance data (based on a 0–4 scale incorporating basal browning and whiteheads/deadheads).

Results and discussion

All entries, including 2–49, showed reduced yield in inoculated plots relative to the untreated checks (Figure 1). This is despite the 2010 season not being overly conducive to the expression of CR as whiteheads. Yield loss due to CR was highest in EGA Bellaroi⦶ and lowest in BO4-17. Lines 241000, 241046 (both NSW DPI) and Hyperno⦶ (released SA variety) also showed low levels of relative yield loss from CR infection. Caparoi⦶ showed significantly better tolerance to CR relative to EGA Bellaroi⦶ and this is consistent with the observation that Caparoi⦶ performs well under both dry and wet conditions. Five lines including 241046 (NSW DPI), BO4-17 (CIMMYT) and three from University of Adelaide node of ADWIP (WID052, Yawa⦶ and WID091) produced good yields under the inoculated treatment (Table 1).

Figure 1: Performance of durum lines in presence of CR relative to uninoculated plots in 2010 in Tamworth.

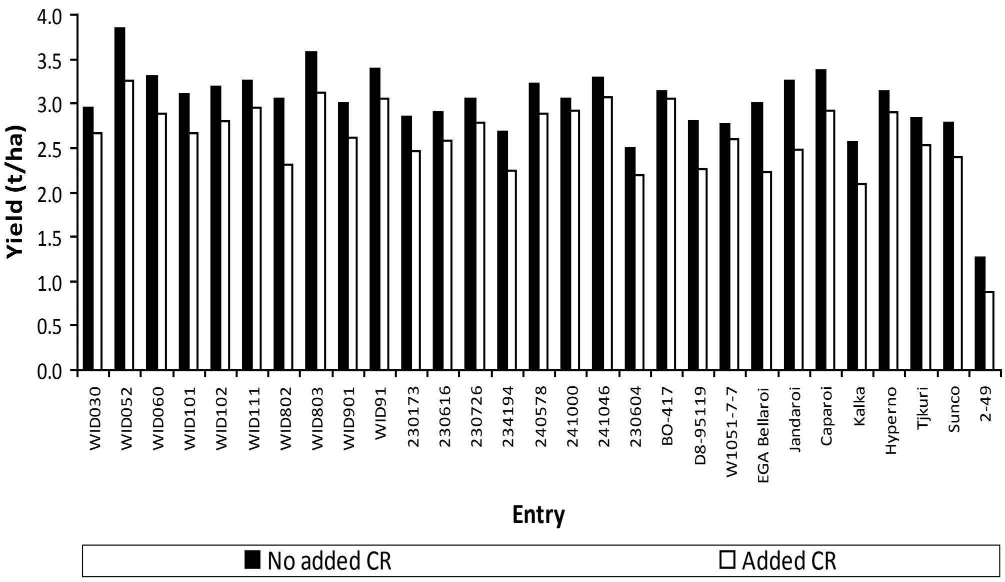

Table 1: CR tolerance and resistance data for selected durum lines.

Lines	Yield (added CR – t/ha)	Yield loss (%)	Field CR severity (%)	Pot test CR severity
WID052	3.25	15.5	39.6	3.9
Yawa⁽ᵇ	3.12	12.9	39.2	3.7
BO4-17	3.06	2.8	44.7	3.2
WID091	3.05	10.1	40.8	2.8
241046	3.00	9.0	37.7	4.0
Caparoi⁽ᵇ	2.91	13.6	42.7	3.8
EGA Bellaroi⁽ᵇ	2.23	25.4	45.5	3.6

Correlation between CR severity data from the field and glasshouse tests was low (0.26). However, both tests detected significant variation among durum lines.

On the basis of these results we conclude there is useful genetic variation for CR tolerance in durum wheat which can be characterised using resistance and tolerance criteria.

Breeding approach

We are working to characterise the material generated by GRDC-funded durum CR pre-breeding project (NSWDPI/USQ) for CR resistance and agronomic traits. Best selections from this material and other durum germplasm that have shown CR tolerance in our work will be crossed to advanced durum lines to incorporate the trait into high yielding and high grain quality backgrounds. In early stages (up to S1), evaluation would be based on performance in disease nursery, marker information and/or glasshouse tests. For lines in intermediate stages (S2/S3), evaluation will be in CR prone trial sites and disease nursery. Advanced (S4) lines will be assessed in inoculated trials to provide CR tolerance data.

Summary

Durum wheat is generally susceptible to CR as shown by many studies but a detailed examination of the response of durum germplasm to the disease in glasshouse and field experiments has revealed significant variation between varieties for yield loss due to CR under field conditions as well as disease severity in glasshouse pots. We hope to make crosses between the CR tolerant lines from this work and high grain quality genotypes to develop commercially useful CR tolerant varieties.

Acknowledgements

This work was partially funded by the Grains Research and Development Corporation.

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2. Raju, T.N. and Turner, M. A. (2008) A brief note on crown rot pot test developed at Plant Breeding Institute, University of Sydney. In 'Collated screening methodologies', *Proceedings of GRDC Crown Rot Screening Workshop*, 15–16 October, 2008. The University of Sydney, Australia.

Tolerance of mungbean to broadleaf herbicides

Bill Manning and Dougal Pottie NSW DPI, Gunnedah
Jim Hunt Hunt Ag Solutions, Gunnedah

Key findings

Mungbeans in this trial tolerated a range of commonly used broadleaf herbicides.

Further trial work is required to test the impact of these herbicides over a broader range of growing conditions.

Introduction

Mungbeans are a useful opportunity crop that can be sown directly into cereal stubble in years of above average summer rainfall. Like most pulse crops the range of broadleaf herbicide options is limited. This trial aimed to investigate the potential use of presently unregistered herbicides in Mungbean crops in comparison to two currently registered products.

Site details

2011/12

Location:	**Mullaley**
Co-operator:	**Don Parish**
Variety:	**Crystal**⍉
Previous Crop:	**Grain sorghum**

Treatments

A total of nine herbicides were used, five unregistered group C, one unregistered group K, one unregistered group D and two unregistered group B were applied at rates sufficient to provide effective weed control. Spinnaker® at 40 g/ha and Stomp® (330 g/L) at 2.5/ha were also included.

All treatments except one were applied on the 23rd of December, 2011 prior to sowing. The crop was planted the following day with a disc planter. One group B herbicide was applied in crop on the 16th of January. Plots were maintained in a weed free state by hand chipping.

Results

The crop tolerated the treatments well and there were no statistically significant differences in yield (Figure 1 and Table 1). Weather conditions during the trial were typified by good rainfall and moderate temperatures which enabled the crop to recover from any setbacks caused by the herbicide applications.

The sowing operation threw treated soil away from the seed line further reducing the potential for damage.

Chemical No 5 applied in crop caused significant visual damage. The fact that this treatment still managed to yield relatively well is evidence of the favourable growing conditions.

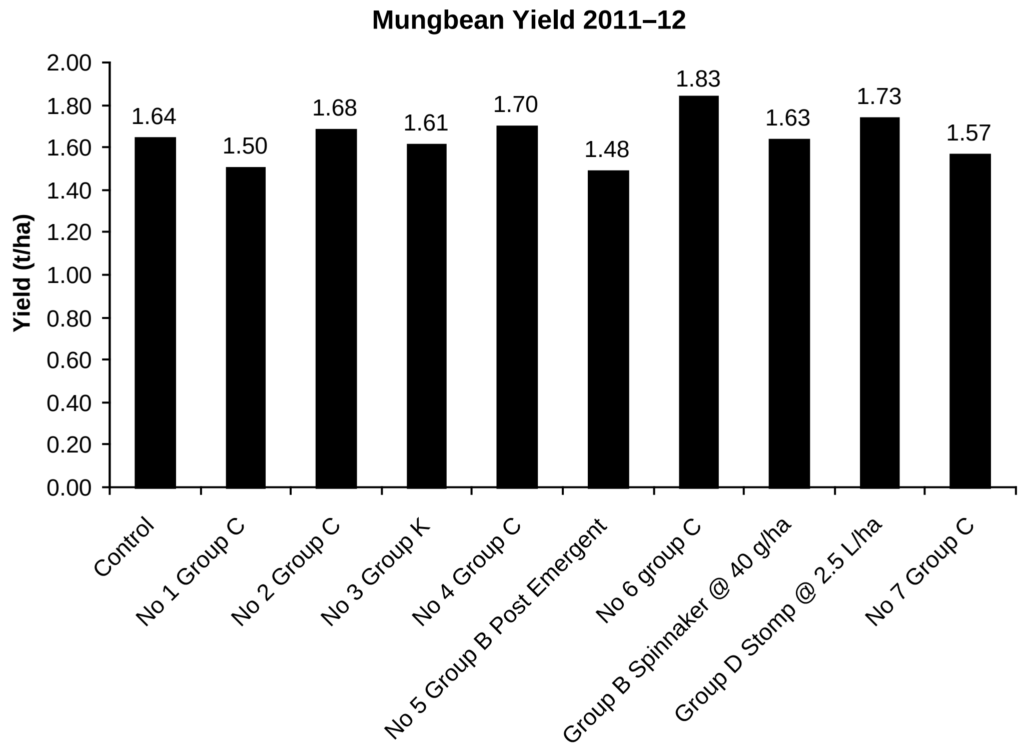


Figure 1: *Yield of mungbean following application of various herbicides 2011–12.*

Table 1: *Yield of mungbean following herbicide application*

Treatment	Yield t/ha	Significance
Control	1.64	a
No 1 Group C	1.50	a
No 2 Group C	1.68	a
No 3 Group K	1.61	a
No 4 Group C	1.70	a
No 5 Group B Post Emergent	1.48	a
No 6 group C	1.83	a
Group B Spinnaker @ 40 g/ha	1.63	a
Group D Stomp @ 2.5 L/ha	1.73	a
No 7 Group C	1.57	a
CV		12%
LSD	0.38 t/ha	

Summary

While mungbeans showed good tolerance to a range of herbicides in this trial further trials are necessary to determine the level of safety in a wider range of conditions prior to seeking any kind of permit to allow registered use of any of these products.

Acknowledgements

Thanks to Peter Formann and Don Parish for assistance with this trial.

The response of four malting barley varieties to varying N nutrition – Walgett, Moree and Bithramere in 2012

Matthew Gardner, Stephen Morphett and Patrick Mortell NSW DPI, Tamworth

Key findings

Navigator⊕ and Bass⊕ appear to be more protein responsive to N applications compared to Commander⊕ and are approximately 1–1.5% higher, which indicates the need to be careful growing these varieties on soils with high residual N.

Commander⊕ and Bass⊕ had the most consistent grain quality across the different sites and soil N levels, however, Commander⊕ would be more suited to higher starting N (with the caution of increased lodging risk).

Commander⊕ was the highest yielding variety across all sites, while Bass⊕ and Navigator⊕ were only slightly better than Gairdner⊕.

High starting soil N should be avoided for Gairdner⊕ due to the large risk of high screenings and low retention, particularly when there is a dry finish to the season.

Introduction

The ability to achieve malt, when a suitable variety has been selected, can result in significant financial advantages in some seasons when producing barley. To meet malt specifications growers should target protein levels of between 10.5–12% to achieve maximum yield and still meet receival standards. As the rate of N supply is increased, yield will generally increase to a maximum level, whereas protein may continue to increase with further N application. Drier or wetter than expected seasonal conditions can significantly change yield potential mid-season, which consequently changes N requirements to meet target protein contents. Therefore, the flexibility of delaying N application to in-crop timings can be a risk management strategy for growers to adapt to changing seasonal conditions. When considering in-crop N applications it is critical to know what N levels are available in the soil at the start of the season. Many paddocks may have high starting soil N levels well in excess of what is required to achieve realistic target yields and maintaining grain protein levels suitable for the production of malting barley.

Site details

Bithramere

Co-operator:	**Gavin Hombsch, "Hyland"**
Previous Crop:	**Durum**
Starting N:	**65 kg N/ha (0–120 cm)**
Sown:	**18th May**

Moree

Co-operator:	**Paul and Charles Tattam, "Bonniedoon"**
Previous Crop:	**Chickpea**
Starting N:	**51 kg N/ha (0–120 cm)**
Sown:	**20th May**

Walgett

Co-operator:	**Dave Denyer, "Wattle Plains"**
Previous Crop:	**Chickpea**
Starting N:	**95 kg N/ha (0–120 cm)**
Sown:	**28th May**

Treatments

In 2012 there were three N sites, located near Walgett, Bithramere and Moree in the northern grains region of New South Wales. Commander⊕, Bass⊕, Navigator⊕ and Gairdner⊕ barley, were grown at a plant population of 100 plants/m^2 at all three trial sites. In each trial 4 rates of N were applied at sowing including 0, 40, 80 and 120 kg N/ha as granular Urea (46% N). Two additional N treatments were implemented, 80 kg N/ha applied at growth stage 31 (GS31 – stem elongation) and a split application treatment where 40 kg N/ha was applied at sowing with a further 40 kg N/ha applied at GS31. The in-crop application of N was applied as 50% diluted liquid UAN, applied through streamer bars at 100 L/ha water rate.

Results

At all sites Commanderᶲ had the highest yield on average compared to the other varieties. Bassᶲ and Navigatorᶲ had similar yield to Gairdnerᶲ in these trials. There was a significant N response at all sites, although much stronger at the Moree site. The Walgett site had high levels of starting N (95 kgN/ha), which resulted in grain yield declines in all varieties at the 120 kg N/ha application rate compared to the 80 kg N/ha rate. The split N application gave similar yields as the 80 kg N/ha up-front treatment at all sites and across the four varieties. However there was one exception with Commanderᶲ at Bithramere where the split N treatment provided an 8% yield benefit (Figure 1a). Delaying N application until stem elongation resulted in a significant decrease in yield for Gairdnerᶲ, Commanderᶲ and Bassᶲ at Moree, whereas, at Bithramere and Walgett there was no significant difference between the delayed N treatment and the 80 kg N/ha up-front (Figure 1).

The protein responses were relatively linear at all sites but there were significant differences between treatments. The Walgett site was less protein responsive only increasing by 2.5% when moving from 0 to 120 kg N/ha compared to 4.6 and 4.9% for the Moree and Bithramere site, respectively. Commanderᶲ had the lowest protein content of all varieties, virtually across all N rates (Figure 1d, e and f). Gairdnerᶲ has been found in previous NSW DPI studies to achieve approximately 1–1.5% higher protein than Commanderᶲ with the same N input, which was again the case at Moree, Walgett and Bithramere in 2012. Bassᶲ, on average, had the highest protein levels across the three sites and was approximately 0.4% higher than Gairdnerᶲ. Delaying or split applications of N at Moree and Walgett significantly reduced grain protein compared to the up-front application of 80 kg N/ha.

Navigatorᶲ at Bithramere was the only instance where the average test weight dropped below 70 kg/hL, however the receival standard for malting barley is 65 kg/hL. On average across the three sites Bassᶲ had the highest test weight, while Navigatorᶲ and Gairdnerᶲ had similar test weights that were lower than Commanderᶲ (Table 1). Bassᶲ and Commanderᶲ had the highest retention levels of all varieties with averages of 89.1 and 86.9% across the sites. The retention at the Walgett site was approximately 20% less than the other sites, which was a direct result of the high starting soil N levels at this site. Both Gairdnerᶲ and Navigatorᶲ were under the receival standard of 70% retention at Walgett, however, Gairdnerᶲ was most affected with nearly 40% lower retention than Navigatorᶲ. Gairdnerᶲ also dropped below the 70% target retention at Moree. In general the screenings from all sites and varieties were below the receival

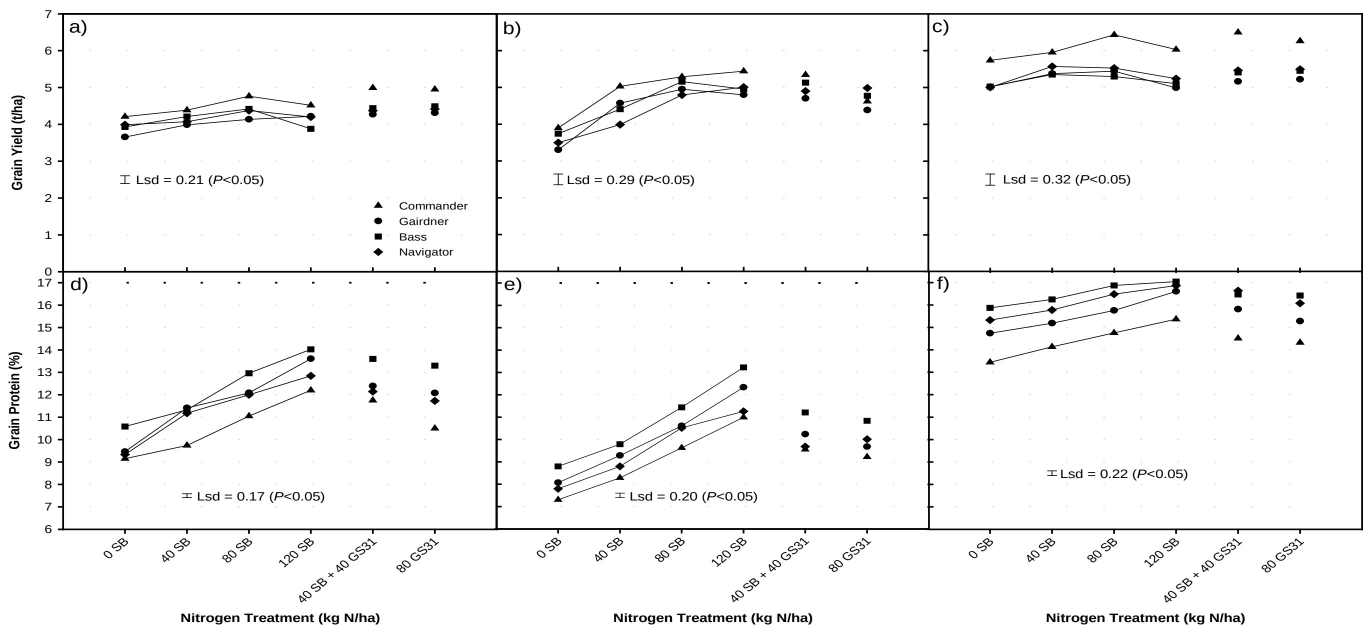


Figure 1: *The yield and protein responses of Commanderᶲ, Bassᶲ, Navigatorᶲ and Gairdnerᶲ barley to six N treatments at Bithramere (a, d), Moree (b, e) and Walgett (c, f) in 2012.*

standard of 7% for malt barley with the exception of Gairdner$^{\phi}$ at Walgett, where screenings were approaching 10%. Bass$^{\phi}$ had the lowest screenings of all varieties, while Commander$^{\phi}$ and Navigator$^{\phi}$ had similar screenings levels (Table 1).

Table 1: *The average grain quality (Test weight(kg/hL), Retention (%), Screenings (%) and 1000 grain weight (g)) for Commander$^{\phi}$, Gairdner$^{\phi}$, Bass$^{\phi}$ and Navigator$^{\phi}$ at Walgett, Moree and Bithramere in 2012. Values designated with different letters within each row are significantly different (P=0.05).*

Site	Quality Trait	Commander$^{\phi}$	Gairdner$^{\phi}$	Bass$^{\phi}$	Navigator$^{\phi}$
Walgett	Test Weight	74.5 a	73.8 b	74.7 a	73.4 b
	Retention %	79.6 a	31.5 d	74.7 b	69.5 c
	Screenings %	3.0 b	9.8 a	2.2 c	3.6 b
	1000GW	41.6 a	38.4 b	39.5 ab	36.4 c
Moree	Test Weight	71.9 b	71.3 c	74.1 a	71.2 c
	Retention %	90.1 b	69.4 d	96.6 a	79.2 c
	Screenings %	4.1 b	4.9 a	0.2 d	2.2 c
	1000GW	40.4 b	41.4 b	45.3 a	39.8 b
Bithramere	Test Weight	70.4 b	70.6 b	72.8 a	68.2 c
	Retention %	91.0 b	75.8 d	96.7 a	87.2 c
	Screenings %	1.7 b	2.8 a	0.6 c	1.7 b
	1000GW	42.0 b	41.3 b	44.6 a	38.6 c

Summary

There has been a trend for new barley varieties to achieve lower proteins; however, both Navigator$^{\phi}$ and Bass$^{\phi}$ appear to be more protein responsive to N applications compared to Commander$^{\phi}$. The low protein of Commander$^{\phi}$ has generally been an advantage to meeting malt specifications, however, over the past couple of seasons extremely low proteins have been achieved throughout the region (<9%) suggesting that yield may have been sacrificed at this level. This highlights the need to have some indication of starting soil N levels. The higher protein achievement of Bass$^{\phi}$ and Navigator$^{\phi}$ indicates that growers may need to be careful growing these varieties on paddocks with high levels of residual N as it may jeopardise achieving malt specifications. Bass$^{\phi}$ and Commander$^{\phi}$ appear to maintain the highest grain quality (in terms of meeting malt specifications) under a range of N levels. However, Commander$^{\phi}$ still maintains a yield advantage over Bass$^{\phi}$ and would be slightly better suited to higher N situations. This recommendation comes with caution that high starting N would increase the risk of lodging in Commander$^{\phi}$, which may be negated through plant population, planting time or delayed application of any N if required. The Walgett site again highlighted the problems with low retention and high screenings in Gairdner$^{\phi}$ when it is grown under high N conditions and has a dry finish to the season.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Paul and Charles Tattam "Bonniedoon", Gavin Hombsch, "Hyland" and Dave Denyer, "Wattle Plains" are gratefully acknowledged for the provision of the trial sites. Technical assistance provided by Rod Bambach, Jan Hosking, Jim Perfrement and Peter Formann are also gratefully acknowledged.

Effect of applied phosphorus on yield in chickpea

Andrew Verrell NSW DPI, Tamworth

Introduction

The availability of adequate phosphorus (P) is essential if chickpeas are to reach their full yield potential. Being a tap rooted plant chickpeas are not as good at thoroughly exploring the soil as cereals which have fibrous root systems. However, they are able to capitalise on a P source, like a fertiliser band very efficiently, by concentrating root activity in the fertiliser band.

If the area sown to chickpeas is to expand they will need to be grown on the areas of red soils of central NSW as well as the uniform clays in north western NSW. The red soils tend to have lower inherent P due to soil type and length of cropping.

Key findings

Under low soil P (Colwell < 20 mg P/kg) applying 10 kg P/ha at sowing gave a yield advantage of 13% over not applying P.

High rates of straight P (20 kg P/ha) tended to lead to yield suppression compared to 10 kg P/ha.

High rates of starter fertiliser (20 kg P/ha) also led to lower yields compared to when 10 kg P/ha was applied.

Treatments

A trial was established at Tamworth Agricltural Institute (TAI) in 2012. In 2012, P was applied at sowing to cultivar PBA HatTrick⁽ᵈ⁾ at rates of 0, 5, 10 and 20 kg P/ha as Triple superphosphate. Additional treatments applied were Granulock SuPreme Z (20 kg P/ha, 10 kg N/ha and 1 kg Zn/ha) and Urea + Triple Superphosphate (20 kg P/ha, 10 kg N/ha).
This trial was sown on a low P (Colwell 16 mg P/kg) red duplex soil.

Results

- Chickpeas responded to applied P at 10 and 20 kg P/ha resulting in increased grain yield (Figure 1).
- There was a tendency for grain yield to be suppressed at 20 kg P/ha compared to when 10 kg P/ha was applied.
- Suppression of yield in PBA HatTrick⁽ᵈ⁾ at high rates of applied P has been seen in previous years.
- The Granulock SuPreme Z treatment had a similar grain yield to the 20 kg P/ha treatment (Figure 2).
- The Urea + triple superphosphate treatment had significantly lower grain yield than the 10 and 20 kgP/ha treatment (Figure 2).

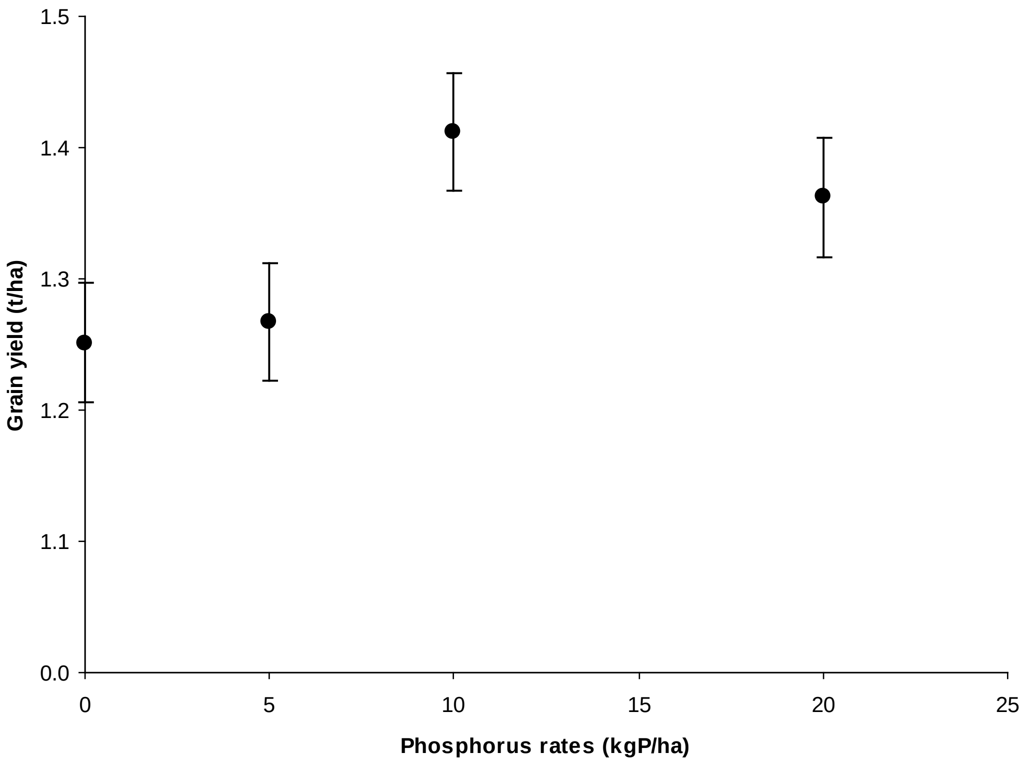
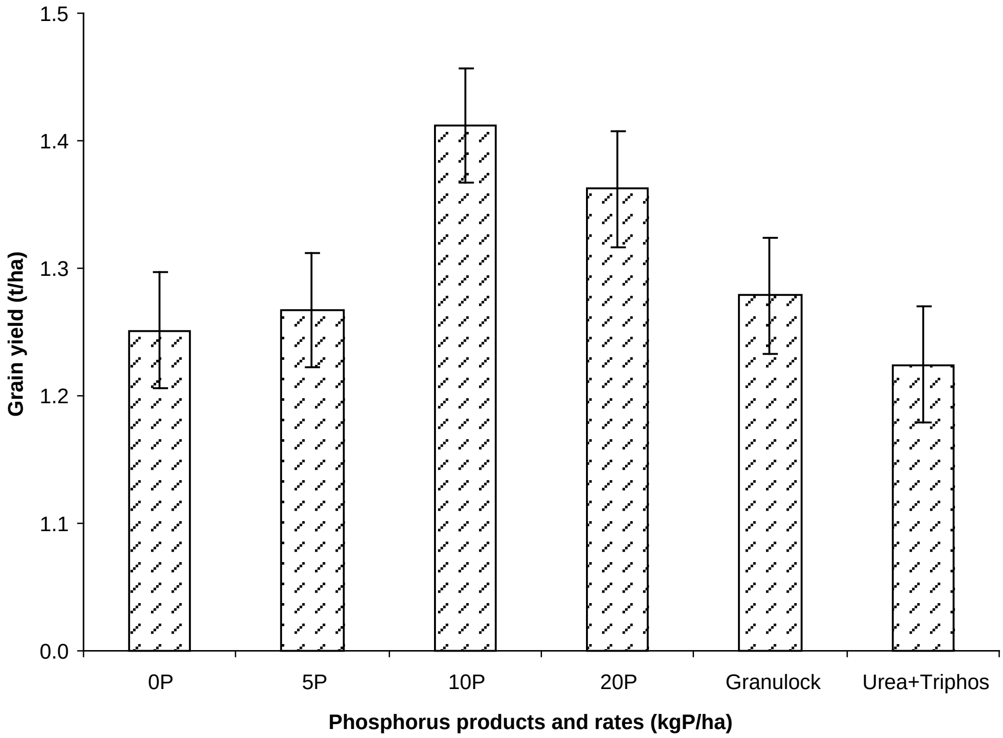


Figure 1: *Chickpea grain yield (t/ha) in response to applied P at sowing (Error bars indicate se ± 0.045 t/ha)*

NUTRITION & SOILS

Figure 2: *Comparison of chickpea grain yield (t/ha) for rates of applied P plus Granulock Zn and Urea + Triple Superphospate (Error bars indicate se ± 0.045 t/ha)*



Summary

Chickpeas certainly respond to applied P, especially where available P is low. A rate of 10 kg P/ha gave a 13% yield advantage over not applying P.

Using a starter fertiliser such as Granulock SuPreme Z or a composite of Urea + Triple Superphosphate (TSP) gave no advantage over the straight Triple Superphosphate application. In fact, the composite of Urea and TSP had a significantly lower yield then these treatments, There was a tendency for yield to be suppressed at this higher rate (20 kg P/ha) which may suggest antagonism in the seeding furrow from high salt content due to these higher rates. At these high rates and at 40 cm row spacing approximately 4g of fertiliser is being applied per metre of row with the seed. This issue needs to be explored further.

Acknowledgements

Thanks to funding from GRDC and Michael Nowland and Paul Nash for their assistance in the trial program.

Nitrogen and sulfur nutrition in canola at Blackville and Moree in 2012

Matthew Gardner, Rod Bambach and Jan Hosking NSW DPI, Tamworth

Introduction

Since fertiliser programs are a major expense and profit margins can be variable in canola production, producers and field agronomists need information on nutrient relationships to fine-tune fertiliser recommendations. The literature indicates that N and S relationships are very important in canola production. The quantity of nutrients required to optimize production depends on the yield potential of the crop, the method and form of application of the fertiliser, and the levels of available nutrients in the soil. Canola has a relatively high nutrient requirement, and most soils on which the crop is grown are deficient in one or more nutrients for optimum seed yield and oil and protein concentration based on current literature.

The N and S requirements of crops are closely related because both nutrients are required for protein synthesis. Sulfur has been described as being especially critical in canola production as S deficiencies have the potential to restrict yield. Nitrogen applications consistently decrease oil and increase protein content; however, large quantities of N are required to maximise grain yield in canola. The nutrient requirement guidelines for canola suggest that crops need 15 kg of S and 60 kg of N/t of grain produced. Typically S nutrition has probably been considered equally important to N. However, there has been increasing questions recently whether there should be greater focus on N nutrition. Therefore, two trials were established to determine the impact of N and S nutrition on grain yield, protein and oil concentration in canola.

Key findings

There was no significant affect of sulfur (S) application on grain yield, oil content or protein in the trials reported here, which supports the findings of other trials conducted in the Central West and Northern regions.

The lack of S response suggests the need to re-evaluate S nutrition tactics and critical soil test levels.

In contrast there were large responses to nitrogen (N). Grain yield and dry matter accumulation significantly increased with increases in N application up to 120 and 200 kg N/ha at Moree and Blackville, respectively.

Grain protein and oil content were inversely related. Increases in protein, from increased N application, caused oil content to decline.

Site details

Moree

Co-operator:	**Paul and Charles Tattam, "Bonniedoon"**
Previous Crop:	**Chickpeas**
Starting N:	**51 kg N/ha (0–120 cm)**
Starting S:	**20 kg S/ha (0–30 cm)** **87 kg S/ha (0–120 cm)**
Sown:	**3rd May**

Blackville

Co-operator:	**Joe Fleming, "Parraweena"**
Previous Crop:	**Wheat**
Starting N:	**41 kg N/ha (0–120 cm)**
Starting S:	**31 kg S/ha (0–30 cm)** **121 kg S/ha (0–120 cm)**
Sown:	**16th May**

Treatments

At both sites two varieties were grown, Pioneer® 44Y84 and Hyola® 555TT as these two varieties are known to have varying oil achievement. Typically the Hyola® 555TT has lower oil achievement compared to Pioneer® 44Y84. The focus of both trials was solely on N and S responses with both sites receiving 20 kg P/ha applied as triple superphosphate at planting with the seed to eliminate P effects. This also provided a baseline level of 1 kg S/ha. Nitrogen was applied as Urea while S was applied as granulated gypsum. Both Urea and gypsum were side banded approximately 7.5cm below the seed and 7.5cm away from the planting row to avoid any impact on establishment. All fertiliser treatments were applied at planting. Nitrogen rates were 0, 40, 80 and 120 kg N/ha at the Moree site and 0, 50, 100 and 200 kg N/ha at Blackville. Higher N rates were used at Blackville as it was expected that grain yields would be 2.5 t/ha compared to 1.5 t/ha at Moree. Applied S rates in the form of Gypsum were 0, 10, 20 and 40 kg S/ha at both sites. The S rates were not adjusted for the baseline S received from the Triple superphosphate. Trials were fully factorial with four N rates × four S rates × two varieties and four replicates.

Results

There was no significant effect of S application on dry matter (DM) accumulation at 50% flowering, grain yield, oil and protein content or harvest index at either site. In addition, there were no interactions between S and N, which means N responses were not limited by S nutrition at either site. The soil levels of S at both sites were relatively low (below the critical level) in the surface 10 cm (<6 mg/kg); however, between the 10–30 cm depth interval values were >4mg/kg (considered the critical level at depth). Therefore, the S present below the surface 10 cm may have been sufficient to prevent any S responses being observed at either site. There is a large proportion of soils in the northern grains region where S levels would be considered high in the subsoil below 60 cm. Therefore, potentially these soils had ample S to meet crop demands without relying on fertiliser inputs.

In contrast there were significant responses to N application for all measured parameters at both sites, which was most likely a result of the low starting residual N levels in the soil profile (0–120 cm). The DM significantly increased by 1.3, 1.7 and 2.0 t/ha for the 50, 100 and 200 kg N/ha treatments, respectively, compared to the 0 N treatment (3.16 t DM/ha) at Blackville. At Moree the DM accumulation for the 0 N treatment was 2.25 t DM/ha, which was 70, 56 and 46% of the DM accumulation achieved from the applications of 40, 80 and 120 kg N/ha. The responses in DM accumulation at anthesis were similar to the grain yield responses.

With each increase in N application at the Moree site there was a significant increase in grain yield. Between the 0 N treatment and the 120 N treatment there was a 0.74 t/ha increase in grain yield. Similarly at the Blackville site there was a 1 t/ha increase in grain yield between the 0 N treatment and the 200 N treatment. Although the application of either 50 or 100 kg N/ha increased grain yield by 0.52 and 0.7 t/ha there was no significant difference between the two N treatments.

However, the application of 80 kg N/ha or more at Moree and 100 kg N/ha or more at Blackville resulted in significant reductions in grain oil content. Decreases in oil content were approximately 2% when increasing N rates from 40 to 120 kg N/ha or 50 to 200 kg N/ha at Moree and Blackville, respectively. There was no significant affect on oil content at Moree for the 0 and 40 kg N/ha treatments, while the application of 50 kg N/ha actually significantly increased oil content at Blackville by 0.76%.

The protein results from Moree were approximately 2% higher than Blackville, while oil contents at Moree were approximately 2% lower than Blackville. With every increase in N application rate there was an increase in grain protein at both sites. The only instance where this was not significant was at Moree where the 40 and 80 kg N/ha treatments achieved similar protein concentrations.

The application of N had little impact on harvest index unless it was the top N rate at Moree or Blackville, which significantly increased harvest index by 4 and 6% compared to the 0 kg N/ha treatment, respectively.

***Table 1:** Responses of anthesis dry matter (DM) yield, grain yield, oil content, protein and harvest index to four N nutrition levels at Blackville in 2012.Values designated with different letters within each column are significantly different (P=0.05).*

N rate (kg/ha)	DM Yield (t/ha)	Grain Yield (t/ha)	Oil (%)	Protein (%)	Harvest Index (%)
0	3.16 c	0.99 c	45.47 b	18.05 a	26.96 b
50	4.51 b	1.51 b	46.23 a	18.38 b	27.07 b
100	4.86 b	1.69 b	45.80 b	18.97 c	27.53 b
200	5.23 a	1.99 a	44.68 c	19.83 d	31.43 a
Lsd (P =0.05)	0.36	0.19	0.37	0.32	1.20

***Table 2:** Responses of anthesis dry matter (DM) yield, grain yield, oil content, protein and harvest index to four N nutrition levels at Moree in 2012. Values designated with different letters within each column are significantly different (P=0.05).*

N rate (kg/ha)	DM Yield (t/ha)	Grain Yield (t/ha)	Oil (%)	Protein (%)	Harvest Index (%)
0	2.25 d	0.73 d	43.87 a	20.60 a	17.91 b
40	3.22 c	1.08 c	44.30 a	21.47 b	17.69 b
80	3.99 b	1.31 b	43.22 b	21.83 b	18.51 b
120	4.85 a	1.47 a	42.27 c	22.88 c	21.99 a
Lsd (P =0.05)	0.28	0.14	0.52	0.40	1.30

There was no significant interaction between variety and N treatment. However, Pioneer® 44Y84 had higher grain yield (0.26 t/ha) and oil content (2.4%), while having significantly lower protein content (2.1%) on average across both sites.

Summary

There was no significant affect of S application on grain yield, oil content or protein, which may be explained by the high levels of S available in the subsoil. However, similar trials in the conducted in the Central west by NSW DPI and Grain Orana Alliance (GOA) have also reported no response to S application in canola, despite available S being much lower than these trials (as low as 18 kg S/ha down to 90 cm). This suggests that our traditional approach to S nutrition in the northern grains region may have to be re-evaluated. Typically S nutrition has been considered equally important to N, however, from these trials responses were only significant N treatments across all measured parameters. At both sites the application of N significantly increased both grain yield and DM accumulation at anthesis. These responses were relatively linear suggesting that there may have been greater responses with higher N rates. Protein and oil content were inversely related where increases in protein from increased N application caused oil content to decline.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Joe Fleming, "Parraweena" and Paul and Charles Tattam, "Bonniedoon" are gratefully acknowledged for the provision of the trial sites. Technical assistance provided by Patrick Mortell, Stephen Morphett, Jim Perfrement and Peter Formann are also gratefully acknowledged.

The effect of nitrogen and phosphorus application on establishment and yield of four canola varieties – Nyngan 2012

Rohan Brill NSW DPI, Coonamble **and Tim McNee** NSW DPI, Nyngan

NUTRITION & SOILS

Key findings

Averaged across four canola varieties, the application of 30 kg/ha nitrogen significantly increased average grain yield of four canola varieties by 0.26 t/ha. Applying 60 kg/ha N increased average grain yield by a further 0.21 t/ha compared with the 30 kg/ha N treatment.

The application of 5 kg/ha phosphorus significantly increased grain yield of all varieties by an average of 0.16 t/ha, with no further yield increase for applications of P above 5 kg/ha.

Introduction

Phosphorus and nitrogen represent two major input costs for canola production. In western areas the application of these nutrients can be risky with a higher rate of crop failures; however, there can also be significant increases in yield potential when seasonal conditions allow.

The nutritional demand of canola (especially N and P) is complicated by the knowledge that the application of fertiliser with the seed can affect canola establishment. At the row spacing used in this trial (33.3 cm), GRDC recommends a phosphorus rate of 5 kg/ha to avoid establishment losses from fertiliser toxicity.

This trial aims to determine the response of applied N and P to canola in a western region of the NSW cropping belt, as well as to determine if there are differences in N and P use between canola varieties and types. Further to this the trial also investigates the effect of fertiliser rate (triple super) on the establishment of the canola varieties.

Site details

Soil type:	**Red loam**
Sow date:	**17th April**
N applied:	**23rd May**
PAW at sowing:	**160 mm (estimate)**
In-crop rainfall:	**97 mm**
Previous crop:	**Wheat**
Soil tests (0–10 cm):	**Colwell P 22 mg/kg** **pH ($CaCl_2$) 5.0**
Deep N:	**N/A**

Treatments

4 varieties (sown at 60 seeds/m²): ATR-Stingray⁽ᴾ⁾, Hyola 555TT⁽ᴾ⁾, Pioneer® 43Y85 CL, Pioneer® 43C80 CL.
4 P rates: 0, 5, 10 and 20 kg/ha (applied as triple super with the seed)
3 N rates (applied only at the 20 kg/ha P rate): 0, 30 and 60 kg/ha

Results

- Increasing the rate of phosphorus applied from nil to 20 kg/ha reduced establishment of all varieties by an average of 65%. There was a significant reduction in canola establishment for each increase in P rate, with no interaction between variety and P rate.

- Despite the reduced establishment, there was a yield increase of 0.16 t/ha as a result of applying 5 kg/ha P compared with the nil P treatment (Figure 2).
- There was no further yield increase for applications above the 5 kg/ha P rate, suggesting that the positive nutritional response of phosphorus outweighed the negative effect of triple super on canola establishment.
- The application of 30 kg/ha N increased grain yield by 0.26 t/ha averaged across all varieties.
- Increasing the N application rate from 30 to 60 kg/ha resulted in a further yield increase (averaged across all varieties) of 0.21 t/ha.
- Pioneer® 43Y85 CL (average yield 1.8 t/ha) was the highest yielding variety at all N rates. ATR Stingray⁽ᶜᵇ⁾ (average yield 0.7 t/ha) was the lowest yielding variety at all N rates.
- There was no effect of either nitrogen or phosphorus application on the oil concentration in this trial.
- There were varietal differences in oil concentration, with Pioneer® 43Y85 CL and Pioneer® 43C80 CL averaging 39% oil. This was 1% higher than Hyola 555TT⁽ᶜᵇ⁾ and 3% higher than ATR Stingray⁽ᶜᵇ⁾.

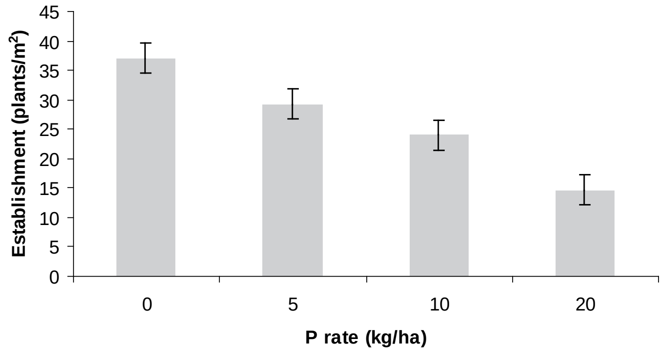


Figure 1: *Effect of phosphorus rate (as triple super) on the average establishment of four canola varieties at Nyngan in 2012*

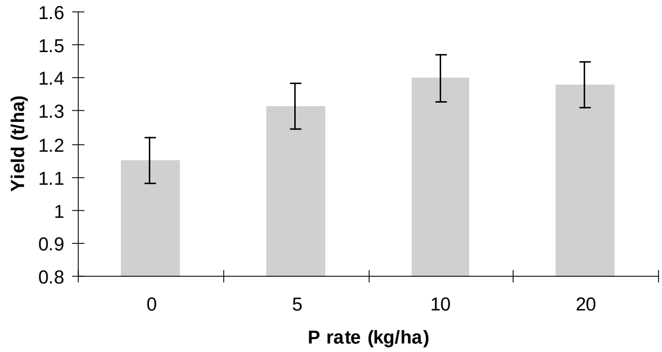


Figure 2: *Effect of phosphorus rate (as triple super) on the average grain yield of four canola varieties at Nyngan in 2012*

Summary

This trial showed a significant detrimental effect of increasing triple superphosphate rate on crop establishment. It is unclear from this trial whether the effect on plant establishment was due to toxic effects of the phosphorus or general osmotic effects of the fertiliser. Where moisture for canola establishment is marginal at sowing, it would be recommended to reduce contact of fertiliser with the canola seed to avoid affecting establishment.

It is also unclear if the lack of yield response at the higher rates of P was due to reduced establishment or a general low requirement for this crop in this paddock.

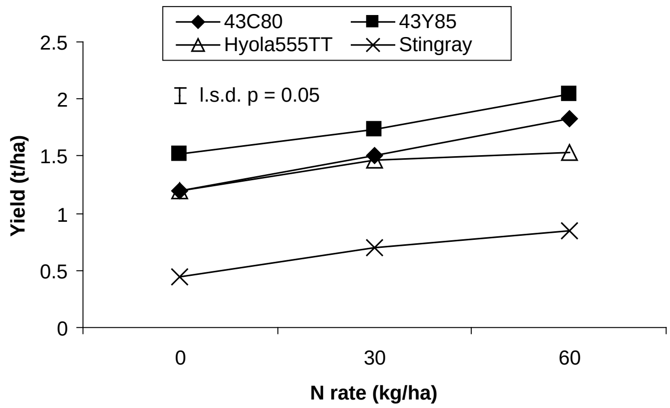


Figure 3: *Effect of nitrogen rate on the average grain yield of four canola varieties at Nyngan in 2012*

The grain yield response to applied nitrogen was consistent across all varieties. The application of 30 kg/ha N resulted in a grain yield response of 0.26 t/ha, which represents about 9 kg/ha increased grain yield for each 1 kg/ha of nitrogen applied.

Of the varieties sown in VSAP canola trials in the central-west in 2012, hybrid Clearfield varieties have been consistently high yielding, while lowest yielding varieties have generally been the open-pollinated TT lines.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

Nitrogen response of four canola varieties – Gilgandra and Wellington 2012

Rohan Brill NSW DPI, Coonamble **Greg Brooke** NSW DPI, Wellington **Kathi Hertel** NSW DPI, Dubbo

NUTRITION & SOILS

Key findings

There was a yield increase with increasing nitrogen (N) rate for all varieties at Wellington, but only for 45Y82 CL⁽ᵖ⁾ (40 kg/ha rate only) at Gilgandra.

45Y82 CL⁽ᵖ⁾ was the highest yielding variety at Gilgandra, while at Wellington both 45Y82 CL⁽ᵖ⁾ and AV-Garnet⁽ᵖ⁾ were the highest yielding varieties.

Jackpot TT⁽ᵖ⁾ had high oil concentration in both trials; however this was offset by having the lowest yield in both trials.

Increasing N rate at Gilgandra significantly reduced oil concentration for all varieties, even where there was no associated yield benefit.

Introduction

The GRDC funded Variety Specific Agronomy Packages (VSAP) project is focused on closing the yield gap between seasonal potential and achieved yields through optimising specific variety agronomy. It has previously been shown that N is crucial for maximum canola yields to be achieved; however, it is not known whether canola varieties vary in the response to N. These nitrogen trials are designed primarily to investigate the grain yield and oil responses of several varieties of canola across different regions. Specifically in these two trials, the varieties represent three different herbicide groups; Clearfield – Pioneer® 45Y82 CL; Conventional – AV-Garnet⁽ᵖ⁾; Triazine Tolerant (TT)– Hyola 555TT⁽ᵖ⁾ and Jackpot TT⁽ᵖ⁾. Further there are two hybrid varieties; Pioneer® 44Y84 CL and Hyola 555TT⁽ᵖ⁾ and two open-pollinated varieties; AV-Garnet⁽ᵖ⁾ and Jackpot TT⁽ᵖ⁾.

Site details

Gilgandra

Soil type:	**clay loam**
2011 crop:	**Wheat**
2010 crop:	**Lucerne pasture**
Deep nitrogen test:	**62 kg/ha N (0–60 cm)**
PAW at sowing:	**180 mm (estimate)**
In-crop rainfall:	**178 mm**
Sowing date:	**26th May 2012**

Wellington

Soil type:	**Clay loam**
2011 crop:	**Wheat**
2010 crop:	**Canola**
Deep nitrogen test:	**54 kg/ha N (0–60 cm)**
PAW at sowing:	**180 mm (estimate)**
In-crop rainfall:	**228 mm**
Sowing date:	**27th May 2012**

Treatments

4 varieties – AV-Garnet⁽ᵖ⁾, 45Y82 CL⁽ᵖ⁾, Hyola 555TT⁽ᵖ⁾, Jackpot TT⁽ᵖ⁾
3 nitrogen rates at sowing – 0, 40, 80 kg N/ha as Urea 180 kg/ha single super applied to all treatment.

Results

- There was a significant yield response at Wellington from increasing nitrogen from 0 to 40 kg/ha (0.33 t/ha canola) and from 40 to 80 kg/ha (0.19 t/ha canola) (Figure 1).
- At Gilgandra, the application of 40 kg/ha of N significantly increased the yield of 45Y82 CLΦ only (0.55 t/ha), however there was no yield affect beyond 40 kg N/ha (Figure 2).
- AV-GarnetΦ and 45Y82 CLΦ were the highest yielding varieties at Wellington (Figure 1).
- 45Y82 CLΦ was the highest yielding variety at Gilgandra (Figure 2).
- At Wellington, AV-GarnetΦ and Jackpot TTΦ (45% oil) had significantly higher oil concentration than both 45Y82 CLΦ and Hyola 555TTΦ (43% oil). There was no effect of increasing N rate on oil concentration.
- At Gilgandra, Jackpot TTΦ (46% oil at nil N) had on average a 3% higher oil concentration than AV-GarnetΦ, 45Y82 CLΦ and Jackpot TTΦ (average 43% oil at nil N).
- At Gilgandra, there was a 1% decrease in oil concentration where N was increased from nil to 40 kg/ha, with a further 1.1% oil decrease where N was increased from 40 to 80 kg/ha, which was irrespective of changes in grain yield.

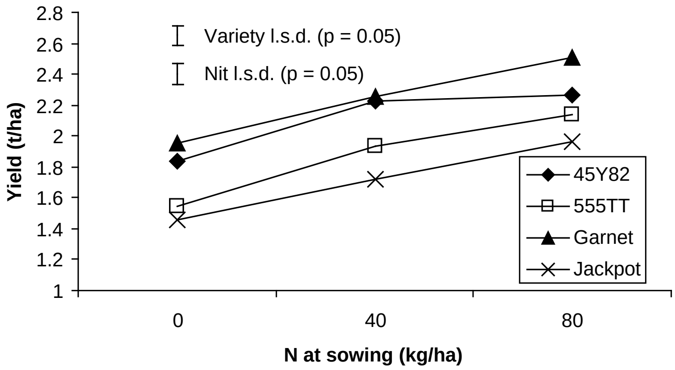


Figure 1: *Effect of nitrogen rate at sowing on yield of four canola varieties at Wellington in 2012*

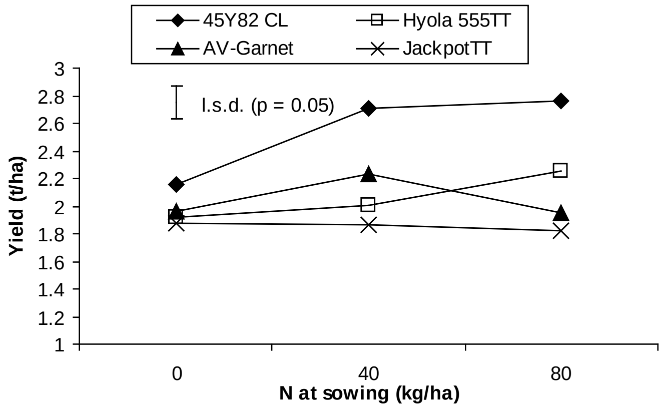


Figure 2: *Effect of nitrogen rate at sowing on yield of four canola varieties at Gilgandra in 2012*

Summary

Pioneer 45Y82 CL had consistently high yield at Gilgandra and Wellington. AV-GarnetΦ had high yield at Wellington only, showing its suitability to relatively higher rainfall and longer season environments. AV-GarnetΦ has been a standout variety for dual purpose canola in southern NSW, and may have a strong fit for this purpose in the central-west slopes.

There were five VSAP canola nitrogen trials sown in 2012 across the region, with four of the five having some level of positive yield response to the application of nitrogen.

Increased nitrogen rates may reduce oil concentration. This was seen at Gilgandra, where increasing nitrogen applied from nil to 80 kg/ha resulted in a 2.1% reduction in oil concentration, which represents a price deduction at the silo of 3.2%.

Clearfield hybrid varieties have been the highest or one of the highest yielding varieties across twelve VSAP canola trials in the central-west in 2012. In contrast, open-pollinated TT lines have been the lowest yielding across these trials. Despite of this, there are still advantages in growing TT varieties as Group B and Group A herbicides become less effective on weeds.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

The effect of nitrogen and sulfur rate on grain yield and oil concentration of canola – Trangie and Coonamble, 2012

Rohan Brill NSW DPI, Coonamble **Leigh Jenkins** NSW DPI, Warren

NUTRITION & SOILS

Key findings

There was no significant effect of nitrogen or sulfur application on grain yield or oil concentration in the Coonamble trial.

The application of nitrogen significantly increased grain yield at Trangie, but significantly decreased oil concentration. There was no effect of sulfur application on grain yield or oil concentration at Trangie.

Of the two varieties sown at Trangie Pioneer® 44Y84 CL was on average 0.4 t/ha higher yielding than Pioneer® 43C80 CL.

Introduction

Along with phosphorus; nitrogen and sulfur are two important nutrients required for canola production. Nitrogen and sulfur can be applied together as ammonium sulphate or individually as Urea or as gypsum, respectively. With declining soil fertility and an increase in cropping intensity, greater demands are being placed on fertiliser nitrogen to meet the requirements of canola crops. This is prominent in the Macquarie Valley region, where the area sown to pulse crops is low relative to north-western NSW.

This trial reports on two nitrogen and sulfur trials conducted at Coonamble and Trangie in 2012. Nitrogen was applied as Urea at the zero S treatments and as various combinations of Urea and ammonium sulphate at higher S treatments.
All S treatments were applied as ammonium sulphate.

Deep soil testing showed high N and S levels in the soil at Trangie compared with moderate N and low S levels at Coonamble. The high level of S available in the soil at Trangie is largely due to the presence of gypsum, increasing at depth.

Site details

Trangie

Soil type:	**Grey vertosol**
Sow date:	**7th May**
N applied:	**21st May**
PAW at sowing:	**180 mm (estimate)**
In-crop rainfall:	**109 mm**
Previous crop:	**Wheat**
Deep N:	**112 kg/ha N (0–90 cm)**
Deep S:	**161 kg/ha S (0–90 cm)**

Coonamble

Soil type:	**Sandy clay loam**
Sow date:	**22nd April**
N applied:	**21st May**
PAW at sowing:	**170 mm (estimate)**
In-crop rainfall:	**100 mm**
Previous crop:	**Wheat**
Deep N:	**56 kg/ha N (0–90 cm)**
Deep S:	**20 kg/ha S (0–90 cm)**

Treatments

4 N rates – 0, 25, 50 and 100 kg/ha
4 S rates – 0, 10, 20 and 30 kg/ha
20 kg/ha P applied as triple super to all treatments
2 varieties at Trangie – Pioneer® 44Y84 CL and Pioneer® 43C80 CL 1 variety at Coonamble – Pioneer® 44Y84 CL

Results

- There was no significant effect of nitrogen or sulfur application on grain yield at Coonamble. The average yield of Pioneer® 44Y84 CL at Coonamble was 2.6 t/ha.
- At Trangie, the application of 50 kg/ha N increased grain yield by 0.2 t/ha compared with where nil N was applied. The application of 100 kg/ha N increased grain yield by 0.3 t/ha compared with where nil N was applied.
- There was no effect of sulfur application on grain yield at Trangie.
- At Trangie, Pioneer® 44Y84 CL was on average 0.4 t/ha higher yielding than Pioneer® 43C80 CL.

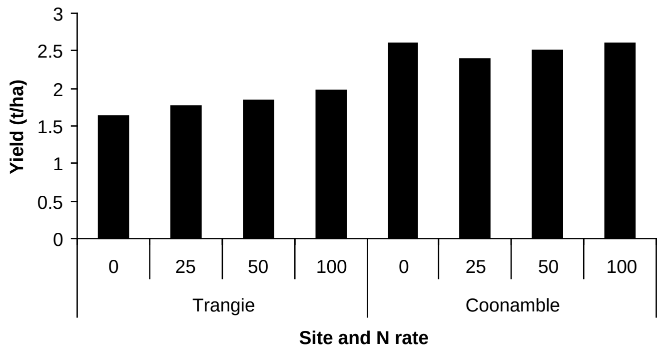


Figure 1: *Effect of nitrogen rate on the grain yield of canola in trials at Coonamble and Trangie in 2012*
L.s.d. (P = 0.05) Coonamble – 0.4 t/ha, Trangie 0.2 t/ha

- There was no significant effect of N or S application on oil concentration at Coonamble (average 42%).
- At Trangie, oil concentration was reduced with increasing N application. At the 50 and 100 kg/ha N rates, the respective oil concentrations were 0.6 and 1.6% lower than the nil N treatment.
- There was a small but significant difference in oil concentration between the two varieties at Trangie. Pioneer® 44Y84 CL had an oil concentration of 42.5% compared with 41.9% for Pioneer® 43C80 CL.

Summary

There were five VSAP canola nitrogen trials conducted in the central-west region in 2012. Four of the five trials had some degree of positive response to nitrogen application, ranging from only one variety being responsive at the low N rate at Gilgandra, to all varieties having increased grain yield at all N application rates at Wellington and Nyngan. These trial results highlight the high nitrogen demand of canola.

It is also accepted that canola has a high demand for sulfur; however, neither trial reported here had a grain yield or oil concentration response to the application of sulfur. The deep soil test at Coonamble (20 kg/ha available S) would be considered a low S value for canola. The reason for the lack of yield response is unclear, but could be due to lower demand of canola than is generally accepted or an issue with the soil testing process, such as poor calibration of soil test values or not testing deep enough. Traditionally, S decisions have been made on S values in the surface 30cm. Testing soil to the entire crop rooting depth may enable the development of a more comprehensive response curve across a range of soil types. Typically in Vertosols S generally increases in concentration with increasing soil depth. This was the case at Trangie, where there were high levels of S available in the soil at sowing, with sulfur being present in the soil as gypsum. The gypsum concentration increases markedly with depth.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

Phosphorus response of four canola varieties – Trangie and Coonamble 2012

Rohan Brill NSW DPI, Coonamble **Leigh Jenkins** NSW DPI, Warren

NUTRITION & SOILS

Key findings

There was no effect of phosphorus (P) application (triple super) on canola establishment at Trangie. The application of 10 kg/ha P significantly increased grain yield compared to where no P was applied (0.14 t/ha), with no further yield increase at the 20kg/ha P rate.

Increasing the rate of phosphorus applied reduced canola establishment and grain yield at Coonamble.

Pioneer® 43Y85 CL was the highest yielding variety, being 0.3 t/ha higher yielding than the next variety Pioneer® 43C80 CL in both trials.

Introduction

The NSW DPI and GRDC funded Variety Specific Agronomy Packages (VSAP) project is focussed on maximising variety performance in local farming systems. These trials investigated whether the grain yield and oil responses of several varieties of canola varied with different P nutrition. Besides testing the phosphorus nutrition effect on canola, the trials also examined the effect of phosphorus fertiliser on canola establishment on two contrasting soil types, Grey Vertosol and Sandy Clay Loam. At the row spacing (33.3 cm) and with narrow knife points, it is recommended that a phosphorus application rate of approximately 5 kg/ha is safe when applied directly with the seed and where good moisture is available. The amount of P that can be safely applied with the seed increases as row spacing is narrowed.

Site details

Trangie

Soil type:	**Grey vertosol**
2011 crop:	**Wheat**
Phosphorus (0–10 cm):	**19 mg/kg Colwell** **37 mg/kg BSES**
PAW at sowing:	**180 mm (estimate)**
In-crop rainfall:	**109 mm**
Sow date:	**7th May 2012**

Coonamble

Soil type:	**Sandy clay loam**
2011 crop:	**Wheat**
Phosphorus (0–10 cm):	**76 mg/kg Colwell** **202 mg/kg BSES**
PAW at sowing:	**180 mm (estimate)**
In-crop rainfall:	**100 mm**
Sow date:	**22nd May 2012**

Treatments

4 varieties – Pioneer® 43C80 CL, Pioneer® 43Y85 CL, Hyola® 555TT⁽ᴾ⁾, ATR Stingray⁽ᴾ⁾
4 phosphorus rates (triple super – 0N:20P) at sowing – 0, 5, 10 & 20 kg/ha

Results

- There was no effect of P application rate on canola establishment at Trangie.
- Increasing the rate of P applied significantly reduced canola establishment of all varieties at Coonamble (Figure 1).
- Averaged across all varieties, there was a significant yield increase of 0.14 t/ha at Trangie from the application of 10 kg/ha P compared with where no P was applied. There was no further yield increase from the application of 20 kg/ha P (Figure 2).
- Averaged across all varieties, there was a significant yield reduction at Coonamble as a result of increasing the P application rate above the nil P treatment (Figure 2).
- Pioneer® 43Y85 CL was the highest yielding variety at both sites (average 1.7 t/ha at Trangie and 1.6 t/ha at Coonamble), which was at least 0.3 t/ha higher yielding than all other varieties (data not shown).
- ATR-Stingray⁽ᴰ⁾ was the lowest yielding variety at Coonamble (average 0.8 t/ha).
At Trangie ATR-Stingray⁽ᴰ⁾ and Hyola® 555TT⁽ᴰ⁾ had similarly low yields (average 1.2 t/ha) (data not shown).
- There was no effect of P rate on oil concentration at Trangie or Coonamble (data not shown).
- There were small but significant differences in oil concentration between varieties. Pioneer® 43C80 CL had the highest oil concentration at both sites (42.4% oil at Trangie and Coonamble) (data not shown).

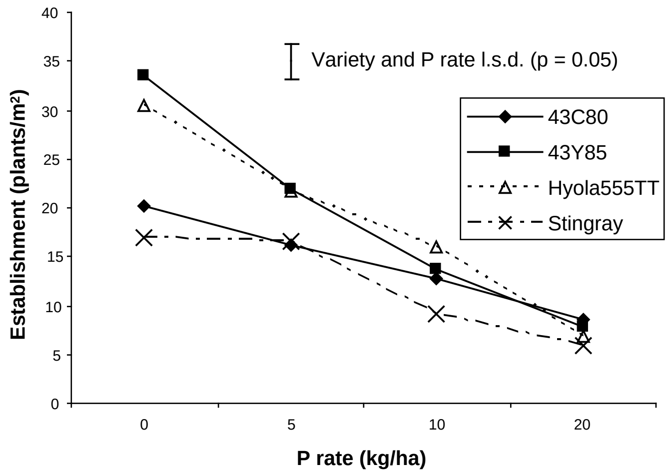


Figure 1: *Effect of phosphorus rate (as triple super) applied at sowing on establishment of four canola varieties at Coonamble in 2012*

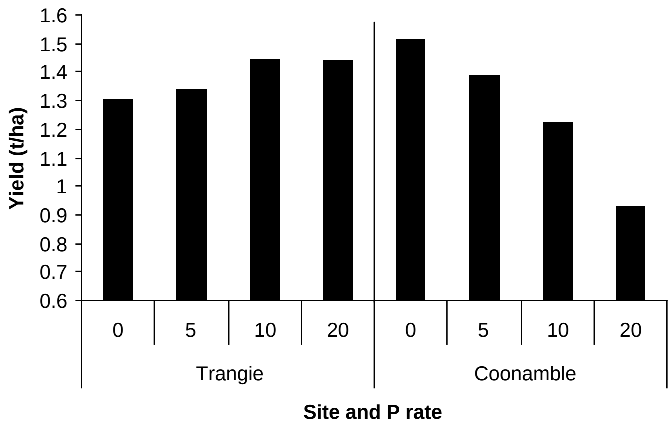


Figure 2: *Effect of phosphorus rate (as triple super) applied at sowing on the average grain yield of four canola varieties at Trangie and Coonamble in 2012*
l.s.d. Trangie (p = 0.05) variety and P rate 0.12 t/ha
l.s.d. Coonamble (p = 0.05) variety and P rate 0.1 t/ha

Summary

The application of phosphorus as triple super reduced the establishment of canola at two sites in the central-west in 2012, Coonamble and Nyngan (paper also included in 2013 Northern Grains Region Trial Results Book). Both these trial sites could be described as 'light' or 'red' soil types. There was no effect of P rate on canola establishment at Trangie on a grey vertosol soil.

In relatively wide row farming systems of northern NSW, for a given fertiliser rate in kg/ha, more fertiliser is placed in a planting furrow than in narrower row farming systems. At a row spacing of 33.3 cm, GRDC's fertiliser toxicity fact sheet recommends applying no more than 5 kg/ha P with the seed. The trial reported here indicates that significant damage can occur even at this low P rate.

It is unclear if the effect of triple super on canola establishment is due to phosphorus toxicity, salt effects or other chemical effects such as fluorine toxicity. However for situations where soil tests indicate a high P requirement, there needs to be some level of separation between seed and fertiliser to ensure good establishment rates are achieved.

The reduced yield at Coonamble where P rate was increased was indirectly due to reduced establishment. At the lower plant populations, the effect of weed competition (not quantified) increased. Visually there appeared little effect of weeds on plots with good establishment; however, where establishment was poor, the weeds were larger and competed with the crop for water and nutrients. Establishment of an even plant stand with good early vigour is a useful tool to reduce reliance on herbicides.

There was no advantage of large seeded hybrid varieties in terms of establishment at high P rates compared with the smaller seeded open pollinated varieties. However, Pioneer® 43Y85 CL was the highest yielding variety in both these trial. The Clearfield hybrid varieties have generally been the highest yielding varieties in all central-western VSAP trials in 2012, except for in the eastern environment at Wellington.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

Further Reading

GRDC Fertiliser Toxicity Fact Sheet:
http://www.grdc.com.au/~/media/90895519B46D4E2FA75925761C23B2F6.pdf

Surface soil carbon is higher under minimum tillage in major cropping soils of NSW North-West Slopes and Plains region

M.K. McLeod, G.D. Schwenke and S. Harden NSW DPI, Tamworth **A.L. Cowie** Rural Climate Solutions, UNE

Key findings

Total organic carbon in the surface 10 cm was 19–28% greater under minimum tillage than conventional tillage across 122 Chromosol and Vertosol sites.

The influence of rainfall, temperature, bulk density, texture, and management history on soil C stocks needs to be considered when assessing C sequestration potential of cropping soils.

Introduction

The low carbon (C) stock level in Australian agricultural cropping soil provides a significant opportunity for C sequestration. The recent initiative to consider soil C in domestic emissions trading requires a scientific assessment of soil C levels under a range of cropping soil management practices. Some of the previous research in southern and western NSW showed that the rate of C decline in cropping soils is slowed under minimum tillage. However, despite the increasing adoption of reduced tillage practices in the NSW North-West Slopes and Plains region, such comparison is rare.

The objective of this paper is to compare and contrast total soil carbon stock on two major cropping soils (Vertosol and Chromosol) in the NSW North-West Slopes and Plains region to assess the potential of tillage practices to maintain or sequester C.

Site details

A soil survey was conducted across 122 commercial grain and cotton cropping sites across the NSW North-West Slopes and Plains region. The average annual rainfall is about 450 mm in the western part to around 850 mm in the eastern part of the region. For each site management history for the previous 10 years was recorded. Information included crop/pasture type, crop yield, tillage practice, fallowing history, stubble management, rates of nitrogen, phosphorus and potassium fertiliser applied, and whether irrigation and soil ameliorants were used.

Treatments

Soil type:	**Vertosol (cracking clays) and Chromosol (red-brown earth)**
Tillage:	**Conventional tillage (2 or more tillage operations in addition to sowing per year) and** **Minimum tillage (0 or 1 tillage operation in addition to sowing per year).**

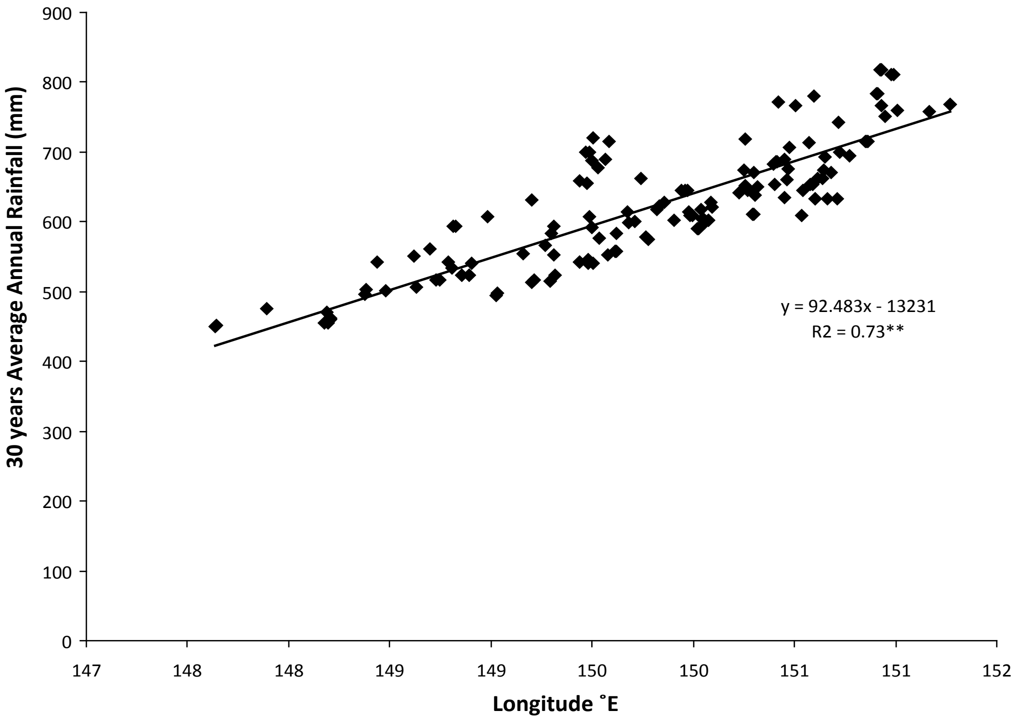
At each site, soil samples were collected at 10 cm depth increments down to 30 cm from 10 representative sampling points within a selected 25 × 25 m area. Soil samples were analysed for bulk density, moisture content, and total carbon and nitrogen. Soil C results were expressed on a mass basis (Mg ha^{-1}) by multiplying the C in a depth segment by the soil bulk density for that segment.

Results

- Total organic carbon (TOC) stocks were influenced by location, environmental factors, soil properties, and management (i.e fertiliser history).
- There was a significant trend of increasing TOC from western to the eastern part of the region, and it was consistent with the increasing average annual rainfall from west to east (Figure 1).
- Soil C was higher at sites with higher average rainfall but lower at sites with higher average temperature.
- Soil C stock in the 10 cm zone increased with the increase in total soil nitrogen (TN) but was decreased with the increase in soil surface bulk density.
- Soil C was increased with the increase in soil silt content at 0–10 cm depth, but decreased with the increase in sand content.
- There was no relationship between soil C stock and measured clay content.

These environmental, soil and management factors are inter-related because the east-west distribution of sites is also related to rainfall and temperature. The eastern region is generally wetter, more elevated, and thus cooler than the western areas of region, with a gradient of lower rainfall and higher temperature from east to west.

*__Figure 1:__ East-west distribution of rainfall across cropping sites. ** indicates highly significant correlation (P<0.01).*



Soil carbon stock in the surface 10 cm was affected by tillage practices (Figures 2 and 3):

- In Vertosols, TOC for the whole 0–30 cm depth was not statistically different between conventional tillage (27.5 Mg ha^{-1}) and minimum tillage (31.4 Mg ha^{-1}). But in the surface 0–10 cm, it was significantly greater under minimum tillage (15.2 Mg ha^{-1}) than conventional tillage (11.9 Mg ha^{-1}).
- In Chromosols, TOC was higher under minimum tillage than conventional tillage in the 0–30 cm (39.8 Mg ha^{-1} vs 33.5 Mg ha^{-1}) and in 0–10 cm (19.7 Mg ha^{-1} vs 16.9 Mg ha^{-1}).

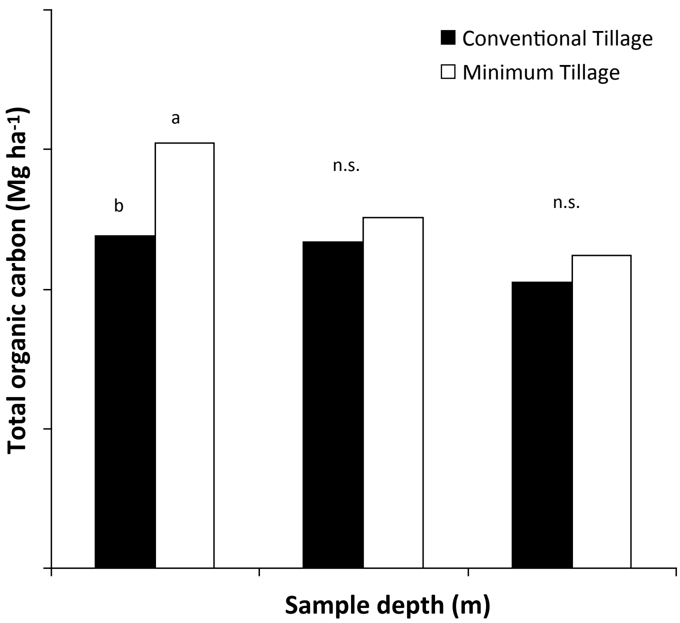


__Figure 2:__ Mean TOC in each sample depth under conventional tillage and minimum tillage on Vertosol sites. Letters on columns denote statistically significant differences (P<0.05); n.s. indicates no significant difference

Conventional tillage breaks down soil aggregates and prevents formation of new aggregates that protect soil organic matter (SOM). Tillage operations increases soil aeration and can also lead to higher soil temperature, both these factors enhance decomposition of SOM. Cultivated soils are also more vulnerable to loss of organic matter-rich topsoil through wind and water erosion.

Changing from conventional tillage with stubble burning to no-tillage, N-fertilised cropping with stubble retention has been demonstrated to slow or even reverse the decline of TOC. However, the significance of tillage practice per se is unclear. Many studies suggest that reduced or zero tillage can maintain or increase soil C, relative to conventional tillage. However, doubts about the benefits of reduced tillage have been raised over the magnitude of the potential benefits. Studies that have sampled to greater depths have tended to find less overall impact on soil C as a result of tillage practice than those that have concentrated only on the topsoil.

Recent studies have also concluded that the impact of tillage on soil C is affected by soil type, climate, specific tillage/stubble management techniques, and the crop yield response to reduced tillage. Minimum tillage practices tend to increase the particulate soil C fractions but these are easily degraded by cultivation which exposes protected organic materials to microbial activity.

We found that TOC stock within the surface 10 cm depth was 19–28% higher under minimum tillage than under conventional tillage on both soil types. However, the TOC stock for the combined depths (0–30 cm depth) on Vertosol soils was not affected by tillage practices, while on Chromosols, it was higher under minimum tillage compared to conventional tillage.

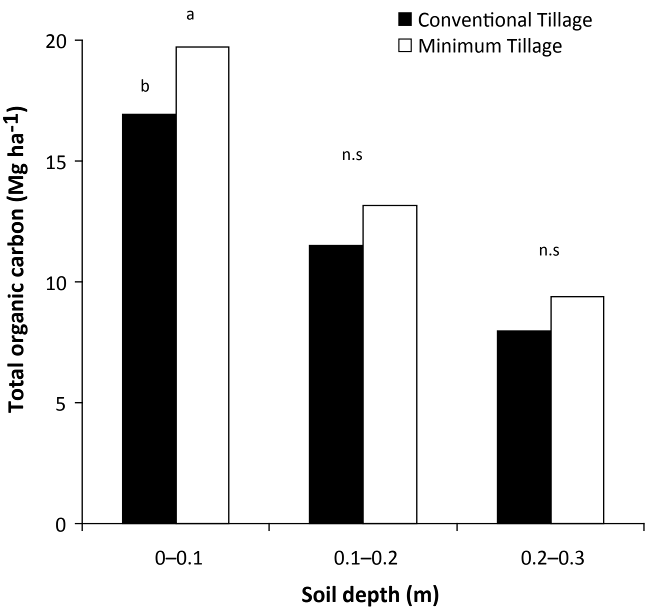


Figure 3: *Mean TOC in each sample depth under conventional tillage and minimum tillage on Chromosol sites. Letters on columns denote statistically significant differences (P<0.05); n.s. indicates no significant difference.*

Summary

Analysis of soil samples from 122 commercial cropping sites in the NSW North-West Slopes and Plains region has demonstrated that reducing the number of tillage operations can lead to greater TOC in the surface (0–10 cm) of Vertosols, and the whole 0–30 cm in Chromosols. In Vertosols, the surface soil C stock is about 28% higher while on Chromosols it is around 16%.

Our data showed strong influences of rainfall, temperature, bulk density, texture, and management history on soil C stocks. To gauge soil C sequestration potential under current and novel tillage practices requires further monitoring and/or field experiments in key regional locations.

Acknowledgements

This project was funded by the Department of Agriculture, Fisheries and Forestry and the Grains Research and Development Corporation through the national Soil Carbon in Agriculture Research Program, The University of New England, and NSW Department of Primary Industries. We acknowledge the assistance of staff from NSW OEH, UNE, and CSIRO during sample collection and processing and data management. Thanks to the many District Agronomists within NSW DPI who identified possible sampling locations and to all surveyed landholders who provided access to their properties and supplied information about management history.

Tropical grass pastures have potential to restore soil organic carbon in degraded cropping soils of North-West NSW

Graeme Schwenke, Malem McLeod, Sean Murphy and Steven Harden NSW DPI, Tamworth

NUTRITION & SOILS

Key findings

Conventionally tilled cropping leads to increased bulk density (soil compaction) and decreased soil total organic carbon (TOC) and total nitrogen (TN), compared to native grass pastures.

Productive tropical grass pastures have the potential to restore soil TOC and TN after conventionally tilled cropping, though changes were limited to the surface soil in Vertosols.

Introduction

Continuous cropping with multiple tillage operations per year typically leads to a loss of soil total organic carbon (TOC) due to; reduced organic inputs, increased rates of organic matter decomposition, increased soil erosion and physical disruption of soil aggregates that otherwise protect organic materials from decomposer organisms. Previous trials found that only a change in land use from cropping to perennial grass-based pastures can reverse the decline of TOC in degraded cropping soils.

Considerable research, development and extension has increased the popularity of tropical grass pastures throughout the NSW North-West Slopes and Plains. It is estimated that more than 300,000 ha of tropical grass pastures have been planted in the past 10 years, highlighting the magnitude for potential improvement in TOC at the landscape scale. What is not known is whether this potential is being realised in commercial farm paddocks of the region.

The aim of this study then was to compare TOC and related soil properties of improved tropical grass pastures, with examples of conventionally tilled cropping paddocks and with pastures growing native grasses in the NSW North-West Slopes and Plains.

We also compared TOC in samples taken from a 6-year old pasture species experiment on a degraded Chromosol, comparing TOC under two improved varieties of tropical perennial grass species, a mix of native grasses, and a perennial legume pasture.

Site details

Survey

145 farm paddocks from Goondiwindi (north) to Dunedoo (south), and from Walgett (west) to Inverell (east)

Field trial:	Gowrie, near Tamworth
Co-operator:	Clive Barton

Treatments

Survey

Land use:	Native grass pasture (NP) Continuous cropping (CT) Tropical grass pasture (TP)
Soil type:	Vertosol (cracking clay) Chromosol (red-brown earth)

Field trial

Pasture type:	Premier Digit, Katambora Rhodes, native grass mix (Wallaby grass, Redgrass, Bluegrass and Windmill grass), Lucerne (cv. Venus).

Survey Results

Chromosols

- In the surface soil (0–0.1 m), TOC was highest in native pastures (NP), while tropical pastures (TP) were higher than conventional tillage cropping (CT) (Figure 1).
- TOC in TP paddocks was mid-way between NP and CT at 0.1–0.2 m. There were no TOC differences below 0.2 m.
- When all three depth segments were combined, TOC was equivalent in NP and TP, but lower in CT.
- Analysis of soil total nitrogen (TN) in the same samples showed similar treatment effects as TOC, except (1) there was no difference between NP and TP in the surface 0–0.1 m, and (2) the treatment differences for TN extended to the 0.2–0.3 m segment.
- Bulk density, a measure of soil compaction, was greater in CT and TP than NP in the soil surface, while in the next layer TP was less than CT (and similar to NP). There were no treatment differences below 0.2 m.

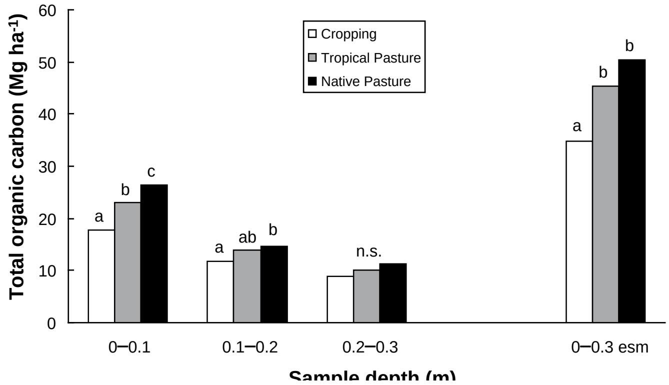


Figure 1: *Mean TOC of surveyed Chromosol cropping, tropical pasture and native pasture sites. Letters on columns denote statistically significant differences between land use at a particular sample depth (P<0.05); n.s. = no significant difference between land uses.*

Vertosols

- In the surface soil (0–0.1 m) TOC was higher for both pasture types (NP and TP) than CT (Figure 2).
- There was no effect of land use below 0.1 m, nor when all three depths were combined.
- Total N in vertosols showed similar treatment differences to TOC, except TN was higher in NP than CT when all depths were combined, with TP in between.
- Bulk density in the surface 0–0.1 m of vertosols was higher in TP than NP, with CT in between. In the next layer CT had a higher bulk density than NP with TP in between.
- In this survey, on average, TOC tended to be higher in Chromosols than Vertosols, which is the opposite to what would normally be expected as Vertosols commonly have a higher clay content in the surface soil. Clays benefit the storage and protection of organic carbon in the soil. However, the survey covered a wide region and the Chromosols surveyed tended to be concentrated more to the east of the region, where rainfall is typically higher, whereas many of the Vertosols sampled were to the west of the region where rainfall is less. When compared in the same locality, TOC in Chromosols was usually less than in Vertosols.

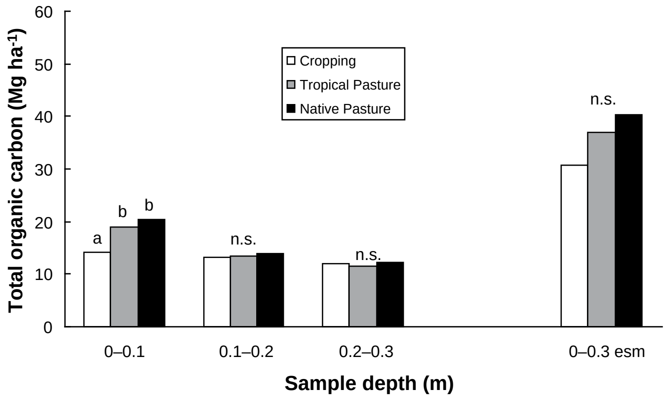


Figure 2: *Mean TOC of surveyed Vertosol cropping, tropical pasture and native pasture sites. Letters on columns denote statistically significant differences between land use at a particular sample depth (P<0.05); n.s. = no significant difference between land uses.*

Pasture Trial Results

- After 6 years of pasture growth, there was no significant difference between pasture species treatment on TOC or TN at any individual sample depth nor when depths were combined.
- Although there were large differences in the amount of aboveground plant matter produced between the treatments, much of this material was regularly removed from the site to simulate grazing.
- This herbage removal may have contributed to the lack of treatment effects on TOC. There was also high variability in soil texture across the site, and TOC and TN were negatively correlated to the soil's silicon (sand) content and also the degree of soil compaction.
- The fertilised grass and lucerne pasture treatments had a lower soil pH and higher Colwell P compared to the native grass mix (unfertilised).

Summary

The adoption of sown improved perennial tropical grass species has the potential to restore the TOC lost from degraded conventionally-tilled cropping soils. The need for this restoration is probably greater in Chromosols than Vertosols, as Chromosols have suffered more widespread soil loss through erosion during cropping. To successfully restore TOC in soils with degraded fertility requires significant above- and below-ground biomass inputs from highly productive pastures, which can only happen if the sown pastures are well supplied with nutrients from fertilisers or other nutrient sources. Establishing a productive improved tropical pasture takes careful preparation and management, but has the potential to restore TOC to levels equivalent to undisturbed native grass pastures, if not better.

Acknowledgements

This project "The potential for agricultural management to increase soil carbon in NSW", was funded by NSW DPI, UNE, GRDC, and DAFF. Soils were sampled by NSW OEH, processed by UNE, analysed by UNE and CSIRO, and the data compiled by UNE. Thanks to all the farmers for permission to sample their paddocks and for site history information.

Legume-cereal rotations reduce soil nitrous oxide (N_2O) emissions, compared to non-legume rotations

Graeme Schwenke, Bruce Haigh and Guy McMullen NSW DPI, Tamworth
Pip Brock NSW DPI, Port Stephens **David Herridge** UNE, Armidale

Introduction

Nitrous oxide (N_2O) is a greenhouse gas with around 300 times the global warming potential of carbon dioxide (CO_2). A major source of N_2O emissions is associated with the application of nitrogen (N) fertilisers to agricultural soils. The period of greatest risk for N_2O loss is soon after fertiliser application – if the soil becomes waterlogged in-between fertiliser N application and crop N uptake, leading to losses via denitrification.

Emissions of greenhouse gases from cropping systems may be minimised through reduced N fertiliser use and by satisfying some of the crop N demand through biologically-fixed N from legumes. The greatest risk of N_2O loss from legume-derived N occurs if the soil becomes waterlogged in-between legume-crop harvest and uptake of N by the next crop.

Direct emissions of N_2O from soil represent only a fraction of total greenhouse gas emissions related to N fertiliser use. Greenhouse gases (principally CO_2 but also N_2O) are also emitted in the production, transport and application of N fertilisers, as well as other agricultural chemicals. All gas emissions associated with growing and harvesting a crop can be quantified by using life cycle assessment (LCA) software called SimaPro.

Our research objectives were to (i) measure soil N_2O emissions from crop sequences with contrasting inputs of fertiliser-N and legume-N, and (ii) to compare total greenhouse gas emissions from these crop sequences using cradle-to-gate LCA.

Key findings

Nitrous oxide (N_2O) emissions peaked when nitrate-laden soil became waterlogged.

Most greenhouse gas emissions from cropping were due to nitrogen (N) fertiliser use.

N_2O emitted directly from the soil accounted for up to half of total greenhouse gas emissions.

The use of legumes reduced total greenhouse gas emissions by up to a half over 3 years.

Site details

Trial period: **May 2009–June 2012**

Location: **Tamworth Ag. Institute**

Soil type: **Black Vertosol (cracking clay)**

Treatments

Crop rotation	2009	2010	2011
CaWB	Canola (+N)	Wheat (+N)	Barley (+N)
CpWB	Chickpea	Wheat (+N)	Barley
CpWCp	Chickpea	Wheat	Chickpea
CpS	Chickpea	Sorghum(+N)	

Results

- Over three years of measurement, the canola-wheat-barley rotation, where each crop was fertilised with Urea-N, had more than twice the N_2O emissions as the chickpea-wheat-chickpea rotation, where no Urea-N was used (Table 1).
- As a proportion of the N added to the soil (by either fertiliser or legume N_2-fixation), the losses from these two rotations were the same (Table 1, Emission Factors). This means that the actual source of the N input did not greatly affect the rate of N_2O loss.
- N_2O emissions from the chickpea-sorghum rotation were proportionally much higher than any of the other three treatments. This was due to an extended period of rain and waterlogging immediately following Urea-N application at sorghum planting in late spring 2010.

NUTRITION & SOILS

__Table 1:__ Nitrogen inputs, total N_2O emissions from 4 crop rotations over 3 years (2009–2012) and the emissions factor. Numbers in parentheses are standard errors about the mean.

Crop rotation	N added* (kg N/ha)	Total N_2O emitted (g N/ha)	Emission Factor** (%)
CaWB	80+80+60	1616 (±46)	0.73 (±0.02)
CpWB	49+80+0	1013 (±214)	0.79 (±0.17)
CpWCp	49+0+41	669 (±98)	0.74 (±0.11)
CpS	49+40	1053 (±125)	1.18 (±0.14)

* N added to canola, wheat and barley as Urea and N added to chickpea by Rhizobia N_2-fixation
** Not corrected for background soil emissions.

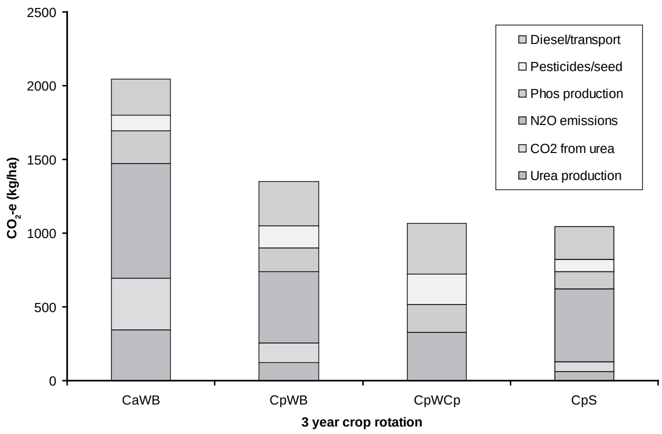


***Figure 1:** Total greenhouse gas emissions from the 4 crop rotations, grown over 3 years.*

- As well as direct N_2O emissions from the soil, the use of N fertiliser also produces carbon dioxide (CO_2) from Urea manufacture and dissolution when applied to the soil. Altogether, the use of N fertiliser in the canola-wheat-barley rotation produced 72% of the total greenhouse gas emissions from the 3 year period (Figure 1).
- The remaining 28% of the total emissions came from P fertiliser manufacture, pesticide manufacture, and from fuel use in transport of fertilisers and in-paddock tractor operations.
- In contrast to the N-fertilised non-legume rotation, the chickpea-wheat-chickpea rotation had only half of the total greenhouse gas emissions over the 3 years (Figure 1).

Summary

The N losses as N_2O emissions from fertilised crops can be significant if soil is saturated soon after fertiliser is applied. N_2O emissions during post-harvest fallows can also be significant if soil is saturated after residue decomposition of N-rich crops (chickpea, canola).

Growing legume crops in rotation with cereals reduces total N_2O emissions, although as a proportion of N inputs, fertiliser or legume N, the emissions may not be different. However, legume N_2-fixation means a significant reduction in the total greenhouse gases emitted during the production and transport of the N fertiliser that would otherwise be used on a non-legume crop. Legume-N benefits to following cereal crops can also mean a further reduction in overall N fertiliser requirement compared to non-legume rotations.

Acknowledgements

This project "Mitigating nitrous oxide emissions from soils using pulses and improved nitrogen management" was funded by NSW DPI and GRDC (UNE00012). Many thanks to Kelly Leedham, Adam Perfrement and the TAI cereal agronomy team for their technical assistance.

Poultry litter biochar enhances nutrient content of soil amended with cow manure and maize stubble

Malem McLeod, Victor Shoemark and Steven Harden NSW DPI, Tamworth
Peter Slavich NSW DPI, Wollongbar

Introduction

Biochars are carbon-rich products obtained when biomass is heated in a closed container in the absence of oxygen (pyrolysis). Biochar is produced with the intent to be applied to soil as a means to improve soil productivity, carbon storage, or filtration of percolating water. Whilst biochars usually contain some nutrients the primary intent of applying biochar to soil is to increase soil carbon storage and improve soil physical properties, and not to replace fertilisers but to supplement them.

Research to date shows that biochar can influence nutrient dynamics in the soil. However, long term data to support these claims are lacking for Australian farming systems. Biochar made from poultry litter (PLB) is rich in phosphorus (P), nitrogen (N), carbon (C) and has been found to improve P availability in acidic soil and increase crop and pasture yields. This paper presents nutrient dynamics results over 24 months from six soil mixtures containing cow manure (CM), maize stubble (MS), and PLB. The aim of the research is to assess the interaction of biochar and organic matter in soils and how it influence nutrient availability over time.

Key findings

Adding biochar or organic matter alone to soil increased total N, total C, available P, pH and CEC.

These nutrient contents in soil were higher and remained higher for up to 24 months when both biochar and organic matter were added together.

Site details

Location: **Tamworth Agriculture Institute**

The site was historically productive cropping soil, but it has experienced long term top soil erosion, and hence has a low fertility.

Treatment

Soil, PLB, CM and MS were mixed as in the following table.

ZERO PLB biochar	+ 10 gr PLB Biochar
Control= 200 g soil	200 g soil
200g soil + 10 gr CM	200g soil + 10 gr CM
200 gr soil + 10 gr MS	200 gr soil + 10 gr MS

Each mixture was placed in a fine mesh bag and buried in the field at 10 cm depth. Bags were harvested at 6, 12, and 24 months and soil samples were analysed for total C, N, available P, soil pH. Both PLB and CM had the same N content (1.6%) and a similar C content (36% and 39%, respectively).

Results

- Adding CM, MS and PLB to soil significantly increased total N, C, the available P and soil pH. But after 6 months, total N and C, available P, and soil pH in mixtures without PLB approached those under the control treatment. In contrast, these nutrients remained significantly higher in mixtures containing PLB at 24 months (Figures 1-4).
- The available P in CM was highest (1.4 times that in PLB, and 5.4 times that in MS) at the beginning of the experiment. But the increase in available P in the CM was short term, while in MS treatments there was no increase. Available soil P was increased by PLB and this persisted for 24 months.

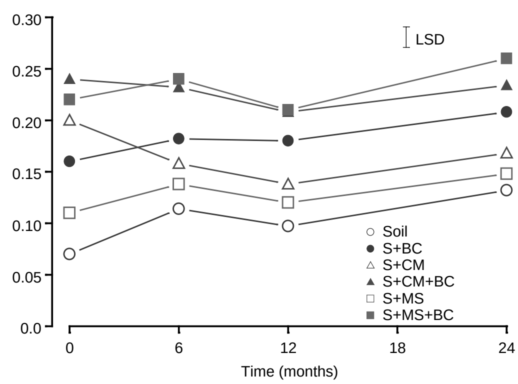


***Figure 1:** Total nitrogen (%) over time*

NUTRITION & SOILS

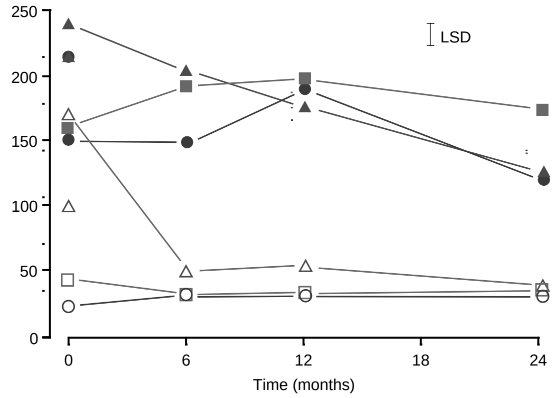


***Figure 2:** Total available P (mg kg-1) over time.*

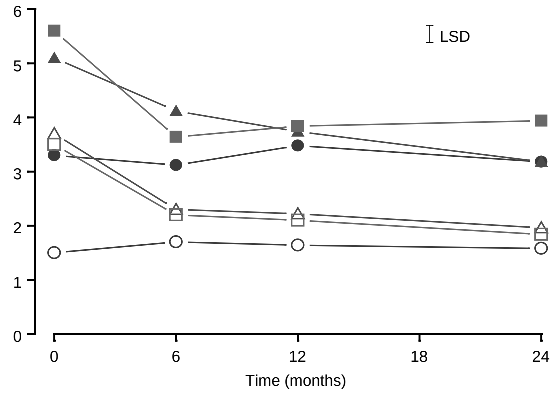


***Figure 3:** Total soil carbon (%) over time.*

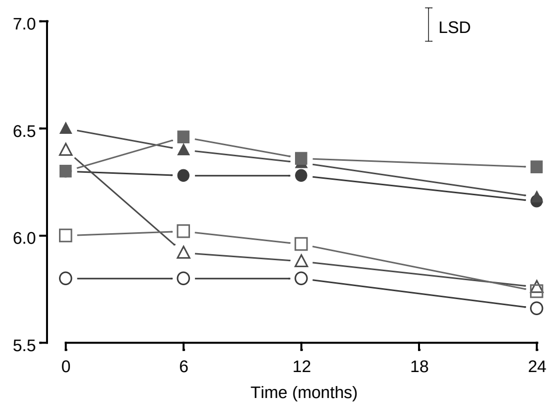


***Figure 4:** Soil pH over time*

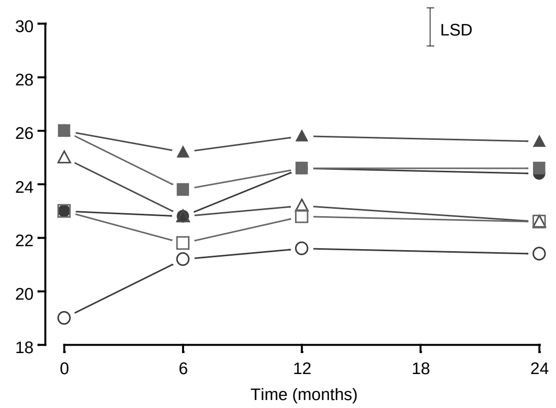


***Figure 5:** Soil CEC (cmol(+) kg-1) over time*

- Amongst the mixtures containing PLB, combination with other organic amendments (CM or MS) enhanced total C, N and soil pH beyond that with PLB only treatment.
- The liming effect of PLB was more persistent than the liming effect of the MS or CM (Figure 4).

Summary

Adding biochar and organic amendment mixture to soil enhances and maintains the nutrient contents of the soil.

This study is continuing to evaluate the longevity of the biochar effect on carbon and nutrient cycling from other organic matter.

Acknowledgements

This project is funded by the Australian Centre for International Agriculture Research (ACIAR) and NSW Department of Primary Industries

Ammonia volatilisation losses from nitrogen fertilisers surface-applied to Vertosols

Graeme Schwenke, Bruce Haigh and Guy McMullen NSW DPI, Tamworth
Bill Manning NSW DPI, Gunnedah

Introduction

Two emerging trends in nitrogen (N) fertiliser use in the region prompted the current research, (1) pre-plant surface spreading of by-product ammonium sulphate (from gas purification of coke ovens at steelwork industries), and (2) post-plant surface application of Urea or liquid N products ahead of forecast rainfall events. While it is well known that ammonia volatilisation is governed by soil properties, weather conditions, and agricultural practices, there was no data on the magnitude of N volatilisation losses occurring in the region.

We measured N volatilisation from fertilisers applied both pre-plant and in-plant in farmer's paddocks. The results should lead to better informed N fertiliser management for cereals.

Key findings

Volatilisation of nitrogen (N) fertilisers applied to the soil surface can result in significant losses of N.

In medium to heavy clay soils of northwest NSW, N losses were less than 20% of the applied N in bare-fallows, except when ammonium sulphate was applied on soils with naturally-occurring lime.

N volatilisation losses from topdressing wheat were less than 10% of applied N in all products used.

Site details (2011–2012)

Locations:	**Tamworth, Edgeroi (2), Mullaley, Emerald Hill, Caroona (4), Garah (2), Spring Ridge (2), Bellata (2).**
Co-operators:	**Ian Gourley, Andrew Martin, Bart Brady, James Hockey, Derek Bloomfield, Angus Duddy, Frank Elsley, Jim Russell, Drew Penberthy**
Soil types:	**Grey, Brown and Black Vertosols (medium-heavy cracking clays)**

Treatments – fertiliser products

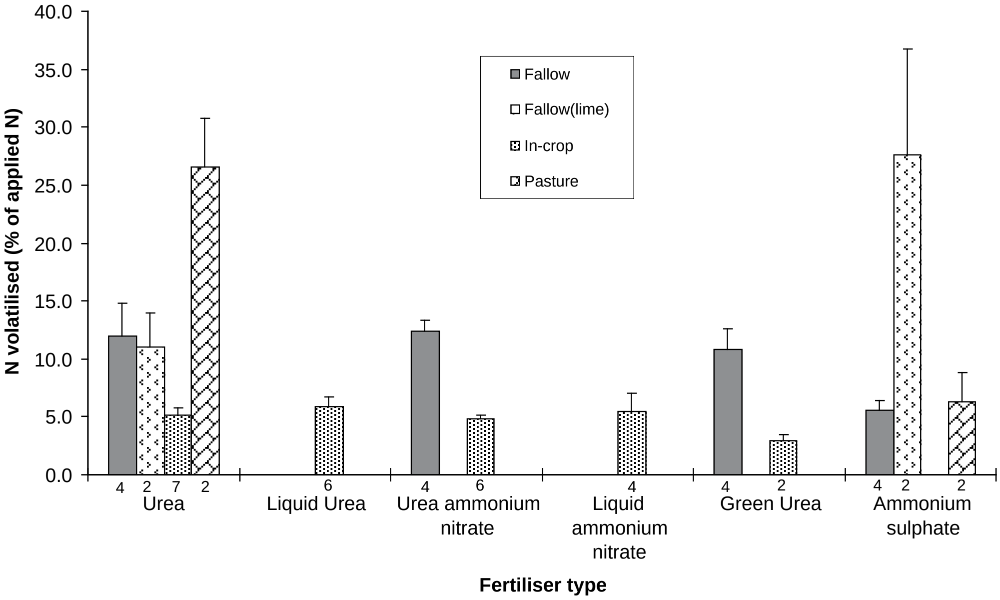
- Urea (prilled solid)
- Green Urea (urease inhibitor coating)
- Urea ammonium nitrate (liquid)
- Urea (liquid solution)
- Ammonium nitrate (liquid solution)
- Ammonium sulphate (crystalline form; a by-product from steelworks)

At each trial paddock we applied fertiliser either by hand (solid products) or by quad-bike sprayer (liquids) to circular plots (50 m diameter). We captured ammonia volatilised from the soil using acidified glass tubes secured to a rotating mast located in the centre of each plot. Plots were separated from each other by at least 100 m.

Results

- Results of all fifteen N volatilisation trials to date are summarised in Figure 1.
- In 3 out of 4 trials on bare fallowed soils without lime, N loss from ammonium sulphate was about half that from Urea, Urea ammonium nitrate or green Urea products. N losses from these products occurred gradually for 2–3 weeks after application of the fertiliser.
- However, in 2 trials on bare fallowed soils <u>with</u> naturally-occurring lime at the surface, N loss from ammonium sulphate were more than twice that from Urea when applied to bare fallow soils. Losses from ammonium sulphate in these soils totalled up to 37% of the N applied. Most of this was lost within days of application to the soil.

Figure 1: *Summary of N volatilisation losses (as % of N applied) measured in field trials comparing various fertiliser N products. Bars indicate the mean N loss (and standard error of the mean) across 2–7 separate paddock trials during 2011 and 2012. Fallow (lime) refers to soils with naturally-occurring lime at the surface.*



- Ammonium sulphate chemically reacts with lime in the soil to form an unstable, high-pH compound that rapidly converts to ammonia gas which can be lost through volatilisation.
- N volatilisation losses from fertilisers applied as topdressing in-crop (to wheat) tended to be low, averaging just 5% of the N applied. Although the average loss from green Urea appears less than normal Urea in Figure 1, it was only statistically less than normal Urea at 1 of the 3 trial sites where the two products were compared.
- At two grass-based perennial pasture sites, we measured significantly higher N volatilisation losses from Urea application than ammonium sulphate. Neither of these sites had lime present in the soil. Insufficient rain fell in the week after application to wash the Urea through the plant and litter to the soil before it dissolved and began conversion to ammonium. The conversion process, known as hydrolysis, generates a localised high pH that results in more ammonia gas than ammonium ions, resulting in increased N volatilisation losses.
- In these medium to heavy cracking clay soils, N volatilisation was likely limited by rapid adsorption of ammonium onto the charged clay mineral surfaces, high soil pH buffering capacity, and, when applied in-crop, canopy absorption of ammonia and protection against wind at the surface.
- Only 2 of the 15 trial paddocks received more than 5 mm of rain within the first week after fertiliser was applied; one paddock had 5.4 mm and the other had 12.0 mm.

Summary

When surface-applying N fertilisers, there is the potential for some of the N to be lost by ammonia volatilisation. Trials on medium to heavy clay soils in northwest NSW have found that these losses are less than 20% of the N applied to bare fallow soils and less than 10% when applied to a wheat crop at late tillering stage.

N losses from ammonium sulphate applications were less than normal Urea in both bare fallows and grass-based perennial pastures. However, ammonium sulphate should be avoided on soils with naturally-occurring lime in the surface.

Acknowledgements

This project "How much ammonia is lost from surface-applied nitrogen fertiliser in northwest NSW?" is funded by NSW DPI and GRDC (DAN00144). All trial co-operators are gratefully acknoledged for providing trial sites. Many thanks to Adam Perfrement, Kelly Leedham, Bill Keene, Zara Temple-Smith, Dougal Pottie, Rebecca Byrne, Russell Carty, George Truman, Peter Formann, Annabelle McPherson, Wayne McPherson, and Kamal Hossain for technical assistance.

Denitrification contributing to crop N deficiencies in 2012: analysis using 'NBudget' and soil test data

David Herridge UNE – PIIC, Tamworth **Matthew Gardner** NSW DPI, Tamworth

Introduction

Managing nitrogen (N) supply for cereal and oilseed crops remains a challenge for growers, particularly when the weather conditions are extreme. In the 2012 winter season, many wheat crops in the northern NSW grains region were obviously N deficient prior to flowering with many more likely to be marginally N deficient. The upshot was that proteins of grain delivered to the receival depots were generally low, e.g. 60% of wheat delivered to depots in the Dubbo zone had proteins of 10.5% or less (Brill *et al.* 2013).

Brill *et al.* (2013) speculated that the low grain proteins were a result of low soil nitrate levels, in turn due to:

- high grain yields of preceding crops
- low N contributions from N_2-fixing pulses
- depletion of residual nitrate deep in the profile
- denitrification losses
- insufficient inputs of fertiliser N.

It is likely that all of the above contributed to the crop N deficiencies and low grain proteins during 2012. In this paper, we examine the possible role of denitrification in more detail. It is not possible to simply measure denitrification in the field. Rather, we used 'NBudget', the NSW DPI CropMate-based N decision tool, to predict soil nitrate levels at sowing in 2012 for a number of experimental sites in northern NSW, then compared the predictions with measured values. We would discount denitrification as a loss factor if the predicted and measured soil nitrates were similar. If the predicted values were substantially higher than the measured values, we could reasonably suspect denitrification losses.

Site details

2012

Location:	**Bithramere**
Co-operator:	**Gavin Hombsch, "Hyland"**
Location:	**Blackville**
Co-operator:	**Joe Fleming, "Parraweena"**
Location:	**Gurley**
Co-operator:	**Scott Carrigan, "Murray Cumummualah"**
Location:	**Moree**
Co-operator:	**Paul and Charles Tattam, "Bonniedoon"**
Location:	**Tamworth**
Co-operator:	**NSW DPI (TAI)**
Location:	**Walgett 1 and 2**
Co-operator:	**Dave Denyer, "Wattle Plains"**

Key findings

Widespread N deficiencies of cereal crops were evident in northern NSW during the 2012 winter season, culminating in receivals of large amounts of low protein grain.

We used 'NBudget', the NSW DPI CropMate-based decision-support tool, to predict sowing soil nitrate levels for a number of the 2012 experimental sites and compared with measured values.

Greatest differences between predicted and measured soil nitrates were at the sites that either had the highest fallow rainfall or were inundated with floodwater, suggesting denitrification losses of N may have been a contributing factor.

Due to the difficultly in predicting denitrification losses, growers are advised to consider deep coring for nitrate testing, particularly following saturating rainfall or flooding as was experienced during the 2011–12 fallow.

Treatments

Site	Paddock N status, histories of N fertiliser inputs (kg N/ha), grain yields (t/ha) and proteins (%)
Bithramere	Medium N fertility** 2010 barley, 50N 2011 durum, 80N, 4.5 t/ha @ 13.5%
Blackville	Medium N fertility 2010 barley, 60N 2011 wheat, 80N, 5 t/ha @ 10.0%
Gurley	Low-medium N fertility* 2010 barley, 60N 2011 faba beans, 0N, 2.2 t/ha
Moree	Low-medium N fertility 2010 wheat, 40N 2011 chickpeas, 0N, 3.5 t/ha
Tamworth – TAI	Medium N fertility 2010 wheat, 50–100N 2011 canola, 80N, 3.3 t/ha
Walgett 1	Medium N fertility 2010 wheat, 0N 2011 chickpeas, 0N, 0.9 t/ha
Walgett 2	Medium N fertility 2010, 0N 2011 wheat, 0N, 1.8 t/ha @ 12.5%

* Low-medium N fertility – long cropping history and low-moderate use of fertiliser N

** Medium N fertility – short cropping history and/or moderate-high use of fertiliser N

Results

- Not all the sites are available in Cropmate. Tamworth was used when simulating data for Bithramere; Quirindi was used for Blackville; Moree was used for Gurley.
- Predicted and measured sowing soil nitrates were similar for four of the sites (Figure 1)
- For the remaining three sites – Walgett 2, Moree and Tamworth – measured soil nitrates were much lower than predicted.
- Two of these sites had the highest fallow rainfall during the 2011–12 summer fallow (700+ mm), while the Walgett 2 site was inundated with flood water. Sites with the high fallow rainfall and/or flood water were likely to have experienced the highest levels of denitrification.
- There may have been some limited denitrification activity at the other sites (fallow rainfalls of 450 and 610 mm), which would explain the slightly higher predicted values.
- The Moree and Walgett 1 sites both came out of chickpeas in 2011 following wheat in 2010, so their post-fallow soil nitrate levels in April/May 2012 should have been similar.
- The big difference between the two profiles is that there was very little nitrate below 30 cm depth at the Moree site (Figure 2). It is likely that nitrate released from mineralisation was denitrified before it was leached into the lower part of the root zone. There could also have been denitrification at depth.

- The small amount of nitrate in the surface 30 cm at Moree may have been released during the latter part of the fallow, i.e. March–April, when normal weather conditions returned.
- Are the Walgett data typical of post-chickpeas, post-fallow soil nitrate levels?

- Data in Figure 3 are from the NSW DPI long-term farming systems experiments at North Star, NSW. There were two sites, which were sampled either in October 1989, 1990 or 1993 (harvest) or May 1990, 1991 or 1994 (sowing). Thus, each of the profile nitrates on the graph is the average of 32 sites × years × tillage × N fertility treatments.
- The sowing (post-fallow) profile is very similar to the one recorded for Walgett with 20–30 kg nitrate-N/ha in each of the 30 cm segments down the profile.
- The graph also shows the accumulation of nitrate during the fallow. Overall, it was 55 kg N/ha with most of it remaining in the top 60 cm. There was essentially no accumulation of nitrate-N below 90 cm depth.

Summary

Crop N deficiencies leading to widespread receivals of low protein grain in 2012 was likely due to a number of factors, including depletion of mineral N reserves, inadequate fertiliser N inputs and denitrification losses. To further examine the latter, we predicted soil nitrate levels at 7 NSW DPI experimental sites using 'NBudget', the CropMate-based decision-support tool and compared the predicted values with measured values. Differences between the two were greatest at sites that had the wettest pre-crop fallows or were inundated with floodwater, which could indicate denitrification losses. Because such losses are difficult to predict, growers would be advised to deep core for nitrate, particularly following saturating rainfall such as experienced during the 2011–12 summer.

Acknowledgements

This project was funded by NSW DPI, UNE and GRDC under the Nitrogen and Legumes in Farming Systems project (UNE00014) and the VSAP Project (DAN00169).

References

Brill R, Gardner M, Graham R, Fetttell N (2013). Will low protein become the new norm? In GRDC Grains Research Update, Coonabarrabran, In Press.

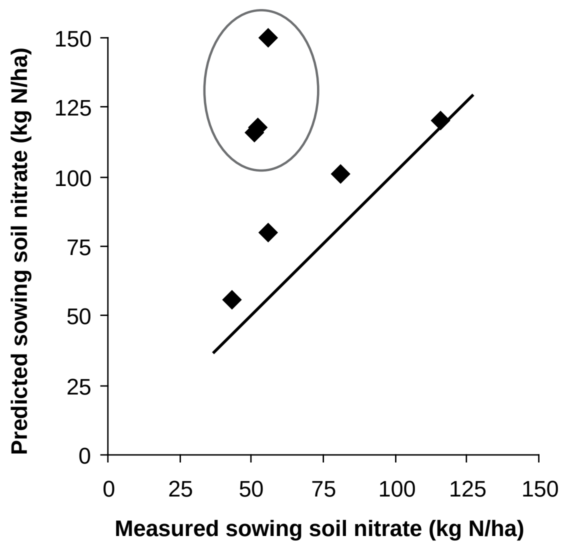


Figure 1: *Measured and NBudget-predicted sowing soil nitrates at the 7 experimental sites. The drawn line is the 1:1 line.*

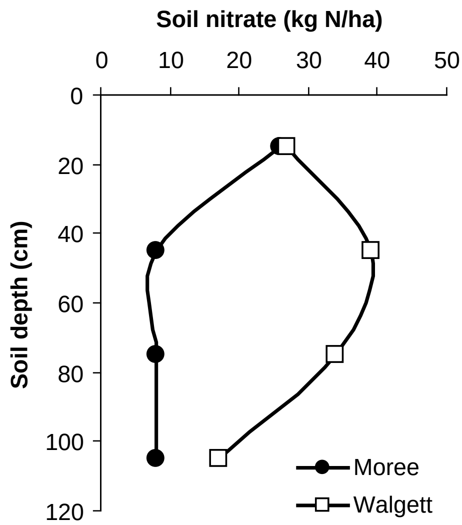


Figure 2: *Measured sowing soil nitrate levels in the root zone at the Moree and Walgett sites pre-sowing 2012.*

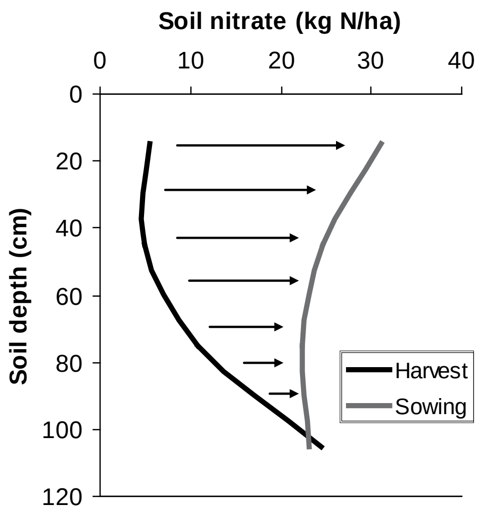


Figure 3: *Typical patterns of soil nitrate accumulation during the summer fallow following chickpeas. Data are from the NSW DPI farming systems trials at North Star during 1989–1994.*

NUTRITION & SOILS

Nitrogen response of four wheat varieties – Gilgandra and Wongarbon 2012

Rohan Brill NSW DPI, Coonamble **Greg Brooke** NSW DPI, Wellington **Kathi Hertel** NSW DPI, Dubbo

Key findings

There were grain yield and grain protein responses to nitrogen application at both sites.

EGA Gregory⁽ᴰ⁾ was the highest yielding variety at both sites.

Nitrogen applied at sowing resulted in significantly higher yields than delayed application at Z31 or split application (sow and Z31). There were few significant rainfall events following the in-crop applications, which limited the ability of the applied N to move into the root zone and be utilised by the crop.

Introduction

The GRDC funded Variety Specific Agronomy Packages (VSAP) project is designed to test the response of new varieties to agronomic treatments in local farming systems. These nitrogen trials are designed primarily to investigate the yield, protein and grain quality response of the relatively new varieties Suntop⁽ᴰ⁾ and LongReach Spitfire⁽ᴰ⁾, compared with the commonly grown varieties of EGA Gregory⁽ᴰ⁾ and Livingston⁽ᴰ⁾.

Site details

Gilgandra

Soil type:	**Red loam**
2011 crop:	**Canola**
2010 crop:	**Lucerne**
Nitrogen:	**45 kg/ha (0–60 cm)**
Phosphorus:	**20 mg/kg (Colwell)**
Sow date:	**28th May**
In-crop rainfall:	**188 mm**

Wongarbon

Soil type:	**Red basalt**
2011 crop:	**Canola**
2010 crop:	**Wheat**
Nitrogen:	**14 kg/ha (0–60 cm)**
Phosphorus:	**61 mg/kg (Colwell)**
Sow date:	**1st June**
In-crop rainfall:	**202 mm**

Treatments

4 varieties – EGA Gregory⁽ᴰ⁾, Livingston⁽ᴰ⁾, LongReach Spitfire⁽ᴰ⁾, Suntop⁽ᴰ⁾
4 nitrogen rates at sowing – 0, 40, 80 kg/ha
3 nitrogen timings for the 40 kg/ha rate (sow:Z31) – 40:0 (up-front), 20:20 (split), 0:40 (delayed)

Results

- There was a significant yield response to the 40 kg/ha of nitrogen treatment applied at sowing for all varieties in both trials (Figures 1 and 2)
- There was a smaller response from further increasing nitrogen application at sowing from 40 to 80 kg/ha, which was only significant for EGA Gregory⁽ᴰ⁾ and Livingston⁽ᴰ⁾ at Gilgandra and LongReach Spitfire⁽ᴰ⁾ and Suntop⁽ᴰ⁾ at Wongarbon.
- EGA Gregory⁽ᴰ⁾ was the highest yielding variety in both trials.
- At Gilgandra the up-front N treatment (4.0 t/ha) had higher grain yield compared with the split treatment (3.7 t/ha) and the delayed treatment (3.4 t/ha) (data not shown).

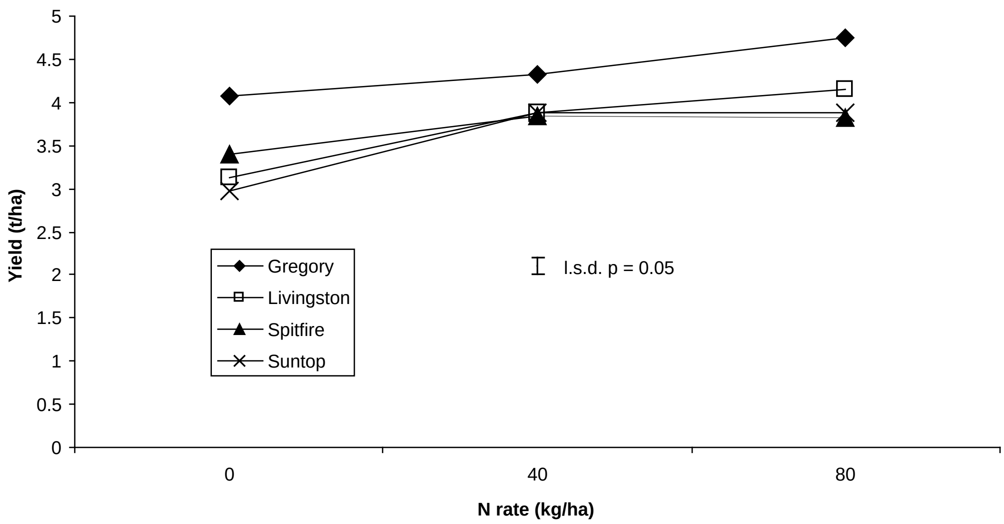


***Figure 1:** Effect of nitrogen rate at sowing on yield of four wheat varieties at Gilgandra in 2012*

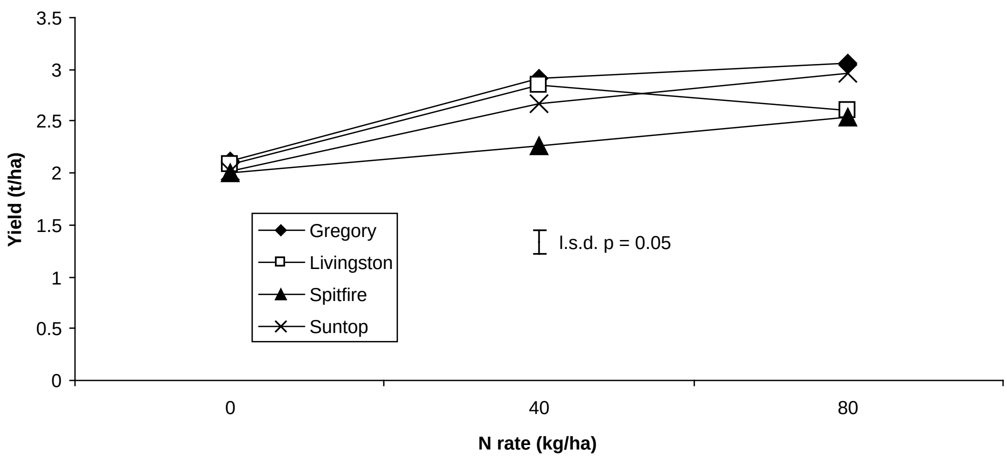


***Figure 2:** Effect of nitrogen rate at sowing on yield of four wheat varieties at Wongarbon in 2012*

- At Wongarbon the up-front N treatment (2.7 t/ha) had higher grain yield compared with the split and the delayed treatment (both 2.3 t/ha) (data not shown).
- Grain protein concentration was low in both trials, with the 0 kg/ha nitrogen rate resulting in an average protein of 8.1% at Wongarbon and 10% at Gilgandra.
- The application of 40 kg/ha nitrogen at sowing significantly increased grain protein concentration compared with nil nitrogen for all varieties in both trials (average 0.55%).
- A further increase to 80 kg/ha of nitrogen resulted in a further grain protein concentration increase in both trials (average 0.7%).
- LongReach Spitfire⊕ had the highest grain protein concentration in both trials and EGA Gregory⊕ the lowest. The rate of increase in grain protein concentration as a result of increasing nitrogen rate was similar for all varieties.
- There was no grain protein benefit from applying nitrogen late (0:40) or splitting nitrogen (20:20) compared with applying all nitrogen at sowing (40:0).
- The apparent recovery of fertiliser N in the grain was moderate at the 40 kg/ha N rate (36% at Gilgandra and 26% at Wongarbon) and reduced to low levels at the 80 kg/ha N rate (9% Gilgandra and 8% at Wongarbon).

Summary

At both trial sites, the apparent recovery of fertiliser N in the grain was moderate at the 40 kg/ha N rate and low at the 80 kg/ha N rate. This is quite low considering the grain protein achieved, especially at Wongarbon. The nitrogen recovery may have been low due to the receival of low-moderate in-crop rainfall, which was not enough to move the nitrogen deep into the root zone where water was being extracted. To improve grain protein concentration nitrogen needs to be moved down into the root zone and taken up by the plant, which will be most sustainably achieved by growing more legume crops and/or pastures. Legume residues mineralise relatively slowly, providing a slow release form of nitrogen, with peak mineralisation occurring at times of peak crop growth.

EGA Gregory⊕ was consistently high yielding in these trials, with this relatively high yield being the main reason for its low grain protein relative to Livingston⊕ and Suntop⊕. LongReach Spitfire⊕ appears to achieve yields close to average across many sites, but has been shown here and in many other trials to achieve a relatively high grain protein concentration for a given yield level.

There was no advantage of either splitting nitrogen or delaying all nitrogen for later growth stages compared with applying all nitrogen at sowing for grain yield or protein. It is assumed that this lack of uptake of in-crop nitrogen was primarily due to a lack of follow up rainfall (less than 40 mm total at both sites).

Soil tests showed very low nitrogen at Wongarbon and moderate nitrogen at Gilgandra. The depth of testing was only 60 cm at each site, which may underestimate nitrogen quantity in the soil. For accurate prediction of N availability, soil testing needs to be as deep as the maximum root zone for the particular soil.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins and Rob Pither for technical assistance.

Strategic nitrogen management for western no–till farming systems on Vertosols

Tim Weaver NSW DPI, Walgett **Greg Rummery and Sarah Groat** Greg Rummery Consulting Pty Ltd
Neil Newton Newton AG Pty Ltd **Brad Coleman and Murray Smith** Coleman Agriculture Pty Ltd
Simon Logan Logan Agri Services Pty Ltd

Introduction

In the past Walgett growers have been able to sow AH or APH wheat without the addition of fertiliser in their grey Vertosols and achieve the required protein (>11%). The sole reliance on soil N over time has depleted soil fertility, which has been compounded with three flood events alone over the past four years that would have resulted in significant denitrification losses. EGA Gregory⊕ is an example of a variety that is APH and has struggled to reach this grade without the addition of N-fertiliser at Walgett. Livingston⊕ is another common variety sown in the Walgett district that has also struggled to reach it's AH grade.

Considering the episodic nature of rainfall in the Walgett district, it can be costly if a crop fails and especially if nitrogen has been applied up-front. Walgett rainfall is summer dominant (60:40 split) with an annual rainfall of 478 mm. Therefore it is suggested that nitrogen might be better applied during the growing season after rainfall events when there is more confidence of the crop reaching maturity.

Common techniques to apply nitrogen that have been used in the Walgett district have included water run Urea, broadcast Urea or direct drilled Urea at sowing. The fertiliser rates have varied from 20 to 80 kg N/ha and applied anywhere from pre-plant to grain fill. The purpose of this trial was to compare the use of a Rodgers root zone injector (Plate 1) to apply in-crop nitrogen following rain with the traditional methods used in the district.

Plate 1. *Root zone Injector at 'Bridgewater'*

Key findings

80 units N/ha drilled at sowing had the highest response ($P<0.001$) in protein 12.6% at 'Eulengo' and 11.2% at 'Bridgewater' compared to the control 8.5% and 8.7%, respectively.

Liquid run Urea (4.3 t/ha), pre drilled Urea (4.6 t/ha), root zone injection (4.2 t/ha) and broadcast Urea (4.5 t/ha) at 80 units N/ha produced the highest yields ($P<0.001$) at 'Bridgewater' when compared to the control (3.9 t/ha).

Pre drilled Urea (3.3 t/ha) 40 and 80 units N/ha produced the highest yield ($P < 0.001$) at 'Eulengo' when compared to all other treatments. (Control 2.5 t/ha).

There were no N-response differences in protein or yield between EGA Gregory⊕ and Livingston⊕ at either 'Bridgewater' or 'Eulengo'.

Site details

Location Site 1: **Walgett 'Bridgewater'**

Co-operator: **Greg Weber**

Previous crop: **Wheat**

Soil Type: **Grey Vertosol**

Location Site 2: **Cryon 'Eulengo'**

Co-operator: **Priscilla Radford**

Previous crop: **Wheat**

Soil Type: **Grey Vertosol**

Soil nitrate-N results are shown in Table 1.

Table 1: *Soil analysis of both sites for starting nitrate-N (depth in cm).*

Bridgewater	**0–10**	**10–30**	**30–60**	**60–90**	**90–120**
Ammonium Nitrogen mg/kg	5	7	7	7	9
Nitrate Nitrogen mg/kg	4	2	2	3	2
Eulengo	**0–10**	**10–30**	**30–60**	**60–90**	**90–120**
Ammonium Nitrogen mg/kg	10	5	5	3	9
Nitrate Nitrogen mg/kg	5	7	5	4	6

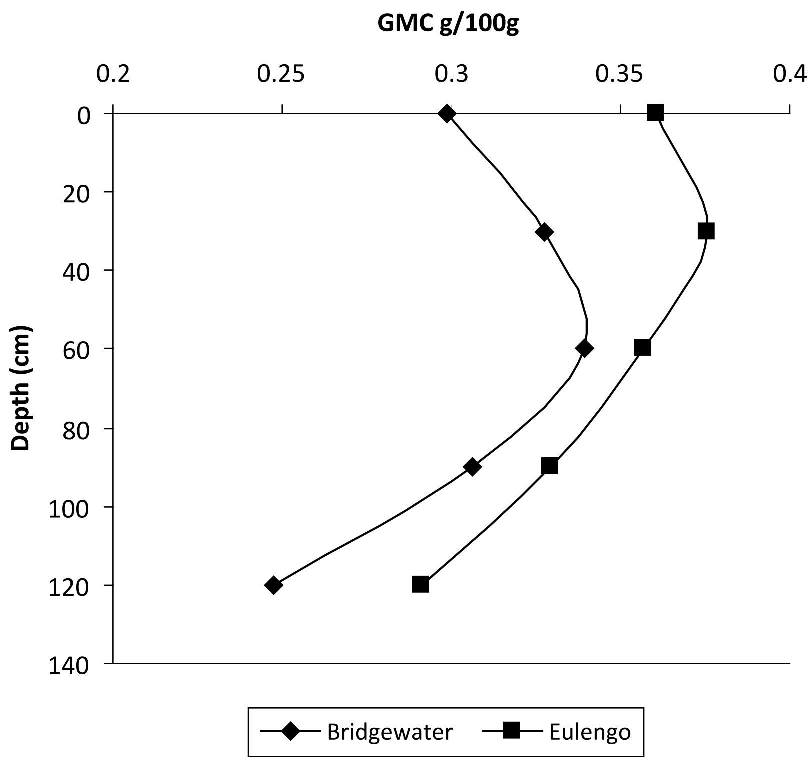


Figure 1: *Gravimetric moisture content of soil profile for 'Bridgewater' and 'Eulengo' at sowing.*

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Treatments

The Bridgewater and Eulengo sites were sown on the 16th May and the15th June, respectively. Livingston⦷ and EGA Gregory⦷ were sown at 30 kg/ha for both sites. Treatments were applied according to rainfall events and their dates are listed in Table 2. Both sites were harvested on the 12th November.

***Table 2:** Treatments and dates they were applied at the Walgett and Cryon N-response sites.*

Treatment/Site	Bridgewater	Eulengo
Control		
Urea 80 kg/ha at sowing	16/05/12	15/06/12
Urea 40 kg/ha at sowing	16/05/12	15/06/12
Urea 40 kg/ha pre rain	20/08/12	
Urea 80 kg/ha pre rain	20/08/12	
Liquid Spray 40 kg/ha event 1	1/08/12	9/08/12
Liquid Spray 80 kg/ha event 1	1/08/12	9/08/12
RZI 40 kg/ha post rain	3/08/12	10/08/12
RZI 80 kg/ha post rain	3/08/12	10/08/12
Liquid Spray 40 kg/ha event 2	17/09/12	
Liquid Spray 80 kg/ha event 2	17/09/12	

Telemetry rain gauges were installed on the 9th July and EnviroPro LE 160 cm soil moisture probes on the 13th August.

***Table 3:** Rainfall (mm) for 'Bridgewater' and 'Eulengo'.*

	Bridgewater	Eulengo
May	19.5	
June	18.5	1
July	42	58
August	4.5	11.5
September	1.5	5.5
October	0	2.5
November	0	4
Total	86	82.5

Results

Soil Water

The output of the EnviroPro LE probes showing rainfall, soil moisture and soil temperature for both sites are shown in Figures 2 and 3. The 'Eulengo' soil moisture depleted in a linear pattern when compared to the 'Bridgewater' site that appears to have depleted steeply initially and then more gradual. The approximate starting plant available water content (PAWC) estimated from the gravimetric moisture content and bulk densities from CSIRO's SoilMapp App was 260 mm for the 'Bridgewater' site and 293 mm for 'Eulengo'.

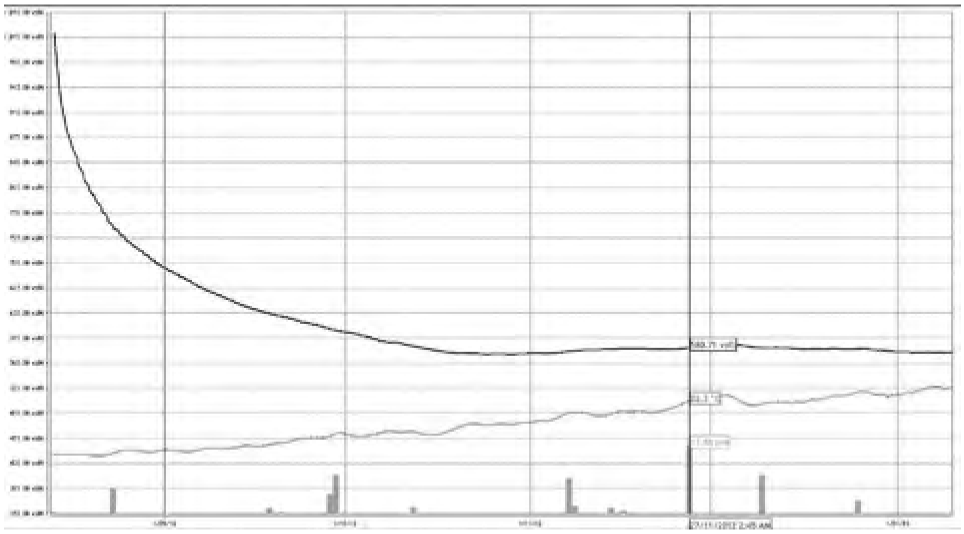

Figure 2: *EnviroPro LE soil moisture, soil temperature and rainfall for 'Bridgewater'.*

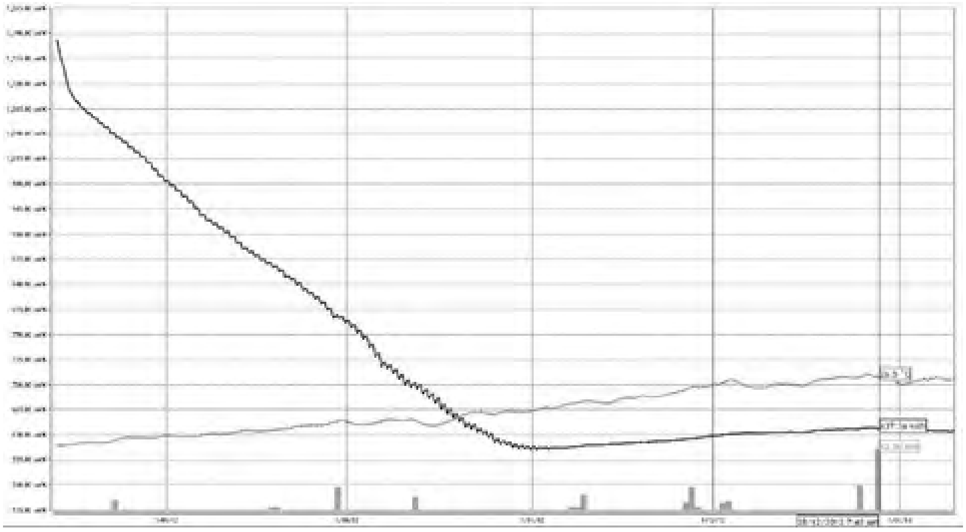

Figure 3: *EnviroPro soil moisture temperature and rainfall for 'Eulengo'.*

Protein

The results of the protein for both sites and varieties are shown in Figures 4 and 5. The direct drilled Urea at 80 units N/ha at sowing produced the highest protein at 'Eulengo' 12.6% and 'Bridgewater' 11.2% for both varieties and was significantly different to the other treatments (P<0.001). There was no statistical difference between EGA Gregory$^{\phi}$ and Livingston$^{\phi}$ at both sites. There were no significant differences between the other treatments.

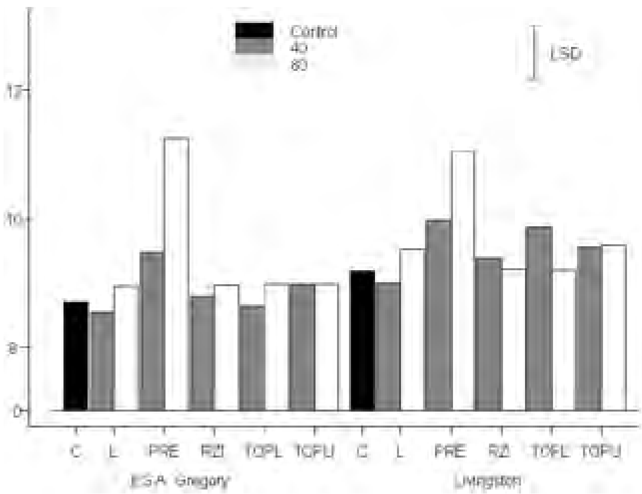

Figure 4: *'Bridgewater' protein (%) for EGA Gregory$^{\phi}$ and Livingston$^{\phi}$. LSD bar indicates significant differences between treatments (P=0.05). (C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast)*

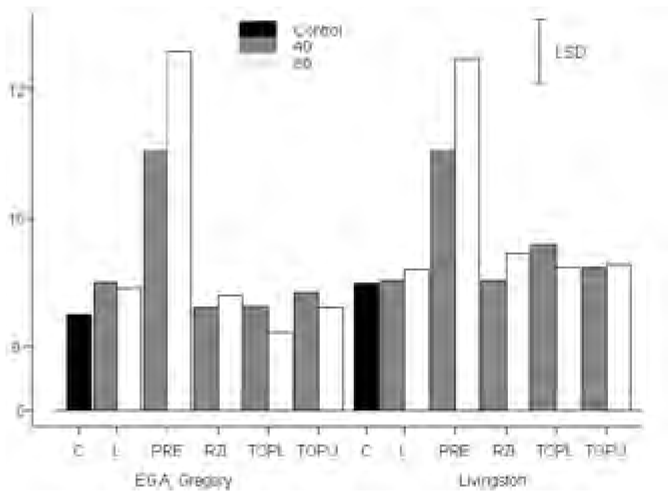

Figure 5: *'Eulengo' protein (%) for EGA Gregory$^{\phi}$ and Livingston$^{\phi}$. LSD bar indicates significant differences between treatments (P=0.05) (C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast)*

Yield

The yield results for both sites and varieties are shown in Figures 6 and 7.

The Liquid run Urea (4.3 t/ha), pre drilled Urea (4.6 t/ha), root zone injection (4.2 t/ha) and broadcast Urea (4.5 t/ha) at 80 units N/ha produced the highest yields and were significantly higher then the other treatments (P <0.001) at 'Bridgewater' when compared to the control (3.9 t/ha). Pre drilled Urea 40 (3.3 t/ha) and 80 (3.1 t/ha) units N/ha produced the highest yield (P < 0.001) at 'Eulengo' when compared to the other treatments (Control 2.5t/ha). There was no statistical difference between EGA Gregory and Livingston at both sites. There were no significant differences between the other treatments.

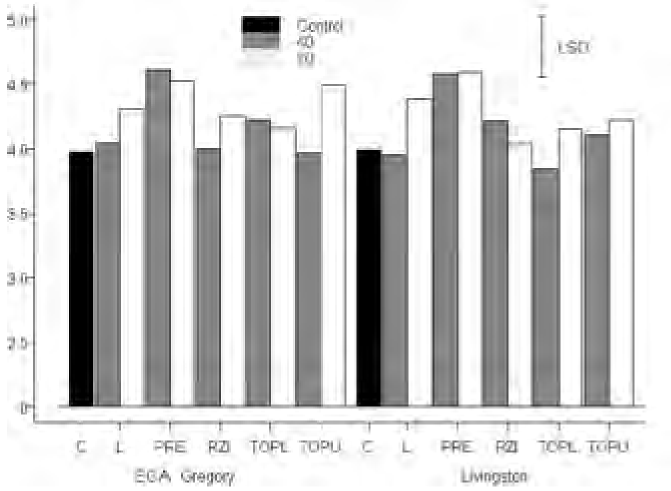

Figure 6: *'Bridgewater' Yield (t/ha) for EGA Gregory⊕ and Livingston⊕. LSD bar indicates significant differences between treatments (P=0.05)(C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast).*

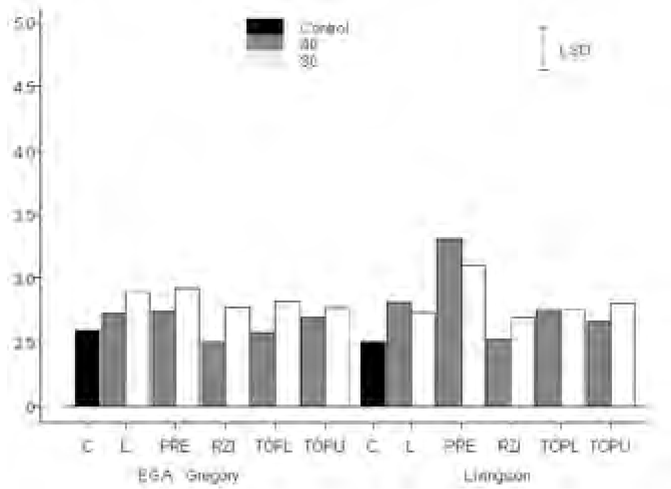

Figure 7: *'Eulengo' Yield (t/ha) for EGA Gregory⊕ and Livingston⊕. LSD bar indicates significant differences between treatments (P=0.05). (C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast)*

Discussion

The starting soil nitrate-N for both sites was very low with an approximately 17 kg/ha for 'Bridgewater' and 35 kg/ha for 'Eulengo' to 1.2 metres (Table 1). The low starting nitrate-N concentrations were ideal to investigate protein and yield response using traditional methods for applying nitrogen and compare them with the root zone injector.

Rainfall (Table 3) at both sites was limited in the later part of the growing season (Aug. Sept., Oct., Nov.). Therefore rainfall that did eventuate was very low and could explain the lack of response in protein and yield following liquid applications or broadcast Urea applications.

Considering the episodic rainfall patterns in the Walgett region and the results of this report it would seem a logical conclusion to direct drill Urea at sowing. Nitrate-N is then available to the crop and there is no risk of missing liquid run or broadcast applications of nitrogen in-crop due to paddock accessibility after rainfall. This method also conceals the product in the soil and reduces the potential for ammonia volatilisation losses. However, this is costly if you are planting on half a profile of moisture and risk losing your crop. In-crop application of nitrogen is an important management tool for many farmers to capitalise on boosting their protein and yield if good rainfall eventuates. In-crop applications of nitrogen allow for the careful management of supplying the crop at strategic growth stages as well. However, this can be very difficult to achieve if there is no rain at the targeted growth stage. This is where a root zone injector may be better utilised. Injecting liquid Urea at 5000 PSI it has the potential to inject nitrogen into the soil and reach the shallow roots of the crop. Injecting would allow the liquid to penetrate the soil and minimise the risk of ammonia volatilisation losses. The root zone injector application of nitrogen in this study did not produce a response to yield and protein; however neither did any other in crop N application treatments, which is more a reflection of the in crop rainfall rather then the methods of application. The root zone injector has potential to be another management tool for applying nitrogen in crop and needs further investigation under varying seasonal conditions. The root zone injector also has the benefit of minimal disturbance when applying nitrogen in crop and therefore less soil moisture loss after rainfall.

Summary

- 80 units N/ha drilled at sowing had the highest response ($P<0.001$) in protein 12.6% at 'Eulengo' and 11.2% at 'Bridgewater' compared to the control 8.5% and 8.7% respectively.
- Liquid run Urea (4.3 t/ha), pre drilled Urea (4.6 t/ha), root zone injection (4.2 t/ha) and broadcast Urea (4.5 t/ha) at 80 units N/ha produced the highest yields ($P <0.001$) at 'Bridgewater' when compared to the control (3.9 t/ha).
- Pre drilled Urea (3.3 t/ha) 40 and 80 units N/ha produced the highest yield ($P < 0.001$) at 'Eulengo' when compared to all other treatments (Control 2.5t/ha).
- There were no differences in protein or yield responses between EGA Gregory and Livingston at either 'Bridgewater' or 'Eulengo'.

Acknowledgements

Thank you to GRDC for the Agribusiness grant (Tender 7.2.3.01C). Thanks to Priscilla Radford 'Eulengo' and Greg Weber 'Bridgewater' for allowing us to conduct the trials on their properties. Thanks also to Steven Harden for statistical analysis of the data. Thanks to GrainCorp at Walgett for grain analysis.

Response of six wheat varieties to varying N nutrition – Spring Ridge and Moree 2012

Matthew Gardner, Stephen Morphett and Patrick Mortell NSW DPI, Tamworth

Key findings

Suntop⟨PBR⟩ appears to behave similarly to EGA Gregory⟨PBR⟩ in terms of both yield and grain protein accumulation, which means that the N removal on a per hectare basis is equivalent to other varieties.

EGA Gregory⟨PBR⟩ has the same NUE as most other bread wheat commercially available.

LongReach Spitfire⟨PBR⟩ appears unique in the fact that, unlike EGA Gregory⟨PBR⟩, even when it achieves higher yields it is still able to maintain protein concentration, giving it the potential to remove more N per hectare.

Limited responses from in-crop N applications reported here highlights the risk associated with the reliability of in-crop rainfall to make use of these applications in the northern region.

Introduction

Efficient use of nitrogen (N) is crucial to economic wheat production, with the risk and reward trade off with applied N being more marginal for western regions. Excessive application of N may increase the susceptibility of the crop to disease and increase water use early in the growing season whereas insufficient application may limit grain yield, grain protein and subsequent profitability. Within a given season in a cereal crop, fertiliser rate and timing are the major tactical tools used in N management. Applications of N at sowing or up to the start of stem elongation drive greater crop biomass and grain yield response in comparison to late applications (around flowering i.e. GS61) which have little influence on grain yield but can drive a significant increase in grain protein concentrations.

Grain protein levels have continued to gain attention moving into 2013. The 2012 season could be considered the third low protein season in a row for much of the northern grains region. Receivals in some areas throughout the region have been dominated (60% in some areas) by low protein wheat (<10.5%) in 2012. It is generally considered that there are only minor differences among commercial varieties in regard to grain protein accumulation. The results from the 2011 VSAP trials indicated that most varieties conform to the yield protein trend where with increasing yield there is a decline in grain protein levels. One variety that appears to be different to this trend is LongReach Spitfire⟨PBR⟩ which tends to achieve a higher protein level for a given yield compared with other varieties. Despite results from trials in 2011 there is still a common misconception that EGA Gregory⟨PBR⟩ has lower grain protein accumulation relative to other varieties.

Site details

Moree

Location:	**"Bonniedoon"**
Co-operator:	**Paul and Charles Tattam**
Previous Crop:	**Chickpeas**
Starting N:	**51 kg N/ha (0–120 cm)**
Sown:	**20th May 2012**

Spring Ridge

Location:	**"Yoorooga"**
Co-operator:	**Angus Murchison**
Previous Crop:	**Long fallow out of cotton**
Starting N:	**110 kg N/ha (0–120 cm)**
Sown:	**15th June 2012**

Treatments

Two nitrogen use efficiency (NUE) trials were conducted in 2012 at Moree and Spring Ridge. These trials consisted of a number of varieties including EGA Gregory⟨PBR⟩, Suntop⟨PBR⟩, LongReach Spitfire⟨PBR⟩, Caparoi⟨PBR⟩, Sunvale⟨PBR⟩ and Livingston⟨PBR⟩. In a fully factorial design there were six N treatments in total. They consisted of four up-front N rates (0, 40, 80 and 160 kg N/ha) side-banded at planting and two split application treatments

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with half applied at planting and the other half applied at either stem elongation or anthesis. The total N applied for the split application treatments was 80 kg N/ha. In-crop applications of N were done using liquid UAN applied through streamer nozzles in a 1:1 dilution with water.

Results

To simplify interpretation of the yield and protein responses to N application only four of the varieties are presented in Figures 1 and 2. At Moree, grain yield significantly increased for all varieties up to the 80 kg N/ha treatment (Figure 1a). The yield of Suntop$^{\Phi}$, Sunvale$^{\Phi}$ and LongReach Spitfire$^{\Phi}$ plateaued between the 80 and 160 kg N/ha application rates. In contrast, between 80 and 160 kg N/ha the grain yield for EGA Gregory$^{\Phi}$ continued to increase Figure 1a. The split applications of N where the second N application occurred at stem elongation or at anthesis achieved similar yields compared to the same total rate of N applied at sowing for all varieties.

Protein responses to N application were linear at Moree with all varieties responding similarly to N application, however there were differences in protein accumulation between varieties (Figure 1b). EGA Gregory$^{\Phi}$ had the lowest protein concentration at all N application rates compared to the other varieties. Conversely, LongReach Spitfire$^{\Phi}$ had the highest grain protein of all varieties. Suntop$^{\Phi}$ was approximately 0.4% lower in protein than Sunvale$^{\Phi}$ across all N treatments except the 0 N treatment where they were similar.

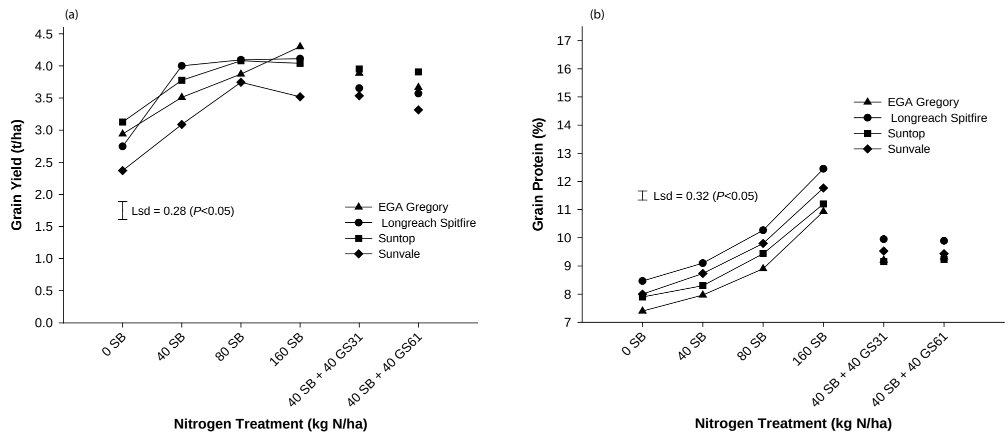


Figure 1: *(a) Grain yield and (b) protein of EGA Gregory$^{\Phi}$, LongReach Spitfire$^{\Phi}$, Suntop$^{\Phi}$ and Sunvale$^{\Phi}$ for six different N treatments – Moree 2012.*

Yield response to N application at Spring Ridge was far less pronounced compared to the Moree trial, which reflects the nearly double starting soil N levels at this site. Despite this the 80 kg N/ha treatment still had significantly higher grain yield than the 0 N treatment for all varieties (Figure 2a). Similar to the Moree site all varieties had a plateau in grain yield beyond 80 kg N/ha, except for Suntop$^{\Phi}$ which still had a significant yield gain up to 160 kg N/ha. There was less grain yield separation between varieties at Spring Ridge compared to Moree, however, Suntop$^{\Phi}$ and EGA Gregory$^{\Phi}$ had a 0.3 t/ha greater grain yield compared to LongReach Spitfire$^{\Phi}$ and Sunvale$^{\Phi}$. The split applications of N where the second N application occurred at stem elongation achieved similar yields compared to the same total rate of N applied at sowing. The only exception at Spring Ridge was where splitting the 80 kg/ha N rate into 40 kg/ha at sowing followed by 40 kg/ha at stem elongation resulted in higher yield for EGA Gregory$^{\Phi}$ and Suntop$^{\Phi}$ compared to where 80 kg/ha of N was all applied at sowing (Figure 2a).

LongReach Spitfire(D had the highest grain protein at Spring Ridge being on average more than 2% greater than EGA Gregory(D and Suntop(D (Figure 2b). Sunvale(D had around 1% higher grain protein than EGA Gregory(D for all N treatments. At the Moree and Spring Ridge sites applying 40 kg N/ha at sowing and a further 40 kg N/ha at anthesis did not increase grain protein compared to all applying the whole 80 kg N/ha at sowing or the earlier split application timing treatment. The lack of protein response to an anthesis application of N is most likely due to the lack of rainfall after that application to facilitate root uptake.

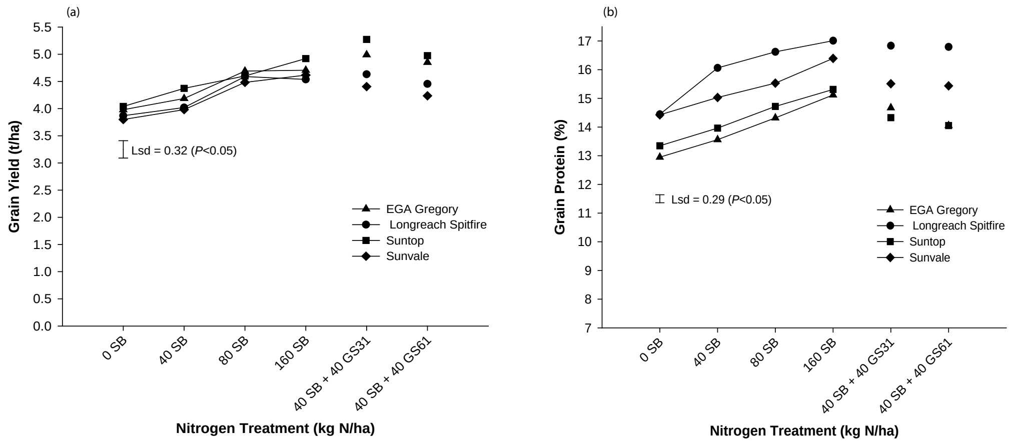


Figure 2: *(a) Grain yield and (b) protein of EGA Gregory(D, LongReach Spitfire(D, Suntop(D and Sunvale(D for six different N treatments – Spring Ridge2012.*

Nitrogen removal in grain for each variety at Moree and Spring Ridge are presented in Figure 3a. LongReach Spitfire(D had a 2% protein advantage over EGA Gregory(D at the Spring Ridge site, which enabled it to remove significantly more N compared to all other varieties, with the exception of Suntop(D. EGA Gregory(D had similar N removal to all other varieties. At the Moree site there was no significant difference in N removal between LongReach Spitfire(D, EGA Gregory(D, Suntop(D or Livingston(D. However, LongReach Spitfire(D had significantly higher N removal than Sunvale(D and Caparoi(D, both of which had reduced yields at high N rates at this site. LongReach Spitfire(D is clearly an outlier when considering the relationship between grain yield and protein (Figure 3b). EGA Gregory(D is not a poor grain protein accumulator compared to other varieties, its protein levels are simply a dilution associated with increased yield. LongReach Spitfire(D is the exception in that it appears to have improved grain protein accumulation which is less sensitive to dilution with increasing yield which warrants further investigation.

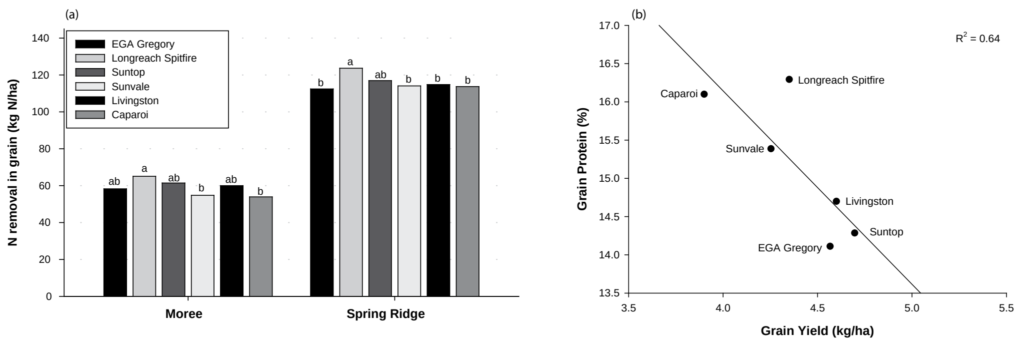


Figure 3: *(a) Grain N removal of six wheat varieties at Moree and Spring Ridge when averaged across six N treatments, and; (b) the linear relationship between grain yield and grain protein at Spring Ridge for six wheat varieties in 2012.*

Summary

EGA Gregory⁽ᵇ⁾ and Suntop⁽ᵇ⁾ were among the highest yielding varieties at both Moree and Spring Ridge which supports the results of NVT and other VSAP trials conducted in the Central West in 2012. Furthermore, EGA Gregory⁽ᵇ⁾ had the lowest grain protein in all trials compared to LongReach Spitfire⁽ᵇ⁾, Livingston⁽ᵇ⁾ and Sunvale⁽ᵇ⁾. Suntop⁽ᵇ⁾ appears to behave similarly to EGA Gregory⁽ᵇ⁾ in terms of both yield and grain protein accumulation, which means that the N removal on a per hectare basis is equivalent to other varieties. LongReach Spitfire⁽ᵇ⁾ appears unique in the fact that, unlike EGA Gregory⁽ᵇ⁾, even when it achieves higher yields it is still able to maintain protein concentration, giving it the potential to have a higher protein yield. In the situation where large premiums are paid for protein, EGA Gregory⁽ᵇ⁾ and Suntop⁽ᵇ⁾ may need specific N management targeting grain protein. However, the limited responses from in-crop N applications reported here highlights the risk associated with the reliability of in-crop rainfall to make use of these applications in the northern region and posses the challenge of how we can reliably supply N throughout the season to adjust for changes in seasonal potential. LongReach Spitfire⁽ᵇ⁾ on the other hand may need N management with a greater emphasis on maximising yield. With the exception of LongReach Spitfire⁽ᵇ⁾, there was generally no significant difference in grain N removal between varieties indicating that achieving protein will be influenced more by other factors, such as residual N, rather than straight variety choice.

Acknowledgements

This trial was run under the Variety Specific Agronomy Package Project (DAN00169), which is jointly funded by NSW DPI and GRDC. Angus Murchison, "Yoorooga" and Paul and Charles Tattam, "Bonniedoon" are gratefully acknowledged for the provision of the trial sites. Technical assistance provided by Rod Bambach, Jan Hosking, Jim Perfrement and Peter Formann are also gratefully acknowledged.

The effect of nitrogen rate and timing on grain yield and grain protein of eight wheat varieties – Coonamble 2012

Rohan Brill NSW DPI, Coonamble **Matthew Gardner** NSW DPI, Tamworth

Introduction

Nitrogen nutrition represents a significant cost for grain growers. With declining soil fertility in the northern grains region, it is important to select varieties that convert soil N and fertiliser N into grain yield and protein. In the northern grains region there is typically limited opportunity to apply nitrogen within the growing season, therefore most N is applied at or before sowing. There is the potential that high N rates at sowing may cause excessive early growth, causing crops to 'hay off'. This Variety Specific Agronomy Packages (VSAP) trial aims to investigate grain yield, protein and quality response of commonly grown wheat varieties to N fertiliser application.

Key findings

Only one variety, LongReach Impala$^{\phi}$, had a significant increase in grain yield as a result of the application of nitrogen (N) (only at 100 kg/ha N rate). Both EGA Gregory$^{\phi}$ and Caparoi$^{\phi}$ had significant reductions in grain yield as a result of the application of nitrogen.

Where no N was applied, the grain yield of EGA Gregory$^{\phi}$, Sunguard$^{\phi}$ and Suntop$^{\phi}$ were similar; however Sunguard$^{\phi}$ and Suntop$^{\phi}$ were able to maintain grain yield with increased N application.

Yield of most varieties was maximised at grain protein concentrations less than 10%, which goes against the 11% protein 'rule of thumb'.

LongReach Spitfire$^{\phi}$ had a higher grain protein concentration than all other varieties and also maintained good grain size at increased N rates.

Increasing the rate of N at sowing increased pre-anthesis dry matter production which left less water available for grain fill post-anthesis.

Site details

Soil type:	**Grey vertosol**
Sow date:	**21st May**
PAW at sowing:	**200 mm (estimate)**
In-crop rainfall:	**115 mm**
Previous crop:	**Chickpeas**
Deep N:	**53 kg/ha N (0–90 cm)**

Treatments

6 bread wheat varieties – EGA Gregory$^{\phi}$, Livingston$^{\phi}$, LongReach Spitfire$^{\phi}$, Sunguard$^{\phi}$, Suntop$^{\phi}$ and Sunvale$^{\phi}$
1 durum variety – Caparoi$^{\phi}$ 1 soft wheat variety – LongReach Impala$^{\phi}$
4 N rates at sowing – 0, 25, 50 and 100 kg/ha. 3 timings for the 50 kg/ha N rate – sowing, sowing:Z31, sowing:anthesis

Results

- Increasing the rate of applied N resulted in a significant yield increase for LongReach Impala$^{\phi}$ only. EGA Gregory$^{\phi}$ and Caparoi$^{\phi}$ had a significant reduction in yield with increasing N application rate (Figure 1).
- There was no significant increase in grain protein (averaged across all varieties) at the 25 kg/ha N rate compared with nil N. Grain protein increased significantly at the 50 kg/ha N rate compared with the nil N rate and increased further at the 100 kg/ha N rate (Figure 2).
- LongReach Spitfire$^{\phi}$ had the highest grain protein concentration at all rates of applied N.
- Averaged across all varieties, grain yield was maximised at a grain protein concentration of 9%.
- Screenings (% of grain below 2 mm screen) of LongReach Spitfire$^{\phi}$ and Sunguard$^{\phi}$ remained relatively stable at all N rates (average 5%). As a result of increasing nitrogen rate from nil to 100 kg/ha, screenings of Caparoi$^{\phi}$ increased from 7 to 18% (Figure 3).

***Figure 1:** Effect of nitrogen rate on the grain yield of eight wheat varieties at Coonamble in 2012 L.s.d. (P = 0.05) 0.38 t/ha*

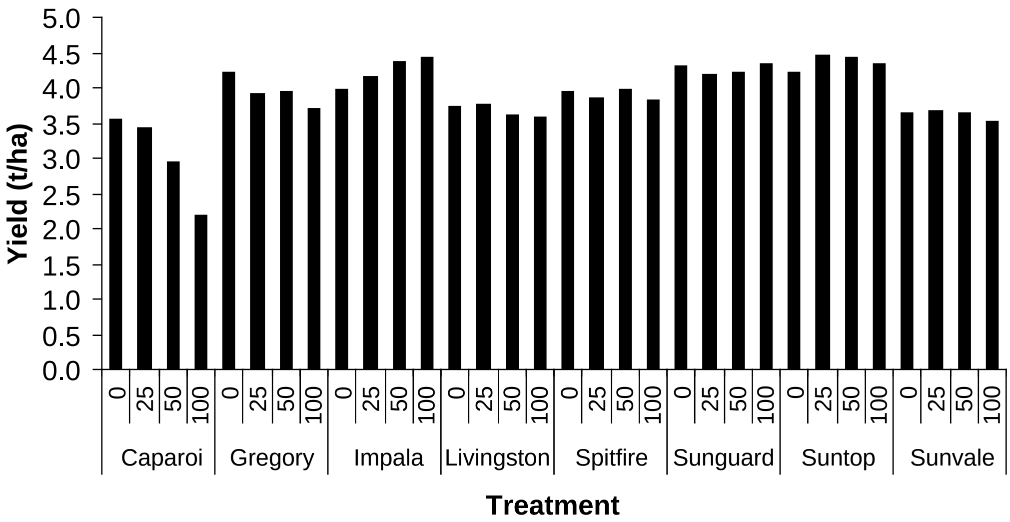


***Figure 2:** Effect of nitrogen rate on grain protein of eight wheat varieties at Coonamble in 2012 L.s.d. (P = 0.05) variety – 0.41%, N rate – 0.29%*

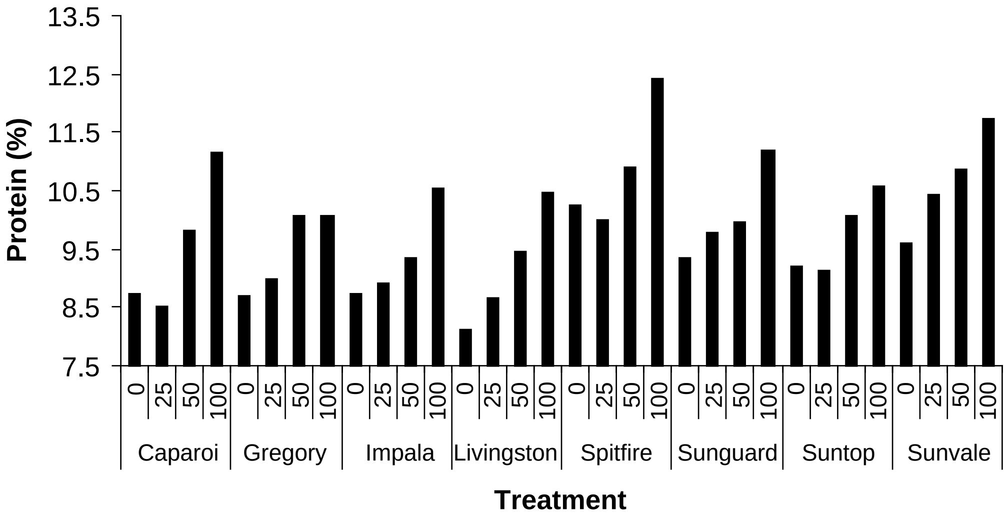
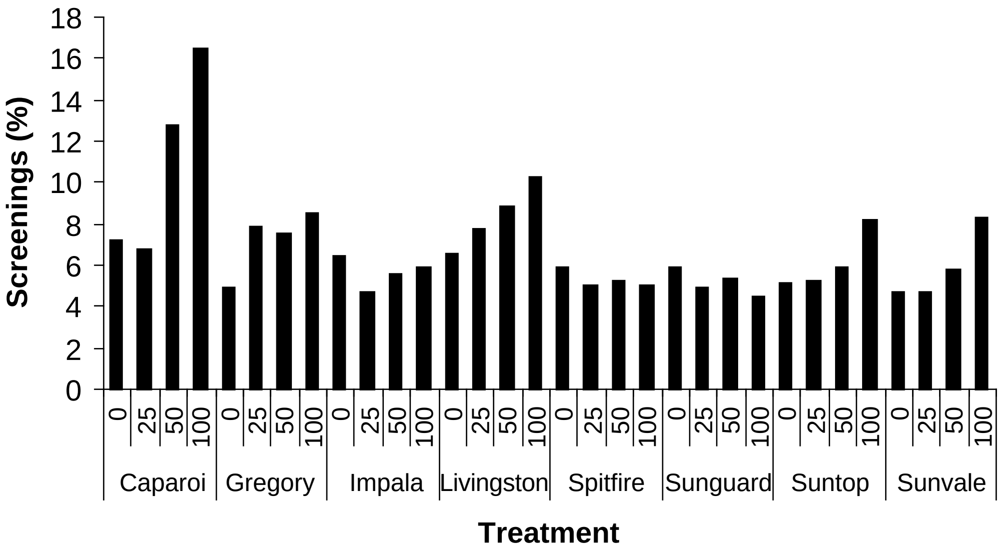


***Figure 3:** Effect of nitrogen rate on screenings % (2 mm screen) of eight wheat varieties at Coonamble in 2012 L.s.d. (P = 0.05) 0.6%*



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Summary

There was only a small recovery of applied fertiliser N in grain in this trial. Increasing the rate of nitrogen applied significantly decreased the yield of EGA Gregoryⓓ and Caparoiⓓ. It is unclear from this data alone the reasons for the yield loss from increasing N; however it may have been due to increased vegetative growth or from interactions with crown rot. Stubble samples were collected and crown rot severity is currently being assessed to determine its impact on the trial.

Suntopⓓ and Sunguardⓓ had relatively high grain yields at all N rates and are potential options for north-western NSW due to their good levels of resistance to crown rot and tolerance of the root lesion nematode *Pratylenchus thornei*. Suntopⓓ and Sunguardⓓ have APH and AH, respectively. Over several trials, Suntopⓓ has shown grain protein levels similar to EGA Gregoryⓓ.

Soil nitrogen levels in northern NSW have declined over the past three years, particularly in the subsoil, which has contributed to increased quantities of low protein wheat delivered into bulk handling facilities.

Leguminous crops and pastures appear the most sustainable option to increase nitrogen availability in the soil (especially in the subsoil). Increasing N concentration in the subsoil will allow access to that N later in the growing season. Ideally, fertiliser nitrogen should form only a small part of total crop nitrogen needs, especially in western farming systems.

Acknowledgements

This project is funded by NSW DPI and GRDC under the Variety Specific Agronomy Package Project (DAN00169). Thanks to Jayne Jenkins, Rob Pither, Patrick Mortell, Jim Perfrement, Steve Morphett, Rod Bambach and Jan Hosking for their technical assistance.

The effect of nitrogen rate and timing on grain yield and grain protein of eight wheat varieties – Trangie 2012

Rohan Brill NSW DPI, Coonamble **Leigh Jenkins** NSW DPI, Warren

NUTRITION & SOILS

Key findings

Increasing the rate of nitrogen applied at sowing increased grain yield of all wheat varieties from an average of 1.5 t/ha at the nil N rate to 2.9 t/ha at the 100 kg/ha N rate.

The lowest N application rate (25 kg/ha) did not increase grain protein significantly compared with the nil N rate (8.3% compared with 8.1%). Grain protein was increased by 1% from the application of 50 kg/ha N at sowing compared with where no N was applied and increased by a further 1.7% from the application of 100 kg/ha N at sowing.

At the 50 kg/ha N rate, splitting the N application between sowing and Z31 or sowing and Z65 had significantly lower yield than where the whole application was made at sowing.

The soft wheat variety LongReach Impala and the prime hard variety EGA Gregory⟨PBR⟩ were the highest yielding varieties in this trial, regardless of nitrogen rate.

Longreach Impala⟨PBR⟩ and the durum variety Caparoi⟨PBR⟩ had the lowest grain protein in this trial.

Introduction

Nitrogen (N) nutrition represents a significant cost for grain growers. With a declining soil fertility trend in the northern grains region, particularly over the past 3 seasons, it is important to select varieties that convert soil N and fertiliser N into grain yield and protein. This Variety Specific Agronomy Packages (VSAP) trial at Trangie aims to investigate grain yield and protein response of commonly grown wheat varieties to N fertiliser application. Further the trial examined the effects of nitrogen timing (50 kg/ha N rate only) on grain yield and protein.

Site details

Soil type:	**Red loam**
Sow date:	**17th May**
N applied:	**23rd May**
PAW at sowing:	**150 mm (estimate)**
In-crop rainfall:	**109 mm**
Previous crop:	**Canola**
Deep Nitrogen:	**50 kg/ha N (0–90 cm)**

Treatments

6 bread wheat varieties – EGA Gregory⟨PBR⟩, Livingston⟨PBR⟩, LongReach Spitfire⟨PBR⟩, Sunguard⟨PBR⟩, Suntop⟨PBR⟩, Sunvale⟨PBR⟩
1 durum variety – Caparoi⟨PBR⟩ 1 soft wheat variety – LongReach Impala⟨PBR⟩
4 N rates at sowing – 0, 25, 50 and 100 kg/ha as broadcast Urea. 3 timings for the 50 kg/ha N rate – sowing, sowing:Z31 (N split between sowing and stem elongation), sowing:Z65 (N split between sowing and anthesis). N applied as broadcast Urea.

Results

- Increasing the rate of N applied increased the grain yield of all varieties for N rates from 0 to 100 kg/ha (Figure 1).
- The conversion of fertiliser N into grain N was highest (43%) at the 25 kg/ha N rate, decreasing to 34% at the 100 kg/ha N rate (data not shown). This conversion of fertiliser N to grain N was the highest of six VSAP nitrogen trials in the northern grains region.
- There was reduced yield from splitting nitrogen (50 kg/ha N rate only) between sowing and Z31 (0.2 t/ha) or sowing and anthesis (0.3 t/ha), compared with where all N was applied at sowing (data not shown).
- EGA Gregory⟨PBR⟩ and LongReach Impala⟨PBR⟩ were the highest yielding varieties across all N rates.
- The application of 25 kg/ha nitrogen did not significantly increase protein. There was a significant grain protein increase of 1% from the 50 kg/ha N rate compared with the nil N rate. This was further increased by 1.7% from the application of 100 kg/ha N rate.

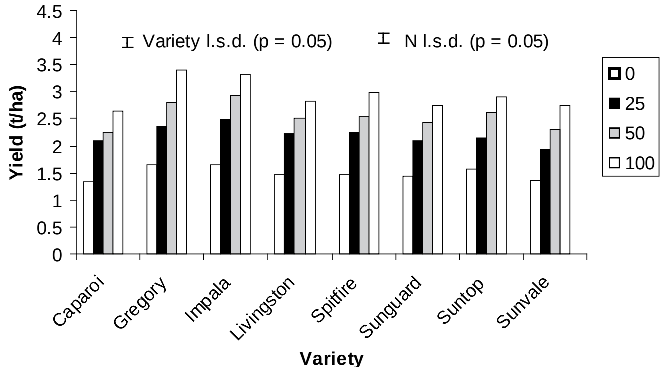

Figure 1: *Effect of nitrogen rate at sowing on the grain yield of eight wheat varieties at Trangie in 2012*

- Sunvale⦷ and LongReach Spitfire⦷ had the highest grain protein, whereas, LongReach Impala⦷ and Caparoi⦷ had the lowest grain protein.
- The difference in grain protein between EGA Gregory⦷ and LongReach Spitfire⦷ was less than 1%, which is less than has been observed in other VSAP trials over the past two seasons.

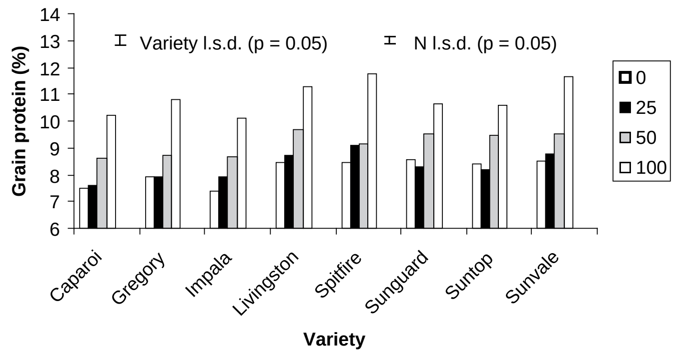

Figure 2: *Effect of nitrogen rate on grain protein of eight wheat varieties at Trangie in 2012*

NUTRITION & SOILS

Summary

There was a strong response to nitrogen for all N application rates in this trial; however there was no advantage in delaying any portion of the N applied to Z31 or anthesis, which was potentially due to the low in-crop rainfall received at the site. The late N applications were not taken up by the crop, as the roots were extracting water from much deeper in the soil profile.

EGA Gregory$^{\Phi}$ has been shown to be consistently high yielding over several seasons and a range of soil types. Grain protein concentration of EGA Gregory$^{\Phi}$ may be lower than other varieties, but this is largely due to its high yields, which causes dilution of protein with starch. LongReach Spitfire$^{\Phi}$ has been shown to achieve a high grain protein concentration for a given yield level; however the protein advantage of LongReach Spitfire$^{\Phi}$ over other commercial varieties was not as marked at this low N site.

Suntop$^{\Phi}$ has been at least as high yielding as EGA Gregory$^{\Phi}$ in trials grown on northern heavy soils; however yield on red soils have generally been less than EGA Gregory$^{\Phi}$ over the past two seasons. This could potentially be due to greater acid soil tolerance of EGA Gregory$^{\Phi}$ (red soils) and improved crown rot resistance of Suntop$^{\Phi}$ (heavy soils). Over several VSAP trials in 2011 and 2012, Suntop$^{\Phi}$ has displayed a grain protein concentration similar to EGA Gregory$^{\Phi}$.

LongReach Impala$^{\Phi}$ was a high yielding variety in this trial and other 2012 VSAP trials. LongReach Impala$^{\Phi}$ is a soft wheat variety, so would fit well where premiums for soft wheat exist. LongReach Impala$^{\Phi}$ is rated MR to stripe rust, which is a major improvement on past soft wheat lines; however it is rated moderately intolerant – intolerant of the root lesion nematode *Pratylenchus thornei*.

The soil test at this site showed a nitrogen availability of 50 kg/ha in the 0–90 cm soil zone. This soil test is about average for the northern grains region, which indicates that soil N reserves need to be increased to enhance grain yield and protein. Growing leguminous crops and/or pastures (with supplementary N fertiliser) appears a more sustainable way of increasing soil N compared with relying on N fertiliser applications alone.

Acknowledgements

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Nitrogen timing and its impact on the grain yield and protein of Caparoi⁽ᵈ⁾ under irrigated conditions at Breeza in 2012

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Key findings

The results from this trial highlight the importance of ensuring there is sufficient N supplied at or prior to stem elongation to maximise grain yield potential.

Topdressing at GS31 achieved a balance between yield and protein benefit from N application.

Splitting N topdressing across planting, stem elongation and flag leaf emergence resulted in high grain yields and protein, however this is unlikely to be a cost effective N strategy when application costs are considered.

Delaying some of the N budget to anthesis by applying either 25 or 50 kg N/ha was an effective means of increasing grain protein by 0.4 and 0.8%, respectively. However, this delay did reduce grain yield by approximately 5%.

NUTRITION & SOILS

Introduction

Nitrogen (N) requirements should be determined at the beginning of the season based on available N in the soil, yield potential and target protein content (targeting above 13% to meet DR1 classification). The use of irrigation can provide greater certainty in achieving grain yield targets unlike dryland crops where drier or wetter than expected seasonal conditions can significantly change yield potential mid season. Therefore, the quantity of N required to achieve yield and protein targets can be determined with much more certainty under irrigated systems. Manipulating N application through timing or split applications becomes increasingly important to ensure protein targets or premium grades are achieved. Previous studies have established that tactically delaying N can maintain yield or increase yield when split between sowing and up to stem elongation (GS31) compared to when all N is applied at sowing. In contrast, applying N after GS39 resulted in lower grain yields but significantly increased grain proteins. A trial was conducted at Breeza to investigate topdressing and N timing strategies in Caparoi⁽ᵈ⁾ under irrigation.

Site details

Breeza

Location:	**Liverpool Plains Research Station**
Sowing date:	**30th June, 2012**
Fertiliser:	**100 kg/ha Triple Superphosphate**
Starting soil N:	**71 kg N/ha**

Treatments

Caparoi⁽ᵈ⁾ plots were established, at 100 plants/m^2, on irrigation beds and 25 cm row spacing's. The crop received 5 irrigations throughout the season in an attempt to minimise moisture stress, with the last two irrigations occurring after anthesis.

There were two main treatments implemented:

1. Timing of N application
2. Anthesis application of 3 N rates as UAN

All treatments received a total of 220 kg N/ha that was applied as:

(a) single applications at planting (SB), stem elongation (GS31) and flag leaf emergence (GS39) or

(b) as split applications at growth stages:

- SB +GS31
- SB + GS39
- GS31 + GS39
- SB + GS31 + GS39

For each N timing treatment there were three delayed N treatments where either 0, 25 or 50 kg N/ha was applied approximately 4–5 days after anthesis. Delayed N treatments were liquid UAN diluted with water in a 50:50 mixture applied through streamer bars. A final control treatment was included, which had no N applied throughout the season.

Results

The control treatment had grain yields of 5.15 t/ha, which was significantly lower than all other treatments. The single application of N at GS39 had the lowest yields of all the N timing treatments yielding 5.94 t/ha. The SB, GS31, SB + GS31 and the SB + GS31 + GS39 treatments had the greatest grain yields of all treatments, averaging 6.85 t/ha. Where half of the total N was applied at GS39 yields were 6.26 t/ha, which was 9% lower than the top yielding N treatments.

The application of N treatments increased grain protein by 2.0 – 3.0% compared to the control treatment. Any treatments where SB N was applied resulted in similar grain protein, averaging 14.22%. Splitting N application between GS31 + GS39 resulted in the highest grain protein content of 15%. The single application of N at GS39 resulted in grain proteins of 14.6%, which was similar to the three way split application treatment.

Delaying the application of either 25 or 50 kg N/ha from earlier in the season to after anthesis resulted in a significant reduction in grain yield of 5%. There was no significant difference in yield reduction between the 25 or 50 kg N/ha treatment. For every 25 kg N/ha applied after anthesis there was a significant increase in protein by approximately 0.40%.

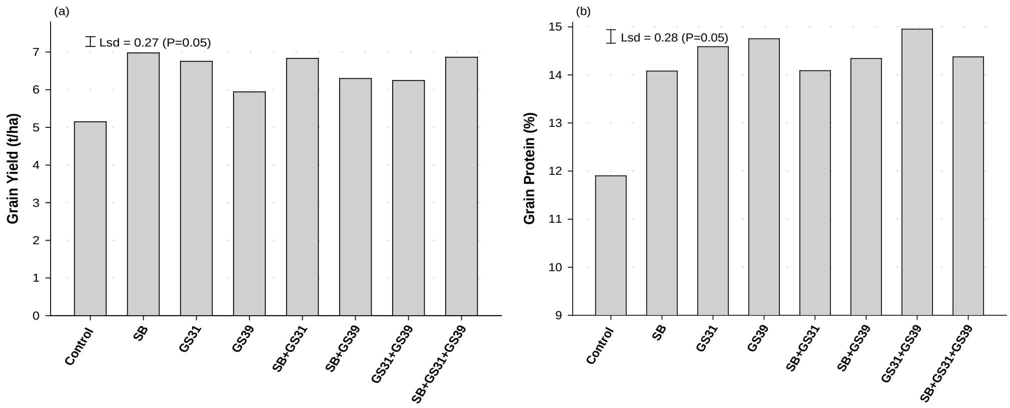

Figure 1: *The effect of N timing on the grain yield (a) and protein (b) of Caparoi*[(] *at Breeza in 2012 under irrigation.*

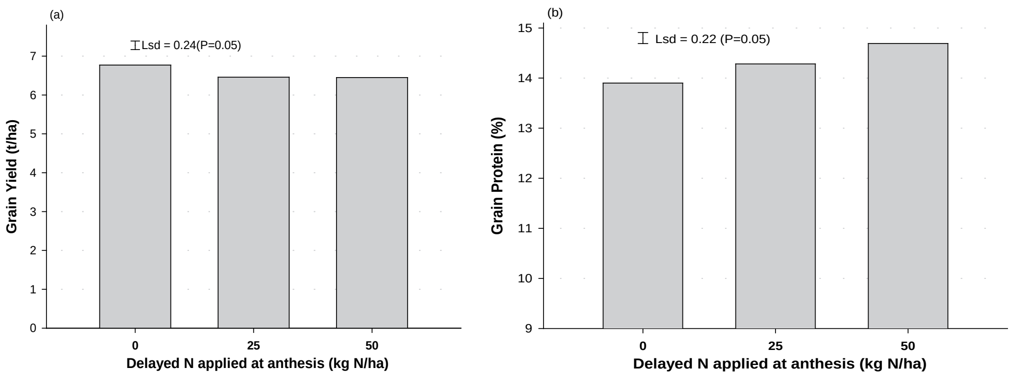

Figure 2: *The effect of delaying 0, 25 or 50 kg N/ha until 5 days after anthesis on grain yield (a) and protein (b).*

Summary

The results from this trial highlight the importance of ensuring there is sufficient N supplied at or prior to stem elongation to maximise grain yield potential. The split application treatments suggest that delaying more than 33% of N supply after stem elongation would significantly reduce grain yield potential. The opposite was true for grain protein. Any treatments that included the application of N at planting had significantly lower grain protein than the GS31 and GS39 treatments. The highest grain proteins from a single N application were at GS39, while the 3 way split treatment achieved the highest grain protein for the trial. These results support previous work (McMullen unpublished) the topdressing of N at GS31 increased grain yield, whereas late topdressing (GS61) had lower yield but increased protein. Topdressing at GS31 achieved a balance between yield and protein benefit from N application. Splitting N topdressing across 3 growth stages resulted in high grain yields and protein. Although having multiple topdressing applications optimises N use efficiency by reducing the opportunity for large quantities to be available for loss, it is unlikely to be a cost effective N strategy when application costs are considered. Delaying some of the N budget to anthesis and applying either 25 or 50 kg N/ha was an effective means of increasing grain protein by 0.4 and 0.8%, respectively. However, this delay did reduce grain yield by approximately 5%.

Acknowledgements

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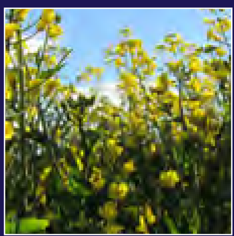

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