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Contents

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The Board of the Hart Field-Site Group Inc would also like to acknowledge the significant contribution of site collaborators and donors of inputs, equipment and labour.

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Site Managers

SARDI Clare Crop Evaluation and Agronomy Unit and Field Crop Evaluation Unit, Waite – John Nairn, Site Manager; Assisted by: Rob Wheeler, Larn McMurray, Peter Maynard, Rohan Steele, Stuart Sheriff and Shafiya Hussein.

Board of the Hart Field-Site Group Inc.

Contact us

The Hart Board welcome you as a visitor to Hart and value your feedback and questions.

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Diary Dates and Membership

Diary Dates

GETTING THE CROP IN
March 16th 2011
8am – 1pm
The Valley's Lifestyle Centre
AGM
March 16th 2011
1:30pm
The Valley's Lifestyle Centre

WINTER WALK
Tuesday 26th July 2011

HART FIELD DAY
Thursday 22nd September 2011

SPRING TWILIGHT WALK
Tuesday 18th October 2011

Membership

Choose a level of admission / membership to best suit you and your business.
Membership terms now Field Day to Field Day.
No-fuss - renew as you register at the Field Day each year.

BRONZE $30
General Admission

- Entry to this year's Field Day
- Field Day Book
- Hart email updates - quarterly

SILVER $60

- Entry to this year's Field Day
- Field Day Book
- Hart email updates - quarterly
- Trials Results Book
- Hart Beat newsletter (Yield predictions throughout the growing season)

GOLD $90 (farming business)
CORPORATE $200
(non-farming business)

- Entry to this year's Field Day (for up to **3 partners** in your business)
- Field Day Book per partner
- Hart email updates - quarterly
- Trials Results Book
- Hart Beat newsletter (Yield predictions throughout the growing season)
- Exclusive access to Gold Members Only lane (food and drink) at the Field Day
- Priority booking and 30% discount for all Hart seminars and workshops.
- "Hart" Hat

All Financial Members are eligible nominate for a position on the Hart Board and to attend and vote at our AGM.

What if you can't attend the Field Day?

We'll contact you after each year's Field Day *(provided we have your up to date contact details)* and offer you the opportunity to renew. On receipt of your payment, we'll send you a copy of the Field Day book and a copy of the Trials Results book on its release, according to which level of membership you choose. You'll also be eligible for all other benefits as applicable.

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Interpretation of statistical data from the trials

The least significant difference (LSD P<0.05), seen at the bottom of data tables gives an indication of the treatment difference that could occur by chance. NS indicates that there is no difference between the treatments. The size of the LSD can be used to compare treatment results and values must differ by more than this value for the difference to be statistically significant.

So, it is more likely (95%) that the differences are due to the treatments, and not by chance (5%).

Of course, we may be prepared to accept a lower probability (80%) or chance that 2 treatments are different, and so in some cases a non-significant result may still be useful.

Disclaimer

While all due care has been taken in compiling the information within this manual the Hart Field-Site Group Inc or researchers involved take no liability resulting from the interpretation or use of these results.

We do not endorse or recommend the products of any manufacturers referred to. Other products may perform as well or those better than specifically referred to.

Any research with unregistered pesticides or of un-registered products and rates in the manual does not constitute a recommendation for that particular use by the researchers or the Hart Field-Site Group Inc.

Hart 2010 grower survey

This is a summary of the responses collated from the 2010 grower survey (29 responses). We hope this information helps to add value to your business.

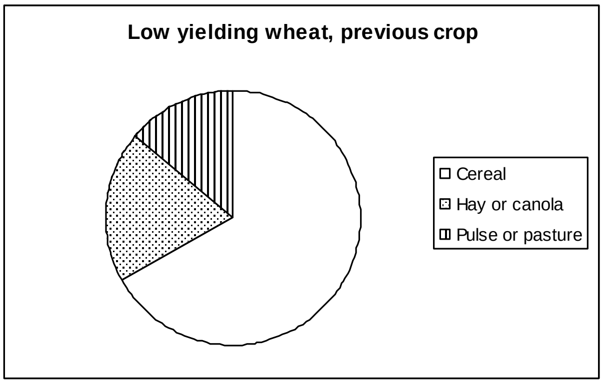
1. Rainfall – below are the average rainfall, yield and water use efficiency figures from growers' farms in 2010.

Town	2010 rainfall (mm)	GSR (mm) (Apr - Oct)	Average wheat yield (t/ha)	WUE (kg/mm/ha)
Ardrosson	412	322	4.8	22.5
Balaklava	518	320	4.2	20.0
Blyth	557	415	5.5	18.0
Booborowie	599	394	4.6	16.2
Brinkworth	516	354	4.3	17.7
Curramulka	401	313	4.5	22.2
Gulnare	513	378	4.0	14.9
Hoyleton	634	427	6.1	19.2
Jamestown	603	454	4.5	13.1
Kimba	448	254	2.6	18.1
Koolunga	528	366	4.6	18.0
Kybunga	612	446	5.2	15.5
Long Plains	470	343	4.5	19.3
Maitland	400	300	4.5	23.7
Paskeville	520	388	5.5	19.8
Pt Pirie	419	272	3.0	18.6
Riverton	755	528	6.4	15.3
Spalding	559	403	4.9	16.7

The average grain yield of wheat in 2010 was 4.5 t/ha, ranging between 2.6 t/ha and 6.4 t/ha (Table 1). For the lowest yielding wheat paddocks a cereal (durum, wheat or barley) was generally the previous crop while a pulse crop or pasture was generally grown before the highest yielding wheat crops 75% of the time (Figure 1)

Table 1. Minimum, maximum and average grain yield for the whole farm average, lowest or highest wheat yields in 2010.

2010 crop yield (t/ha)	Grain yield (t/ha)	Range (t/ha)	
		Minimum	Maximum
Average	4.5	2.6	6.4
Lowest paddocks	3.5	1.2	4.9
Highest paddocks	5.1	3.3	7.1



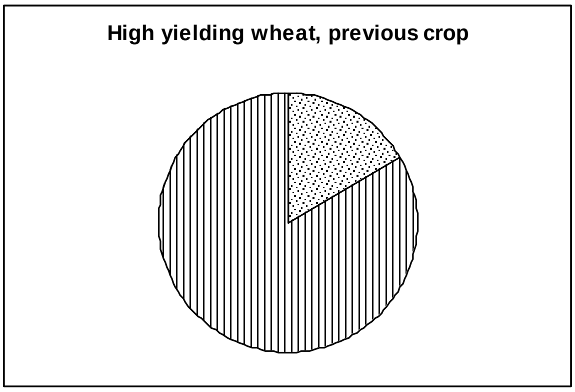
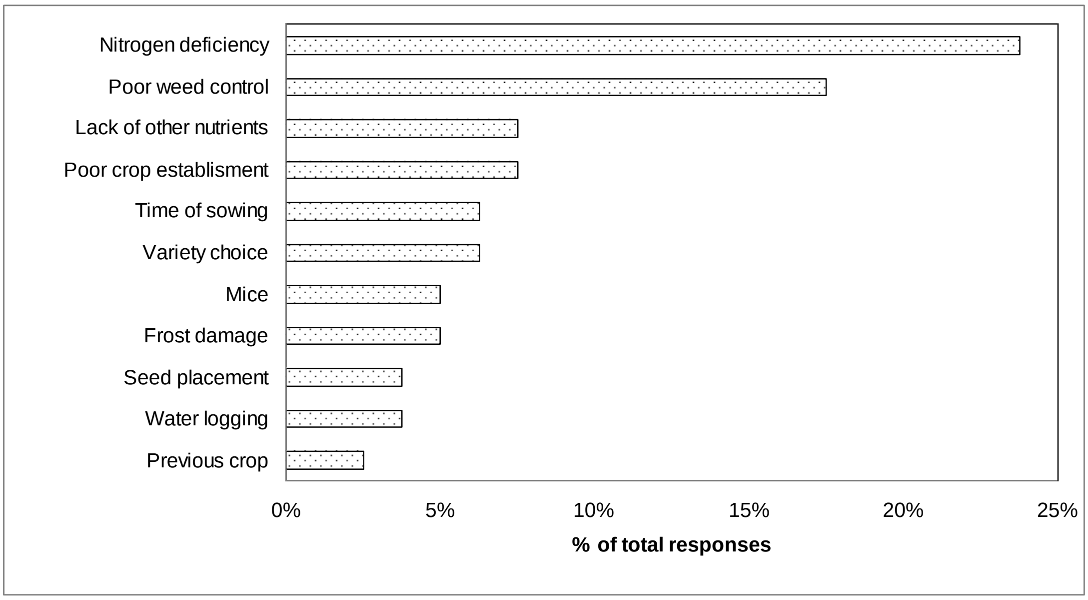
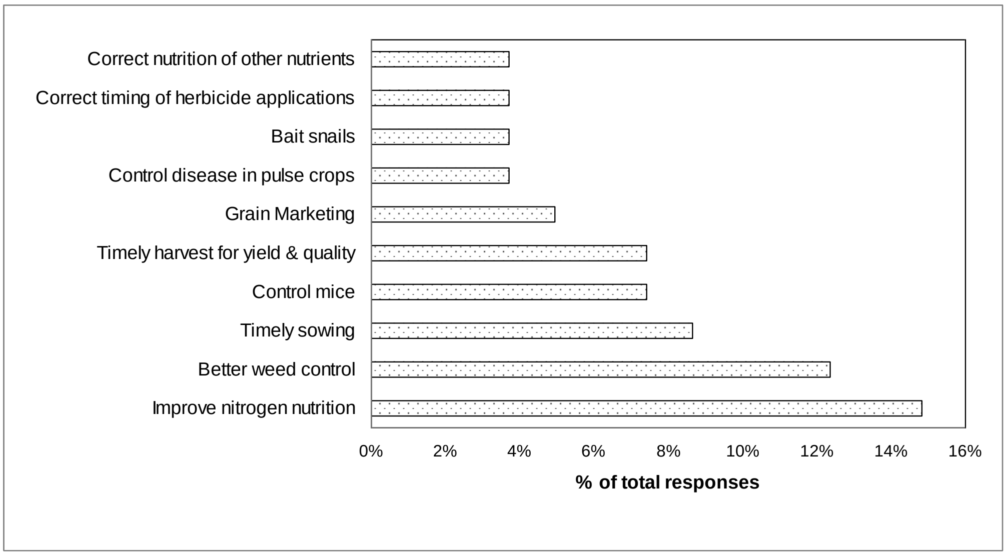


Figure 1. The proportion of cereal (durum, wheat or barley), canola or hay, or pulse or pasture grown before the lowest or highest yielding wheat paddocks in 2010.

2. What were the main limiting factors to achieving maximum grain yields in wheat and barley in 2010?



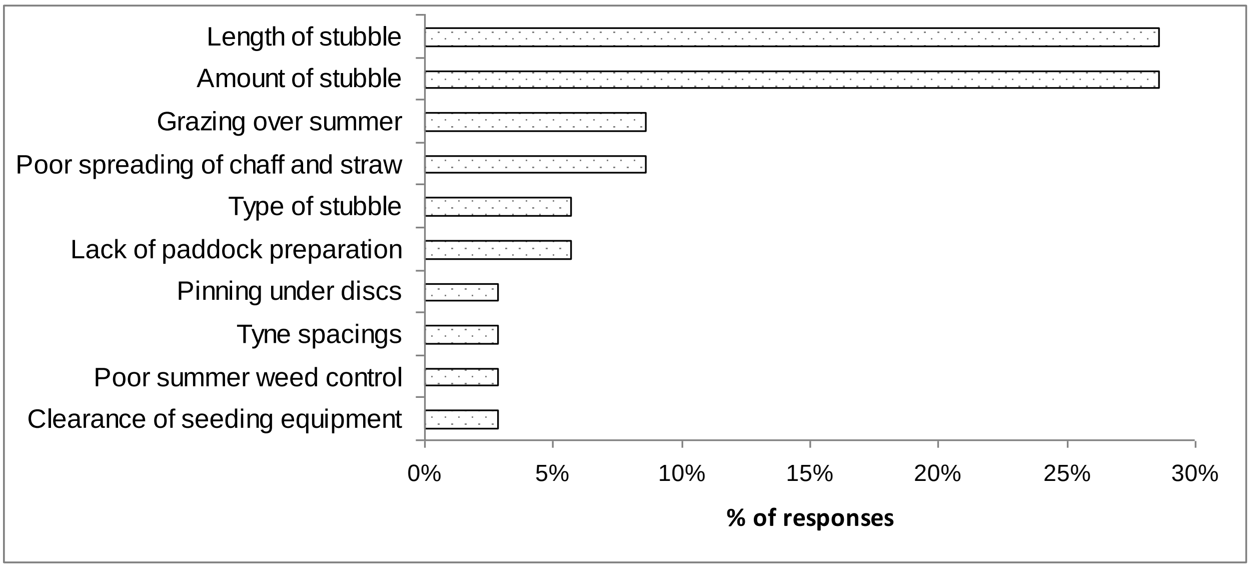
3. What were three key lessons you learnt in 2010 in your farming operation to get the best economic return?



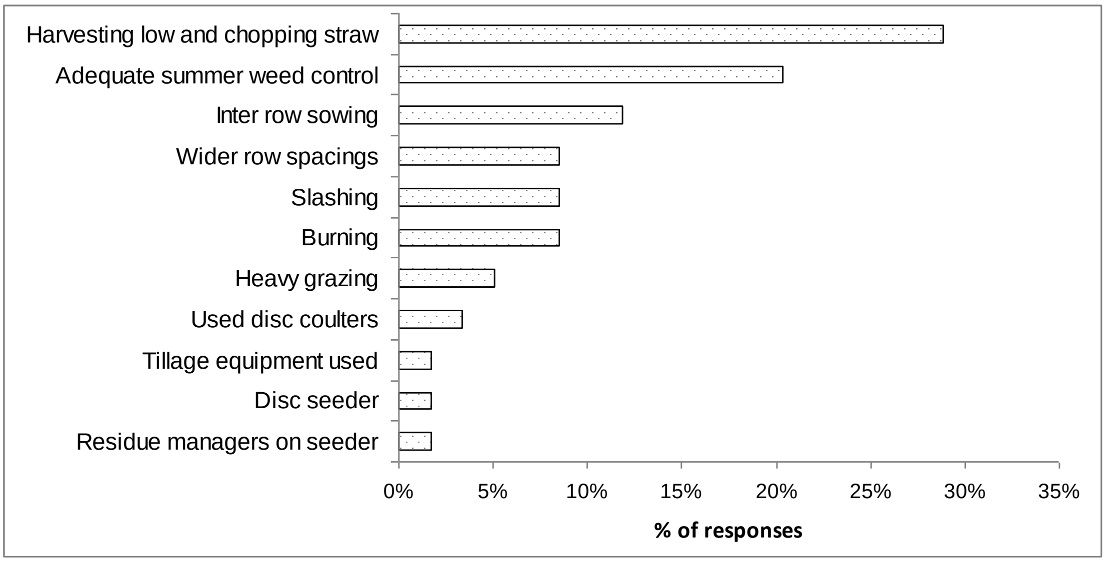
Other responses:

- Rain makes a difference
- Nitrogen for protein
- Use reliable contractors
- Grow a variety of crops with different maturities
- Don't sow peas too early
- Pre-order fertiliser
- Pre-emergent herbicides
- Use fungicides in a good year
- Watch for late wild oats
- Sprouting in cereals
- Summer weed control
- Use rotation to control grasses
- Use good early knock down

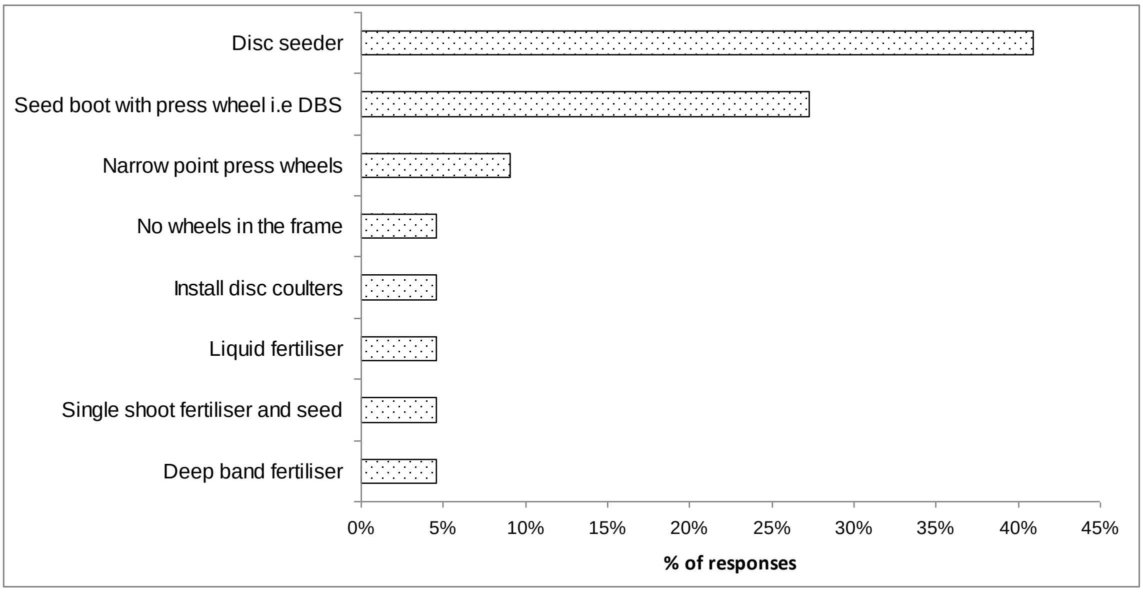
4. At seeding did you have any trouble sowing through the residue from 2009? If so, what contributed to this problem?
   In 2010, 66% of growers had difficulties sowing and the reasons are below.



5. If you didn't have any trouble with residue what helped to avoid this problem?



6. Would you like to change your seeder, and if so what would you like?



Comparison of wheat varieties

Key findings

- Yitpi, Correll and Mace were the highest yielding hard wheat varieties at Hart in 2010, averaging 4.59 t/ha. Pugsley, Scout, Guardian and Espada were the highest yielding APW varieties, averaging 4.53 t/ha.
- Axe produced the highest wheat grain protein (10.4%) at Hart in 2010.

Why do the trial?

To compare the performance of new wheat varieties and lines against the current industry standards.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	32:10 (DAP/Urea) @ 70 kg/ha UAN @ 100 L/ha 10th August
Seeding date	14th May 2010		

The trial was a randomised complete block design with 3 replicates and 25 varieties. Fungicides were applied as necessary to keep the crop free of disease i.e stripe rust.

Plot edge rows were removed prior to harvest. All plots were assessed for grain yield, protein, test weight and screenings (mainly cracked grains) with a 2.0 mm screen.

Results

Grain yields ranged between 3.19 t/ha (Peake) and 4.78 t/ha (Yitpi and Orion) at Hart in 2010. Soft varieties Bowie, Orion and Yenda, APW varieties Espada, Guardian, Scout and Pugsley, and hard varieties Yitpi, Correll and Mace were the highest yielding wheat varieties in 2010, averaging 4.54 t/ha (Table 1). The grain yield across all wheat varieties at Hart in 2010 was 4.1 t/ha.

Wheat grain protein levels ranged from 8.3% (Orion) to 10.4% (Axe) with an average of 9.2%.

Axe, Clearfield JNZ, Orion, Magenta, Guardian and AGT Katana, produced test weights lower than 74 kg/hL, the minimum required for maximum achievable grade.

Axe, Bowie, Catalina, Clearfield JNZ, Orion, Pugsley and Wyalkatchem produced the lowest screenings at Hart in 2010 with an average of 3.9%. Lincoln produced the highest screenings at 10.6% and the average screenings (%) across all varieties at Hart in 2010 was 6.0%.

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of wheat varieties at Hart in 2010.

Quality	Variety	Grain yield (t/ha)	% of Yitpi	Protein (%)	% of Yitpi	Test weight (kg/hL)	% of Yitpi	Screenings (%)	% of Yitpi
APW	Espada	4.41	92	9.4	106	76.1	99	4.8	80
	Guardian	4.42	93	9.0	101	72.2	94	8.7	143
	Pugsley	4.72	99	8.7	98	76.8	100	3.0	49
	Scout (LPB05-1164)	4.58	96	8.9	100	78.7	102	5.0	83
	Wyalkatchem	3.91	82	8.8	99	76.6	100	4.2	69
	Estoc (RAC1412)	4.15	87	9.6	108	78.8	102	6.0	99
	Kord CL Plus (RAC1669R)	4.10	86	9.3	105	73.9	96	8.6	142
ASW	Magenta	4.20	88	9.4	106	72.1	94	7.6	125
Soft	Barham	4.18	87	9.2	104	74.0	96	4.7	76
	Bowie	4.30	90	8.7	98	75.6	98	4.2	70
	Yenda	4.36	91	9.5	107	73.8	96	8.4	138
	Orion	4.78	100	8.3	93	70.2	91	3.3	54
Hard	Axe	3.70	77	10.4	117	69.6	90	4.4	72
	Bolac	3.27	69	9.6	108	74.8	97	8.0	131
	Catalina	3.98	83	9.7	110	79.9	104	4.4	72
	Correll	4.60	96	8.9	100	76.1	99	7.2	119
	Derrimut	4.06	85	9.2	104	75.7	98	6.0	98
	Gladius	4.10	86	9.9	111	75.4	98	4.7	77
	Clearfield JNZ	3.27	68	9.1	102	70.2	91	3.7	61
	AGT Katana	4.07	85	9.4	106	72.6	94	8.2	135
	Lincoln	3.25	68	8.8	99	75.5	98	10.6	173
	Mace	4.40	92	9.1	103	77.5	101	6.4	105
	Peake	3.19	67	9.5	107	74.3	97	5.4	89
	Yitpi	**4.78**	**100**	**8.9**	**100**	**76.9**	**100**	**6.1**	**100**
	Young	3.83	80	9.7	109	77.4	101	5.4	90
	Site mean	4.10	86	9.2	104	75.0	97	6.0	98
	LSD (0.05)	0.54	11	0.6	7	7.1	9	1.6	26

Comparison of barley varieties

Key findings

- Feed varieties Capstan, Fleet, and Yarra and malting varieties Buloke, Commander and Oxford were the highest yielding barley varieties at Hart in 2010, averaging 5.59 t/ha.
- Capstan (9.5%) and the hull-less variety Finniss (12.1%) were the only varieties to produce screenings above 5%.

Why do the trial?

To compare the performance of new barley varieties and lines against the current industry standards.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	32:10 (DAP/Urea) @ 70 kg/ha UAN @ 100 L/ha 10th August
Seeding date	14th May 2010		

The trial was a randomised complete block design with 3 replicates and 18 varieties. Fungicides were applied as necessary to keep the crop free of disease i.e net blotch.

Plot edge rows were removed prior to harvest. All plots were assessed for grain yield, protein, test weight, screenings with a 2.2 mm screen and retention with a 2.5 mm screen.

Results

The feed varieties Capstan (5.66 t/ha), Fleet (5.66 t/ha) and Yarra (5.44 t/ha) and malting varieties Commander (5.67 t/ha), Buloke (5.55 t/ha) and Oxford (5.55 t/ha) were the highest yielding barley varieties at Hart in 2010 (Table 1).

The average grain yield across all feed varieties was 5.37 t/ha compared to 5.22 t/ha for the malting varieties.

The malting variety Oxford and the hull-less variety Finnis produced an average protein of 9%. All other named varieties produced statistically similar protein with an average of 10.5%.

Malt varieties Commander, Baudin and Gairdner produced test weights of 64 kg/hL, just below the required 65 kg/hL for malting specification. Capstan and the hull-less variety Finnis were the only feed varieties not to meet the test weight specifications for the maximum grade.

Capstan (9.5%) and Finniss (12.1%) were the only varieties to produce screenings above 5%. All malting varieties produced retention greater than the required 86%.

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of barley varieties at Hart in 2010.

Quality	Variety	Grain yield (t/ha)	% of Sloop SA	Protein (%)	% of Sloop SA	Test weight (kg/hL)	% of Sloop SA	Screenings (%)	% of Sloop SA	Retention (%)	% of Sloop SA
Feed	Capstan	5.66	111	10.4	95	61.4	93	9.5	318	78.3	81
	Fleet	5.66	111	11.0	100	63.3	96	1.6	52	96.0	100
	Hannan	5.07	100	10.4	95	67.0	102	2.6	88	93.7	97
	Hindmarsh	5.30	104	10.5	96	67.4	102	4.8	159	88.7	92
	Keel	5.16	101	10.4	94	63.0	96	3.0	99	96.4	100
	Maritime	5.25	103	10.7	98	64.3	98	0.9	30	97.8	102
	Scope (VBHT0805)	5.40	106	10.6	96	67.4	103	1.5	51	93.3	97
	Yarra	5.44	107	10.5	95	64.2	98	2.2	73	96.4	100
Malting	Baudin	4.93	97	10.4	94	64.3	98	2.4	80	94.6	98
	Buloke	5.55	109	10.2	92	65.1	99	2.1	69	90.9	94
	Commander	5.67	112	10.6	96	64.3	98	4.3	144	93.3	97
	Flagship	4.94	97	10.6	96	67.2	102	2.5	83	92.8	97
	Gairdner	5.18	102	10.3	93	64.4	98	5.0	166	86.3	90
	Oxford	5.55	109	8.7	79	68.3	104	2.6	86	88.3	92
	Schooner	4.84	95	10.2	93	64.8	99	2.2	72	93.4	97
	SloopSA	**5.09**	**100**	**11.0**	**100**	**65.7**	**100**	**3.0**	**100**	**96.2**	**100**
Hull-less	Finnis (WI3930)	4.99	98	9.3	85	60.6	92	12.1	403	65.2	68
Yet to be classified	WI4262	5.60	110	9.2	83	65.1	99	1.2	40	95.5	99
	Site mean	5.29	104	10.3	93	64.9	99	3.5	117	90.9	95
	LSD (0.05)	0.26	6	0.8	7	1.9	3	1.1	110	2.9	3

Comparison of durum varieties

Key findings

- WID803 was the highest yielding durum line producing 4.51 t/ha.
- Caparoi, Hyperno, Tjilkuri and Saintly produced statistically similar yields with and average of 3.83 t/ha.

Why do the trial?

To compare the performance of new durum varieties and lines against the current industry standards.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	32:10 (DAP/Urea) @ 70 kg/ha UAN @ 100 L/ha 10th August
Seeding date	14th May 2010		

The trial was a randomised complete block design with 3 replicates and 7 varieties.

Plot edge rows were removed prior to harvest.

All plots were assessed for grain yield, protein, test weight and screenings with a 2.0 mm screen.

Results

WID803 was the highest yielding durum variety at Hart in 2010, 4.51 t/ha. Of the named varieties Caparoi, Hyperno, Tjilkuri and Saintly produced statistically similar yields with an average of 3.83 t/ha (Table 1).

Across all durum varieties protein ranged from 9.4% (Tjilkuri) to 10.9% (Caparoi), and the average across all varieties was 10.0%.

Test weights for all durum varieties were above 74.0 kg/hL and screenings were all below 3.0 % at Hart in 2010.

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of durum varieties at Hart in 2010.

Variety	**Grain yield (t/ha)**	% of Tamaroi	**Protein (%)**	% of Tamaroi	**Test weight (kg/hL)**	% of Tamaroi	**Screenings (%)**	% of Tamaroi
Caparoi	3.88	123	10.9	101	78.9	104	1.0	66
Hyperno	3.91	124	9.7	90	73.3	96	2.6	166
Saintly	3.71	118	10.4	97	76.3	100	1.4	92
Tamaroi	**3.15**	**100**	**10.8**	**100**	**76.2**	**100**	**1.6**	**100**
Tjilkuri (WID801)	3.81	121	9.4	87	74.1	97	1.4	91
WID802	3.61	115	9.6	90	73.5	97	2.0	126
WID803	4.51	143	9.4	88	75.0	99	2.9	186
Site mean	3.80	121	10.0	93	75.3	99	1.9	118
LSD (0.05)	0.33	10	0.5	5	1.5	2	0.7	44

Comparison of triticale varieties

Key findings

- Jaywick and Kosciuszko were the highest yielding triticale varieties at Hart in 2010, averaging 3.53 t/ha.

Why do the trial?

To compare the performance of new triticale varieties and lines against the current industry standards.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	32:10 (DAP/Urea) @ 70 kg/ha UAN @ 100 L/ha 10th August
Seeding date	14th May 2010		

The trial was a randomised complete block design with 3 replicates and 7 varieties.

Plot edge rows were removed prior to harvest.

All plots were assessed for grain yield, protein, test weight and screenings with a 2.0 mm screen.

Results

Jaywick (4.68 t/ha) and Hawkeye (4.49 t/ha) were the highest yielding triticale varieties at Hart in 2010 (Table 1).

Triticale protein ranged from 7.6% (Bogong) to 9.1% (Speedee) and the average across all varieties was 8.4%.

Bogong produced the highest test weight (70.8 kg/hL) in the trial.

Screenings averaged 1.7% and there was no significant difference between varieties.

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of triticale varieties at Hart in 2010.

Variety	Grain yield (t/ha)	% of Tahara	Protein (%)	% of Tahara	Test weight (kg/hL)	% of Tahara	Screenings (%)	% of Tahara
Bogong	3.99	95	7.6	93	70.8	105	1.8	138
Hawkeye	4.49	107	8.3	101	67.8	100	2.2	166
Jaywick	4.68	111	8.1	98	69.1	102	1.7	126
Kosiuszko	4.15	98	8.3	100	67.5	100	1.8	133
Rufus	4.11	97	8.2	100	67.4	100	1.2	90
Speedee	3.45	82	9.1	111	64.6	96	1.8	136
Tahara	4.21	100	8.2	100	67.5	100	1.3	100
Site mean	4.18	99	8.4	102	67.3	100	1.7	125
LSD (0.05)	0.24	8	0.9	8	1.4	2	ns	ns

Time of sowing and seeding rate in wheat

This trial was funded by GRDC and conducted in collaboration with SARDI.

Key findings

- The highest yielding wheat variety in the time of sowing trial at Hart in 2010 was Yitpi (4.81 t/ha) sown on May 1st.
- Wheat varieties Axe and Gladius increased grain yield as time of sowing was delayed from May 1st until May 29th.

Why do the trial?

To measure the effect of time of sowing (TOS) and plant density on wheat and durum varieties with different development habits and maturities.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	32:10 (DAP/Urea) @ 80 kg/ha UAN @ 100 L/ha 19th August
Seeding date	TOS 1 - 1st May 2010 TOS 2 - 14th May 2010 TOS 3 - 29th May 2010		

The trial was a randomised block design with 3 replicates 3 wheat varieties and 1 durum variety, 3 plant densities and 3 times of sowing.

The wheat and durum varieties used were Axe (early maturing), Gladius (early-mid maturing), Tjilkuri durum (WID801) (mid maturing) and Frame (mid-late maturing).

The plant densities achieved are shown in Table 1.

Sowing rate	Plant density (plants/sq m)
Low	93
Medium	121
High	161
LSD (0.05)	5.8

Table 1: Wheat and durum plant density (plants per square metre) averaged across variety and time of sowing at Hart in 2010.

Plot edge rows were removed prior to harvest. All plots were assessed for grain yield, protein, test weight, grain weight and screenings with a 2.0 mm screen.

Results

Grain yields of the earlier maturing varieties (Axe and Gladius) were highest at the latest time of sowing (TOS 3 29th May)(Table 2 or Figure 1). However, for the later maturing variety Yipti, grain yield was highest (4.81 t/ha) at TOS1 1st May. This was not significantly different to Yitpi sown at TOS 2 or TOS 3. The grain yield of Tjilkuri durum averaged 4.15 t/ha and was not significantly affected by time of sowing or plant density. There was no significant response in grain yield to plant density for any of the wheat varieties.

Table 2: Grain yield (t/ha) for time of sowing and variety at Hart in 2010, averaged for sowing rate.

Time of Sowing		Grain yield (t/ha)				
		Axe	Gladius	Tjilkuri	Yitpi	Average
TOS 1	May-01	3.59	4.21	4.04	4.81	4.16
TOS 2	May-14	3.92	4.31	4.19	4.74	4.29
TOS 3	May-29	4.58	4.61	4.22	4.70	4.53
Average		4.03	4.38	4.15	4.75	
LSD (0.05)						
TOS				0.13		
Variety				0.12		
TOS*Variety				0.21		

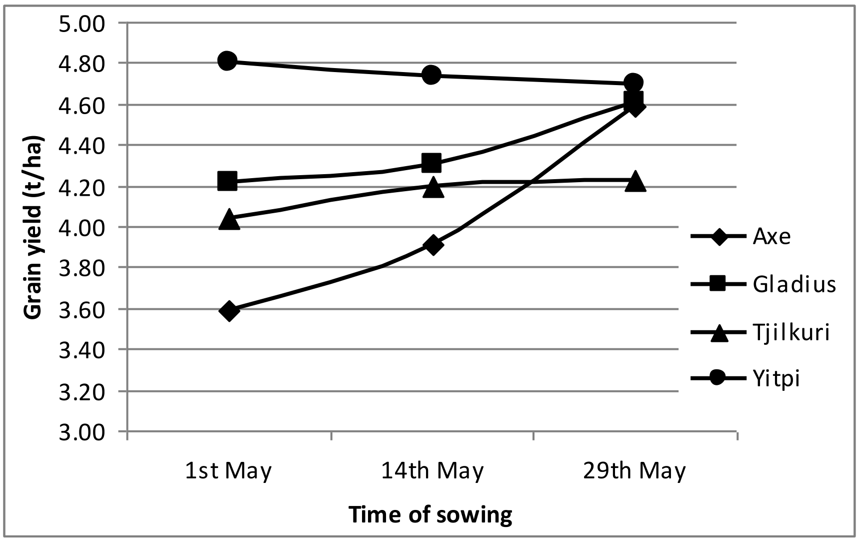


Figure 1: Grain yield (t/ha) for time of sowing and variety at Hart in 2010, averaged for sowing rate.

For all times of sowing Axe produced the highest grain protein (Table 3). In contrast, grain protein for Gladius was not influenced by time of sowing. The longer season varieties Tjilkuri and Yitpi produced higher grain protein as time of sowing was delayed, ranging from 9.2% for both Tjilkuri and Yitpi sown May 1st to 9.8% (Tjilkuri) and 10.1% (Yitpi) sown May 29th.

Table 3: Grain protein (%) for time of sowing and variety at Hart in 2010, averaged for sowing rate.

Time of Sowing		Grain protein (%)				
		Axe	**Gladius**	**Tjilkuri**	**Yitpi**	**Average**
TOS 1	May-01	11.0	10.2	9.2	9.2	9.9
TOS 2	May-14	10.8	10.1	9.4	9.5	9.9
TOS 3	May-29	10.4	10.1	9.8	10.1	10.1
Average		10.7	10.1	9.4	9.6	
LSD (0.05)						
TOS				ns		
Variety				0.2		
TOS*Variety				0.4		

All treatments produced test weights equal or above 74 kg/hL, the minimum requirement for maximum achievable grade for all varieties (Table 4). The highest test weight was produced by Yitpi (76.8 kg/hL) when sown at the medium sowing rate. Time of sowing did not significantly affect test weight.

Table 4: Grain test weight (kg/hL) for seeding rate and variety at Hart in 2010, averaged for time of sowing.

Variety	Grain test weight (kg/hL) Seeding rate			
	Low	**Medium**	**High**	**Average**
Axe	74.8	75.0	74.0	74.6
Gladius	75.6	75.2	75.5	75.4
Tjilkuri	75.1	75.4	75.3	75.3
Yitpi	75.4	76.8	76.4	76.2
Average	75.4	75.8	75.7	
LSD (0.05)				
Seed rate		ns		
Variety		0.5		
Seed rate*Variety		0.9		

Screenings for all treatments in the wheat time of sowing trial at Hart in 2010 were below 1.5% (Table 5). Axe and Gladius produced the lowest screenings of only 0.5%.

Table 5: Grain screenings for time of sowing and variety at Hart in 2010, averaged across sowing rate.

Time of Sowing		**Screenings (%)**				
		Axe	**Gladius**	**Tjilkuri**	**Yitpi**	**Average**
TOS 1	May-01	0.5	0.6	1.3	1.1	0.9
TOS 2	May-14	0.5	0.6	0.9	0.8	0.7
TOS 3	May-29	0.4	0.5	0.9	0.7	0.6
Average		0.5	0.5	1.1	0.9	
LSD (0.05)						
TOS				ns		
Variety				0.1		
TOS*Variety				0.3		

Head density increased with sowing rate and was not significantly affected by time or sowing (Table 6). Axe, Gladius and Yitpi all produced statistically similar head numbers, averaging 140 heads per square metre (Table 7). Tjilkuri produced the lowest head number of only 116 heads per square metre.

Table 6: Head density (heads per square metre) for seeding rate at Hart in 2010, averaged across variety and time of sowing.

Seeding rate	**Head density (heads/sq m)**
Low	117
Medium	135
High	150
LSD (0.05)	10

Table 7: Head density (heads per square metre) for variety at Hart in 2010, averaged across seeding rate and time of sowing.

Variety	**Head density (heads/sq m)**
Axe	141
Gladius	143
Tjilkuri	116
Yitpi	137
LSD (0.05)	11

Durum agronomy – variety response to seeding rate

This trial was funded by the GRDC in collaboration with the SA Durum Grower's Association, SARDI and the Hart Field-Site Group.
Compiled by Kenton Porker and Rob Wheeler, SARDI.

Key findings

- Higher seeding rates increased overall yields in 2010 in all durum varieties.
- Grain protein levels were reduced at the higher seeding rate; all other quality parameters were unaffected.
- Seeding rate is an effective and reliable method of manipulating early shoot density in durum, (higher seeding rate = higher shoot densities).

Why do the trial?

To evaluate the performance of new durum varieties at different sowing rates in order to maximise yield and maintain quality.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	DAP (18:20) @ 90kg/ha + 2% Zn
Seeding date	11th June 2011		Urea post emergent 75kg N/ha (34kg N/ha applied on the 19th August, followed by an additional 41kg N/ha)

The trial was a randomised complete block design consisting of 3 replicates, 7 durum varieties and 3 seeding rates.
7 varieties - Caparoi, Tjilkuri, Hyperno, Saintly, Tamaroi, WID802 and WID803
3 seeding rates (seeds per square metre) – low (120), medium (155) and high (190).

The plant densities achieved are shown in Table 1.

Table 1: Plant density averaged across all 7 durum varieties for seeding rate at Hart in 2010.

Seed Rate	Plant density (plants/sq m)
Low	120
Medium	158
High	194
LSD (0.05)	0.34

Plot edge rows were removed prior to harvest.
All plots were assessed for grain yield, protein, test weight, grain weight and screenings with a 2.0 mm screen.

Results

Grain yields ranged between 4.11 t/ha (low density) and 4.36 t/ha (high density) when averaged across all durum varieties (Table 2).

For all plant densities Saintly (4.54 t/ha) was the highest yielding variety (Table 3). Apart from Tjilkuri (4.06 t/ha) all of the newer durum releases and advanced breeder lines (averaging 4.30 t/ha) significantly out yielded the older variety Tamaroi (3.96 t/ha).

Over all the varieties, increasing seeding rate significantly decreased grain protein (Table 2). It was 0.65% lower at the higher plant density (9.5%) compared to medium and lower densities (10.2%). Protein levels were lower than those required to reach DR1 grade across all seeding rates, however low and medium seeding rates did reach the protein requirement (>10%) for DR3.

Table 2. Grain yield, tiller density, head density, and grain quality measurements averaged across all durum varieties for different seeding rates at Hart 2010.

Seed Rate	Grain yield (t/ha)	Tiller density (tillers/sq m)	Head density (heads/sq m)	Protein (%)	Screenings (%)	Test weight (kg/hL)
Low	4.11	294	285	10.1	2.3	76.7
Med	4.28	341	322	10.2	2.1	76.5
High	4.36	407	330	9.5	2.0	76.2
LSD (0.05)	0.14	44	35	0.2	ns	ns

Table 3. Grain yield, yield components, and grain quality measurements averaged across all seeding rate treatments for each variety at Hart in 2010.

Variety	Grain yield (t/ha)	Tiller density (tillers/sq m)	Head density (heads/sq m)	Test weight (kg/hL)	Screenings (%)	Protein (%)	Bin Grade
Caparoi	4.22	391	304	79.3	0.9	10.2	DR3
Tjilkuri	4.06	370	333	75.5	1.5	9.9	
WID802	4.28	346	309	74.4	3.0	9.5	
WID803	4.36	375	351	75.7	3.9	9.6	
Hyperno	4.35	330	300	76.1	2.8	10.1	DR3
Saintly	4.54	343	302	77.1	1.1	9.9	
Tamaroi	3.96	318	302	77.3	1.5	10.4	DR3
LSD (0.05)	0.21	34	ns	0.65	0.21	0.37	

All other grain quality responses were variety specific (Table 3). All varieties were under the 5% screening requirement for DR1, however there were slightly higher levels amongst the new durum's WID803 (3.9%), Hyperno (2.8%) and WID802 (3%). All varieties achieved test weights greater than 74kg/hl, with WID802 the lowest at 74.4kg/hL. Caparoi had superior quality, achieving both the highest test weight (79.3kg/hL) and the lowest screening levels (0.9%).

Increasing seeding rates significantly increased tiller density and consequently head number (Table 2). Tiller densities were greatest in the higher seeding rates (407 tillers per square metre). Differences in head numbers at maturity were small but significant. Despite greater tiller death the higher seeding rate still produced more heads per square metre (Figure 1).

The varieties Caparoi, Tjilkuri, and WID803 were the most prolific tillering, producing approx 13% more tillers compared to the other varieties; however this did not translate to differences in head number at maturity due to differences in tiller abortion (Table 3 & Figure 1).

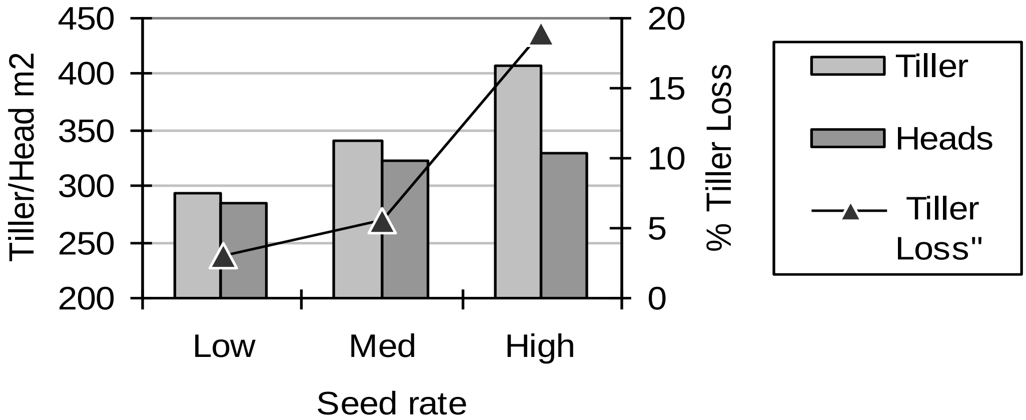


Figure 1. Tiller density, head density and the percentage of tillers lost at maturity averaged across all durum varieties for seeding rate at Hart in 2010.

Seeding rate did not significantly effect varietal maturity. Varietal differences in maturity were consistent with their maturity classifications. Saintly was the earliest to head emergence, followed by Tamaroi and Hyperno 5 to 7 days later, WID802 and Caparoi, a further 2 to 3 days later, and Tjilkuri, and WID803 the latest varieties approx 2 days later at Hart in 2010.

Summary

Despite large tiller death, the higher seeding rate still produced the greatest amount of heads which is likely to explain the yield differences observed between seeding rates. Similar to the 2009 results at Hart, the difference in tiller loss between seeding rate treatments highlight the flexibility of durum to abort tillers to adjust for final head number (compensatory effects). However in a dry finish this may result in increased screenings.

The varietal differences observed in tiller number is predominately due to the differences in plant development length (plant maturity) with later varieties (WID803, Caparoi, Tjilkuri) producing the most tillers. However, this did not necessarily increase yield; despite 2010 being a long wet season, Saintly was surprisingly the highest yielding variety given its early maturity. Apart from Saintly, varietal differences in quality were consistent with National Variety Trial (NVT) testing results, highlighting the slightly increased screening levels associated with new durum's WID803, WID802, and Hyperno. Caparoi retained its reputation for superior grain quality but also showed that it can yield well.

In conclusion, varieties are not likely to respond differently to seeding rate but growers can influence the crop canopy of durum through plant population. Higher seed densities are more likely to result in improved shoot densities in durum due to their inability to tiller as prolifically as bread wheat and barley.

Seasonal conditions (ie spring rainfall) and nutrition (ie nitrogen) are more likely to play the biggest role in durum's yield and quality response to seeding rate rather than varietal differences as observed in the longer seasons of 2009 and 2010 at Hart. Seeding rate is a an effective and reliable method of manipulating early shoot density in durum, however will need to be strategically used in conjunction with time of sowing and nitrogen management to achieve grain quality targets in durum wheat.

Acknowledgements:
The SA Durum Growers Association thank GRDC for funding this research, SARDI Clare staff for trial management and the Hart Field-Site Group for provision of the land and extension of the work.

GRDC visit
September 8th 2010
Photo courtesy GRDC

Seeding rates for hybrid triazine tolerant canola

Key findings

- The grain yield of hybrid triazine tolerant canola (CB Mallee) was not affected by reduced crop emergence compared to an open pollinated variety (Tawriffic TT).

Why do the trial?

To measure the effect of improved early vigour and production of hybrid triazine tolerant canola, compared to a standard open pollinated variety, on grain yield and quality.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	DAP @ 75 kg/ha
Seeding date	24th May 2010	**Variety**	CB Mallee Tawriffic TT

The trial was a randomised complete block design with 3 replicates and 12 treatments.

An early maturing hybrid triazine tolerant canola (CB Mallee) and an open pollinated triazine tolerant canola (Tawriffic TT) were compared over 6 seeding rates (0.6, 1.2, 1.8, 2.4, 3.0 or 4.5 kg/ha).

Plots were assessed for grain yield and oil content.

Results

The canola grain yields ranged between 1.38 t/ha (CB Mallee) and 2.09 t/ha (Tawriffic TT). Tawriffic TT produced the highest grain yield (1.85 t/ha) compared to CB Mallee (1.62 t/ha).

The grain yield of CB Mallee was not significantly different between 17 to 110 plants per square metre. The grain yield for Tawriffic TT was significantly reduced at the lowest crop emergence (9 plants per square metre) and increased with more plants. Although the lowest level of emergence for Tawriffic TT was less than CB Mallee (9 versus 17 plants per square metre), the hybrid variety (CB Mallee) was still able to produce maximum grain yield at the lower plant densities.

The oil content for CB Mallee was significantly higher 43.9%, compared to Tawriffic TT 42.5%, across all seeding rates.

Table 1: Grain yield (t/ha) and oil content (%) results for hybrid and open pollinated triazine tolerant canola over 6 seeding rates at Hart in 2010.

Variety	Emergence (plants per sq m)	Grain yield (t/ha)	Oil content (%)
CB Mallee	17	1.62	43.8
	26	1.73	44.1
	46	1.59	43.7
	45	1.63	44.0
	65	1.38	43.8
	110	1.75	43.8
Tawriffic TT	9	1.43	42.5
	31	1.84	42.7
	40	1.82	42.4
	71	1.86	42.5
	81	2.09	42.6
	104	2.06	42.4
LSD (0.05)			
Variety	ns	0.13	0.1
Density	5	0.23	ns
Variety * Density	ns	0.33	ns

Nitrogen timing and sowing date in barley

This trial was funded by the GRDC and conducted in collaboration with SARDI and the Hart Field-Site Group.
Compiled by Kenton Porker and Rob Wheeler, SARDI.

Key findings

- Later applications of nitrogen (GS30 & GS37) were the most profitable with the highest yield and quality, for malt barley in 2010.
- There was no significant differences in yield of varieties between early and later sowings.
- Crop sensors provide a good measure of nitrogen response and can improve nitrogen use efficiency.

Why do the trial?

To improve the nitrogen use efficiency of malt barley by manipulating canopy size and structure by application of nitrogen at different timings across the growing season.
To establish the link between sowing date and nitrogen timing in new malt barley varieties in order to maintain yield and quality.
To assess the value of using optical crop sensors in aiding nitrogen management.

How was it done?

Plot size 1.4m x 10m

Fertiliser DAP @ 90kg/ha + 2% Zn

Sowing dates:

Time of Sowing 1 (TOS 1) - 4th May 2010

Time of Sowing 2 (TOS 2) – 2nd June 2010

Varieties:

Commander

Buloke

The trial was a randomised complete block design with 3 replicates, 6 nitrogen timings, 2 varieties and 2 sowing dates. The early time of sowing occurred on the 4th of May, and the later timing on the 2nd of June. Nitrogen treatments are shown in Table 1. Crop assessments, using the GreenSeeker, were used to adjust the rate of total nitrogen applied based on crop growth and the seasonal conditions.

All plots were assessed for biomass, crop reflectance (NDVI), nitrogen uptake, tiller & head number, grain yield, protein, test weight, screenings (<2.2mm) and grain weight. Edge rows were removed prior to harvest.

NDVI is a comparison of reflectance of red and near infra red wavelengths (NIR-R/NIR+R) and is a good indicator of the crop biomass and nitrogen status.

Table 1. Nitrogen treatments, application timing and total nitrogen applied at Hart 2010.

Nitrogen treatment	Date of application		Total nitrogen (kg N/ha)
	TOS 1 4th May	TOS 2 2nd June	
Nil nitrogen	-	-	0
100% incorporated by sowing (IBS)	4th May	2nd June	60
50% IBS + 50% GS30 (stem elongation)	4th May + 13th July	2nd June + 15th August	60
100% GS30	13th July	15th August	60
50% GS30 + 50% GS37 (tip of flag leaf)	13th July + 15th August	15th August + 6th September	60
Crop sensor TOS 1 = 100% GS37 TOS 2 = 100% GS30	15th August	15th August	46 TOS 1 23 TOS 2

Results

Buloke and Commander malt barley responded similarly to time of sowing and nitrogen application timing. Commander yielded slightly better than Buloke (Table 2).

Table 2. Grain yield of Commander and Buloke malt barley averaged across all nitrogen treatments and time of sowing at Hart, 2010.

Variety	Grain yield (t/ha)
Buloke	5.21
Commander	5.36
LSD (5%)	0.12

For both varieties grain yield in the nil nitrogen treatment increased from 3.98 t/ha with early sowing to 4.33 t/ha for later sowing (Table 3). Grain yield also decreased in the crop sensor treatment at the later time of sowing (2nd June) and reduced nitrogen rate (23 kg N/ha). All other nitrogen treatments did not differ between sowing dates, highlighting the lack of yield penalty or benefit associated with delayed sowing of barley at Hart 2010.

For both sowing dates split nitrogen at GS30 and GS37 and 100% nitrogen at GS30 were the highest yielding treatments. The crop sensor strategy was also the highest yielding for the first time of sowing, even at a lower nitrogen rate (46 kg N/ha) but not quite as effective at the later sowing, with a much less nitrogen applied (23 kg N/ha)(Table 3).

Table 3. Grain yield averaged across Buloke and Commander barley in response to time of sowing and nitrogen timing at Hart, 2010.

Nitrogen treatment	Grain yield (t/ha)			
	TOS 1		TOS 2	
Nil nitrogen	3.98	f	4.33	e
100% IBS	5.13	d	5.29	cd
50% IBS + 50% GS30	5.34	cd	5.45	bc
100% GS30	5.62	ab	5.67	ab
50% GS30 + 50% GS37	5.91	a	5.68	ab
Crop sensor	5.77	a	5.21	cd
Average	5.29		5.27	
LSD (P<0.05) N x TOS	0.3			

During the growing season the GreenSeeker readings produced a good relationship with crop biomass, crop nitrogen uptake (kg N/ha)(Figure 1) and tiller density. This relationship is more significant between late tillering and early stem elongation, an important stage for considering further nitrogen requirements. Nitrogen uptake for the later sowing was slightly higher than early sowing, at growth stages 31 and 37 (Figure 1).

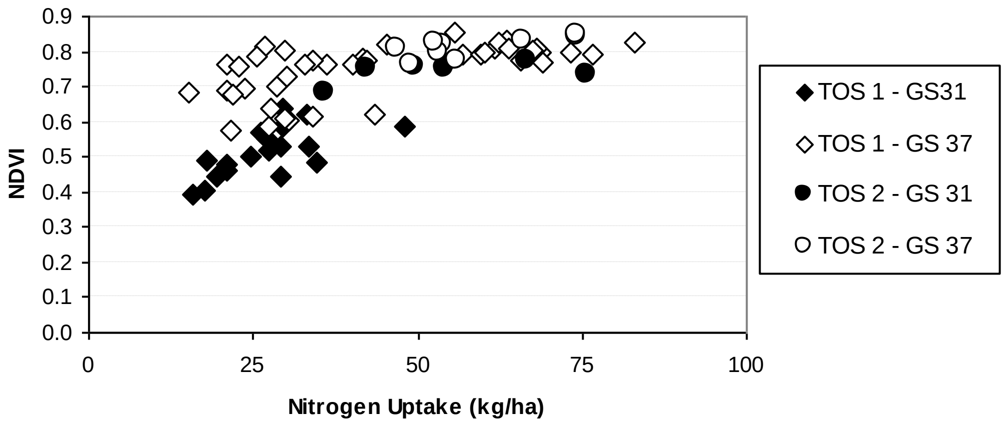


Figure 1. Nitrogen uptake (kg N/ha) and GreenSeeker NDVI across all nitrogen rates and varieties in this trial, Hart 2010 (R^2=0.57).

Tiller density was greatest when nitrogen was applied IBS (Figure 2). This resulted in a higher percentage of tiller death and consequently treatments with IBS applications of nitrogen had reduced head number per square metre compared to treatments with nitrogen applied at or after stem elongation. Time of sowing and variety did not result in differences in tiller and head number.

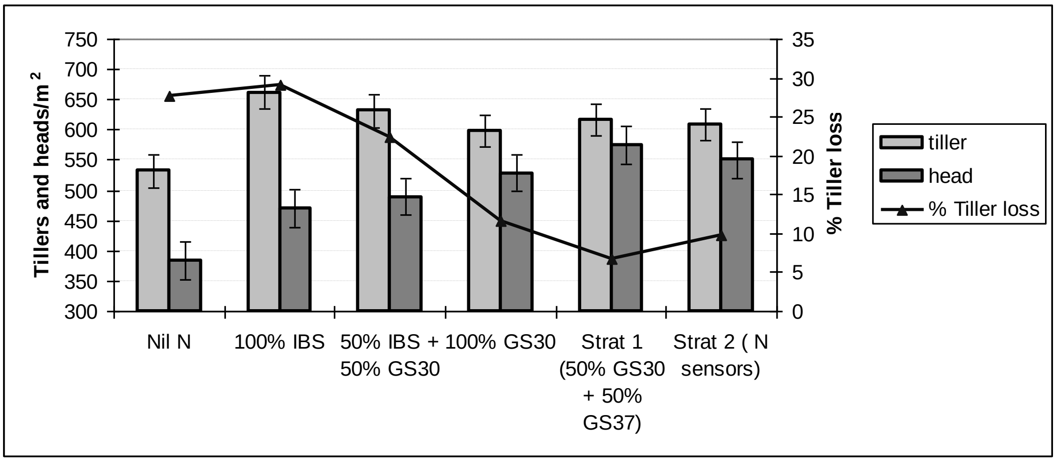


Figure 2. The influence of nitrogen strategy on tiller and head number, and % tiller loss at Hart in 2010.

Grain quality effects were significant for time of sowing, variety, and nitrogen treatments. Grain weight, test weight and screenings were significantly affected by time of sowing and nitrogen timing (Table 4). However, the differences between treatments were not large enough to change receival grades, all being within the malt standards. Variety responses to time of sowing and nitrogen did not differ.

Table 4. The effect of nitrogen timing and time of sowing averaged for Buloke and Commander barley for grain weight, test weight, and screenings at Hart 2010.

Nitrogen treatment	Grain weight (mg/grain)		Test weight (kg/hL)		Screenings (%<2.2mm)	
	TOS 1	TOS 2	TOS 1	TOS 2	TOS 1	TOS 2
Nil nitrogen	47.6	49.5	68.1	69.5	0.4	0.6
100% IBS	48.2	49.5	68.2	69.6	0.7	0.6
50% IBS + 50% GS30	48.3	48.2	68.4	68.7	0.6	0.9
100% GS30	47.1	47.5	67.9	69.9	0.6	0.8
50% GS30 + 50% GS37)	45.7	48.1	68.8	70.2	0.8	0.7
Crop sensor	46.1	49.1	68.8	69.7	0.7	0.6
LSD (Fpr<0.05) TOS x N	1.2		2.0		0.1	

Grain protein responded to nitrogen application timing and barley variety. Commander produced 9.4% protein for the 100% GS30 treatment compared to 8.7% in Buloke (Table 4). 50% GS30 + 50% GS37 was the only nitrogen strategy to achieve protein readings greater than 9.0% in both varieties.

Table 5. The grain protein response to nitrogen timing in Buloke and Commander barley at Hart 2010.

Nitrogen treatment	Grain protein (%)	
	Buloke	**Commander**
Nil nitrogen	8.3	8.3
100% IBS	8.7	8.8
50% IBS + 50% GS30	9.0	8.7
100% GS30	8.7	9.4
50% GS30 + 50% GS37	10.0	9.5
Crop sensors	8.6	9.0
LSD (Fpr <0.05) Variety * Nitrogen	0.53	

Grain retention levels were not affected by nitrogen or sowing date, however Buloke had slightly lower retention compared to Commander (Table 5). Variety specific differences in other grain quality factors were significant but small.

Table 6. The grain quality of Buloke and Commander averaged across all nitrogen treatments and sowing dates at Hart 2010.

Variety	Grain weight (mg/grain)	Screenings (<2.2mm)	Retention (%>2.5mm)	Test weight (kg/hL)	Grain protein (%)
Buloke	49	0	92	70	46
Commander	46	1	95	68	47
LSD (Fpr<0.05)	0.6	0.2	1.0	1.1	ns

Summary:

Whilst there was no real yield benefit or penalty from earlier sowing in this trial, the benefits may come in the improved opportunity to manage the crop canopy. The earlier planting (May) had a longer development period and hence greater opportunity to manipulate the crop canopy during the stem elongation period with crop nitrogen applications. Crop sensors provided a good measure of N response and hence are a useful tool in determining the nitrogen requirement.

Differences in tiller/head densities and tiller death highlight the ability to manipulate the crop canopy with post sowing N applications. Greater emphasis on nitrogen upfront created greater tiller numbers but consequently had higher shoot losses between GS31 and grain filling and, hence, lower yields. The GS30 (100%) and later strategic applications of N maintained the highest proportion of tillers and consequently yielded higher than early N applications.

The main grain quality response measured between the treatments was in grain protein. 50% GS30 + 50% GS37 was the only nitrogen regime to achieve the target protein of 9% required for malt in both varieties.

The benefits of a strategic approach to nitrogen management is highlighted by this trial; matching nitrogen inputs to seasonal conditions rather than a predetermined nitrogen strategy proved to be the most profitable (highest yield & quality) across both sowing dates at Hart in 2010.

SPRING TWILIGHT WALK 2010

Canola nitrogen management

Key findings

- The grain yield of TT Tornado canola was not significantly affected by nitrogen form (urea or SOA) or timing (IBS to green bud).

Why do the trial?

To investigate different nitrogen timings on the grain yield and quality of canola. Also to compare the performance of urea and sulphate of ammonia (SOA) as sources of nitrogen. SOA is sometimes applied to canola to provide extra sulphur, with evidence suggesting that it might also produce an increase in grain yield.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	DAP @ 75 kg/ha
Seeding date	24th May 2010	**Variety**	TT Tornado @ 5 kg/ha
Available soil moisture 10th March (0-90cm)	0mm	**Available soil nitrogen 10th March (0-90cm)**	55 kg N/ha

The trial was a randomised complete block design with 3 replicates and 8 treatments.

Nitrogen fertiliser (80 kg N/ha) was applied in the form of urea or sulphate of ammonia (SOA) at 3 different timings:

IBS – spreading urea or SOA onto the ground and incorporated by seeding (IBS)
IBS:Budding – 50% of the urea or SOA was incorporated by seeding and the remaining 50% at appearance of the green flower buds (16th August) and spread by hand prior to rain.
Budding – 100% of the urea or SOA at appearance of the green flower buds (16th August) and spread by hand prior to rain.

Plots were assessed for grain yield and oil content.

Results

There was no significant difference between urea or SOA on the grain yield or oil content of TT Tornado canola at Hart in 2010 (Table 1).

The nil nitrogen treatments were significantly lower yielding 1.69 t/ha, compared with 2.27 t/ha where 80 kg/ha of nitrogen had been applied. However, there were no differences between the nitrogen application timing treatments on grain yield or oil content.

Table 1: Grain yield (t/ha) and oil content (%) results for TT canola for nitrogen form and timing at Hart in 2010.

Nitrogen form	Nitrogen timing	Grain yield (t/ha)	Oil content (%)
Urea	Nil	1.70	42.9
	IBS	2.27	42.8
	IBS:Budding	2.37	42.5
	Budding	2.18	42.7
Sulphate of ammonia	Nil	1.68	43.0
	IBS	2.22	42.6
	IBS:Budding	2.23	42.7
	Budding	2.36	42.3
LSD (0.05)		ns	ns

Nitrogen management in wheat at Hart

This trial was funded by GRDC, in collaboration with Nick Poole (Foundation for Arable Research, NZ) and Sam Trengove (Trengove Consulting)

Key findings

- Grain yield was 0.3 t/ha (8%) higher when nitrogen application was delayed until stem elongation.

Why do the trial?

To improve the nitrogen and water use efficiency of wheat by using post sowing applications of nitrogen.

How was it done?

Plot size 1.4m x 10m

Seeding date 13th May 2010

Fertiliser Single super (0:9:0) @ 60 kg/ha

Variety Correll wheat @ 70 kg/ha

Available soil moisture 10th March (0-90cm) 0mm

Soil nitrogen 10th March (0-90cm) 106kg N/ha

The trial was a randomised complete block design, with 3 replicates and 6 times of nitrogen application.

All treatments received 46 kg N/ha (100 kg urea/ha). Post emergent nitrogen was applied as granular urea (46:0:0) by hand prior to rain. Sowing applications of nitrogen were broadcast prior to and incorporated by sowing.

Edge rows were removed prior to harvest.

All plots were assessed for grain yield, protein, test weight, screenings less than 2.0 mm and grain weight.

Table 1. Nitrogen timing treatments at Hart in 2010.

Nitrogen timing	Date of application
Nil nitrogen	
100% IBS at sowing	13th May
50% IBS at sowing + 50% at stem elong (GS30)	13th May + 14th July
100% at stem elong (GS30)	14th July
50% GS30 + 50% at flag leaf emergence (GS37)	14th July + 16th August
100% at tip of flag leaf emergence (GS37)	16th August
50% flag leaf emergence (GS37) + 50% awn emergence (GS49)	16th August + 6th September

Results

Grain yields ranged between 3.23 t/ha (100% GS37) and 4.31 t/ha (50% GS30 + 50% GS37). Grain yield was significantly higher for the 100% GS30 (4.18 t/ha) and 50% GS30 + 50% GS37 (4.31 t/ha) treatments. Delaying the total application until GS37 produced significantly lower grain yield in this trial, the reasons for this are unclear. When nitrogen was applied at GS37 in a split application the grain yield was similar or better than other treatments.

Grain protein ranged between 8.8% (nil nitrogen) and 10.1% (50% GS37 and 50% GS49). Grain protein was generally greater where nitrogen application was delayed until GS30 or later.

The treatments produced no significant difference in screenings. Grain weight was highest in the nil nitrogen treatment.

Table 3: The response in grain yield (t/ha), protein (%), screenings (%) and grain weight (mg/grain) to nitrogen application timing at Hart 2010.

Nitrogen timing	Gain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)	Grain weight (mg/grain)
Nil nitrogen	3.30	8.8	75.4	1.6	49.9
100% IBS	4.02	9.3	74.4	2.2	48.0
50% IBS + 50% GS30	4.10	8.9	74.7	2.1	47.9
100% GS30	4.18	9.5	75.5	1.7	48.0
50% GS30 + 50% GS37	4.31	9.7	75.1	1.9	48.0
100% GS37	3.23	9.0	73.9	2.4	48.2
50% GS37 + 50% GS49	4.10	10.1	76.1	1.8	46.8
LSD (0.05)	0.17	0.4	0.9	ns	1.4

Kate Bourke speaking on barley agronomy at the 2010 Hart Field Day

Nitrogen management in wheat at Tarlee

This trial was funded by GRDC (SFS 00017) in collaboration with Nick Poole (Foundation for Arable Research NZ) and the Mid-North High Rainfall Group (Mick Faulkner and Jeff Braun).

Key findings

- With a soil nitrogen (N) content of 103 kg N/ha at sowing, Mace wheat yielded 3.1 t/ha with no N fertiliser applied and contained 6.6% protein.
- Optimum gross margins were recorded with 75 kg N/ha, though none of the N levels up to 100 kg N/ha reached 9% protein.
- Yield response was greatest for N application timings at sowing, GS31, or a split application between GS31 and GS39.
- A crop sensor was used to measure in season nitrogen responsiveness and was able to predict the optimal N rate.

Why do the trial?

To compare how different nitrogen strategies effect crop growth, grain yield and protein.

To maintain yield and quality, while reducing the risks associated with excess early crop growth.

To evaluate the performance of crop sensors for measuring crop growth and predicting crop responsiveness to N.

How was it done?

Plot size	1.5m x 10m	**Fertiliser**	Triple super phosphate (0:20:0) @ 60kg/ha
Seeding date	13th May 2010		Urea applied as per treatment
Available soil moisture 13th April (0-90cm)	35mm	**Soil nitrogen 13th April (0-90cm)**	103 kg/ha
Location	Mid North High Rainfall Site, Tarlee		

The trial was a randomised complete block design with 4 replicates.

The treatments included:

- 4 nitrogen timings by 5 nitrogen rates
  - N timings: incorporated by sowing (IBS, 13th May), 1st node (GS31, 31st July), flag leaf fully emerged (GS39, 7th Sept) and a split application with 50% applied GS31 and 50% applied GS39.
  - Nitrogen rates: 0, 25, 50, 75, 100 kg N/ha (0, 54, 109, 163, 217 kg urea/ha)
- 2 nitrogen rates (25 and 50 kg N/ha) applied at flowering (GS65, 12th Oct)
- 1 treatment with 25 kg N/ha applied at GS31, GS39 and GS65 (total 75 kg N/ha)
- A strategic N application based on in season crop measurement using crop sensors. Nitrogen response was predicted as a ratio from measurements in the unfertilised treatment referenced against the measurements from the 100 kg N/ha IBS treatment. This resulted in 50 kg N/ha applied at GS31 and 25 kg N/ha applied at GS39.

All plots were assessed for biomass, nitrogen uptake, crop reflectance using crop sensors (NDVI), green area index (GAI), tiller and head number, grain yield, protein, test weight, screenings (<2mm) and grain weight. Edge rows were removed prior to harvest.

NDVI is a comparison of reflectance of red and near infra red wavelengths [(NIR-Red)/(NIR+Red)] and is a good indicator of the green leaf area of the crop.

Results

At all N timings there was a significant grain yield response to N up to 75 kg N/ha. The maximum rate of 100kg N/ha did not produce a significant yield response (Figure 1). Yield response was greatest for N application timings at sowing, GS31 or a split application between GS31 and GS39. Delaying all of the N application until GS39 reduced the yield response, however this was not significant. N application delayed until flowering resulted in significantly lower grain yields compared to earlier applications (Figure 1).

Delaying N application until GS65 reduced the nitrogen use efficiency to 6 kg grain/kg N, whereas N applied at sowing or stem elongation had an efficiency of 29-37 kg grain/kg N at the rates of 25 and 50 kg N/ha (Figure 2). Calculating the nitrogen use efficiency shows that there is a declining rate of return with increasing N rate (Figure 2).

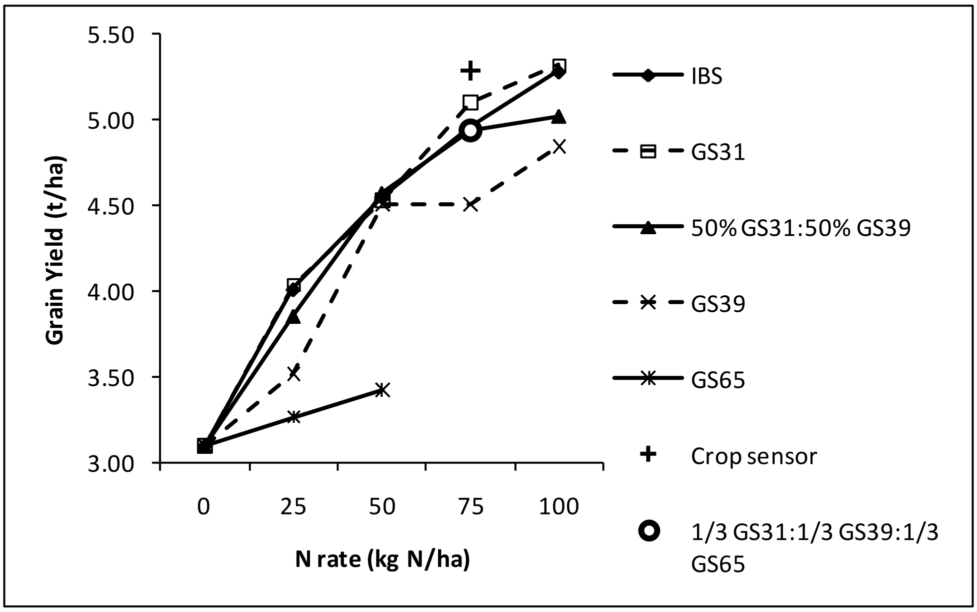


Figure 1: Grain yield (t/ha) for different N rates and application timings. (l.s.d. rate = 0.31, l.s.d individual treatments = 0.67).

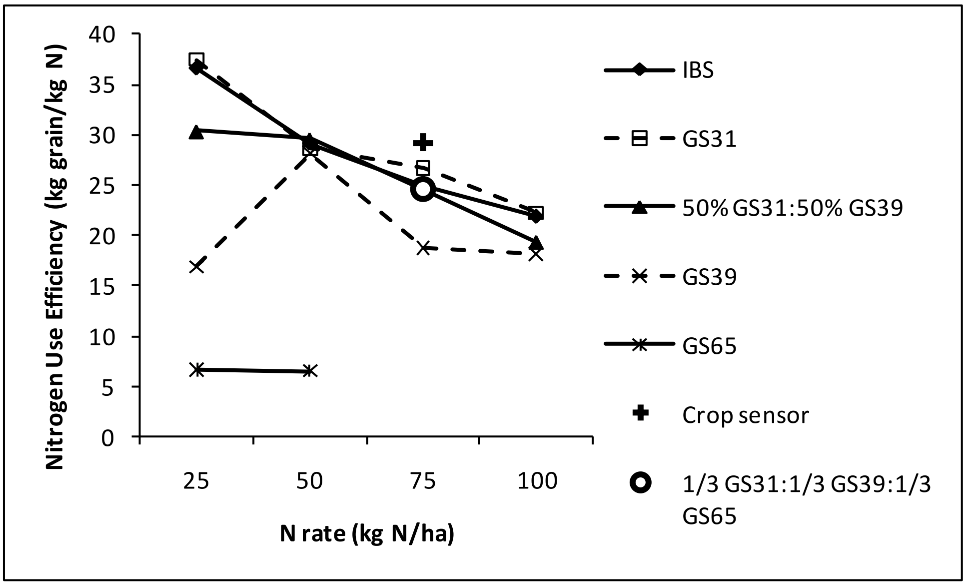


Figure 2: Nitrogen use efficiency (kg grain/kg N) for different N rates and application timings.

Delayed N application resulted in higher grain protein levels, as did higher N rates (Figure 3). No treatments produced protein levels greater than 9%, therefore all treatments would have been classed ASW. With earlier N applications (IBS or GS31), there appears to be a slight reduction in protein with low rates of N, this can be attributed to the increasing yield associated with those treatments diluting the protein concentration and offsetting any gains in total N uptake.

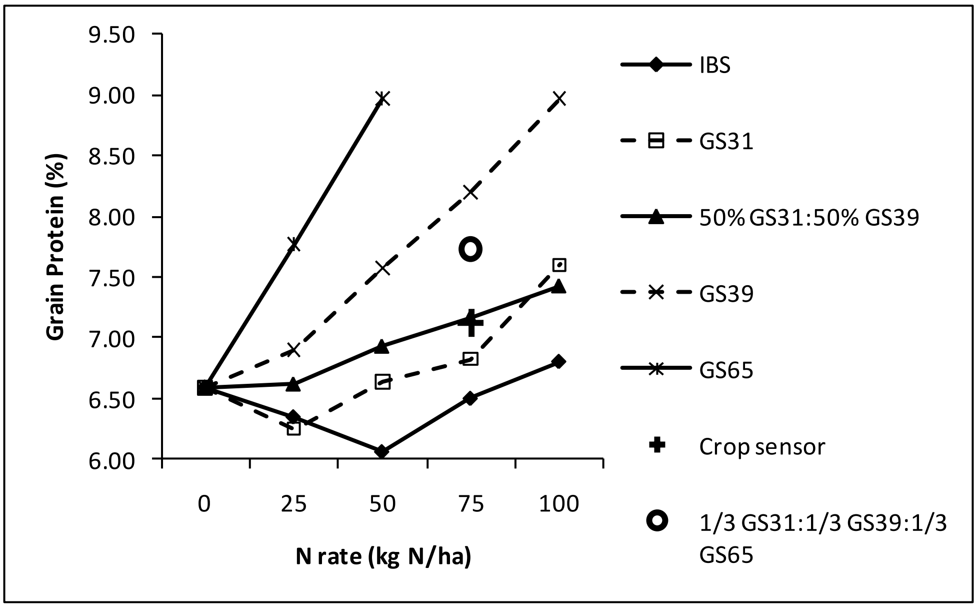


Figure 3: Grain protein (%) for different N rates and application timings. (l.s.d. rate = 0.23, l.s.d. timing = 0.21, l.s.d individual treatments = 0.59).

Nitrogen recovery is a measure of what percentage of N that is applied is recovered in the grain. Nitrogen recovery is highest for N applications delayed up until GS39, however for later N applications (GS65) the nitrogen recovery is reduced to levels similar to GS31 applications (Figure 4).

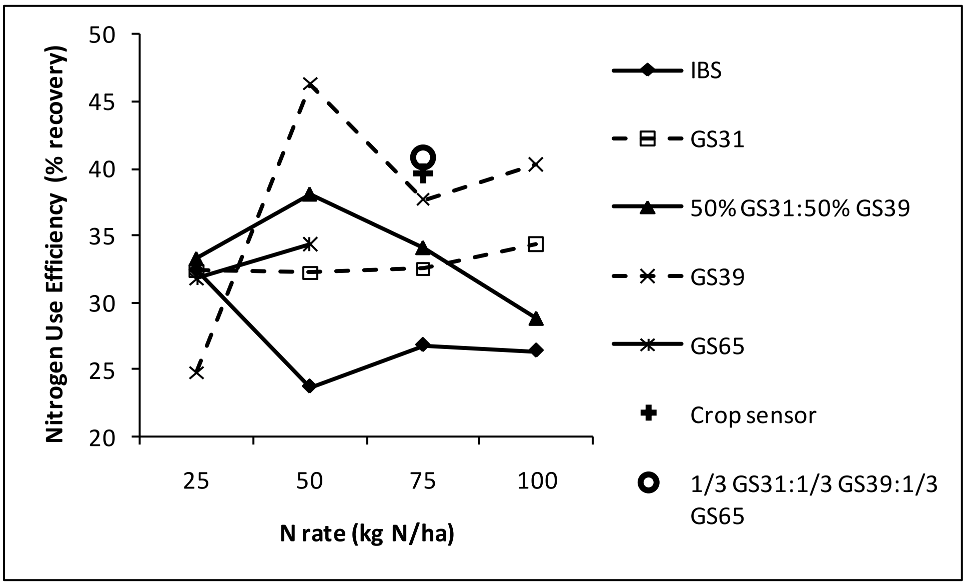


Figure 4: Nitrogen use efficiency (% recovery) for different N rates and application timings. Percent recovery indicates how much of the N that was applied is recovered in the grain.

Three applications of 25 kg N/ha at GS31, GS39 and GS65 did not result in a significant yield difference to other treatments with 75 kg N/ha applied, however the late application did increase protein levels, although not to the level of 75 kg N/ha applied at GS39. The late application did improve yield compared with just 25 kg N/ha applied at GS31 and GS39 (total 50 kg N/ha). Provided that yield potential is not limited too severely during stem elongation, both yield and protein can still be gained with N applications as late as flowering.

The crop sensor treatment predicted a yield response to N at GS31 based on comparison of measurements in the nil and 100 kg N/ha IBS treatment. The suggested N rate was 75 kg N/ha and this was applied in two applications, with 50 kg N/ha applied at GS31 and 25 kg N/ha applied at GS39. This treatment produced a yield of 5.29 t/ha, which was equivalent to the highest yields in the trial, including those treated with 100 kg/ha.

Increasing applied nitrogen rate had the biggest affect on gross margins up to 75 kg N/ha. Time of N application had a smaller effect, however using crop sensors for an in season prediction of N response was able to optimise the gross margin in this trial.

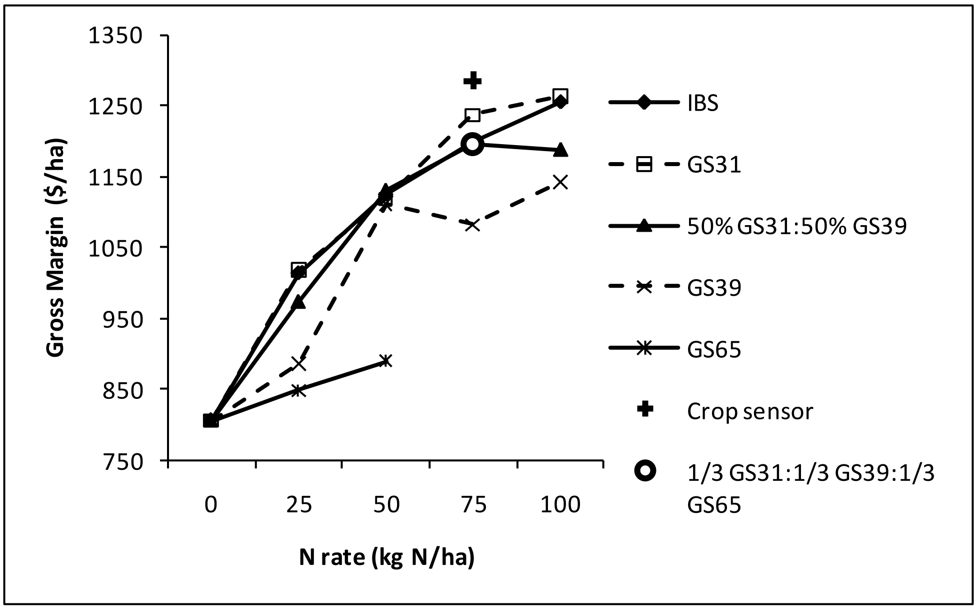


Figure 5: Gross margin ($/ha) for different N rates and application timings. Indicative prices used were ASW = $260/t and urea = $550/t. (l.s.d. rate = 81, l.s.d individual treatments = 164).

Using Crop Sensors as an aid for nitrogen decisions

Funded by Caring For Our Country and GRDC (SFS 00017).

Key findings

- Crop sensors are a useful tool for measuring and mapping the growth of crops, however their limitations need to be recognised.
- Poorer crop growth and lower sensor NDVI values can indicate lower N availability within a paddock, but this should be ground truthed, rather than assumed as there are many potential constraints to crop growth that could also be the cause.
- The use of an N-rich strip in conjunction with crop sensors can provide an indication of the likely grain yield response to N.
- The N rate calculation still requires a yield prediction – a potential fit with APSIM / Yield Prophet.
- Utilising predefined paddock zones created from historical yield and/or soil data may help to refine the use of crop sensors for variable rate applications.

Background

There has been a movement away from applying all crop N requirements at sowing to now apply most of the crop's needs in crop during stem elongation (GS30 – 39). This change in application timing allows N input to be better matched to seasonal conditions and may allow greater use of crop sensor technology to aid in N rate decisions. Crop sensors include Greenseeker, Crop Spec, Crop Circle, N-Sensor and may also include imagery from aeroplanes and satellites.

While each of these sensors differs in specifications and features, their current outputs are largely responsive to the green leaf area of the crop, which is often related to crop biomass and N uptake (kg N/ha). The normalised difference vegetative index (NDVI) is an index that is output most commonly from the hand held sensors Greenseeker and Crop Circle, however investigations into improved indices are continuing.

Where variability in crop growth is influenced by N availability these sensors can be utilised to identify the areas in a paddock of higher and lower N availability. Figure 1 demonstrates how a difference in crop growth due to different levels of N availability can be detected by the Greenseeker NDVI sensor at various growth stages. However, the NDVI measurements don't reflect the accumulation of N during the season (Figure 2). This is because the NDVI measurement has a limited range (~ 0.13-0.18 for bare ground to ~ 0.9 for full canopy closure) and "saturates" at high leaf area index, or in this case N uptake (Figure 3).

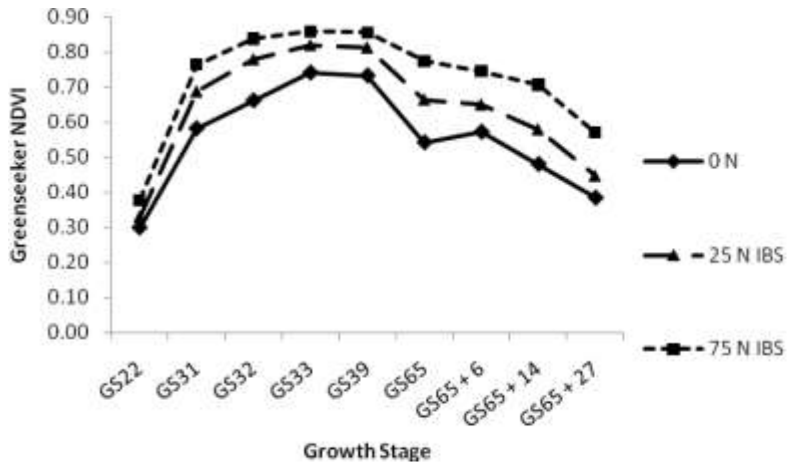


Figure 1: Greenseeker NDVI response to N applied at seeding at a range of crop growth stages. Tarlee 2010, cv Mace.

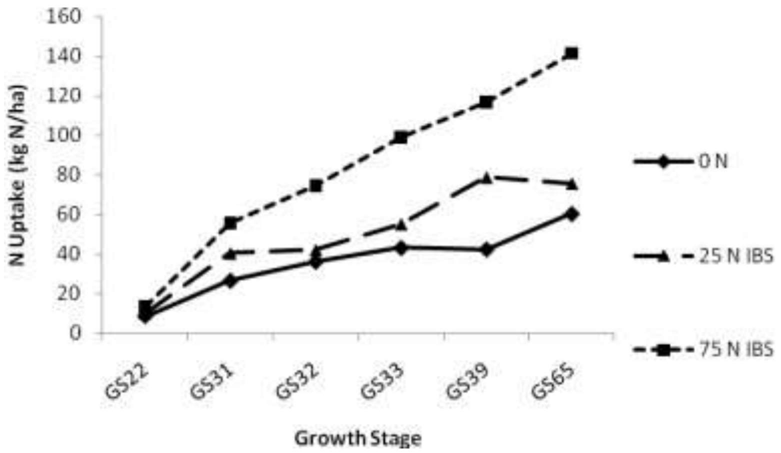


Figure 2: Nitrogen uptake response to N applied at seeding at a range of crop growth stages. Tarlee 2010, cv Mace.

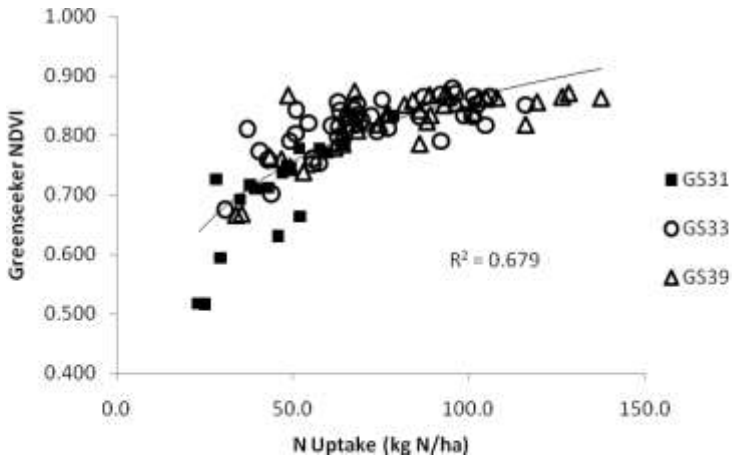


Figure 3: Greenseeker NDVI relationship with N uptake at three growth stages. Tarlee 2010, cv Mace.

Predicting a nitrogen response: N-rich strips

It is possible to implement an automated variable rate system, whereby crop sensing technology is linked directly to a variable rate spreader or boom sprayer, and the rate of N is manipulated according to crop growth. In most circumstances for N application during stem elongation these sensors are calibrated such that N rates are increased where the sensor identifies poorer crop and reduced where the sensor identifies more vigorous crop. This is based on the assumption that N is limiting crop growth and that variable N availability is the cause of variability in crop growth. Where this assumption holds true it is a valid use of the crop sensors.

To validate the assumption that N is limiting crop growth and is the cause of variability in the field N-rich strips can be applied to act as an in-field reference. An N-Rich strip is a high N reference strip that the farmer managed crop can be referenced against. Crop sensor measurements of both the N-rich strip and the farmer managed crop can be recorded and a response index (RI) calculated, that is indicative of the likely final yield response to N, where

RI = NDVI fertilised reference strip/ NDVI unfertilised crop

To establish the relationship between the in season RI and the final yield response trials have been setup in five paddocks across the Mid North in 2009 and 2010. N-Rich strips have been applied to wheat and barley across a range of soil types (Figure 4). NDVI of the N-rich strip and the adjacent unfertilised crop were measured during the growing season to determine the RI. A range of RI's were established in each paddock and at each of these sites a replicated small plot trial was put in place with N treatments ranging from 0 to 100 kg N/ha (Figure 4).

These were applied during stem elongation. Grain yield and protein were measured at each site in each paddock, an example of the yield responses observed in a paddock at Kybunga is shown in Figure 5. Grain yield N response at each site was calculated and correlated with the RI measured during the season (Figure 6 & 7).

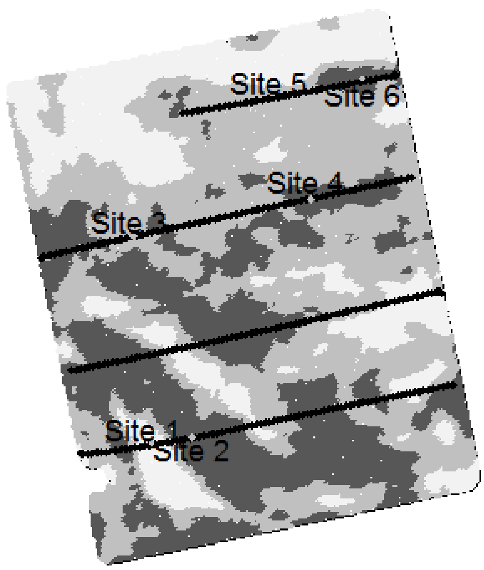


Figure 4: Location of N-rich strips (black lines) and trial sites in relation to the paddocks productive zones in a paddock at Kybunga, 2010. Similar designs were utilised in the other four paddocks.

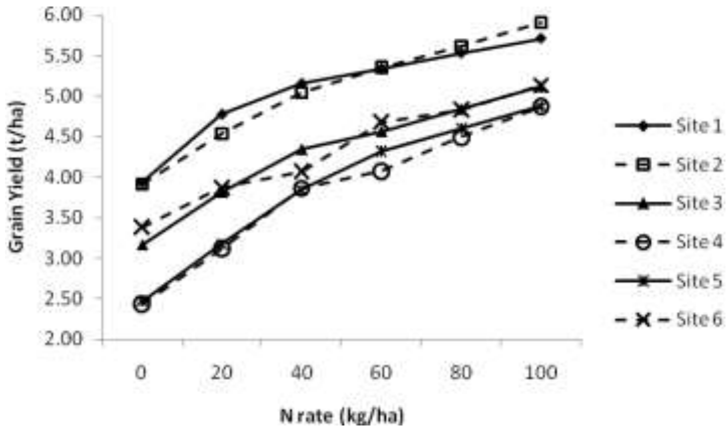


Figure 5: Grain yield response to applied N at six sites in a paddock at Kybunga, 2010.

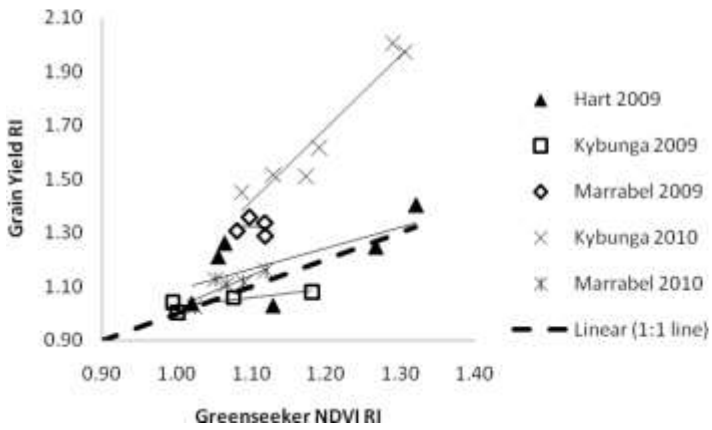


Figure 6: Relationship between in season response index and final grain yield response index for five paddocks. Growth stage is indicated in brackets. Hart 2009 (GS32, R2 = 0.44), Kybunga 2009 (GS22 R2 = 0.71), Marrabel 2009 (GS32 R2 = 0.009), Kybunga 2010 (GS32, R2 = 0.92), Marrabel 2010 (GS37, R2 = 0.71).

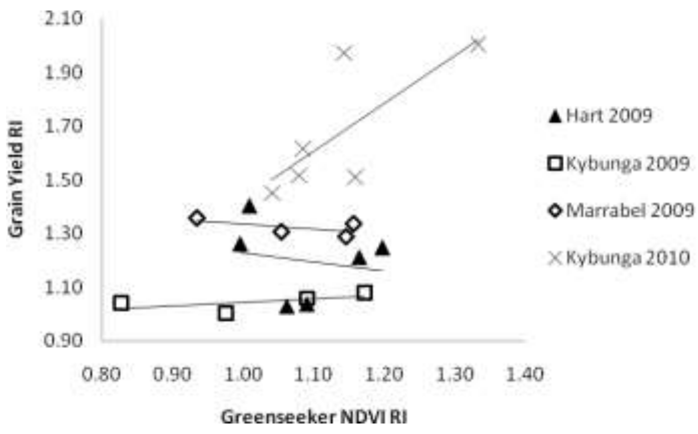


Figure 7: Relationship between in season response index and final grain yield response index for four paddocks. Growth stage is indicated in brackets. Hart 2009 (GS14, R2 = 0.04), Kybunga 2009 (GS13 R2 = 0.36), Marrabel 2009 (GS15 R2 = 0.38), Kybunga 2010 (GS30, R2 = 0.57).

The relationship between in season growth response measured by NDVI and the final yield response was found to have a correlation coefficient (R^2) of 0.44 or greater in 4 of 5 paddocks (Figure 6). The Marrabel 2009 data had a poor within paddock correlation, this can be related to the very narrow range of both in season NDVI RI and grain yield RI. However, the points still fall within the range of the other paddock data sets. The in season NDVI RI never exceeded 1.32, while the grain yield RI reached a maximum of 2. The limited range of the NDVI RI can be attributed to the limited range of the NDVI itself.

The growth stage when the in season NDVI RI is calculated appears to have a significant impact on the relationship with final grain yield response. The in season NDVI RI's measured at earlier growth stages (GS13 to GS30) in Figure 7 tend to have a poorer relationship with final grain yield response compared to the in season NDVI RI's measured at later growth stages (GS22 to GS37) in Figure 6. It might be possible in the future to establish a relationship between the timing that a significant in season NDVI RI can be measured and the final grain yield response. Increasing the period before the in-season measurements are recorded increases the time for the crop to "display" (in crop canopy greenness and biomass) how much N is available to it at that time.

In the five trial paddocks, calculating an in season NDVI RI improved the prediction of a grain yield N response compared with using the NDVI of the unfertilised crop only in some cases (Figure 8). At the Hart paddock in 2009 utilising N rich strips across the range of soil types improved the prediction of a grain yield response significantly, where the correlation coefficient increased from 0.04 when relying on the NDVI of the unfertilised crop only to 0.44 when incorporating the in season RI (Figure 6 & 8). In this paddock one of the six sites had a low NDVI suggesting a large N response would be expected, however it also had a low in season response to applied N, and this was due to other soil constraints limiting the crops ability to respond to N. It subsequently had a low grain yield response to N.

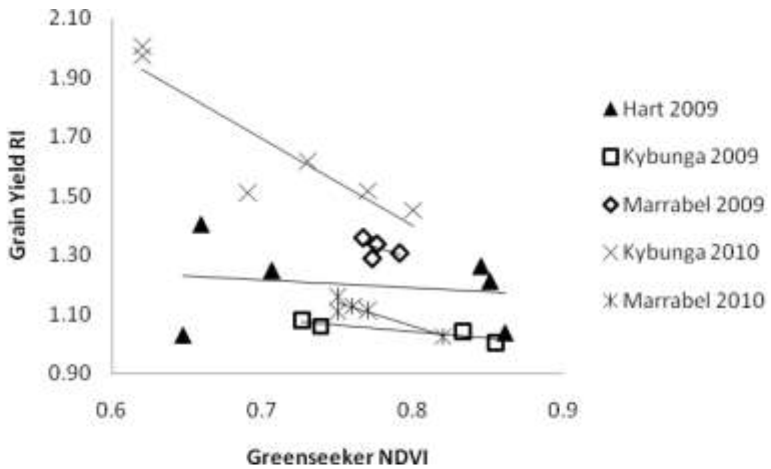


Figure 8: Relationship between NDVI of unfertilised crop and final grain yield response index for five paddocks. Growth stage is indicated in brackets. Hart 2009 (GS32, R^2 = 0.04), Kybunga 2009 (GS22 R^2 = 0.83), Marrabel 2009 (GS32 R^2 = 0.23), Kybunga 2010 (GS32, R^2 = 0.81), Marrabel 2010 (GS37, R^2 = 0.86).

Fine tuning the N rate calculation

The crop sensors in conjunction with an N-rich reference strip provide an indication of N supply to the crop at that point in time and a relative indication of the likely final yield response to N. However, in isolation it does not provide a recommended N rate. Oklahoma State University use the following methodology to calculate an N rate based on the sensor readings –

1. Estimate of grain yield without additional N, based on NDVI measured at GS30 and the growing degree days (GDD) > 0 (INSEY based on numerous trials)
2. In season response index (RI) = NDVI N-rich/NDVI unfertilised paddock
3. Estimation of yield with N = RI x Yield with no N applied
4. N rate to be applied = [Grain N content of fertilised crop (from step 3) – Grain N content of unfertilised crop (from step 1)] / Nitrogen use efficiency (usually 40-50% under Australian conditions)

The methodology has merit for use in Australia, however it is expected that the grain yield estimate could be improved by incorporating soil moisture and historical climate data into the calculation, i.e. in the form of APSIM. The relationship between in season crop growth and final crop yield can be highly variable between seasons under Australian conditions due to the variable spring conditions that are encountered, and the potential for haying off, so higher NDVI measured at GS30 does not necessarily imply higher yield as it does in the above methodology.

Also, step 3 assumes a 1:1 relationship between final grain yield response and in season N response measured by NDVI. This assumption is not always valid. Figure 6 shows that the grain yield N response ratio with in season N response ranged from 0.9 to 1.55:1. This too may be influenced by variable climatic conditions following the collection of in season measurements. It may also be an artefact of the limited range of the NDVI, and therefore also the in season NDVI RI.

To incorporate an improved yield prediction that utilises soil water holding parameters on a spatial basis requires the use of additional data layers, including historical yield data and soil sensing data such as EM38 and Gamma radiometrics, an example is shown in Figure 4. Combining the use of historical data and in season imagery recognises that there can be zones of significantly different yield potential within a paddock, however there can still be significant variability within those zones that the crop sensors can identify.

Digital photos for measuring canopy cover

This trial was funded by the GRDC (SFS 00017) in collaboration with Nick Poole (Foundation for Arable Research NZ) and the Mid-North High Rainfall Group (Mick Faulkner and Jeff Braun).

Key findings

- Digital photos collected up to GS31 and processed for green ground cover provided a good measure of crop biomass and N uptake.
- Images collected after GS31 had poorer relationships with crop growth.

Why do the trial?

To test the ability of readily available camera technology to measure canopy cover.

How was it done?

Images were collected with a 5 mega pixel digital camera held 1.5m directly above the canopy. Images were collected at GS22, GS31, GS32, GS33, GS39 and GS65. The images were of the nitrogen treatments in the canopy management trial at the Mid North High Rainfall Site at Tarlee. The images were processed to determine the number of ‘green’ pixels in the image using a USDA-ARS and USGS Weed Cover Calculator that uses an Excess Green – Excess Red algorithm.

Results

Digital camera images can be used to provide a measure of canopy ground cover (Figure 1 & 2). This only works well at early growth stages though. When the leaves overlap and the canopy closes the digital imagery is not able to detect changes in canopy size, this occurred after GS31 in this trial (Figure 2). At the early growth stages the digital imagery results have a good relationship with Greenseeker NDVI (Figure 3).

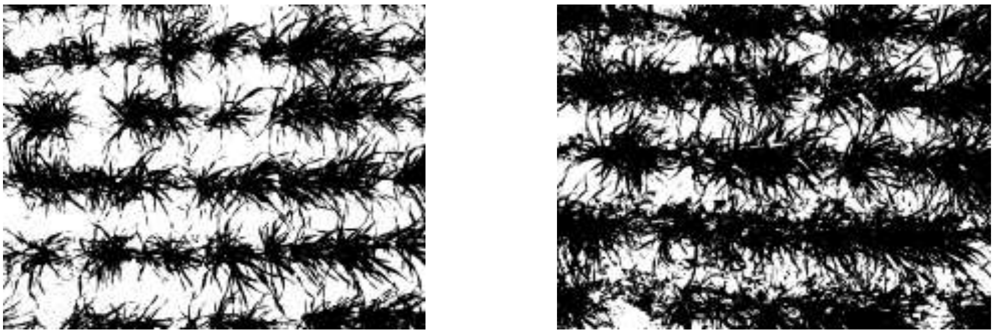


Figure 1: example of processed digital images collected at GS31, where black represents green canopy and white background soil and stubble. The image on the left has 44% cover and the image on the right 66% cover.

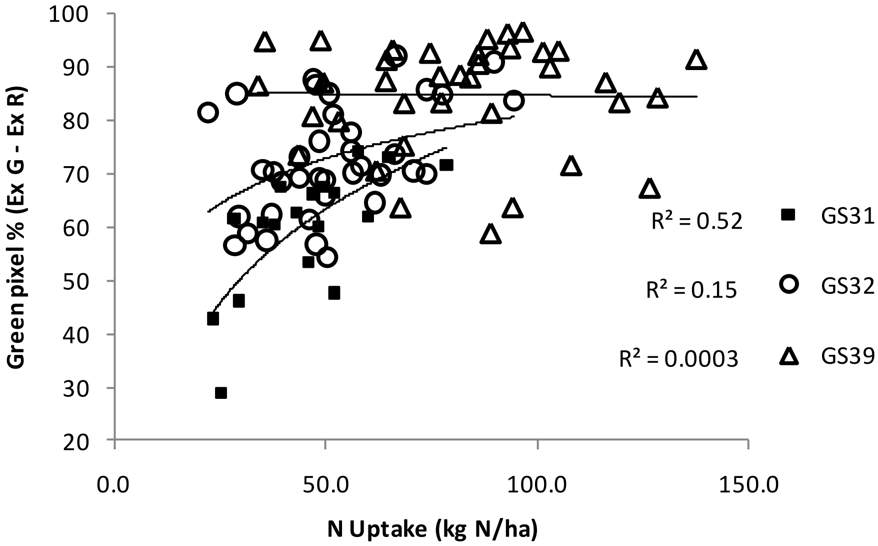


Figure 2: The relationship between nitrogen uptake of the plant and green pixel cover measured from digital photos at three growth stages.

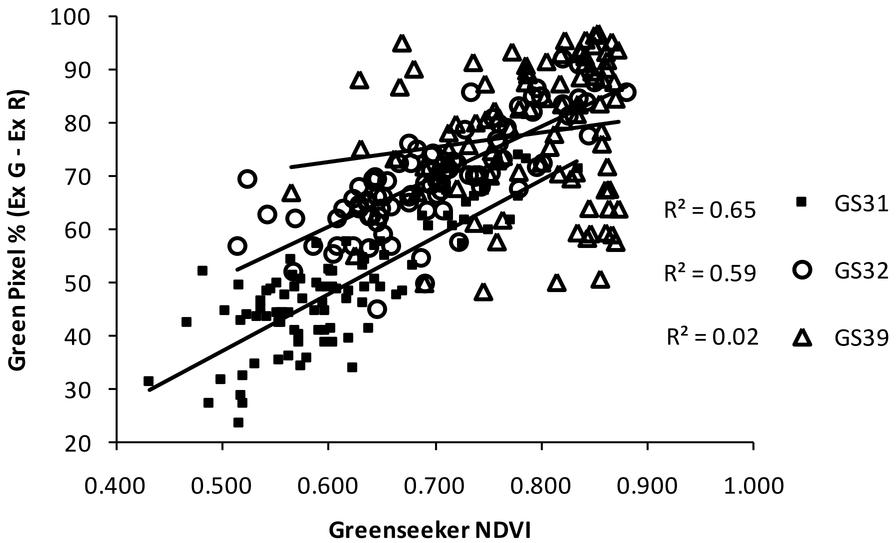


Figure 3: The relationship between Greenseeker NDVI and green pixel cover measured from digital photos at three growth stages.

Phosphorus rate trial and alternative fertilisers

Key findings

- After 4 years of no applied phosphorus fertiliser grain yield of barley was significantly lower than where phosphorus had been applied.
- Alternative phosphorus sources such as biosolids, chicken litter or biochar, produced significantly lower yields compared to phosphorus fertiliser.

Why do the trial?

To investigate the impact of conventional phosphorus fertilisers and alternative sources of phosphorus on the grain yield and quality of barley.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	Urea @ 35 kg/ha at sowing Urea @ 50 kg/ha 10th August Phosphorus applied as per treatment
Seeding date	11th June 2010	**Variety**	Flagship barley @ 80 kg/ha

Trial 1. Phosphorus rate: randomised complete block design with 3 replicates and 4 treatments.

Treatments were re-sown over the same treatments from 2007, 2008 and 2009.

Trial 2. Biosolids and chicken litter: randomised complete block design with 3 replicates and 8 treatments.

A single application of biosolids and chicken litter were broadcast by prior to sowing in 2008. The biosolids + 65 kg/ha single super and chicken litter + 65 kg/ha single super treatments had a repeated application of 65 kg/ha single super in 2009 and 2010.

Treatments were sown over the same treatments areas each year.

Trial 3. Biochar, phosphorus solubiliser and Avail fertiliser treatment: randomised complete block design with 3 replicates and 12 treatments.

Avail phosphorus fertiliser enhancer was included in 2010 as a single treatment or with either 5 or 10 kg P/ha. All other previously applied treatments of biochar or phosphorus solubiliser received phosphorus (single super) only.
Treatments were sown into standing wheat stubble from the 2009 commercial crop.

Single superphosphate was used as the standard phosphorus treatment.
The initial Colwell soil phosphorus (March 2007) was 40 mg/kg (0 – 10 cm)
The phosphorus buffering index (PBI) was 102.

Plots were assessed for grain yield, protein, test weight and screenings with a 2.2 mm screen and retention with a 2.5mm screen.

Samples of the biosolids and chicken litter used in 2008 were analysed for nutrient concentration (Table 1).

Table 1: Fertiliser nutrient concentrations (kg/t) of biosolids and chicken litter applied in 2008.

Nutrient	Single superphosphate	DAP	Biosolids	Chicken litter
Nitrogen	0	180	15	43
Phosphorus	90	200	10	8
Potassium	0	0	8	2
Sulphur	110	15	8	6
Zinc	0	0	1	1

Results

In the long term phosphorus experiment (Trial 1) the grain yield ranged between 4.72 t/ha (nil phosphorus) to 5.49 t/ha (15 kg P/ha). While this was not statistically significant at the 95% level, there is still a trend where the nil treatment has produced the lowest grain yield, after 4 years of receiving no phosphorus. Protein was also significantly lower with this treatment.

In trial 2 the addition of 10 or 12 kg P/ha for the past 3 seasons significantly increased grain yield compared with no phosphorus. The biosolid or chicken litter treatments alone were lower yielding. Treatments had no effect on grain quality.

In trial 3 grain yields ranged between 4.39 t/ha and 5.20 t/ha, with no difference in grain quality between the treatments. All treatments receiving 5 or 10 kg P/ha for the past 2 seasons were significantly higher yielding. The addition of biochar, phosphorus solubilisers or Avail did not increase grain yield.

Table 2: Trial 1.Grain yield (t/ha), protein (%), test weight (kg/hL), retention (%) and screenings (%) at Hart in 2010.

Treatment	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)	Retention (%)
Nil	4.72	10.7	67.7	1.4	90.7
5kg/ha P	4.97	11.7	67.4	1.4	89.2
10kg/ha P	5.00	11.7	68.3	1.5	90.0
15kg/ha P	5.49	11.4	68.0	1.4	91.2
LSD (0.05)	ns	0.4	ns	ns	ns

Table 3: Trial 2. Grain yield (t/ha), protein (%), test weight (kg/hL), retention (%) and screenings (%) at Hart in 2010.

Treatment	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)	Retention (%)
Nil	4.40	11.0	67.9	1.6	88.9
5t/ha Biosolids	4.86	11.4	68.6	1.4	89.8
5t/ha Biosolids + 12kg/ha P	5.06	11.0	68.5	1.7	88.5
3t/ha Chicken litter	4.40	11.3	68.5	1.7	88.5
3t/ha Chicken litter + 12kg/ha P	5.30	11.2	68.5	1.9	88.1
10kg/ha	5.20	10.7	68.1	1.6	89.8
LSD (0.05)	0.24	ns	ns	ns	ns

Table 4: Trial 3. Grain yield (t/ha), protein (%), test weight (kg/hL), retention (%) and screenings %) at Hart in 2010.

Treatment	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)	Retention (%)
Nil	4.48	11.4	67.4	1.9	89.3
5kg/ha P	5.10	11.5	67.6	2.0	86.4
10kg/ha P	5.10	11.5	68.2	1.7	87.6
500kg/ha Biochar	4.43	11.5	67.5	1.7	88.4
500kg/ha Biochar + 5kg/ha P	4.91	11.3	68.2	1.7	88.5
500kg/ha Biochar + 10kg/ha P	5.20	11.0	68.0	1.6	89.9
500kg/ha Biochar + Liquid P	4.77	11.4	68.0	1.6	90
P solubiliser	4.39	11.4	67.2	1.8	87.5
P solubiliser + 5kg/ha P	4.97	10.8	67.7	1.7	88.3
P solubiliser + 10kg/ha P	5.15	11.4	67.1	1.4	87.9
Avail + 5 kg P	4.82	11.2	67.2	1.9	87.9
Avail + 10 kg P	4.92	11.8	68.3	1.6	90.1
LSD (0.05)	0.31	ns	ns	ns	ns

Maximising grain yield of field peas

Mick Lines, Jenny Davidson & Larn McMurray, SARDI

Key findings

- Grain yield of field peas sown at Hart in 2010 averaged 2.5t/ha across all varieties.
- No time of sowing response was observed in 2010.
- Early sown plots with uncontrolled blackspot showed a 35% yield loss compared to the optimum control (fortnightly chlorothalonil), which yielded 3.6t/ha.
- Prospective releases OZP0703 and OZP0903 show a lot of promise, with OZP0703 performing similarly to Kaspa and OZP0903 yielding 10% greater.
- Chlorothalonil (Bravo®), pyraclostrobin (Cabrio®) and azoxystrobin plus chlorothalonil (Amistar® Opti) increased yields compared to the nil treatment with disease pressure.

Why do the trials?

To identify optimum sowing times in new field pea varieties and to improve recommendations from the 'Blackspot Manager' disease risk prediction model in different regions.

How was it done?

TOS Trial

Plot size	1.5m x 10m	**Fertiliser rate**	MAP @ 75kg/ha with seed
Sowing date	TOS 1: 30th April 2010 TOS 2: 21st May 2010 TOS 3: 11th June 2010	**Inoculant** **Row Spacing**	- 22.5 cm (9")
Varieties (seed rate)	Alma(45 plants/sq m) Kaspa, PBA Gunyah, PBA Twilight, OZP0703 & OZP0903 (55 plants/sq m)		
Trial design	Split plot with 3 reps, blocked by rep then sowing date.		

Fungicide Trial

Sowing details	Kaspa, 55 plants/sq m, 30th April 2010
Fungicide Tmts	Nil, Mancozeb (2kg/ha), Chlorothalonil (2L/ha), Amistar® (700ml/ha), Amistar® Xtra (850ml/ha), Amistar® Opti (3L/ha), Amistar® + Tilt (700ml/ha + 500ml/ha), Filan® (200g/ha), Cabrio® (200ml/ha), Filan® + Carbio® (200g/ha + 200ml/ha), Syngenta Product (identity withheld)
Fungicide timing	9 node + early flower

Results

Foliar disease

Conditions were favourable for plant growth, foliar disease and grain yield in 2010. However, blackspot infection was less than the early predictions based on 2009 stubble spore counts. This was most likely due to a combination of high summer and early autumn rainfall, prompting spore releases prior to sowing, and a dry start to May, which generally delayed sowing and reduced blackspot risk. Blackspot was recorded at moderate levels throughout the season despite the favourable growing season, except in the very early sown plots (30th April). Scores comparing Kaspa and PBA Gunyah showed no difference between cultivars, but blackspot infection was lower when sowing was delayed, consistent with previous results.

A wetter than average spring in 2010 meant conditions were also conducive for powdery mildew. A low infection was observed at Hart and its onset was too late to cause any significant yield loss.

Grain yield – Time of sowing and variety trial

Yield of field peas averaged 2.5 t/ha at Hart in 2010, the same as in 2009. Grain yield showed no response to sowing time.

Varietal differences in grain yield were measured (Figure 1). Alma, a tall, trailing conventional type pea, yielded 17% lower than Kaspa (2.12 t/ha). Yield of Alma may have been compromised by the large biomass and severe lodging. Kaspa performed similarly to the site mean.

PBA Gunyah and PBA Twilight performed similarly averaging 2.39 t/ha, and slightly lower than the site mean (2.48 t/ha). PBA Twilight performed similarly to Kaspa, while PBA Gunyah yielded slightly (8%) lower than Kaspa, but still 11% higher than Alma.

Prospective releases OZP0703 (improved bacterial blight tolerance) and OZP0903 (high yielding) both yielded higher than the site mean. OZP0903 yielded 10% higher than Kaspa and 33% higher than Alma and OZP0703 yielded similar to Kaspa.

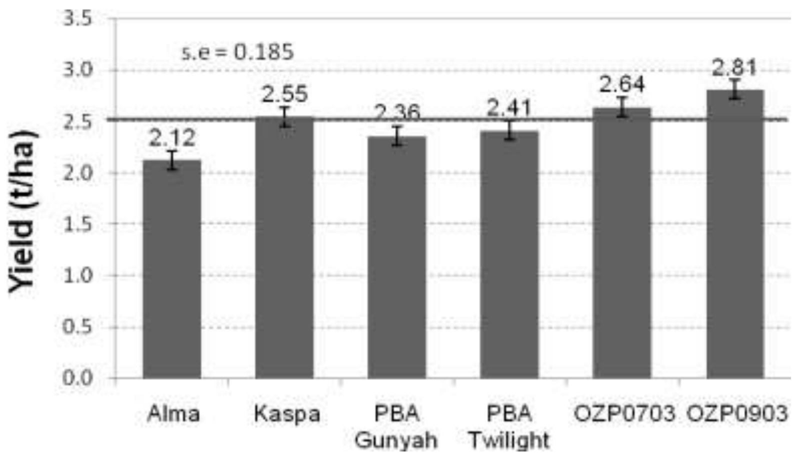


Figure 1: Grain yield of field pea cultivars at Hart, 2010.

Blackspot Manager Model validation

Blackspot infected pea stubble was collected from each time of sowing (early, mid and late) in the field pea disease management trial at Hart in November 2009. The disease level on the stubble varied for these sowing dates with 18, 12 and 8 nodes infected from early, mid and late sown plots in 2009. Nylon pouches containing the stubble were incubated on the soil surface at Hart through 2010. Each fortnight one pouch per sowing date was analysed for spore release. Spore release patterns (Figure 2) show that the peak release was late April and by the time most field pea crops in South Australia were emerging in late May, very few blackspot spores remained. This data validated the prediction of early spore release by 'Blackspot Manager' and blackspot disease was of lesser severity in South Australia in 2010 compared to previous years with late release of spores, except in crops that were sown very early on the break of the season.

The results in Figure 2 show that many more spores were released from the medium severity stubble (mid sown) than either the high or low severity (early or late sown). It was expected that the high severity stubble would produce most spores as had occurred in similar experiments in 2008 and 2009. Nevertheless the number of spores was much lower than in previous years, irrespective of severity of disease on the stubble.

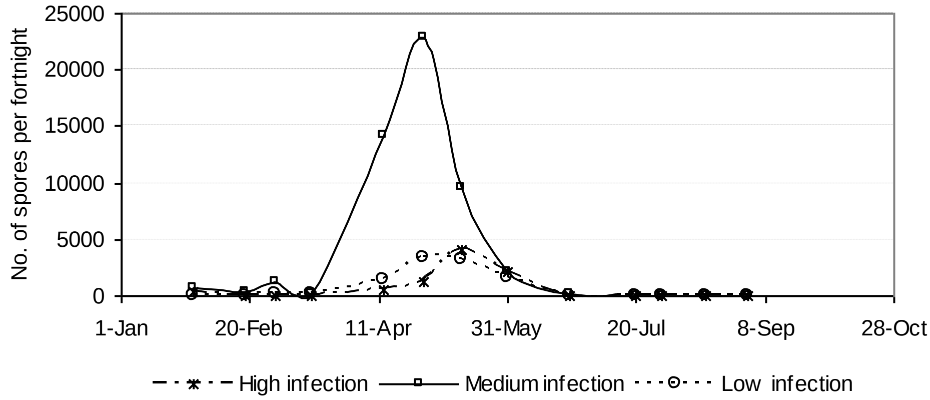


Figure 2. Blackspot spores trapped from pea stubble per fortnight from Hart incubation in 2010.

Alternative fungicides for blackspot on field peas – Fungicide trial

A range of fungicides (unregistered for this purpose) were tested for blackspot control on early sown (30th April) Kaspa peas at Hart in 2010, as the current options either provide inadequate or uneconomical control. Blackspot was assessed six times during the season and results are expressed as Area Under the Disease Progress Curve (AUDPC).

Treatments of chlorothalonil, pyraclostrobin and azoxystrobin plus chlorothalonil reduced disease and increased grain yield (Figures 3 and 4). However, these treatments have still not reached their yield potential as the response from fortnightly sprays of chlorothalonil was even greater (54% yield increase compared to unsprayed plots). This work will be validated in the coming season.

In the meantime the recommended strategy in field pea crops with a yield potential of at least 2.o t/ha is to apply P-Pickel T seed dressing followed by foliar applications of either mancozeb or chlorothalonil at 9 node growth stage and again at early flowering. This strategy should remain economic for grain prices above $200 tonne, but may not be economic in crops that yield less than 2.0 t/ha.

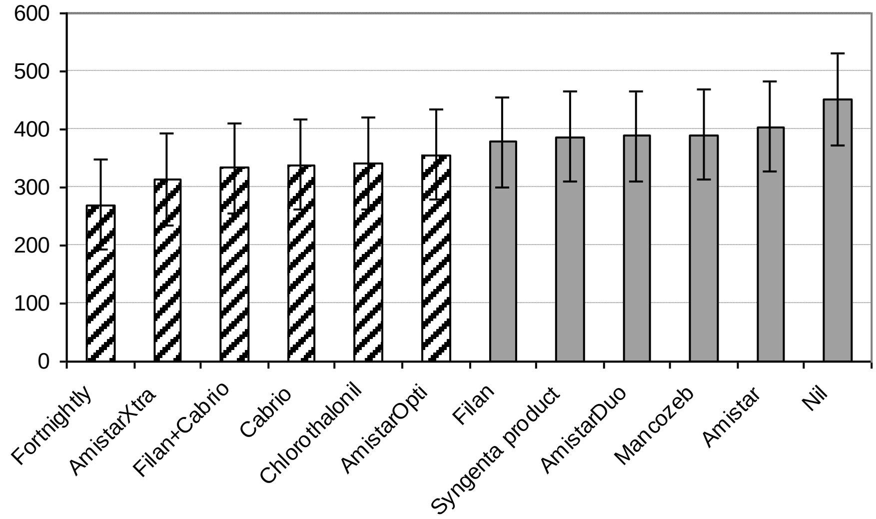


Figure 3: Blackspot assessed as Area Under Disease Progress Curve in fungicide treated plots of Kaspa at Hart 2010. Striped bars have significantly less disease than the untreated. L.S.D. = 78.2

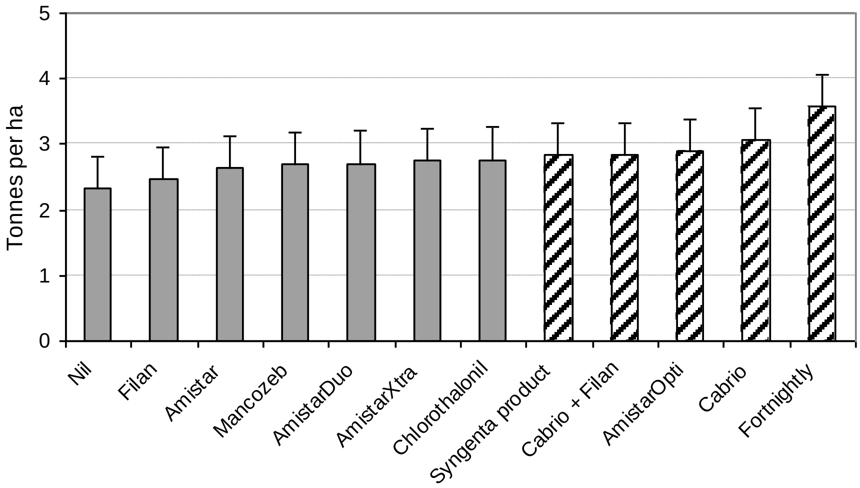


Figure 4: Yield in fungicide treated plots of Kaspa at Hart 2010. Striped bars have significantly more yield than the untreated. L.S.D. = 0.49

Summary

High growing season rainfall and moderate presence of disease meant conditions were favourable for pea production in 2010, with yields averaging 2.5t/ha at Hart. These yields are somewhat disappointing given the favourable growing conditions and relative yields of other crop type. Reasons for this are unclear but this is most likely due to a combination of blackspot (adjacent fungicide trial showed a 35% yield loss compared to fortnightly control), some level of transient moisture stress in September coinciding with flowering and perhaps high biomass leading to shading of some flowers and pods.
Grain yield showed no response to sowing time. This was likely due to the moderate blackspot, which penalised yield of early sown Kaspa by 35% (as evidenced by the fungicide trial), and the favourable season finish (which favoured later sown peas).

Over the last three seasons PBA Gunyah has performed between 7% below (2010) and 15% above (2008) Kaspa at Hart across all sowing dates, averaging 4% greater than Kaspa. PBA Twilight has been included in Hart trials only in the favourable seasons of 2009 and 2010, but has still averaged just 2% below Kaspa over those seasons. Long term NVT data (2004 – 2010) shows both varieties have similar yield to Kaspa, however PBA Gunyah and PBA Twilight have performed up to 17 and 22 percent higher than Kaspa in previous seasons with drier springs and lower yields.

Prospective releases OZP0703 and OZP0903 show a lot of promise. OZP0703 is a high yielding early flowering dun variety with greater tolerance to bacterial blight than current pea varieties. Long term NVT data shows a three percent yield advantage over Kaspa in all pea growing areas, with a range of 99 to 117 percent compared to Kaspa.

OZP0903 is presently being considered for commercial release. OZP0903 is a high yielding, early flowering and erect growing dun pea variety with good pod shatter resistance and high field resistance to bacterial blight and the new strain of downy mildew present in SA. OZP0903 has shown reliable and high yield potential in SA, averaging 6 percent higher than Kaspa in 2010 and 18% higher in 2009 across NVT and PBA field trials in South Australia.

The web-based model ‘Blackspot Manager’ reliably predicted the reduced risk of blackspot in 2010 for South Australian field peas. Model predictions for 2011 will begin late March on the website *www.agric.wa.gov.au/cropdiseases*.

Acknowledgements

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SARDI Clare team for helping with trial management: Stuart Sherriff, John Nairn, Rowan Steele and Peter Maynard.

Lentil agronomy

Stuart Sherriff, Larn McMurray & Matt Dare SARDI

Key findings

- Lentil varieties yielded similarly in varying soil types and at different times of sowing.
- New early maturing lentil varieties PBA Flash (3.6 t/ha) and PBA Blitz (3.57 t/ha) were highest yielding.
- Lentils were equal or higher yielding than PBA Gunyah field peas under favourable conditions in 2010.

Why do the trials?

Interest in growing lentils has increased in recent years primarily due to high relative grain prices. However the availability of more varieties with improved agronomic adaptation, disease resistance and grain quality has also generated renewed interest in growers from more marginal lentil growing areas. Experiments were established to assess the advantages of new lentil varieties with current standards and a field pea at different sowing times and on varying soil types.

How was it done?

Plot size	1.5m x 10m	**Fertiliser rate**	MAP @ 75kg/ha with seed
Sowing date	TOS 1: 30th April 2010	**Inoculant**	-
	TOS 2: 21st May 2010	**Row Spacing**	22.5 cm (9")
Varieties (plant density)	PBA Gunyah (OZP0602) @ 55 plants/sq m & PBA Blitz (CIPAL610), PBA Flash (CIPAL411), Boomer, Nipper, Nugget all @ 120 plants/sq m		
Sites	West (at top of Hart site hill), East (at bottom of Hart site hill).		
Trial design	Split, split plot with 3 reps, blocked by rep, then site then sowing date.		
Fungicides	All plots were treated with Carbendazim @ 500 mL/ha 22/09/2010		

Results

Seasonal conditions favoured plant growth and grain yield in 2010. Low levels of both ascochyta blight and botrytis grey mould were identified, particularly at the heavier textured East site, however, disease was controlled by foliar fungicides.

Dry matter production (Table 1) was over 8 t/ha in the early sown lentil plots and grain yields ranged from 3.2 t/ha (Nugget East site) to 3.6 t/ha (PBA Flash East site). Field peas were lower yielding with yields of 3.1 t/ha at the West site and 2.65 t/ha at the East site (Table 2).

Sowing date had no effect on grain yield however dry matter was 16% higher at the early sowing date when compared with the later sowing date. Generally all lentil varieties performed similarly at both sites although PBA Flash was 11% higher yielding at the East site compared with up the hill at the west site. All varieties including PBA Gunyah field pea yielded the same at the West site. At the East site Nugget lentils were significantly lower yielding and PBA Gunyah was lower yielding than all lentils at this site.

Variety	Dry matter (t/ha)	
	TOS 1	TOS 2
Lentil ave	8.63	7.45
LSD (0.05)	0.61	

Table 1: Average dry matter production of lentil varieties at each sowing time (tonnes/hectare).

Variety	Grain yield (t/ha)	
	East site	West site
Boomer	3.35	3.31
PBA Blitz	3.57	3.30
PBA Flash	3.60	3.26
Nipper	3.30	3.29
Nugget	3.24	3.30
PBA Gunyah	2.65	3.09
Site mean	3.28	3.26
LSD (0.05)	0.29	

Table 2: Yield of lentil varieties at each site (tonnes/hectare).

Grain size varied between lentil varieties (Tables 3 and 4), with Nipper having the smallest and Boomer the largest grain weight across sowing dates and sites. Boomer lentils had a slightly higher grain weight when sown earlier. Otherwise there were little differences due to sowing date or site location.

	100 grain weight (g)		
Variety	East site	West site	Average
Boomer	7.5	7.4	7.5
PBA Blitz	5.3	5.2	5.2
PBA Flash	4.9	4.9	4.9
Nipper	3.4	3.4	3.4
Nugget	4.2	4.2	4.2
PBA Gunyah	22.1	21.5	21.8
Lentil average	5.1	5	5.1
LSD (0.05)			
Variety		0.2	
Site		0.1	
Variety*Site		0.2	

Table 3: Seed size of lentil varieties at each site and average lentil variety seed size (grams / 100 grains).

Variety	100 grain weight (g) TOS 1	TOS 2	Average
Boomer	7.7	7.3	7.5
PBA Blitz	5.2	5.2	5.2
PBA Flash	4.8	5	4.9
Nipper	3.4	3.5	3.4
Nugget	4.2	4.2	4.2
PBA Gunyah	21.7	21.9	21.8
Lentil average	5.1	5	5.1
LSD (0.05)			
Variety		0.2	
TOS		ns	
Variety*TOS		0.3	

Table 4: Seed size of lentil varieties at each time of sowing and average lentil variety seed size (grams / 100 grains).

Summary

Seasonal conditions favoured lentil growth and production with few impediments to grain yield. Disease started but didn't progress due to fungicide use and a period of dry weather beginning in mid September.

Lentil yields averaged above 3.2 tonnes per hectare at both sites. Yields were similar between varieties, sowing date and sites. The lack of difference between sites was unexpected but showed the potential lentils have regardless of soil type in favourable conditions. This result may not always occur across seasons or on less suited soil types.

Pea yields were equal to or lower yielding than the lentils. This was most likely due to black spot infection and this was likely to have been higher at the East site due to heavier soil type and its proximity to previous stubble. Results from a neighbouring fungicide trial showed over a 1.0 t/ha yield loss in field peas due to uncontrolled black spot infection.

Acknowledgements

GRDC for kindly funding this research.
SARDI Clare team for helping with trial management:
Stuart Sherriff, John Nairn, Rowan Steele and Peter Maynard.

Stem rust control in wheat – 2010 trials review

Nick Poole & Tracey Wylie
Foundation for Arable Research (FAR), New Zealand

Key findings

- Fungicides can be employed successfully to control stem rust in wheat (Puccinia graminis f.sp. tritici) but timing in relation to disease development is crucial.
- In susceptible cultivars fungicide application must be made at a very early stage of disease development, preferably before it can be seen.
- Fungicide activity is limited in scenarios where disease is already established in the stem at application, in these cases cultivar resistance was far more effective in defence against this disease than fungicides.
- Propiconazole (Tilt) gave significantly poorer stem rust control than the other fungicides tested at full label rates.
- Prothioconazole the partner azole to tebuconazole in Prosaro was particularly strong on stem rust, making Prosaro one of the most cost effective fungicides for control of this disease.

Following favourable conditions for stem rust development, six trials were set up at short notice to gather fungicide efficacy data on control of this disease. In order to take account of any possible product shortages in an epidemic year, fungicide products were evaluated across a range of rates (N.B. the use of fungicide or use at rates lower than the label does not constitute a recommendation in this report). Since the disease developed late in the season, there has been less opportunity to test the influence of fungicide timing, however some data has been collected. This project is a variation on GRDC project SFS 00017.

How did fungicide product and rate influence stem rust control?
Seven fungicides were evaluated at four trial sites: 1. Booleroo, SA, 2. Jamestown, SA, 3. Quambatook, VIC (Mallee) and 4. Inverleigh, VIC (high rainfall zone - HRZ). At three of these sites fungicides were applied (Table 1) before stem rust infection was visible in the crop, however at the Booleroo site products were sprayed at very low levels of infection (less than 10% less sheathes infected). Fungicide products were applied at three rates (low, intermediate and high). In many cases the high rate was the label rate for stem rust control if registered (Table 2). The infection came in late in crop developmentat all of these trial sites, first infection being evident from early grain fill (GS71). In the three shorter season environments, Booleroo, Jamestown and Quambatook physiological maturity arrested the disease, which had steadily increased until that stage (Table 3). Yipti (S - susceptible stem rust rating) was the cultivar used in all the trials, except in the HRZ where Beaufort feed wheat was used (S - susceptible stem rust rating).

Table 1. Application details (date, growth stage, water rate and nozzle settings)

Trial Site	Application Date	Growth Stage	Water rate l/ha	Nozzles & Pressure
Trial 1 Booleroo SA	Oct 19th	GS72 (early milky ripe)	107 l/ha	015 flat fan nozzles, 1.5 bar
Trial 2 Jamestown SA	Oct 26th	GS71 (watery ripe)	107 l/ha	015 flat fan nozzles, 1.5 bar
Trial 3 Quambatook VIC	Oct 27th	GS69 (end of flowering)	160 l/ha	DG 110-02, 2.0 bar
Trial 4 Inverleigh VIC (HRZ)	Nov 10th	GS55 (50% ear emergence)	100l/ha	110-02 flat fan, 3.0 bar

Influence of fungicide rate (mean of fungicide products - 4 site mean)

Stem rust control assessed over the 4 trial sites (Figure 1) revealed that using a high rate was essential for the control of the disease, even if the fungicide had been applied before infection was visible in the crop. There was a significant advantage to the high rate of fungicide (87% control) over the intermediate rate (76% control), which in turn was superior to the low rate (61% control).

Influence of fungicide product & rate on stem rust control - 4 site mean

At the high rate of fungicide, the formulated mixtures azoxystrobin/cyproconazole (Amistar Xtra), propiconazole/cyproconazole (Tilt Xtra) and prothioconazole /tebuconazole (Prosaro) gave significantly better disease control (92 - 93% control) than propiconazole (e.g. Tilt) at 500ml/ha (75% control). At the intermediate rate, a rate which it must be stressed is below the label rate for most of the products, the spread of performance was greater with Prosaro performing significantly better than single active ingredients epoxiconazole (Opus), tebuconazole (Folicur) and propiconazole (Tilt). At the lowest rate of active ingredient disease control ranged from 46 – 71% control, tebuconazole (Folicur) and propiconazole (Tilt) being inferior to all other fungicides except propiconazole/cyproconazole (Tilt Xtra) .

Was it economic to spray for stem rust in these trials?

At Booleroo in SA there was no significant difference in yield between the treatments (yields ranging from 4.0t/ha - 4.29t/ha) with an untreated yield of 4.14 t/ha. At Quambatook in Victoria (harvested December 31st) all fungicides applied at the high rate gave significantly higher yields than the untreated, except propiconazole (Tilt) and propiconazole/cyproconazole (Tilt Xtra). The significant yield increases ranged from 0.29-0.45 t/ha and all gave rise to economic yield increases, however it was lower cost fungicide products such as Folicur, Prosaro and Opus that gave the greater margins in this trial (Figure 2).

Table 2. Fungicide treatment and application rate. Label rates for stem rust control are highlighted (note Amistar Xtra is not registered for stem rust control in Australia).

Trt	Fungicide treatment and rate	Rate description	Active ingredient
1.	Prosaro® 420SC 75 ml/ha + A	Low	Prothioconazole + Tebuconazole
2.	Prosaro 420SC 150ml/ha + A	Mid	
3.	Prosaro 420SC 300ml/ha + A	High	
4.	Opus® 125SC 125 ml/ha	Low	Epoxiconazole
5.	Opus 125SC 250 ml/ha	Mid	
6.	Opus 125SC 500ml/ha	High	
7.	Amistar Xtra® 280SC 200 ml/ha	Low	Azoxystrobin + Cyproconazole
8.	Amistar Xtra 280SC 400 ml/ha	Mid	
9.	Amistar Xtra 280SC 800 ml/ha	High	
10.	Tilt® 250EC 125 ml/ha	Low	Propiconazole
11.	Tilt 250EC 250 ml/ha	Mid	
12.	Tilt 250EC 500 ml/ha	High	
13.	Tilt Xtra® 330EC 125 ml/ha	Low	Cyproconazole + Propiconazole
14.	Tilt Xtra 330EC 250 ml/ha	Mid	
15.	Tilt Xtra 330EC 500 ml/ha	High	
16.	Folicur® 430SC 72.5 ml/ha	Low	Tebuconazole
17.	Folicur 430SC 145 ml/ha	Mid	
18.	Folicur 430SC 290 ml/ha	High	
19.	Opera® 147SC 250 ml/ha	Low	Pyraclostrobin + Epoxiconazole
20.	Opera 147SC 500 ml/ha	Mid	
21.	Opera 147SC 1000 ml/ha	High	
22 to 24	Untreated		

A – Adjuvant applied was Hasten at 1%.

Table 3. Stem rust development in the untreated plots at 4 trial sites relative to the date of fungicide application in the trial – assessed on the flag leaf sheath.

Trial Site	Assessment method	% Stem rust in untreated (relative to days following fungicide application)			
		0	7	14	22-34
Booleroo	% incidence	6	14	94	99
	% Severity	0	0.2	2.2	6.5
Jamestown	% incidence	0	2	28	95
	% Severity	0	0.01	0.3	1.9
Quambatook	% incidence	0	0	7	83
	% Severity	0	0	0.07	3.2
Inverleigh	% incidence	0	0	16	93
	% Severity	0	0	0.11	2.9

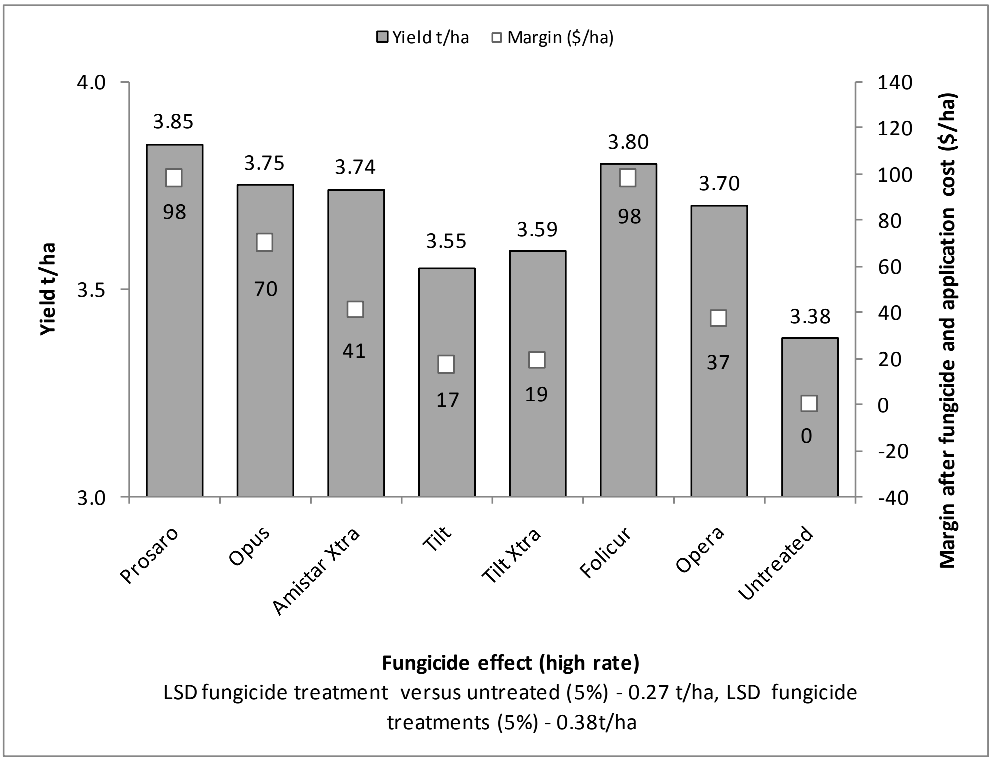


Figure 2. Influence of fungicide application for the control of stem rust on the yield (t/ha) and margin after fungicide and application cost ($/ha) – cv Yipti, Quambatook, VIC
Note: grain price $317/t; 2.5% wheel damage was subtracted from the treated yield;

How important is fungicide timing for stem rust control?

Though there were few opportunities to explore fungicide timing due to the late nature of infection this season, work in the longer season environment in southern Victoria, on the feed cultivar Beaufort, compared fungicide application pre and post infection. Application of the same seven fungicides (as outlined in Table 1) was made at the high rate at 50% ear emergence (GS55) pre visible infection, and then again 16 days later at early grain fill-watery ripe stage (GS71).

Comparisons of stem rust control between the two timings illustrated that when the plant structure to be protected is already infected with stem rust the ability of the fungicide to control the disease is reduced (Figure 3). At GS71, when the second fungicide timing was applied, the flag leaf sheath was already infected (16% flag sheathes infected), in comparison to the earlier application at ear emergence when no infection was noted. As a consequence the stem rust control achieved with high rates applied late (GS71) was significantly inferior to the same rates used earlier (GS55) and was no better for stem rust control than the low and mid rate fungicide applications (Figure 3).

In contrast, the peduncle (the true stem beneath the ear) was not fully exposed to the fungicide at the ear emergence timing (since it was still inside the sheath) and the later application timing, at grain fill (GS71), was applied with no visible infection in the peduncle. In this case there was no significant difference in stem rust control between the two timings for the protection of this part of the plant, though the trend was for the earlier spray to be superior (Figure 4).

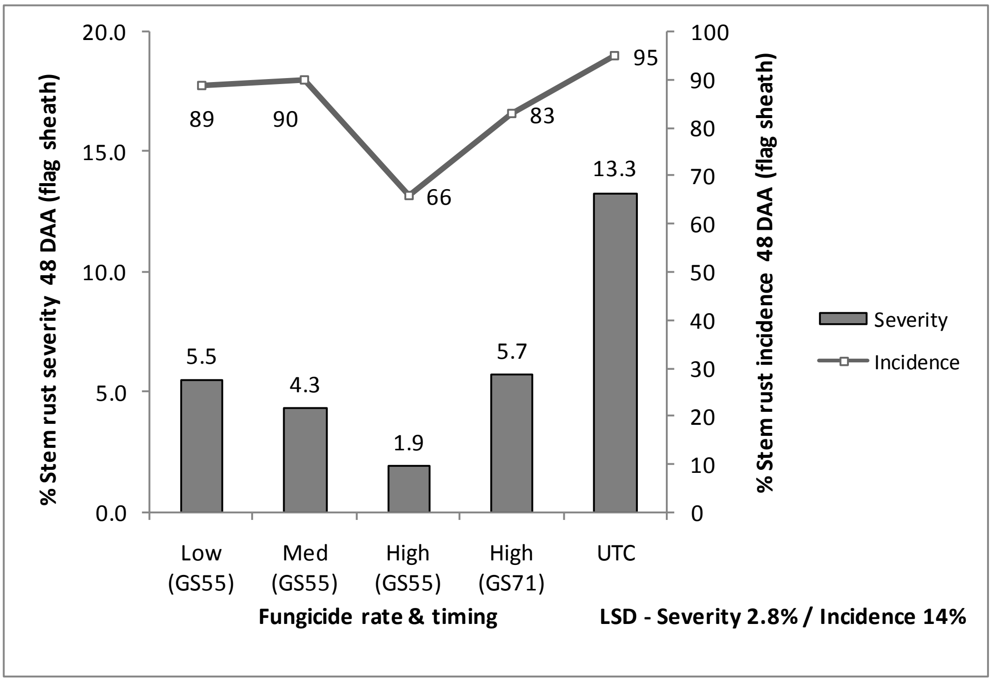


Figure 3. Influence of fungicide timing at 50% ear emergence (GS55) v watery ripe (GS71) and rate of application on stem rust (% incidence and severity) on the flag sheath 48 days after fungicide application at GS55 and 32 days after fungicide application at GS71 (mean of 7 fungicide products) – Inverleigh (HRZ), VIC

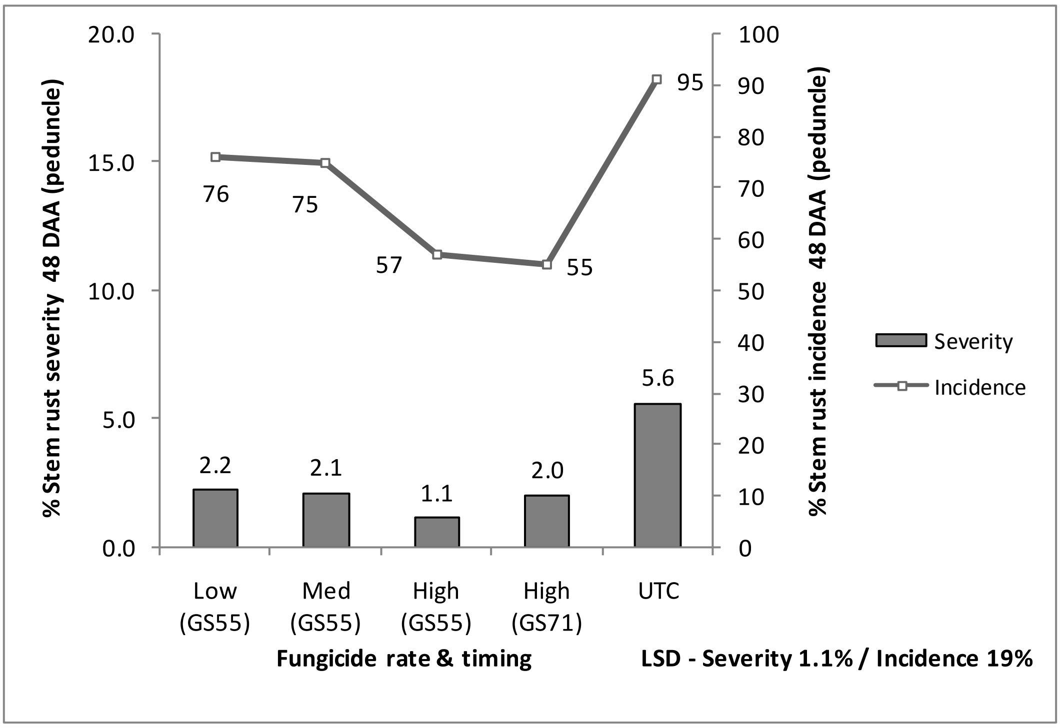


Figure 4. Influence of fungicide timing (50% ear emergence (GS55) v watery ripe (GS71) and rate on stem rust (% incidence and severity) on the peduncle 48 days after fungicide application at GS55 and 32 days after fungicide application at GS71 (mean of 7 fungicide products) – Inverleigh (HRZ), VIC

What is the role of cultivar resistance in the control of stem rust?

Cultivar resistance is crucial for the control of this disease. Whilst information is presented in this paper to show that stem rust can be controlled with foliar fungicides, the activity of these products is limited once infection becomes established. In Gippsland this season, stem rust was first noted in early November by which time the disease was well established on the stem in susceptible cultivars (100% infection incidence). Though yield results are currently being processed, the trial conducted on March and May sown wheat showed little impact from a full rate fungicide (Prosaro 300ml/ha plus Hasten % v/v) in terms of stem rust control where cultivars were badly infected at application (Figure 5). In these trials the impact of Revenue's genetic resistance to stem rust was far superior to the influence of foliar fungicide applied late in the development of the disease.

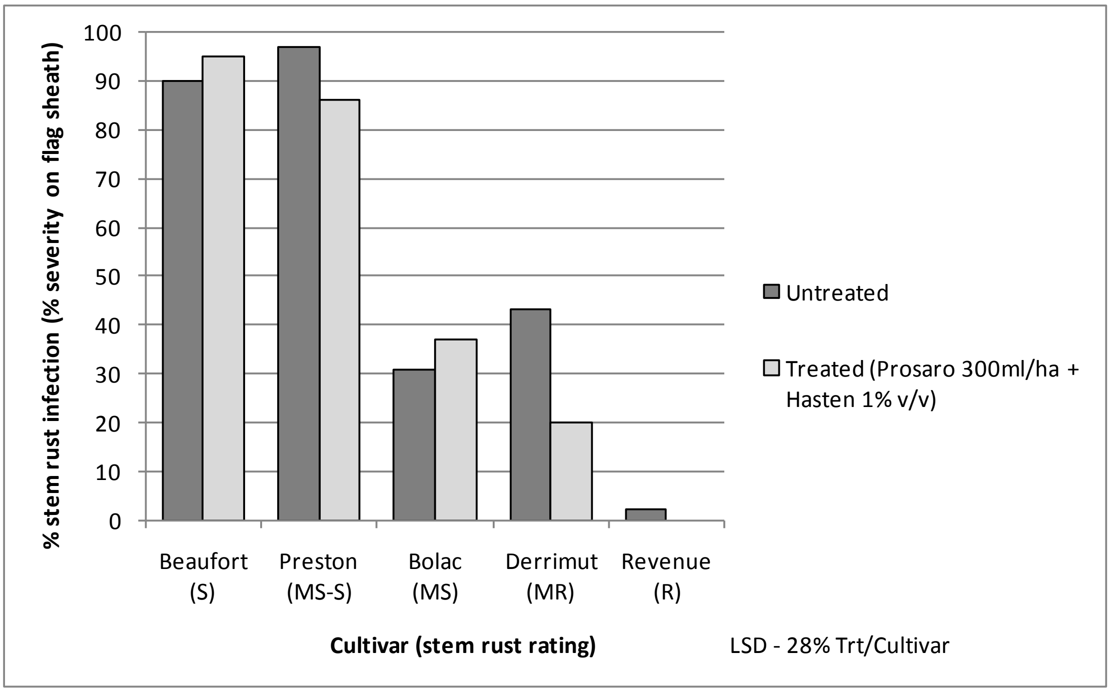


Figure 5. Influence of cultivar resistance and fungicide application on stem rust severity on the flag sheath 18 days after fungicide application assessed at mid dough – physiological maturity (GS85-90) – Bairnsdale, Gippsland, VIC.

Acknowledgements

We would like to acknowledge all the input of our co-workers: in SA Peter Hooper & Sam Trengove (Allan Mayfield consulting), Mick Faulkner & Jeff Bruan (Agrilink Consulting), Dustin Berryman (Landmark) and Stuart Sheriff (SARDI), in Victoria Southern Farming Systems (Jon Midwood, Bruce Dixon & Ben O'Conner) and at Birchip Cropping Group (Simon Craig and Anne Jackman) and our host farmers.

We would also like to acknowledge the funding and co-operation of GRDC in establishing this project at such short notice.

GRDC Project number: SFS 00017

HART FIELD DAY
2010

Ryegrass control with pre-emergent herbicides in wheat

This trial is funded by the GRDC and is part of a collaborative project. It was conducted with Chris Preston, Gurjeet Gill and Sam Kleemann from the University of Adelaide.

Key findings

- Sakura alone or in combination with Avadex Xtra or Dual Gold provided the best pre-emergence ryegrass control (72 to 94%) in 2010.
- New pre-emergent herbicides like Boxer Gold or Sakura provide good control of trifluralin resistant annual ryegrass.
- Post-sowing pre-emergent herbicide applications provide significantly improved ryegrass control in the crop row, and also give longer residual control.
- Sakura significantly reduced the number of ryegrass heads produced.

Why do the trial?

There is an increasing frequency of trifluralin (Group D) resistant annual ryegrass across southern Australia. Pre-emergent herbicides play an important role in current cropping systems and so the evaluation of alternative groups and strategies is vital.

Regardless of herbicide efficacy a common paddock observation is the lack of annual ryegrass control within the crop row. In 2009 the ryegrass control trial clearly showed that pre-emergent herbicides applied after sowing and before emergence (PSPE) were the most effective for in-row ryegrass control.

This trial also aims to measure if the period of residual ryegrass control can be extended using PSPE treatments.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	32:10 (DAP/Urea) @ 80 kg/ha
Seeding date	13th May 2010	**Variety**	Catalina wheat @ 70 kg/ha

The trial was a randomised complete block design with 3 replicates and 17 herbicide treatments (Table 1). Active ingredients of the herbicides used in the trial are listed in Table 2.

To ensure even ryegrass establishment across the trial site, ryegrass seed was broadcast at 25 kg/ha ahead of seeding and worked in with a shallow pass with the seeder prior to herbicide application. The ryegrass used was harvested from paddocks and is approximately 30% resistant to trifluralin.

The seeding equipment used was a knife-point press wheel system on 22.5cm (9”) row spacings.

Pre-sowing herbicides were applied within 1 hour of sowing and incorporated by sowing (IBS), the post-sow pre-emergent (PSPE) herbicides were applied on the 25th May, 12 days after sowing. The site received 24mm of rainfall on the same day as the PSPE application.

Crop emergence was assessed by counting the number of emerged wheat seedlings along both sides of a 0.5 m rod at 3 random locations within each plot. Ryegrass was counted at 6 & 10 weeks after sowing (i.e. July & August) using a 0.1 square metre quadrat from within and between the crop rows from 4 random locations within each plot. Ryegrass head density was measured in September using 0.16 square metre quadrat placed at 4 random locations within each plot.

Table 1. Pre-emergent herbicides, rates & timings at Hart in 2010.

	Herbicide treatments	Cost ($/ha)
1	Nil (untreated control)	
2	Trifluralin 480 1.5 L/ha (IBS)	7.50
3	Avadex Xtra 3.0 L/ha (IBS)	30.0
4	Boxer Gold 2.5 L/ha (IBS)	34.0
5	Sakura 118 g/ha (IBS)	na
6	Outlook 1.0 L/ha (IBS)	na
7	Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS)	27.5
8	Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)	37.5
9	Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS) + Sakura 80g/ha (PSPE)	na
10	Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS) + Boxer Gold 1.5 L/ha (PSPE)	48.0
11	Boxer Gold 2.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS)	54.0
12	Boxer Gold 1.5 L/ha (IBS) + Boxer Gold 1.0 L/ha (PSPE)	34.0
13	Boxer Gold 2.5 L/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)	44.0
14	Sakura 80 g/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS)	na
15	Sakura 80 g/ha (IBS) + Sakura 38 g/ha (PSPE)	na
16	Sakura 118 g/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)	na
17	Outlook 0.7 L/ha (IBS) + Outlook 0.3 L/ha (PSPE)	na

Table 2. Pre-emergent herbicides & their active ingredients at Hart in 2010.

Herbicide	Active ingredients	Herbicide group
Trifluralin 480	trifluralin 480 g/L	D
Avadex Xtra	tri-allate 500 g/L	J
Boxer Gold	Prosulfocarb 800 g/L + S -metolachlor 120 g/L	E+K
Sakura (BAY-191 850WG)	pyroxasulfone 850 g/kg	K
Outlook (Nul-1493)	dimethenamid-P	K
Dual Gold	S-metolachlor 960 g/L	K

Results

All herbicides with the exception of Outlook were safe on wheat with little or no reduction in wheat establishment under the knife-point press wheel system. Outlook reduced crop density by 70% of the untreated control (126 plants per square metre), and also early crop vigour. Outlook, an experimental herbicide developed by Nufarm, is highly soluble and will not be released for use in wheat due the potential for crop damage. It is safe on pulses and has been submitted for registration for this use.

All herbicide treatments reduced ryegrass emergence and averaged 79% total control in July (Table 3 or Figure 1). The combination of Sakura and Avadex Xtra IBS produced the greatest control (94%) while Trifluralin provided the lowest (59%) of the untreated control (385 plants per square metre).

Avadex Xtra (3.0L/ha), Sakura (118g/ha) or Outlook (1.0L/ha) applied alone IBS all provided less than 75% ryegrass control.

Of the IBS treatments Avadex Xtra mixed with Sakura, Boxer Gold or Trifluralin at sowing gave 94, 85 or 82% control respectively, in July. While for all the treatments the best control was produced by applying either Sakura (89%), Boxer Gold (91%) or Dual Gold (92%) post-sowing pre-emergence following a combination of Trifluralin and Avadex applied IBS. Across all the treatments, those containing a PSPE application gave 7% more control compared to all the IBS treatments alone.

Residual control of ryegrass

Control of ryegrass was maintained between July and August for most treatments with an exception for Boxer Gold (2.5L/ha IBS) and Outlook (1.0L/ha IBS). For both treatments control decreased by about 20% between July and August.

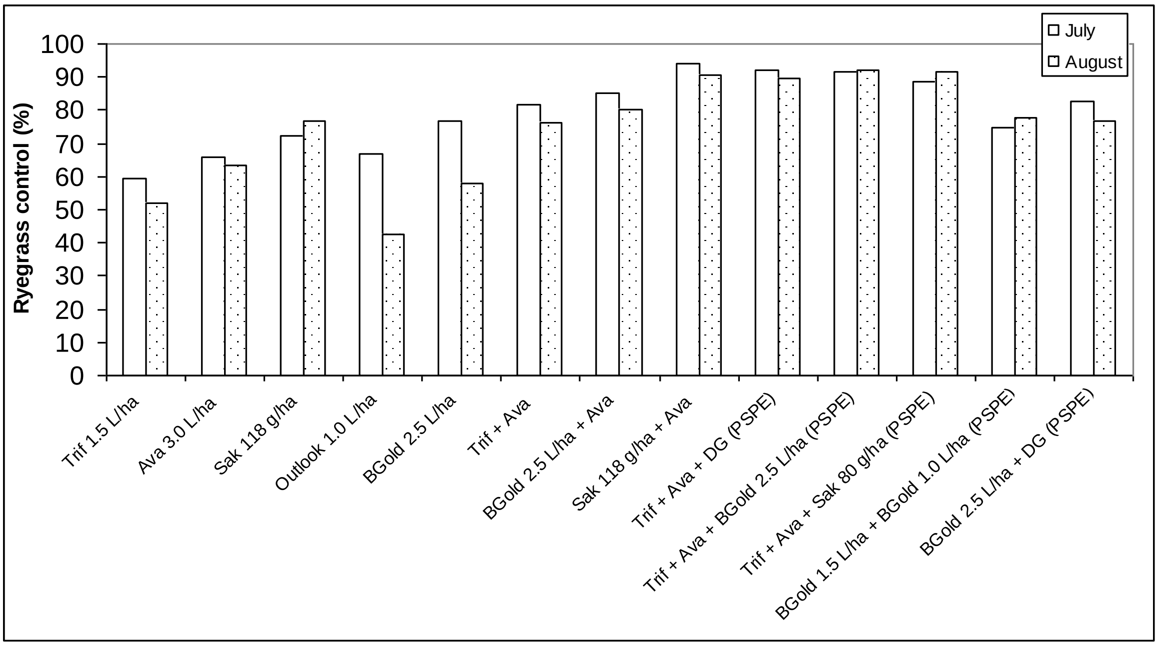


Figure 1. Effect of pre-emergent herbicide treatments on ryegrass emergence (% control) in July and August at Hart in 2010. (Trif = Trifluralin at 1.5L/ha, Ava = Avadex Xtra at 2.0L/ha, DG = Dual Gold at 0.5L/ha and BGold = Boxer Gold)

For the IBS only treatments total control decreased between July and August by 7%. Importantly treatments containing a PSPE application maintained the same level of control.

Treatments containing a PSPE application averaged 16% greater control in the crop row compared to IBS treatments, in July. By August this advantage was greater than 20%.

Ryegrass head density was measured in September to evaluate residual herbicide control. Sakura applied alone or in a mix provided high levels of control and was also able to significantly reduce head number (10 to 40 ryegrass heads per square metre) in comparison to the untreated (541 ryegrass heads per square metre). Some treatments which gave good levels of control in July were ineffective in limiting annual ryegrass seed set, including Boxer Gold and Avadex Xtra treatments. This could be due to the favourable and prolonged moist conditions over the growing season.

Controlling ryegrass in the crop row

Control in the crop inter-row was generally better (81%) compared to control in the crop row (71%), across all treatments. Single herbicides applied at sowing gave less control in the crop row (51%), compared to treatments containing two herbicides at sowing (84%). Trifluralin applied alone IBS showed the least crop row activity, achieving only 15% control.

Across all the IBS only treatments ryegrass control in the crop row was 16% lower compared to the inter-row. However, of the treatments containing a PSPE application the control in the crop row was similar to the inter-row, highlighting the increase in control from this strategy.

Conclusion

Boxer Gold and Sakura (to be available in 2012 provide effective alternatives for the control of trifluralin resistant ryegrass. However, use of these herbicides should be done so in conjunction with robust management strategies that use a diverse rotation of crops, herbicides and non-chemical strategies (i.e. seed catching) so as to prolong the life of existing and new chemical groups against annual ryegrass.

PSPE applications improved ryegrass control and had longer residual activity compared to IBS alone. Care needs to be taken with this application timing as it presents a higher risk to crop safety, depending on soil type and rainfall after application. IBS applications provide a more reliable and less risky option.

Some of the herbicide treatments contain unregistered pesticides and application rates. The results within this document do not constitute a recommendation for that particular use by the author or authors organisations.

Table 3. Effect of pre-emergent herbicide treatments on annual ryegrass emergence (% control) and head density at Hart in 2010. Density values are expressed as the number of ryegrass plants in either a square metre of crop furrow or inter-row (i.e. area between crop rows).

	July				August	
Herbicide treatment	Inter-row	Crop row	Average		Average	September
	Ryegrass plants per square metre (% control)					Ryegrass heads/sq m
Nil (untreated control)	596	174	385		325	541
Trifluralin 480 1.5 L/ha (IBS)	167 (72)	148 (15)	157 (59)		156 (52)	362
Avadex Xtra 3.0 L/ha (IBS)	170 (71)	93 (47)	132 (66)		119 (63)	235
Boxer Gold 2.5 L/ha (IBS)	115 (81)	63 (64)	89 (77)		136 (58)	196
Sakura 118 g/ha (IBS)	148 (75)	63 (64)	106 (72)		75 (77)	39
Outlook 1.0 L/ha (IBS)	200 (66)	56 (68)	128 (67)		186 (43)	325
Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS)	100 (83)	41 (76)	70 (82)		78 (76)	244
Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)	44 (93)	15 (91)	30 (92)		33 (90)	110
Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS) + Sakura 80g/ha (PSPE)	67 (89)	22 (87)	44 (89)		28 (91)	10
Trifluralin 480 1.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS) + Boxer Gold 1.5 L/ha (PSPE)	37 (94)	30 (83)	33 (91)		25 (92)	80
Boxer Gold 2.5 L/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS)	85 (86)	30 (83)	57 (85)		64 (80)	152
Boxer Gold 1.5 L/ha (IBS) + Boxer Gold 1.0 L/ha (PSPE)	148 (75)	48 (72)	98 (75)		72 (78)	128
Boxer Gold 2.5 L/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)	96 (84)	37 (79)	67 (83)		75 (77)	79
Sakura 80 g/ha (IBS) + Avadex Xtra 2.0 L/ha (IBS)	30 (95)	15 (91)	22 (94)		31 (90)	31
Sakura 80 g/ha (IBS) + Sakura 38 g/ha (PSPE)	145 (76)	48 (72)	96 (75)		50 (85)	40
Sakura 118 g/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)	82 (86)	30 (83)	56 (85)		53 (84)	31
Outlook 0.7 L/ha (IBS) + Outlook 0.3 L/ha (PSPE)	178 (70)	56 (68)	117 (70)		136 (58)	250
LSD (0.05)	80	45	48		60	58

Management of glyphosate resistant annual ryegrass on fence lines

Peter Boutsalis, Jenna Malone and Christopher Preston, School of Agriculture, Food & Wine, University of Adelaide.
Funding: Grains Research and Development Corporation

Key findings

- Glyphosate was unable to control glyphosate resistant annual ryegrass on fencelines.
- Addition of other herbicides to glyphosate products improved control, but was still not effective.
- Two applications of Spray.Seed, Spray.Seed plus diuron or Alliance were the best registered treatments.

Why do the trial?

Glyphosate resistance in annual ryegrass is becoming a problem on fence lines.

There are physical management strategies available: cultivation, slashing and so on, but some growers prefer a chemical solution.

This trial was conducted to examine possible chemical options for controlling glyphosate resistant annual ryegrass on fence lines.

How was it done?

A natural population of glyphosate resistant annual ryegrass near Clare was used. Plot sizes were 2 m x 15 m and the trial was conducted in 3 replicates along the fence line.

The trial was sprayed on 2 September 2010 using a hand-held 2 m boom delivering 100 L water per hectare. Products were sprayed with adjuvants as necessary.

The trial was assessed 22^{nd} December 2010 with counts made of ryegrass heads. These were converted to % of the untreated plot in each block and analysed.

Results

The level of control of annual ryegrass in the trial is listed in Table 1. Glyphosate at 1.0 L/ha did not provide any useful control of annual ryegrass. Doubling the glyphosate rate to 2 L/ha provided a small amount of control (25%). Adding residual herbicides to glyphosate improved control, but control was not better than 64%. On the large population of annual ryegrass present at the site this level of control was insufficient.

Spray.Seed alone at 3.2 L/ha provided more than 80% control of the population. Two applications of Spray.Seed at 3.2 L/ha, Spray.Seed mixed with diuron at 6L/ha and Alliance at 4L/ha all provided the best levels of control of the population for the currently registered products and mixtures.

A number of experimental treatments were tested in the trial. Three of these provided high levels of control of annual ryegrass on the site and Experimental treatment E provided 100% control in each of the three blocks.

Table 1: Annual ryegrass control by herbicides as % of untreated. The untreated plots had an average of 4,400 heads per square metre. Letters after the value separate the means using the a 95% level of confidence.

Herbicide treatment	**Annual ryegrass control (%)**
Untreated	0 a
1.0 L/ha Roundup PowerMax	13.2 ab
2.0 L/ha Roundup PowerMax	25.0 bc
1.0 L/ha Roundup PowerMax + 6.0 L/ha AmitroleT	63.8 cde
1.0 L/ha Roundup PowerMax + 6.0 L/ha Diuron	62.7 cde
1.0 L /haRoundup PowerMax + 6.0 L/ha Simazine	47.5 bcd
3.2 L/ha SpraySeed	81.9 deg
3.2 L/ha SpraySeed + 6 L /haDiuron	96.1 fg
3.2 L/ha SpraySeed + 6 L/ha Simazine	78.7 def
4.0 L /haAlliance	84.9 defg
Experimental A	65.9 cde
Experimental B	91.8 efg
Experimental C	80.8 defg
Experimental D	79.5 def
Experimental E	100 g
3.2 L/ha SpraySeed followed by 3.2 L /ha SpraySeed	99.5 fg
Experimental F	93.2 efg


Hart board member Justin Wundke with Balaklava High School students at the 2010 Hart Field day

Wild oat control with pre-emergent herbicides in barley

This trial is funded by the GRDC and is part of a collaborative project. It was conducted with Sam Kleemann, University of Adelaide and Peter Boutsalis, Plant Science Consulting.

Key findings

- Sakura alone or in combination with Avadex Xtra provided the highest levels of wild oat control (75%).
- Although Sakura treatments provided the highest level of wild oat control the high weed density remaining (>50 plants per square metre) would still be expected to cause significant crop yield losses (50%).

Why do the trial?

The density of wild oats *(Avena fatua)* is increasing in the Mid North. This is due to an increase in cereal cropping intensity and the increase in herbicide resistance to Group A fop and dim herbicides. Also, traditional measures implemented for the control of annual ryegrass such as pre-emergent herbicides, export oaten hay, chaff carts and crop topping are generally less effective against wild oats.

This trial aims to evaluate the performance of new pre-emergent herbicides such as Boxer Gold, Sakura and Outlook for the control of wild oats.

Herbicide resistance and wild oats – Peter Boutsalis, Plant Science Consulting
Herbicide resistance in wild oats occurs in all cereal growing regions. A random survey conducted in 1995 detected 5% of wild oat samples collected from NE Victoria as resistant to Hoegrass. In 2006, the number had increased to only 8% in a similar survey. In the Mid-North 35% of paddocks contain wild oat and of these 9% were resistant to Topik or Wildcat (Table 1).

Often wild oats can be resistant to certain Group A Fop herbicides and not others eg. resistant to Wildcat but not Verdict. In addition some fop-resistant wild oats are cross-resistant to Mataven, although Mataven may have never been used previously. Dim/Den herbicides can be effective on fop-resistant wild oats although this can be variable. About 50% of wild oats resistant to Topik or Wildcat are also resistant to Axial and / or Mataven.

A small number of Group B resistant wild oats have been reported. No resistance to IMI (Group B) chemistry or to trifluralin (Group D) or triallate (Group J) has been detected.

*Table 1: Occurrence of herbicide resistance across South Australia and Victoria as detected by **random** sampling. Data is **% of paddocks** with herbicide resistant wild oats. Resistance is defined as samples where ≥ 20% survival was detected in a pot test. A dash indicates no test with that herbicide.*

Herbicide	Victoria Western (2005)	Victoria Northern (2006)	SA Mid North (2008)	SA Eyre Peninsula (2009)
Fields with wild oats	31%	81%	35%	36%
Hoegrass	17	8	>9	>2
Topik/Wildcat	-	-	9	2
Verdict	-	-	4	2
Axial/ Achieve	-	2	6	2
Mataven	-	-	14	0
Atlantis	-	-	0	0

How was it done?

Plot size 1.75m x 6m

Fertiliser 27:12 (MAP/Urea) @ 100 kg/ha
46:0 (Urea) @ 100 kg/ha

Seeding date 25th May 2010

Variety Commander barley @ 80 kg/ha

This trial was established in a grower paddock, north of Clare (White Hut) on an existing patch of wild oats.

The trial was established as a randomised complete block design with 3 replicates and 8 herbicide treatments (Table 1). Active ingredients of the herbicides used in the trial are listed in Table 2.

Herbicides treatments were applied IBS (incorporated by sowing) prior to sowing of barley with a commercial seeder (i.e. knife-point & press wheels).

Crop emergence was assessed by counting the number of emerged barley seedlings along both sides of a 0.5 m rod at 3 random locations within each plot. Wild oats were counted 6 weeks after sowing using a 20 cm × 30 cm quadrat from 4 random locations within each plot.

Table 1. Pre-emergent herbicide treatments used at Clare in 2010.

	Treatments	Cost ($/ha)
1	Nil (untreated control)	
2	Trifluralin 480 1.5 L/ha	7.50
3	Avadex Xtra 3.0 L/ha	20.0
4	Boxer Gold 2.5 L/ha	34.0
5	Outlook 1.0 L/ha	Na
6	Sakura 118g/ha	Na
7	Trifluralin 480 1.5 L/ha + Avadex Xtra 2.0 L/ha	27.5
8	Sakura 118 g/ha + Avadex Xtra 2.0 L/ha	Na

Table 2. Pre-emergent herbicides & their active ingredients.

Herbicide	Active ingredients	Herbicide group
Trifluralin 480	trifluralin 480 g/L	D
Avadex Xtra	tri-allate 500 g/L	J
Boxer Gold	prosulfocarb 800 g/L + S-metolachlor 120 g/L	E + J
Outlook (Nul-1493)	dimethenamid-P	K
Sakura (BAY-191 850WG)	pyroxasulfone 850 g/kg	K

Results

There was no statistically significant effect of herbicide treatments on barley establishment. However Outlook (115 plants per square metre) reduced crop density by 18% compared with the untreated control (140 plants per square metre)(Table 3). Outlook is an experimental herbicide developed by Nufarm. It is highly soluble and will not be released for use in either barley or wheat due to the potential for crop damage.

The site had a high density of wild oats with 246 plants per square metre in the untreated plots. They were generally emerging from a soil depth of 2 to 3 cm. All herbicide treatments reduced wild oat emergence (Table 3).

Sakura alone or in combination with Avadex Xtra provided the highest levels of wild oat control (75%), and showed longer residual activity. The residual activity of Sakura also appears to retard root development of survivors, reducing crop competition and seed production. This result was also achieved in 2009. Sakura will not be available until 2012.

All other treatments provided much lower control with all wild oat densities remaining above 100 plants per square metre. Control ranged between 28 and 49% of the untreated (246 plants per square metre). Trifluralin provided the lowest levels of control (28%).

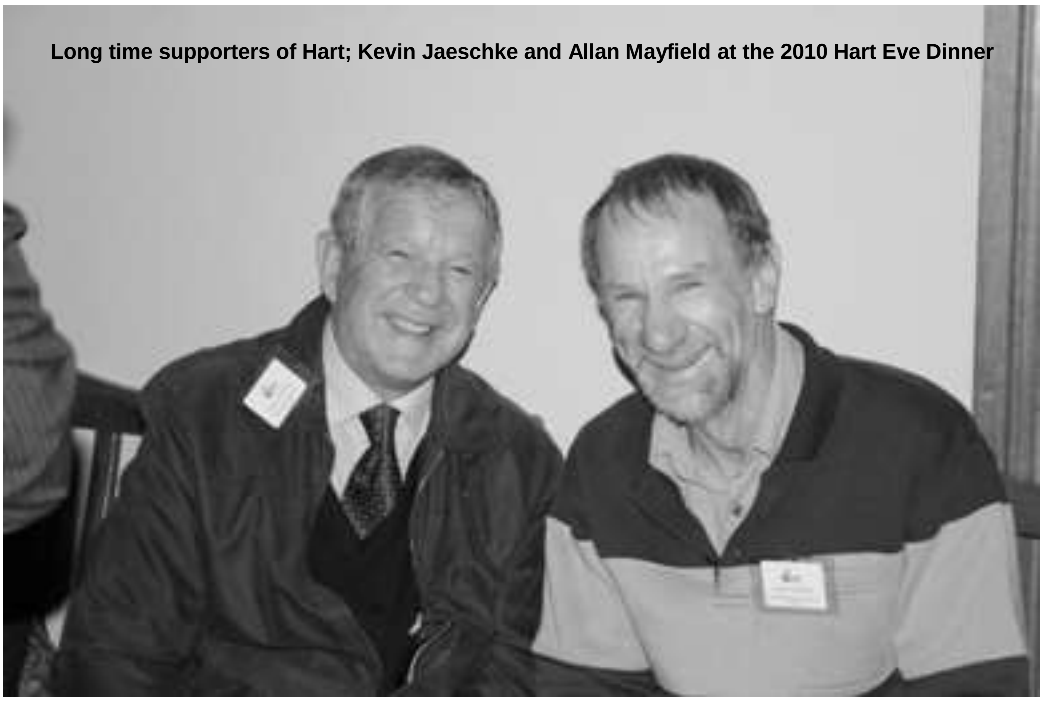
Although Sakura treatments provided the highest level of wild oat control the high weed density remaining (>50 plants per square metre) would still be expected to cause significant crop yield losses (50%) and increase the weed seedbank. Post emergent herbicides would be needed in addition to gain improved control.

Table 3. Effect of pre-emergent herbicide treatments on crop & wild oat density (plants/m^2). Values in brackets are percentage (%) reduction in barley density & wild oat control relative to the nil treatment (untreated control).

Herbicide treatment	Crop density		Wild oat density		
	plants per square metre				
Nil (untreated control)	140	(-)	246	a	(-)
Trifluralin 480 1.5 L/ha	139	(1)	178	b	(28)
Avadex Xtra 3.0 L/ha	130	(7)	125	bc	(49)
Boxer Gold 2.5 L/ha	136	(3)	143	bc	(42)
Outlook 1.0 L/ha	115	(18)	107	cd	(56)
Sakura 118g/ha	130	(7)	62	d	(75)
Trifluralin 480 1.5 L/ha + Avadex Xtra 2.0 L/ha	140	(0)	168	b	(32)
Sakura 118 g/ha + Avadex Xtra 2.0 L/ha	120	(14)	61	d	(75)
LSD (0.05)	NS		55		

Means in the same column followed by the same letters are not significantly different at LSD *P* = 0.05.

Acknowledgments
The Hart Field-Site Group wish to thank Andrew and Richard Hawker for the use of their barley crop and their cooperation with this trial work.



Long time supporters of Hart; Kevin Jaeschke and Allan Mayfield at the 2010 Hart Eve Dinner

Effect of wild oats on grain yield of barley

This trial is funded by the GRDC and is part of a collaborative project. It was conducted with Sam Kleemann, University of Adelaide.

Key findings

- 20 to 25 wild oat plants per square metre caused a 50% loss in barley grain yield.
- High wild oat densities significantly reduced barley grain size from (43 to 28 mg).

Why do the trial?

To measure the impact of increasing wild oat *(Avena fatua)* densities on the grain yield and quality of barley.

How was it done?

Plot size	3.0m x 12m	**Fertiliser**	27:12 (MAP/Urea) @ 100 kg/ha 46:0 (Urea) @ 100 kg/ha
Seeding date	25th May 2010	**Variety**	Commander barley @ 80 kg/ha

This trial was established in a grower paddock, north of Clare (White hut) on an existing patch of wild oats.

Barley grain yield and quality was measured using a 60 x 60 cm quadrat from 2 random locations within each plot. Crop emergence was assessed by counting the number of emerged barley and wild oat seedlings along both sides of a 0.5 m rod at 3 random locations within each plot.

Results

There was no significant effect of wild oat emergence on barley establishment. Wild oat plant number had a significant effect on the yield loss of barley (Figure 1). Approximately 20 to 25 WO plants per square metre caused a 50% loss in barley grain yield.

Barley grain size was significantly reduced (43 to 28 mg) under high wild oat densities (Figure 2).

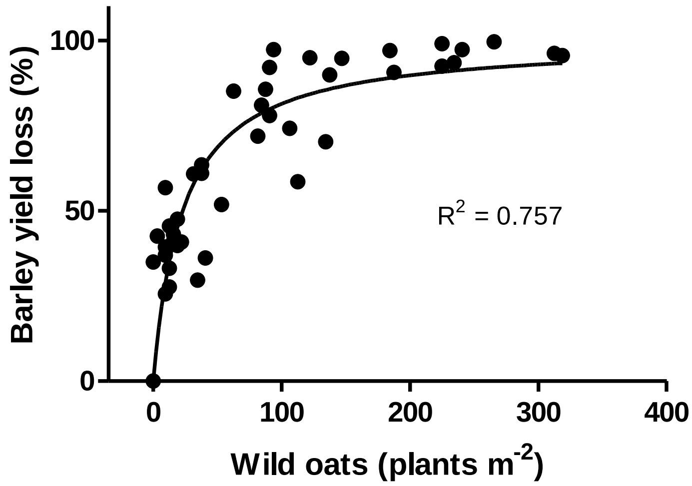


Figure 1. Effect of wild oat density on barley yield loss (%) at Clare in 2010.

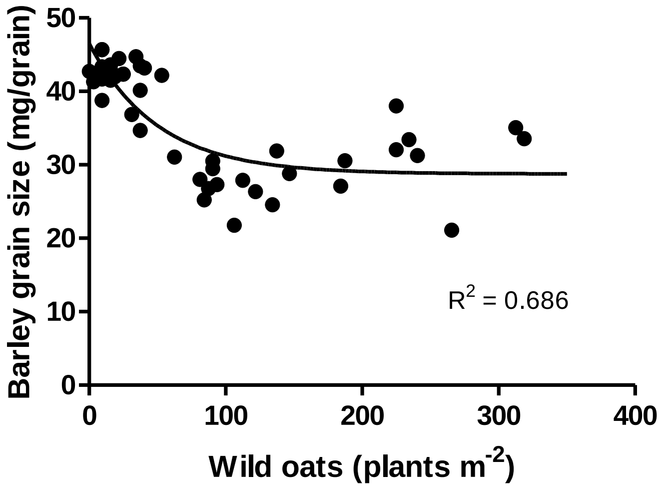


Figure 2. Effect of wild oat density on barley grain size (mg/grain) at Clare in 2010.

Acknowledgments
The Hart Field-Site Group wish to thank Andrew and Richard Hawker for the use of their barley crop and their cooperation with this trial work.

Legume and oilseed herbicide tolerance

Key findings

- Good soil moisture conditions allowed clear separation of relatively safe and more damaging treatments.
- Wilpena sulla showed improved tolerance to Simazine and Broadstrike at the 5 node stage.
- At the 6 node stage Hussar and Crusader did a good job of controlling all crops.

Why do the trial?

To compare the tolerance of legumes and canola varieties to a range of herbicides and timings.

How was it done?

Plot size	2m x 3m	**Fertiliser**	MAP @ 75 kg/ha + 2% Zinc
Seeding date	24th May 2010		

12 strips of canola, pasture, vetch, chickpeas, faba beans, field peas and lentils were sown. 52 herbicide treatments were applied across these crops at one of 5 timings.

The timings were

Pre sowing (IBS)	24th May
Post seeding pre-emergent (PSPE)	31st May
Early post emergent (3 – 4 node)	1st June
Post emergent (6 node)	8th July
Late post emergent (8 node)	3rd August

Treatments were visually assessed and scored for herbicide effects 4 weeks after application.

Crop damage ratings were:

1 = no effect
2 = slight effect
3 = moderate effect
4 = severe effect
5 = death

Results

Many of the herbicides are not registered for the crops that have been sprayed. It is important to check the herbicide label before following strategies used in this demonstration. Herbicide effects can vary depending on soil and weather conditions.

This was particularly the case in 2010 as the initial herbicide control may have been very good, but good growing conditions meant that in some cases plants were able to re-shoot or exhibit improved tolerance.

Wilpena (*Sulla hedysarum*) was a new pasture addition this year. It had similar tolerance to the post sowing pre-emergent treatments compared to the other pasture entries. However, for the 5 node treatment simazine and Broadstrike had no effect on the Wilpena. It had improved tolerance to metribuzin, but was affected more by Brodal Options or Sniper. At the 6 node growth stage it had greater tolerance to Logran, Ally, Eclipse and atrazine compared to the other pastures.

The pre-emergent herbicides Outlook, Boxer Gold and Sakura produced slight effects on all 3 canola varieties. This also occurred in 2009, while the other pre-emergent herbicides had little or no effect on all of the crops. Sakura gave a slight effect on balansa clover and Rasina vetch, while Outlook effected both vetches and the Farah beans.

Terbyne is a relatively new post sowing pre-emergent (PSPE) herbicide. It is a triazine (group C) herbicide and provides good control of mustards, turnips, radish, medic and thistles. Care is needed with Terbyne as it was the only PSPE herbicide to produce damage in the lentils and peas.

Metribuzin applied at 5 node produced greater damage to lentils and Broadstrike was severe on both varieties of vetch.

At the 6 node stage Hussar and Crusader did a good job of controlling all crops. Ecopar and Affinity Force had only a slight effect on lentils and vetch, while Rasina vetch showed only slight effects to ally for the second year in a row.

Most of the knockdown chemicals did a good job on all crops other than the Rasina vetch. When glyphosate and Sprayseed were applied alone the control of legumes was not 100% in many cases. Of the 2 double knock treatments glyphosate // Sprayseed 3DAS gave the best result across all crops. The only knockdown treatment that killed the Rasina vetch was Basta which also did a good job on all other crops.

Legume & Canola Herbicide Tolerance Hart 2010

				Pasture			Lentil	Vetch		Chick Peas	Peas	Beans	Canola		
				Wilpena sulla	Scimitar medic	Frontier Balansa	Flash	Rasina	Capello	Genesis 090	Gunyah	Farah	Conv Garnet	TT Cobbler	CL 44C79
		Treatment	Rate kg/ha	10	10	10	45	45	45	80	100	140	5	5	5
Pre-sow 24/05	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Avadex Xtra	1600ml	1	1	1	1	1	1	1	1	1	1	1	1
	3	Dual Gold	500ml	1	1	1	1	1	1	1	1	1	1	1	1
	4	Outlook (NUL 1493)	1000ml	1	1	1	1	2	2	1	1	2	2	2	1
	5	Boxer Gold	2500ml	1	1	1	1	1	1	1	1	1	1	3	1
	6	Sakura (BAY-191)	118g	1	1	2	1	2	1	1	1	1	1	3	3
PSPE 31/05	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Diuron	850g	4	4	4	1	1	1	1	1	1	5	4	3
	3	Simazine	850g	4	5	5	1	1	1	1	1	1	5	1	3
	4	Diuron + Simazine	410g/410g	4	5	5	1	1	1	1	1	1	3	2	3
	5	Metribuzin	280g	3	5	5	1	1	1	1	1	1	5	1	4
	6	Terbyne	1000g	5	5	5	2	1	1	1	2	1	5	1	5
	7	Spinnaker	70g	2	4	2	3	3	2	1	1	1	5	5	1
	8	Spinnaker + Simazine	40g/850g	4	5	5	2	2	2	1	1	1	5	5	5
	9	Balance	100g	5	5	5	4	4	4	1	4	3	5	5	5
	10	Balance + Simazine	100g/830g	5	5	5	4	4	4	1	4	4	5	5	5
5 node 1/07	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Simazine	850g	1	2	4	1	1	1	1	1	1	1	1	3
	3	Metribuzin	280g	3	5	5	3	3	3	4	2	3	5	2	5
	4	Broadstrike	25g	1	2	1	1	3	4	1	1	2	4	4	2
	5	Brodal Options	150ml	4	1	2	1	2	1	3	1	3	2	4	3
	6	Brodal Options + MCPA Amine	150ml/150ml	4	1	1	1	2	3	4	2	3	4	5	4
	7	Sniper 750WG	50g	3	1	1	1	1	2	2	1	2	2	3	3
	8	Spinnaker + wetter	70g/0.2%	2	3	3	3	3	3	4	1	2	5	5	1
	9	Raptor + wetter	45g/0.2%	3	2	3	4	2	2	4	1	1	5	4	*
6 node 8/07	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Logran+wetter	10g/0.1%	2	4	4	4	4	5	4	4	4	5	5	1
	3	Ally + wetter	7g/0.1%	4	5	5	4	2	5	5	5	5	5	5	1
	4	Eclipse SC + Uptake	50ml/0.5%	2	4	5	4	4	4	4	4	4	5	5	1
	5	Ecopar + MCPA Amine	400ml/500ml	3	3	1	2	2	3	4	3	3	4	4	4
	6	Conclude + Uptake	700ml/0.5%	4	4	5	4	4	5	5	5	4	5	5	4
	7	Precept + Hasten	750ml/1%	4	4	3	4	3	5	4	4	4	4	5	5
	8	Velocity + Hasten	670ml/1%	4	5	4	4	4	5	5	5	4	5	5	5
	9	Banvel M	1L	4	4	5	4	4	5	5	3	4	4	5	4
	10	Intervix + Hasten	600ml/1%	4	5	5	4	3	4	5	4	4	5	5	1
	11	Midas + Hasten	900ml/0.5%	5	5	4	4	4	4	5	4	4	5	5	4
	12	Hussar OD + wetter	100ml/0.25%	4	5	5	5	5	5	5	5	5	5	5	3
	13	Crusader + Uptake	500ml/0.5%	3	4	5	5	4	5	5	5	5	5	5	1
	14	Atlantis OD + Hasten	330ml/0.5%	4	4	5	4	4	4	4	4	4	5	5	1
	15	Affinity Force + MCPA Amine	100ml/500ml	3	3	2	2	2	3	4	3	3	5	5	4
	16	Atrazine + Hasten	833g/1%	3	5	5	1	1	3	3	3	3	4	1	5
	17	Lontrel	150ml	4	5	5	5	4	4	5	4	4	1	1	1
8 node 3/08	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	MCPA Sodium	700ml	1	1	1	3	4	3	3	1	3	3	3	3
	3	MCPA Amine	350ml	1	1	2	2	3	3	3	1	3	3	3	3
	4	Amicide 625	1.2L	3	3	3	3	4	4	4	4	4	4	4	4
	5	2,4-D Ester	70ml	2	2	1	1	3	3	2	2	3	2	2	2
6 node 8/07	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Sprayseed	2L	5	5	5	4	4	4	4	5	4	5	5	5
	3	Glyphosate	1L	4	4	5	5	3	4	4	5	4	5	5	5
	4	Glyphosate + LVE 680	1L/500ml	4	5	5	5	4	5	4	5	4	5	5	5
	5	Glyphosate + Hammer	1L/50ml	4	5	5	5	2	4	4	5	4	4	5	4
	6	Glyphosate + Goal	1L/100ml	4	5	5	5	3	4	4	5	4	5	5	4
	7	Glyphosate + Cadence	1L/115g	5	5	5	5	4	5	5	5	4	5	5	4
	8	Glyphosate + Pyresta	1L/400ml	4	5	5	5	2	4	4	5	4	5	5	5
	9	Glyphosate // Sprayseed 3DAS	1.2L//1.2L	5	5	5	5	3	4	4	5	5	5	5	5
	10	Sprayseed // Sprayseed 3DAS	1.2L//1.2L	5	5	5	3	3	4	4	5	4	5	5	5
	11	Basta	2.5L	5	5	5	4	5	5	5	5	5	4	4	4
	12	NIL		1	1	1	1	1	1	1	1	1	1	1	1

Cropping Systems

Funded by Caring for Our Country and conducted in collaboration with farmers Michael Jaeschke, Justin Wundke and the South Australian No-Till Association.

Key findings

- There was no significant difference between sowing systems or level of nutrition on grain yield but higher grain yield at the higher nitrogen rate.
- Levels of brome grass were higher under the early sowing no-till plots and annual ryegrass was lower in the disc system.

Why do the trial?

To compare the performance of 3 seeding systems and 2 nutrition strategies. This is a rotation trial to assess the longer term effects of seeding systems and higher fertiliser input systems.

How was it done?

Plot size	35m x 13m		**Fertiliser**	DAP @ 60 kg/ha
			High nutrition	Urea @ 160 kg/ha 18th August
Seeding date	Disc	5th May	**Medium nutrition**	Urea @ 80 kg/ha 18th August
	No-till	7th May		
	Strategic	20th May	**Variety**	Clearfield canola @ 3 kg/ha

This trial is a randomised complete block design with 3 replicates, each containing 3 tillage treatments and 2 nutrition treatments. The strategic and no-till treatments were sown using local farmers seeding equipment, Michael Jaeschke and Justin Wundke. The disc seeding treatments were sown by Greg Butler and Andrew Bird from the South Australian No Till Association.

Table 1. Previous crops in the long term cropping systems trial at Hart.

2001	2002	2003	2004	2005	2006	2007	2008	2009
Canola	Janz Wheat	Yitpi Wheat	SloopSA Barley	Kaspa Peas	Kalka Durum	JNZ Wheat	JNZ Wheat	Flagship barley

Tillage treatments:
Disc – sown into standing stubble with a Bertini disc seeder, 275mm (11”) row spacing.

Strategic – worked up pre-seeding, sown with 100mm (4”) wide points at 175mm (7”) row spacing with finger harrows and then prickle chained.

No-till – sown into standing stubble in 1 pass with narrow points with 225mm (9”) row spacing and press wheels.

Nutrition treatments:
Medium – 80 kg/ha post emergent urea on 18th August
High – 80 kg/ha 4th August + 80 kg/ha 18th August post emergent urea

Soil nitrogen (0-60cm) was measured on 10th March in all plots.

For the plant counts, 4 x 1m sections of row were counted across each plot.

All plots were assessed for grain yield and oil content.

Results

Tillage and nutrition treatments significantly influenced the grain yield and quality of Clearfield canola at Hart in 2010.

Conditions at the time of sowing for the disc seeder were dry on the soil surface and so the crop emergence was significantly lower. The no-till seeder was able to mix moist soil into the seedbed and so achieved better emergence.

Grain yield was 0.4 t/ha or 25% greater for the high nutrition treatments where 83 kg/ha of extra nitrogen was applied and there was nearly 20 kg N/ha extra nitrogen in the soil in the 0 to 60cm profile. The increase in grain yield between the medium and high treatments was greater for the no-till and strategic treatments, compared to the disc.

Oil content was higher in the medium nutrition treatment and lower in the strategic tillage treatment, most probably due to the higher level of soil nitrogen.

Table 2. Grain yield (t/ha), oil content (%), crop emergence of Clearfield canola and available soil nitrogen (kg N/ha 0-60cm) for nutrition and tillage treatments at Hart in 2010.

Nutrition	Tillage	Grain yield (t/ha)	Oil (%)	Emergence (plants per sq m)	Available soil nitrogen (kg N/ha)
High	Disc	1.86	42.6	33	70
	No-till	2.04	42.3	52	39
	Strategic	1.94	41.5	65	107
Medium	Disc	1.64	43.4	34	44
	No-till	1.47	43.0	51	39
	Strategic	1.23	42.0	46	79
LSD (0.05)					
Tillage		ns	0.5	15	11
Nutrition		0.16	0.4	ns	9
Tillage * Nutrition		0.28	ns	ns	15

Soil available nitrogen to 60cm was measured in autumn and ranged between 39 kg N/ha (no-till) and 107 kg N/ha (strategic) between the tillage treatments. The strategic tillage treatment had significantly higher soil nitrogen. The high nutrition treatment has accumulated 18 kg N/ha more soil available nitrogen compared to the medium treatment to a depth of 60cm. These results are consistent with those measured previously.

Yield Prophet® performance in 2010

Key findings

- The actual wheat grain yield at Hart in 2010 was 2.46 t/ha, well under the final Yield Prophet® prediction of 3.70 t/ha.

Why do the trial?

Wheat growth models such as APSIM are highly valuable in their ability to predict wheat yield.

Yield Prophet® is an internet based service using the APSIM wheat prediction model. The model relies on accurate soil character information such as plant available water and soil nitrogen levels, as well as historical climate data and up to date local weather information to predict plant growth rates and final hay or grain yields.

The *Yield Prophet®* (YP) wheat growth model has been very accurate throughout Australia over the past 6 years, in a range of soil types and seasons. At 4 sites in the Mid-North over the past 5 seasons YP has demonstrated this accuracy (Figure 1).

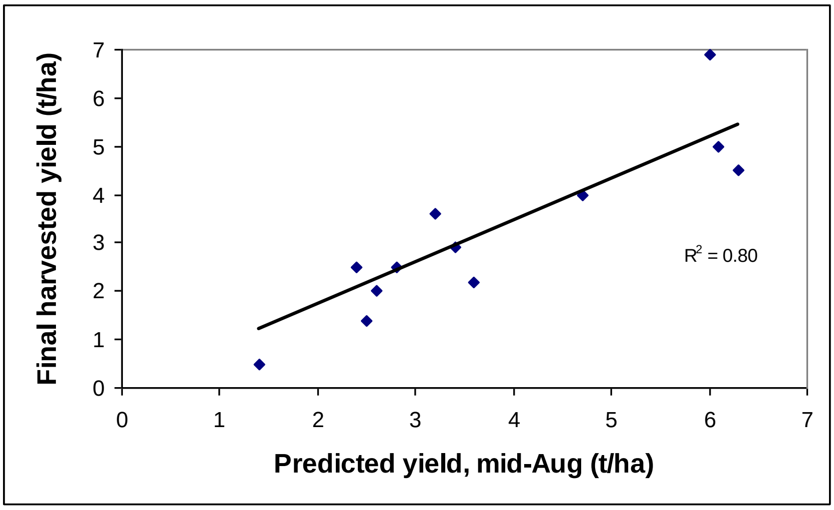


Figure 1. The relationship between predicted yield in mid-August, given an average finish to the season, against harvested grain yield. The sites and seasons include Spalding, Condowie, Tarlee (for 2009 and 2010), and Hart (2005 to 2010). Intercept set through zero.

An early prediction of grain or hay yield potential means it can be used to directly influence crop input decisions.

How was it done?

Seeding date	14th May 2010	**Fertiliser**	DAP @ 50 kg/ha Urea @ 80kg/h 18th August
Variety	Gladius wheat @ 70 kg/ha		

Soil samples were taken for soil nitrogen and moisture on the 10th March 2010.

Table 1: Soil conditions at Hart (0-90cm), 10th March 2010.

Available soil moisture	0 mm
Initial soil N	115 kg/ha

Yield Prophet® simulations were run throughout the season to track the progress of wheat growth stages and changes in grain yield predictions.

20%, 50% and 80% levels of probability refer to the percentage of years where the corresponding yield estimate would have been met, according to the previous 100 years of rainfall data.

Results

The grain yield for Gladius wheat sown on the 14th May at Hart in 2010 was 3.6 t/ha. This final grain yield is below (20%) the final Yield Prophet® prediction (Figure 1). Low grain protein (9.6%) may indicate that more nitrogen fertiliser might have improved the final grain yield.

At the first simulation, 5th July 2010, the Yield Prophet® simulation predicted that Gladius wheat sown on the 14th May would yield 3.0t/ha in 50% of years. The predicted grain yield increased steadily throughout the growing season, due to good rainfall and mild temperatures. The final Yield Prophet® on the 15th October for grain yield, given an average (50%) finish to the season, was 4.4t/ha. Other wheat plots near this trial did yield 4.0 t/ha.

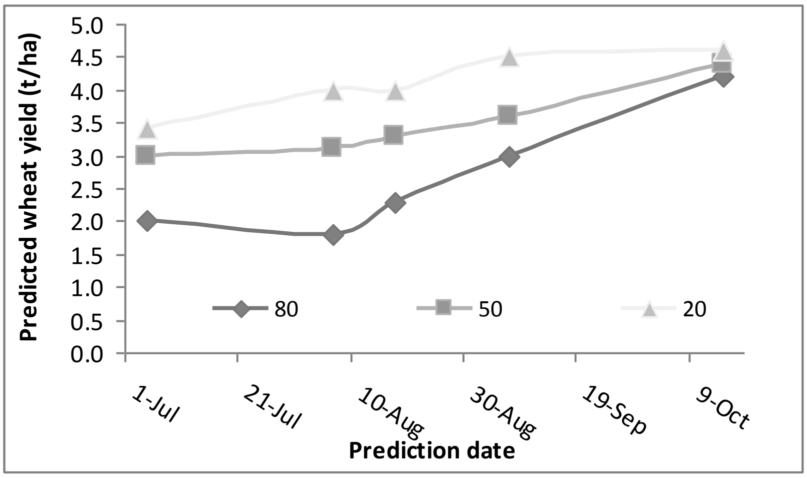


Figure 1: Yield Prophet® predictions from 5th July to the 15th October for Gladius wheat sown on the 14th May with 50 kg/ha DAP. 80%, 50% and 20% represent the chance of reaching the corresponding yield at the date of the simulation.

At sowing plant available water (PAW) measured 0mm (0-90cm). Figure 2 shows that at the first simulation on the 5th of July, PAW had increased to over 30mm. PAW increased significantly during August and while it decreased in September and October, with greater crop use and higher temperatures, it remained above 40mm PAW.

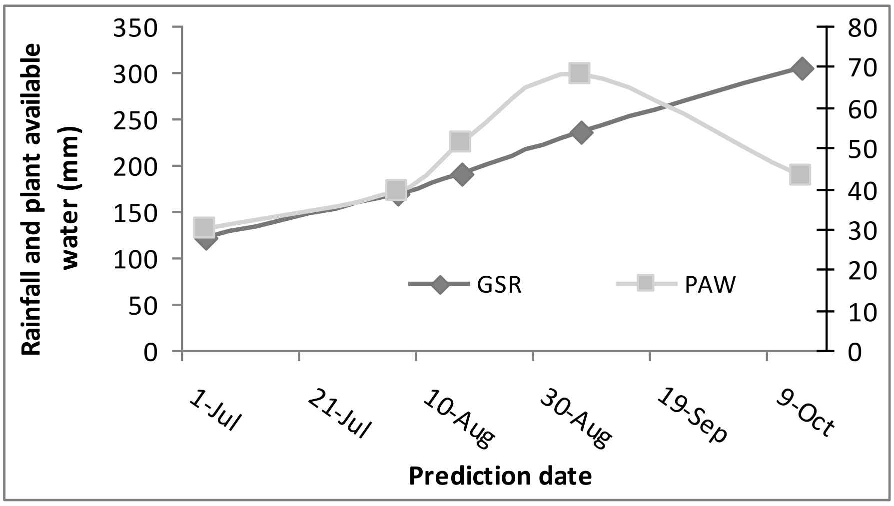


Figure 2: Predicted plant available water and recorded cumulative growing season rainfall from 5th July to the 15th October at Hart in 2010.

Summer rain, stubble management and nitrogen

Funded by the GRDC Water Use Efficiency Initiative and conducted in collaboration with SARDI and the University of Adelaide.

Key findings

- The presence of stubble did not increase stored soil moisture, regardless of the size and number of irrigation events.
- In 2010 additional soil moisture at sowing did not generally increase final grain yield.
- Additional soil moisture can increase crop demand and response to nitrogen.

Why do the trial?

In south-eastern Australia, cereals depend on two sources of water: water stored in the soil during summer fallow, and in-season rainfall. However, the actual value of capturing out-of season water in the Mid-north region of SA is uncertain. In contrast to the dominance of small events in winter rainfall, summer rainfall is characterised by large storm events. The potential for deep-storage of water in soils is greater in large events.

This trial aimed to measure the interaction between stubble management, frequency of rainfall events and fertiliser nitrogen on:

- the retention of soil water accumulated outside the growing season.
- the value of stored water to crop physiological traits and yield.

How was it done?

Plot size	8m x 6m	**Fertiliser**	DAP @ 60 kg/ha
Seeding date	3rd June 2010	**Variety**	Gladius wheat @ 90 kg/ha

Trial 1 – The influence of summer rainfall events and stubble on storing water

This trial was a randomised complete block design with 4 replicates and 8 treatments resulting from the combination of two stubble and four rainfall treatments.

Rainfall treatments:

- Control (no added water)
- 1 event (100mm) – applied 1st February using trickle irrigation
- 2 events (50mm applied twice) – 1st February and 1st March
- 3 events (33mm applied three times) – 1st Febraury, 1st March and 22nd March

Stubble treatments:

- Bare ground control
- Standing (2.4 t/ha)

Trial 2 – The interaction of stored water and nitrogen on grain yield

These trials were randomised complete block designs with 4 replicates and 4 treatments resulting from the combination of two rainfall and two nitrogen treatments. They were located alongside previously established water use efficiency sites. The sites were sown at different times: Hart (3rd June), Roseworthy (3rd June) and Spalding (6th May).

Rainfall treatments:

- Control (no added water)
- 1 event (100mm) – applied 12th February (Hart), 23rd February (Roseworthy) and 24th March (Spalding) using trickle irrigation

Nitrogen treatments:

- Low: 20 kg N/ha (Hart) or 0 kg N/ha (Roseworthy and Spalding)
- High: 70 kg N/ha (Hart), 80 kg N/ha (Roseworthy) or 100 kg N/ha (Spalding)

All trials were sown with 50mm chisel points and press wheels on 22.5cm (9") row spacings. The standing stubble treatments were inter-row sown in trial 1.

All plots were assessed for dry matter, grain yield, yield components and grain quality.

Crop physiological traits were measured throughout the season such as; light interception (ceptometer), NDVI (greenseeker), chlorophyll content (SPAD) and canopy temperature (infra red camera). Soil moisture was measured using a capacitance probe (Diviner 2000).

Results

The mild finish to the season and adequate water supply provided ideal growing conditions. As a result additional stored moisture in the subsoil did not influence final grain yield or quality.

Trial 1 – The influence of summer rainfall events and stubble on storing water

The removal of stubble did not influence the amount of water available at sowing and the size of the rainfall event was also insignificant. All the summer rainfall treatments significantly increased plant available water (PAW) to one metre of soil depth at sowing (Table 1). Most of this water was stored below 60cm.

Table 1: Plant available water (mm) at sowing for each summer rainfall treatment and averaged across stubble treatments.

Number of rainfall events	PAW (mm)	
Nil	64.4	a
1	101.3	b
2	92.0	b
3	100.4	b
P Value	<0.0001	

Although there was between 30-40mm of additional moisture in the soil at sowing, this did not contribute to the final grain yield. There was no significant difference between grain yield, grain weight or harvest index measured between the moisture treatments (Table 2). This can be attributed to the mild finishing season.

Table 2: Grain and biomass yield and components from the 2010 growing season for each summer rainfall treatment.

Summer Rainfall	Biomass yield (t/ha)	Grain yield (t/ha)	Grain weight (mg)	Harvest Index (%)
1 Event	13.3	5.54	42.1	42
2 Events	12.6	5.35	42.6	42
3 Events	12.2	5.19	42.3	42
Nil	11.7	5.04	42.1	43
P Value	n.s	n.s	n.s	n.s

Trial 2 – The interaction of stored water and nitrogen on grain yield

Across the three trial sites the results were variable. At Roseworthy grain yield averaged 6.0 t/ha regardless of any stored moisture or extra nitrogen.

The Spalding site responded significantly to the addition of nitrogen, averaging 5.0 t/ha in the low nitrogen treatment and 7.1 t/ha in the high nitrogen treatment (100 kg N/ha). However, the 100mm of irrigation applied in late March made no difference to grain yield.

Hart was the only trial site where there was a significant grain yield response to both irrigation and nitrogen treatment. That is the combination of 100mm water irrigated on the 12th February and 70 kg N/ha of nitrogen produced 7.17 t/ha. This is significantly greater than the other treatments by nearly 1.5 t/ha, and was due to a higher number of heads.

The interpretation of these results requires further analysis, as they could be dependent on sowing time, soil nitrogen levels, growing season rainfall and so on.

Table 3: Grain and biomass yield and yield components for Hart, Spalding and Roseworthy in 2010.

Summer Rainfall	Nitrogen	Grain yield (t/ha)	Biomass yield (t/ha)	Grain weight (mg)	Heads/m2	Harvest Index (%)
Hart						
Control	High	5.64	13.3	39.3	346	42
Control	Low	5.78	13.8	42.7	351	42
100mm	High	7.17	17.1	40.2	424	42
100mm	Low	5.68	13.7	42.5	313	42
	P Value. S.R	0.01	0.01	n.s	n.s	n.s
	P Value. N	0.01	0.01	0.01	0.01	n.s
	P Value. Interaction	0.01	0.01	n.s	0.01	n.s
Spalding						
Control	High	7.21	18.5	43.2	539	39
Control	Low	4.96	13.1	45.8	374	38
100mm	High	6.95	17.6	45.5	484	39
100mm	Low	5.01	13.3	47.0	351	38
	P Value. S.R	n.s	n.s	0.05	n.s	n.s
	P Value. N	0.01	0.01	0.05	0.01	0.01
	P Value. Interaction	n.s	n.s	n.s	n.s	n.s
Roseworthy						
Control	High	5.63	15.0	32.9	397	38
Control	Low	6.04	15.5	39.0	413	39
100mm	High	6.00	15.6	35.0	374	38
100mm	Low	6.27	15.2	45.2	337	41
	P Value. S.R	n.s	n.s	0.05	n.s	n.s
	P Value. N	n.s	n.s	0.001	n.s	n.s
	P Value. Interaction	n.s	n.s	n.s	n.s	n.s

Soil moisture retention granules

Key findings

- Soil moisture retention granules did not influence wheat grain yield or quality at Hart in 2010.

Why do the trial?

To investigate the performance of soil moisture retention granules on wheat grain yield.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	32:10 (DAP/Urea) @ 80 kg/ha
Seeding date	13th May 2010	**Variety**	Scout @ 70 kg/ha

The trial was a randomised complete block design with 3 replicates and 4 treatments.

Aquaboost soil moisture retention granules (AG100) were applied with the seed at 2, 4 or 10 kg/ha.

Edge rows were removed prior to harvest.

Plots were assessed for grain yield, protein and screenings with a 2.0 mm screen.

Results

Grain yield in this trial ranged from 4.29 t/ha to 4.50 t/ha. The use of soil water retention granules did not significantly affect the yield, protein or screenings of Scout wheat (Table 1).

Table 1: Grain yield (t/ha), protein (%) and screenings (%) results for soil moisture retention granules at Hart in 2010.

Treatment	Grain yield (t/ha)	% of untreated	Grain protein (%)	Screenings (%)
Untreated	4.29	100	8.9	1.3
Granules 2 kg/ha	4.50	105	8.8	1.2
Granules 4 kg/ha	4.24	99	8.9	1.2
Granules 10 kg/ha	4.25	99	8.9	1.3
LSD (0.05)	ns	ns	ns	ns

Improving water use efficiency

This trial is funded by the GRDC and conducted in collaboration with Chris Lawson and Victor Sadras, SARDI, and Glenn McDonald from the University of Adelaide.

Key findings

- The highest recorded WUE was observed at Spalding where 18.3 kg of wheat was produced per hectare for every mm of growing season rainfall.

Why do the trial?

Impressive gains in improving crop and systems water use efficiency (WUE) have been captured by Australian farmers over the past 30 years and some farmers are achieving close to their environmentally attainable yields in most seasons.

This trial will investigate the reasons for these differences in WUE by continuing with trials established at 4 sites in 2008 on different soil types and rainfall zones in selected grower paddocks. The sites established are:

Hart, 400mm annual rainfall, sandy clay loam
Condowie, 350mm, sandy loam
Spalding, 450mm, red brown earth
Saddleworth, 500mm, black cracking clay

How was it done?

Plot size 8m x 10m

Seeding date
Hart 14th May
Condowie 29th April
Spalding 6th May
Saddleworth 7th May

Fertiliser

Hart	DAP@50 kg/ha+2% Zn
Condowie	DAP@35 kg/ha+2% Zn
Spalding	DAP@40 kg/ha+2% Zn
Saddleworth	DAP@80 kg/ha+2% Zn

Post emergent nitrogen
Hart, Spalding and Saddleworth
UAN@100L/ha 19th August 2011

Each trial was a randomised complete block design with 3 replicates and 4 crops.

The 4 crops include Gladius wheat, Keel barley, Kaspa peas and Tornado canola, grown in rotation to ensure weed free plots are available for wheat in each successive season.

All trials were sown with 50mm chisel points and press wheels on 225mm (9”) row spacing.

All cereal grain plots were assessed for grain yield, protein, wheat screenings with a 2.0 mm screen and barley screenings with a 2.2 mm screen and retention with a 2.5mm screen.

The break crops (peas and canola) were not assessed for grain yield or quality.

Drained upper limit and crop lower limit (wheat) were measured at each site in 2008 to calculate plant available water capacity (PAWC).

WUE was calculated for the cereal crops at each site using the French & Schultz formula.
Wheat: Yield potential = (GSR-110mm)*20 kg/mm/ha
Barley: Yield potential = (GSR-90mm)*20 kg/mm/ha

Results

Growing season rainfall in 2010 ranged between 334mm (Condowie) to 486mm (Spalding). In 2010 all sites received at least 72mm more growing season rainfall than their long term average.

The wheat WUE ranged from 12.9 kg/ha/mm at Hart to 18.3 kg/ha/mm at Spalding (Table 1) producing grain yields of 3.63 t/ha and 6.73 t/ha respectively.

Table 1. Soil type, average total and average growing season rainfall (GSR), 2010 total and 2010 GSR and wheat and barley water use efficiency (WUE) for the four WUE sites in 2010.

Site	Soil type	Average total rainfall	Average GSR	2010 total rainfall	2010 GSR	Wheat	Barley
		(mm)				WUE (kg/ha/mm)	
Condowie	sandy loam	349	252	389	334	13.0	13.7
Hart	sandy, clay loam	400	305	573	391	12.9	16.2
Spalding	red brown earth	434	322	664	486	18.3	19.8
Saddleworth	black cracking clay	497	374	536	446	13.4	16.8

Wheat grain yields ranged from 2.92 t/ha (Condowie) to 6.87 t/ha (Spalding) and barley grain yields ranged from 3.07 t/ha (Condowie) to 7.43 t/ha (Spalding) (Table 2).

Wheat protein was generally lower than in previous seasons ranging from 8.0% at Saddleworth to 10.9 % at Condowie and the barley followed similar trends.

Screenings for both crops were below 2.5% at all WUE sites in 2010.

Table 2. Grain yield (t/ha), protein (%) and screenings (%<2.0 mm for wheat and %<2.2mm for barley) at the four WUE sites in 2009.

Site	Crop	Grain yield (t/ha)	Protein (%)	Screenings (%)
Condowie	Wheat	2.92	10.9	0.8
	Barley	3.07	11.1	1.1
Hart	Wheat	3.63	9.7	1.7
	Barley	4.54	9.5	0.6
Spalding	Wheat	6.87	10.4	0.5
	Barley	7.43	10.6	0.8
Saddleworth	Wheat	4.50	8.0	0.9
	Barley	5.63	9.1	2.4

Acknowledgements
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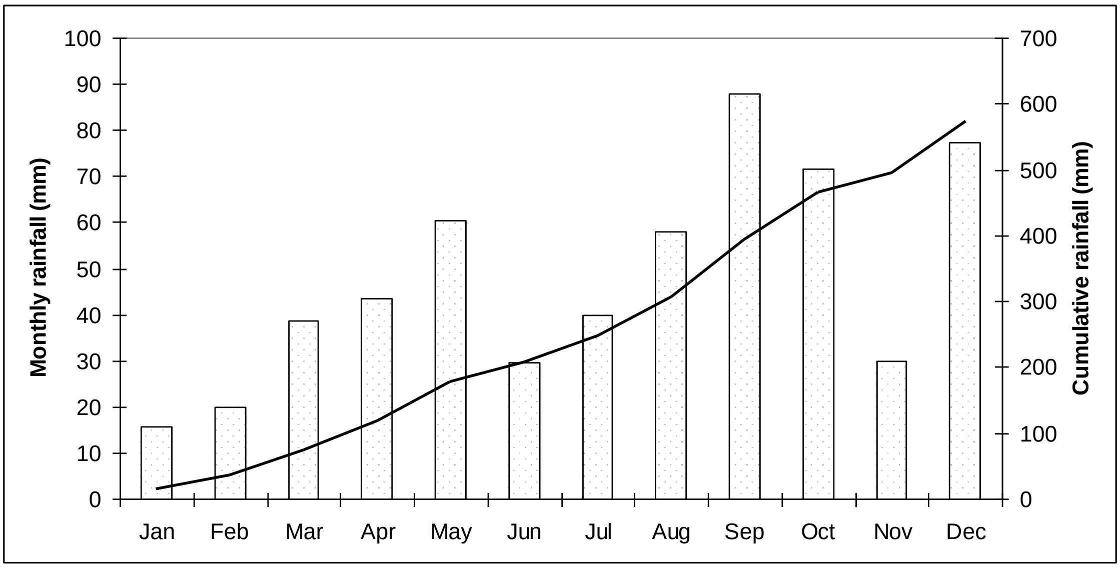
Rainfall, Hart 2010

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1							0.8	6.0				0.4
2								2.0				10.0
3		4.0										
4									38.0			
5								5.0	13.0			
6				3.0					4.6			
7			12	1.4								8.0
8			16.6									46.0
9			0.6	7.0		2.4		7.0	7.0			
10						1.6	5.0		1.2			
11		16.0		5.0		0.8						
12								5.0			13.4	
13	11.0						3.6			10.0	4.6	
14							3.0	2.0	19.0			
15			1.6				7.0	10.0		10.0		
16							6.0	0.4	2.0	3.0		
17						1.0				2.0		
18						0.8		3.4				
19						1.0	10.4					7.0
20						6.0						6.0
21				8.4								
22												
23								4.0		6.0		
24				12.0	7.8							
25				2.0	23.8	11.4		3.0			8.0	
26						1.4		6.0				
27				1.2				3.0				
28	3.2			2.0				1.2			3.6	
29	1.6		8.0	1.6	15.4		4.0		3.0			
30					8.0	3.2				11.0	0.4	
31					5.4					29.6		
Monthly total	15.8	20.0	38.8	43.6	60.4	29.6	39.8	58.0	87.8	71.6	30.0	77.4
Running total	15.8	35.8	74.6	118.2	178.6	208.2	248.0	306.0	393.8	465.4	495.4	572.8

Average GSR (Apr-Oct) 305 mm
2010 GSR (Apr-Oct) 391 mm

Average rainfall 400 mm
2010 total rainfall 573 mm



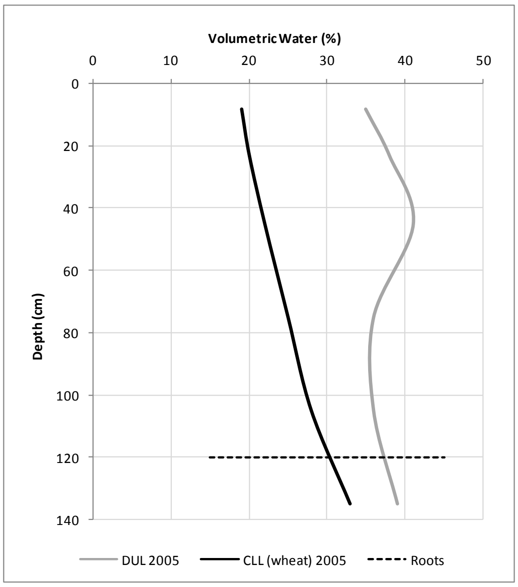
Soil test Hart trial site 2010

March 2010 – Northern quarter

Depth (cm)	0 - 10
Phosporus (ppm) (Cowel P)	52
Potassium (ppm)	579
Salinity (EC dS/m)	0.14
Organic carbon (%)	1.80
pH (calcium chloride)	7.4
pH (water)	8.2
Phosphorus buffering index	97

Available soil moisture 10th March (0-60cm)	0mm	**Soil nitrogen 10th March (0-60cm)**	35 kg N /ha

Hart soil water characteristics



The crop lower limit (CLL) for wheat and the drained upper limit (DUL) for the Hart field site measured in 2005.

Plant available water capacity for wheat at hart is 182mm to the depth of 150cm.

In 2005 roots were found to a depth of 120cm.