Contents

Comparison of wheat varieties

Key findings

- Axe was the highest yielding wheat variety, at 1.13t/ha.
- Generally the early maturing varieties were higher yielding compared to the late maturing varieties.

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	1.5m x 10m	**Fertiliser**	DAP @ 75kg/ha + 2% Zn
Seeding date	29th May 2008		

The trial was a randomised complete block design with 3 replicates and 21 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

Axe was the highest yielding wheat variety at Hart in 2008 (1.13t/ha) and was also among the highest yielding varieties at Hart in 2007.

The APW varieties Espada and Wyalkatchem, and hard varieties Bullet, Peake and Young produced similar yields and were 20% below Axe (Table 1). 4 out of 5 of these varieties are either early or early-mid maturing varieties.

Across the trial grain protein ranged from 14.8% to 16.8%, the average was 15.7%.

None of the varieties tested produced a test weight above the required 74kg/hL for APW. Varieties which produced test weight below 67kg/hL (or 95% of Yitpi) were Pugsley, Barham, Axe, Bullet and Correll.

The lowest value for screenings was 9.5% for Espada wheat. Varieties that produced screenings above 30% included Bullet (51%) and Young (37%).

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of wheat varieties at Hart in 2008.

Quality	**Variety**	**Grain yield (t/ha)**	% of Yitpi	**Protein (%)**	% of Yitpi	**Test weight (kg/hL)**	% of Yitpi	**Screenings (%)**	% of Yitpi	**Maturity**
APW	AGT Scythe	0.77	122	15.5	95	70.1	101	12	82	Early-Mid
	Espada (RAC1263)	0.85	135	15.4	95	69.3	99	9	64	Mid
	Frame	0.31	49	14.8	91	*	*	13	85	Mid-Late
	Guardian	0.58	92	15.1	93	72.3	104	17	118	Early
	Pugsley	0.43	68	15.3	94	66.4	95	14	93	Mid-Late
	Wyalkatchem	0.88	140	15.1	93	68.3	98	10	71	Early-Mid
ASW	GBA Ruby	0.80	127	16.8	104	68.0	97	23	155	Early-Mid
	Krichauff	0.67	107	15.7	97	68.1	98	20	133	Mid
Soft	Barham	0.74	118	16.3	101	65.6	94	21	140	Early-Mid
Hard	Axe (RAC1192)	1.13	179	14.9	92	66.5	95	21	143	Early
	Bullet	0.95	150	15.3	95	63.1	91	51	345	Early
	Catalina	0.81	129	16.0	99	69.8	100	20	136	Early-Mid
	Clearfield JNZ	0.46	73	15.2	94	*	*	12	83	Mid
	Correll	0.64	102	16.7	103	66.2	95	13	91	Mid
	Derrimut	0.75	118	15.9	98	71.6	103	23	155	Early-Mid
	Gladius (RAC1262)	0.80	127	16.0	98	69.4	100	11	75	Early-Mid
	Peake	0.88	140	15.7	97	68.1	98	26	180	Early
	Yitpi	0.63	100	16.2	100	69.7	100	15	100	Mid-Late
	Young	0.92	146	16.2	100	69.2	99	36	248	Early
Yet to be classified	LRB04-0965	0.65	103	15.4	95	71.6	103	21	144	
	WI25057	0.66	104	15.8	97	68.9	99	26	177	
	Site Mean	0.73	116	15.7	97	68.7	99	20	134	
	LSD (0.05)	0.13	20	0.6	3	3.2	5	6	40	

Comparison of barley varieties

Key findings

- The average yield for all barley varieties at Hart was 0.92t/ha ranging from Hindmarsh (1.33t/ha) to Oxford (0.23t/ha)

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	1.5m x 10m	**Fertiliser**	DAP @ 75kg/ha + 2% Zn
Seeding date	29th May 2008		

The trial was a randomised complete block design with 3 replicates and 21 varieties.

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

Results

The feed varieties Hindmarsh (1.33t/ha) and Fleet (1.14t/ha) and the malting varieties Schooner (1.17t/ha) and SloopSA (1.20t/ha) were the highest yielding barley varieties (Table 1).

Grain protein ranged between 13.7% (Keel) and 18.8% (WI3930).

All varieties produced screenings above 50% and test weight below 64kg/hL. Maritime had by far the lowest screenings of the feed varieties at 58%.

Retention for all varieties (greater than 2.5mm) was less than 3%.

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Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%<2.2mm) for barley varieties at Hart in 2008.

Quality	Variety	**Grain Yield (t/ha)**	% of SloopSA	**Protein (%)**	% of SloopSA	**Test weight (kg/hL)**	% of SloopSA	**Screenings (%)**	% of SloopSA
Feed	Barque	1.05	87	16.0	100	62.0	102	70	77
	Capstan	0.96	80	16.9	106	56.5	93	92	100
	Fleet	1.14	95	15.5	97	57.4	94	85	93
	Hannan (WA2321)	0.83	69	16.0	100	52.5	86	94	103
	Hindmarsh	1.33	110	15.4	97	55.8	92	96	105
	Keel	1.03	86	13.7	86	48.7	80	95	104
	Lockyer (WA2288)	0.93	77	16.3	103	54.9	90	94	103
	Maritime	0.90	75	15.3	96	58.2	96	58	63
	Roe (WA2310)	1.13	94	16.1	101	58.2	96	91	99
	Yarra	0.97	81	16.4	103	52.3	86	92	100
Malting	Baudin	0.76	63	15.3	96	50.1	82	97	106
	Buloke	0.79	66	14.9	93	57.1	94	91	99
	Commander (WI3416)	0.91	76	15.3	96	59.2	97	80	87
	Flagship	1.11	93	15.3	96	60.1	99	97	106
	Gairdner	0.49	41	16.3	103	58.0	95	87	96
	Oxford	0.23	19	15.2	95	*	*	53	58
	Schooner	1.17	97	16.3	103	64.0	105	87	95
	SloopSA	1.20	100	15.9	100	60.9	100	92	100
	Vlamingh	0.65	54	17.5	110	54.5	89	90	99
Hull-less	WI3930	1.11	92	18.8	118	61.2	101	99	108
Yet to be classified	WI4262	0.64	53	17.2	108	61.5	101	74	80
	Site Mean	0.92	77	16.0	100	57.2	94	86	94
	LSD (0.05)	0.20	17	0.9	5	1.8	3	9	10

Comparison of durum varieties

Key findings

- WID802 was the highest yielding durum variety.

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	1.5m x 10m	**Fertiliser**	DAP @ 75kg/ha + 2% Zn
Seeding date	29th May 2008		

The trial was a randomised complete block design with 3 replicates and 9 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

WID802 (1.41t/ha) was the highest yielding durum variety with Saintly (WID22279), Jandaroi, Kalka, Tamaroi and WID803 not being significantly different (Table 1).

There was little difference in protein across the durum variety trial, it ranged from 15.8% (WID802) to 16.7% (Hyperno).

Screenings for all varieties were less than 5.6%.

The highest yielding variety WID802 had a significantly lower test weight (74.6kg/hL) compared to the other varieties in the trial.

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%< 2.0mm) for durum varieties at Hart in 2008.

Variety	**Grain yield (t/ha)**	% of Tamaroi	**Protein (%)**	% of Tamaroi	**Test weight (kg/hL)**	% of Tamaroi	**Screenings (%)**	% of Tamaroi
Jandaroi	1.23	100	16.1	102	76.8	101	4	107
Kalka	1.23	100	16.3	103	75.8	100	3	71
Tamaroi	1.23	100	15.8	100	76.0	100	4	100
TD20F	1.11	90	16.4	104	77.6	102	2	51
Hyperno (WID22209)	1.14	93	16.7	106	76.8	101	5	137
Saintly (WID22279)	1.25	102	15.9	101	75.8	100	6	148
WID801	1.17	95	16.5	104	75.1	99	3	88
WID802	1.41	115	15.8	100	74.6	98	5	142
WID803	1.23	100	16.4	104	76.3	100	6	148
Site Mean	1.22	99	16.2	102	76.1	100	4	110
LSD(0.05)	0.20	16	0.7	4	2.6	3	2	46

Comparison of triticale varieties

Key findings

- Speedee, Hawkeye and Jaywick were the highest yielding triticale varieties at Hart in 2008.

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	1.5m x 10m	**Fertiliser**	DAP @ 75kg/ha + 2% Zn
Seeding date	29th May 2008		

The trial was a randomised complete block design with 3 replicates and 6 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

Speedee, Hawkeye and Jaywick produced the highest yields averaging 1.01t/ha, although Kosciuszko and Rufus were not significantly different. Tahara was the lowest yielding variety (0.8t/ha).

Kosciuszko produced the highest protein (16%) followed closely by the three highest yielding varieties Speedee, Hawkeye and Jaywick.

Screening levels for Hawkeye, Speedee and Kosciuszko were above 30% and the lowest yielding variety Tahara had the lowest screenings (13.5%).

The test weight for all triticale varieties ranged between 63kg/hL and 68kg/hL.

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) for triticale varieties at Hart in 2008.

Variety	Grain yield (t/ha)	% of Tahara	Protein (%)	% of Tahara	Test weight (kg/hL)	% of Tahara	Screenings (%)	% of Tahara
Hawkeye	1.00	125	15.2	101	64.6	95	31	231
Jaywick	1.01	127	15.6	104	66.4	97	17	124
Kosciuszko	0.90	113	16.0	107	67.8	99	33	244
Rufus	0.94	118	14.9	99	67.0	98	19	142
Speedee	1.01	126	15.2	101	63.7	93	32	235
Tahara	0.80	100	15.0	100	68.2	100	14	100
Site mean	0.94	118	15.3	102	66.3	97	24	179
LSD(0.05)	0.14	17	0.5	3	6.3	9	4	28

Time of sowing in wheat

This trial was funded by GRDC

Key findings

- Frame was the highest yielding variety when sown on the 1st May.
- As sowing date was delayed the early maturing variety Axe out yielded later maturing varieties Gladius and Frame.

Why do the trial?

To compare the effectiveness of early sowing using a range of wheat varieties with different varietal maturities.

How was it done?

Plot size	1.5m x 10m	**Fertiliser**	DAP @ 75kg/ha + 2% Zn
Seeding date	TOS 1 1st May 2008 TOS 2 22th May 2008 TOS 3 5th June 2008 TOS 4 19th June 2008		

The trial was a randomised complete block design with 3 replicates, 3 varieties and 4 times of sowing.

The varieties were Axe, early maturing, Gladius, early-mid maturing and Frame, mid-late maturing.

Plot edge rows were removed prior to harvest.

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

Results

The highest yielding treatment in this trial was from the mid to late maturing variety Frame, sown at the early time of sowing, on the 1st May. The grain yield of Frame rapidly decreased with later sowing such that by the 5th June (TOS 3) it produced the lowest yield. By the 19th June (TOS 4) Frame and Gladius were significantly lower yielding compared to Axe.

The early maturing variety Axe had a significant yield increase with a delay of sowing by 21 days to the 22nd May (TOS 2) (Figure 1). There were 2 significant frost events at Hart in 2008, these occurred on the 22nd and 23rd of August. It is likely that the Axe sown on the 1st May was affected by these events and suffered significant yield loss.

On the 5th June (TOS 3) there was no difference between Axe or Gladius, the earliest maturing varieties, while Frame had the lowest yield.

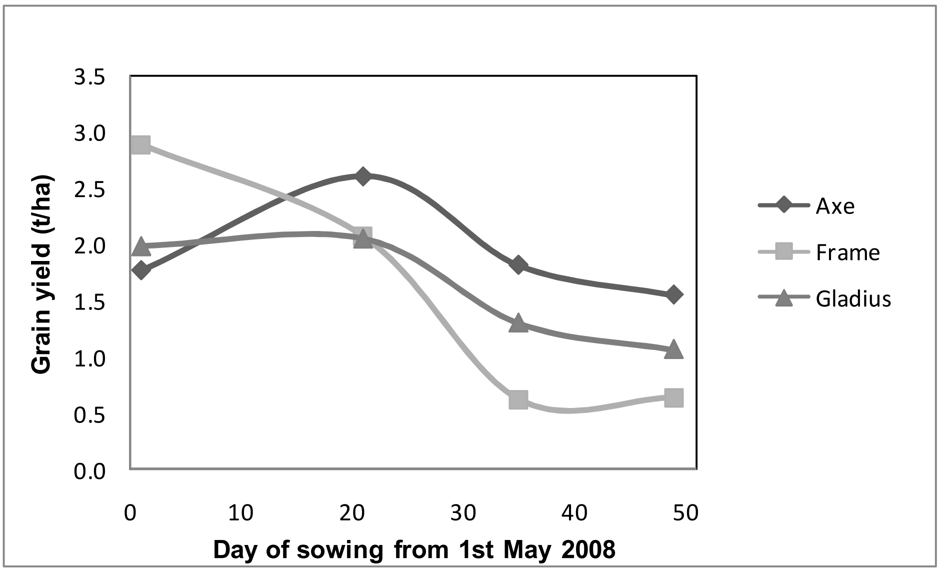

Figure 1: Grain yields of Axe, Frame, Gladius and day of sowing at the Hart field site in 2008, LSD (0.05) variety = 0.24, time of sowing = 0.58, variety*time of sowing = 0.65

For the last 2 times of sowing the early maturing variety Axe was the highest yielding variety followed by the early-mid variety Gladius and than the mid-late variety Frame.

As time of sowing was delayed protein increased while screenings and grain weight decreased across all varieties (Table 2).

Table 2: Grain Protein (%), screenings (%) and grain weight (mg/grain) and time of sowing averaged across all varieties.

Time of sowing	Protein (%)	Screenings (%)	Grain weight (mg)
1st May	14.3	2	35
22nd May	14.9	2	34
5th June	16.4	5	30
19th June	17.9	4	30
LSD (0.05)	1.0	2	3

The grain protein values for Axe, Frame and Gladius were 15.1%, 16.3% and 16.2% respectively. Axe produced the lowest protein independent of sowing date.

Screenings for all varieties and sowing dates were 5% or less. Individual grain weights were significantly higher for TOS 1 and TOS 2.

Over the past few seasons timely seeding has had a large influence on grain yields. Results from this trial show that for early maturing varieties sowing dry or on the opening rains will not always produce maximum yields, even in years of below average growing season rainfall such as in 2008.

Varietal maturity is important and can have a significant impact on grain yields, particularly for crops sown after mid May in marginal seasons.

The Hart wheat variety comparison was sown 7 days after TOS 2 of the time of sowing trial, on the 29th May. Figure 2 shows that as varietal maturity increases grain yields decline. This trend corresponds to the time of sowing trial where at the later times of sowing Axe yielded higher than Gladius, and Gladius yielded higher than Frame.

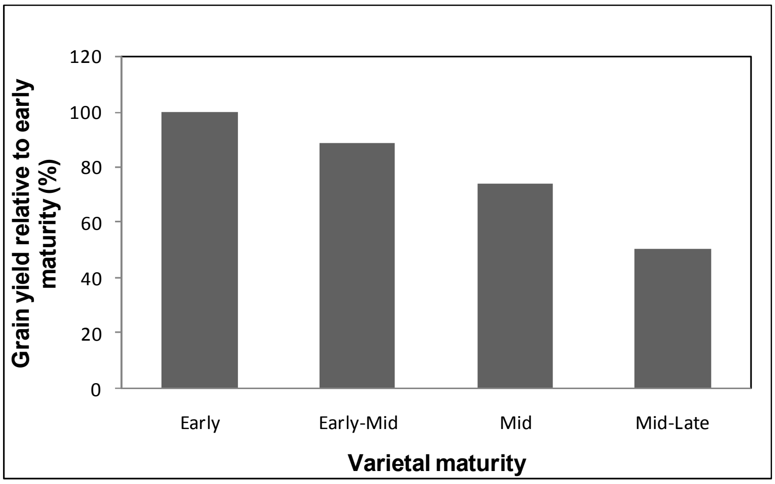

Figure 2: The interaction between grain yield and varietal maturity across all wheat varieties in the wheat variety comparison at Hart in 2008, sown 29th May.

Barley variety response to row spacing

Martin Lovegrove & Rob Wheeler, SARDI Waite

Key findings

- There was no gross margin difference between 225mm (9inch) and 355mm (14inch) row spacings, as it had no impact on grain yield or grain quality.
- Hindmarsh produced the highest grain yields, but Maritime showed the best grain quality.

Why do the trial?

The trial was conducted to determine barley varietal performance across two seeding row spacings. Characteristics measured included differences in early vigor, grain yield and grain quality.

How was it done?

A replicated trial was established at the Hart Field site. The trial assessed four barley varieties, Maritime, Fleet, Hindmarsh and Flagship. These varieties differ in growth rate, habit and height, which were compared across two row spacings, 225mm (9") and 355mm (14").

Seeding rates were adjusted according to grain weight and germination to produce target plant populations of 145 plants per square metre. The trial was sown on the 5th June using chisel points.

Plot size	1.5m x 10m	**Fertiliser rate**	70kg DAP @ 70kg/ha

Plant counts were carried out four weeks after sowing to determine crop establishment. All plots were assessed for Normalised Difference Vegetative Index (NDVI) using a Greenseeker to ascertain any differences through the early growth stages.

The trials were harvested on the 12th of November and scores for straw strength, plant height and grain yield measurements were recorded. Grain quality was assessed for retention (%) with a 2.5mm screen, protein (% dry basis), screenings with a 2.2mm screen and test weight (kg/hectolitre).

Results

Comparison of row spacing grain yields at Hart showed no significant difference between 225mm (9") (1.77t/ha) and 355mm (14") (1.81t/ha) (Table 1). Evaluation of the NDVI for 225mm (9") treatment showed a significantly higher NDVI value compared to the 355mm (14"). There was no difference in barley plant counts.

Table 1: Row spacing grain yields and NDVI at Hart in 2008.

Row Spacing	Grain yield (t/ha)		NDVI		Plant density (plants/m²)	
225mm (9")	1.77	a	0.632	a	150	a
355mm (14")	1.81	a	0.592	b	140	a
LSD (5%)	ns		0.036		ns	

Table 2 displays the barley variety grain yield. Hindmarsh was the highest grain yielding variety, 2.18t/ha, with Fleet yielding 1.83t/ha. The NDVI of Hindmarsh showed a significantly lower index value compared to all other varieties. Flagship and Fleet showed no difference for NDVI.

Table 2. Barley variety grain yield and NDVI at Hart in 2008

Variety	Grain yield (t/ha)		NDVI	
Flagship	1.7	bc	0.6	a
Fleet	1.8	b	0.7	a
Hindmarsh	2.2	a	0.5	c
Maritime	1.5	c	0.6	b
LSD (5%)	0.3		0.1	

There was no difference for all grain quality characteristics across both row spacing treatments (Table 3). Grain protein levels were very high, well above the malt receival standard of 12%. Both treatments showed no significant difference in screenings, retention and test weight with an overall receival grade of Feed 3.

Table 3. Row spacing grain quality characteristics at Hart in 2008.

Row Spacing	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
225mm (9")	17.0	a	35.1	a	15.1	a	66.2	a	F3
355mm (14")	17.2	a	37.7	a	14.1	a	65.3	a	F3
LSD (5%)	ns		ns		ns		ns		

Table 4 shows the variety grain quality characteristics. All varieties had high grain protein with no difference between varieties. Maritime had the lowest screenings (7.7%), with Flagship and Hindmarsh the highest. Maritime also had the highest retention levels. All varieties showed good test weights, Flagship and Maritime the highest. Due to low screenings, Maritime was the only variety to achieve Feed 1 classification; all other varieties were Feed 3 quality.

Table 4. Barley variety grain quality characteristics at Hart in 2008.

Variety	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
Flagship	17.8	a	54.3	c	2.9	c	67.6	a	F3
Fleet	16.5	a	30.3	b	14.3	b	64.1	b	F3
Hindmarsh	16.4	a	53.3	c	4.6	c	64.8	b	F3
Maritime	17.8	a	7.7	a	36.6	a	66.7	a	F1
LSD (5%)	ns		17.1		8.2		1.8		

Discussion

Early rainfall enabled good crop establishment at Hart. Rains throughout winter allowed high biomass production with crops setting high grain yield potential. These beneficial conditions were followed with a very dry spring, imposing severe drought effects on the crop.

Plant counts confirm that there was no difference in barley plants per square meter for the two row spacings. There was no grain yield difference between the two spacings, suggesting that the barley plants were able to adapt to these treatments. There was no barley variety by row spacing interaction for grain yield and quality; indicating that all varieties respond alike to this row spacing effect. Previous row spacing research on Eyre Peninsula has indicated that there is a grain yield penalty incurred when row spacings are wider. These results, and results from the same trial in 2007 at Hart, indicate the contrary with no grain yield or quality difference between row spacings. This may be a result of the very dry springs that have been witnessed during the past two seasons.

There was no gross margin difference between row spacings due to the treatment having no impact on grain yield or grain quality. The barley variety Hindmarsh returned the highest gross margin at Hart, this is attributed to producing the highest grain yield. Maritime had the best grain quality, Feed 1, due to low screenings levels and was the second most profitable variety, despite producing the lowest grain yield.

Barley varieties were also found to generate different NDVI readings. Table 2 shows Maritime recorded a NDVI value higher than all other varieties; this is due to the ability of Maritime to tiller and produce large amounts of dry matter compared to other varieties in the trial. Flagship and Fleet were not different from each other due to both varieties having similar tillering and standing ability. Hindmarsh recorded the lowest NDVI value due to this variety having a more erect growth habit compared to all other varieties in the trial. Rankings may vary if the measurement is taken on a different date, or growth stage, due to the growth habit and rate differences of barley varieties, therefore, it is important to compare NDVI readings taken at the same time.

Trials will continue in 2009 to validate 2007 and 2008 results with different seasonal conditions.

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Funding Body: GRDC, Southern Zone Barley Agronomy.

Contact: 8303 9337

Barley variety response to grazing and ryegrass

Martin Lovegrove & Rob Wheeler, SARDI Waite

Key findings

- Grazing had no grain yield impact for all barley varieties in the trial with Hindmarsh yielding the highest (1.54t/ha).
- There was no significant difference for dry matter produced between varieties.
- The presence of annual ryegrass decreased the grain yield of Hindmarsh and Urambie by 20% and 42% respectively, but had no impact on Flagship and Maritime grain yields.

Why do the trial?

The trial was designed to compare barley variety grain yield response to grazing in the presence of annual ryegrass.

How was it done?

A replicated trial was established at the Hart Field site. The trial assessed 4 barley varieties, Flagship, Hindmarsh, Maritime and Urambie. These varieties differ in growth rate, habit and height. Annual ryegrass was planted at the time of sowing at 25kg/ha.

Seeding rates were adjusted according to grain weight and germination to produce target plant populations of 145 plants per square metres. The trial was sown on the 5th June using chisel points and press wheels.

The grazing treatments were applied when the crop was at Zadoks growth stage 30, simulated using a mower.

Plot size	1.5m x 10m	**Fertiliser rate**	DAP @ 70kg/ha

Barley plant and annual ryegrass counts were carried out four weeks after sowing to determine establishment. The trials were harvest on the 12th of November and scores for straw strength, plant height and grain yield measurements were recorded. Grain quality was assessed for retention (%) with a 2.5mm screen, protein (% dry basis), screenings with a 2.2mm screen and test weight (kg/hectolitre).

Results

Table 1 displays establishment counts for annual ryegrass (ARG) and barley plants. Treatments that did not have ARG planted (Minus ARG) recorded 10.8 ryegrass plants per square meter, which is significantly lower then the planted ARG treatment (Plus ARG) of 231.8 ryegrass plants per square meter. There was no interaction with ARG populations and barley plant populations; this indicates that ARG did not have an impact on barley establishment. No barley plant count difference was recorded between barley varieties, meaning all varieties achieved a good establishment.

Table 1. Annual ryegrass (ARG) and barley crop establishment at Hart in 2008.

	Annual Rye Grass/m²		Barley Plants/m2²	
Minus ARG	11	a	158	a
Plus ARG	232	b	156	a
LSD (P=<0.05)	58		ns	

Comparison of dry matter production at Hart showed no significant difference between all varieties when the grazed dry matter was measured (Table 2). However, there was a significant difference for grain yield between varieties. Hindmarsh was the highest yielding variety followed by Flagship. The lowest grain yielding variety was Urambie producing 0.83t/ha.

Table 2. Barley variety dry matter and grain yield production at Hart in 2008.

Variety	Dry matter (t/ha)		Grain yield (t/ha)	
Flagship	1.46	a	1.23	b
Hindmarsh	1.29	a	1.54	a
Maritime	1.37	a	1.05	c
Urambie	1.08	a	0.83	d
LSD (P=<0.05)	ns		0.14	

Annual ryegrass had no impact on grain yield for barley varieties Flagship and Maritime. Hindmarsh and Urambie showed the presence of annual ryegrass significantly reduced grain yield (Table 3).

Table 3. Barley variety grain yield with and with out annual ryegrass (ARG) at Hart in 2008.

	Flagship		Hindmarsh		Maritime		Urambie	
Minus ARG	1.25	a	1.73	a	1.12	a	1.06	a
Plus ARG	1.21	a	1.35	b	0.98	a	0.61	b
LSD (P=<0.05)	ns		0.27		ns		0.27	

Table 4 shows the grain yield impact of simulated grazing on barley varieties. All varieties responded alike with no significant effect of grazing on grain yield. Although not significant, Flagship and Hindmarsh had grain yield increases as a result to grazing with Flagship increasing by 0.38t/ha.

Table 4. Barley variety grain yield when grazed and un-grazed at Hart in 2008.

	Flagship		Hindmarsh		Maritime		Urambie	
Grazed	1.42	a	1.58	a	0.88	a	0.84	a
Un-Grazed	1.04	a	1.49	a	1.21	a	0.83	a
LSD (P=<.05)	ns		ns		ns		ns	

Table 5 displays the variety grain quality characteristics. All barley varieties showed very high grain protein levels. Hindmarsh and Urambie had the lowest grain protein with, malting variety, Flagship having the highest. All varieties produced very high screenings levels; Flagship, Hindmarsh and Urambie levels were significantly higher compared to Maritime. Maritime also showed significantly higher retention levels compared to all other varieties, although the retention levels were very poor. The test weight of Flagship was significantly higher compared to all other varieties, Hindmarsh produced the lowest. Maritime was the only variety to produce screenings levels low enough to achieve Feed 3 classification. All other varieties produced Feed 4 delivery grade grain quality.

Table 5. Barley variety grain quality characteristics at Hart in 2008.

Variety	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
Flagship	17.7	a	82.9	b	1.4	b	62.9	a	F4
Hindmarsh	15.9	c	81.2	b	2.7	b	59.2	c	F4
Maritime	16.9	ab	42.8	a	13.6	a	61.1	b	F3
Urambie	16.4	bc	76.8	b	2.6	b	60.1	bc	F4
LSD (P=<0.05)	0.9		9.1		5.1		1.8		

The presence of annual ryegrass had no impact on grain quality characteristics grain protein, screenings, retention, test weight or grain quality receival grade (Table 6).

Table 6. Annual ryegrass (ARG) impact on grain quality characteristics at Hart in 2008.

	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
Minus ARG	16.6	a	69.6	a	5.0	a	61.4	a	F4
Plus ARG	16.9	a	72.2	a	5.2	a	60.2	a	F4
LSD (P=<0.05)	ns		ns		ns		ns		

The simulated grazing treatment had no impact on grain protein, screenings, retention, test weight and grain receival grade (Table 7).

Table 7. Grazing impact on grain quality characteristics at Hart in 2008.

	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
Grazed	16.7	a	69.2	a	4.5	a	61.1	a	F4
Un-Grazed	16.8	a	72.7	a	5.6	a	60.6	a	F4
LSD (P=<0.05)	ns		ns		ns		ns		

Discussion

Good early rainfall enabled excellent crop establishment at Hart. Rains throughout winter allowed high biomass production with crops setting high grain yield potential. These beneficial conditions were followed with a very dry spring, imposing severe drought effects on the crop, and as a consequence grain quality was very poor.

The grain yield of Hindmarsh and Urambie was significantly reduced by the increased presence of annual ryegrass (ARG), however ARG did not impact on dry matter production. This indicates that these varieties are less suitable to grow in paddocks with high ryegrass populations due to the inability to compete with this weed. Despite the difference in weed populations all ARG in this trial died due to the extreme conditions endured at the end of the growing season. The early maturing feed variety Hindmarsh was the highest grain yielding in the trial. This result replicates data seen in other trials at Hart in 2008. Urambie produced the lowest grain yields in the trial. Urambie is promoted as a high yielding dual-purpose feed variety with the unique adaptability to early sowing. This variety is historically grown in the eastern states of Australia and has recently been planted in small areas of South Australia. Although this trial was not sown early, as is recommended for to achieve maximum performance, the grain yield of Urambie compared to all other varieties in the trial was significantly less.

Flagship produced the highest amount of dry matter at Zadoks growth stage 30 when the crop was ‘grazed’. This barley variety exhibits good early growth and is quickly established, despite no significant difference in variety dry matter production, Flagship produced the highest amount. The grain yield of Flagship was increased by 0.38t/ha when it when it was grazed. Although this result was not significant, data from the Mid North High Rainfall Zone trial site at Tarlee in 2008 showed the same trend with a significant grain yield increase of Flagship after grazing. Once grazed, Flagships growth habit tends to become more prostrate and the grazing treatment did not reduce the grain yield.

Trials will continue in 2009 to validate 2007 and 2008 results with different seasonal conditions.

Acknowledgements: Thanks go to the GRDC for funding the research, SARDI Clare staff for trial management, SARDI Waite staff for quality evaluation and the Hart field site group for provision of the land.

Contact: 8303 9337.

Barley variety response to seed rate and ryegrass

Martin Lovegrove & Rob Wheeler, SARDI Waite.

Key findings

- Annual ryegrass did not affect crop establishment but did reduce grain yield.
- Seed rate did not influence grain yield or levels of annual ryegrass populations.
- Annual ryegrass populations were found to be significantly lower in Flagship and Maritime plots.

Why do the trial?

The aim of this trial was to determine varietal performances under various seeding rates and the ability of barley varieties to compete with annual ryegrass.

How was it done?

The trial contained 4 barley varieties; Maritime, Fleet, Hindmarsh and Flagship. All varieties differ in growth rates and final growth height. The varieties were compared over three seeding rates 80, 150 and 220 seeds per square metre. These treatments were compared against two weed densities, Annual ryegrass planted at 25kg/ha and an un-treated control.
Seeding rates were adjusted according to grain weight and germination to produce target plant populations specified in the trial design. The trial was sown on the 5th June using chisel points and presswheels.

Plot size 1.5m x 10m **Fertiliser rate** DAP @ 70kg/ha

Barley plant and Annual ryegrass counts were carried out four weeks after sowing to determine crop establishment. The trial was harvested on the 12th of November and scores for straw strength, plant height and grain yield measurements were recorded. Grain quality was assessed for retention (%) with a 2.5mm screen, protein (% dry basis), screenings with a 2.2mm screen and test weight (kg/hectolitre).

Results

Table 1 displays the impact that seeding rate has on grain yield and the establishment of annual ryegrass. Increasing the seed rate from 80 to 150 or 220 seeds per square metre had no significant grain yield impact. However, the seeding rate of 80 seeds per square metre had the highest grain yield of 1.18t/ha. Comparing the establishment of annual ryegrass across the three seeding rates showed no significant difference, indicating that seeding rate had no impact on annual ryegrass populations.

Table 1. Seed rate influence on grain yield and annual ryegrass (ARG) populations at Hart in 2008.

Barley density (plants/m²)	Grain yield (t/ha)		Ryegrass density (plants/m²)	
80	1.18	a	132	a
150	0.89	a	117	a
220	0.94	a	109	a
LSD (5%)	ns		ns	

Barley variety grain yield differences were detected, as seen in Table 2. Hindmarsh and Fleet recorded the highest grain yield, which were both significantly higher than varieties Flagship and Maritime. A difference was seen in annual ryegrass establishments across barley varieties. Populations in Fleet and Hindmarsh were significantly higher compared to levels in Flagship and Maritime.

Table 2. Barley variety grain yield, barley establishment and annual ryegrass (ARG) establishment at Hart in 2008.

Variety	Grain yield (t/ha)		Ryegrass density (plants/m²)	
Flagship	0.82	b	99	b
Fleet	1.14	a	139	a
Hindmarsh	1.22	a	137	a
Maritime	0.84	b	103	b
LSD (5%)	0.12		28	

The presence of annual ryegrass had a negative impact on grain yield reducing 1.05t/ha to 0.96t/ha, Table 3. Annual ryegrass had no impact on barley crop establishment as there was no difference in plant numbers whether the weed was present or not. The annual ryegrass plant count displays the difference in populations per square meter with the sown annual ryegrass plots having significantly higher populations compared to those without.

Table 3. Presence of annual ryegrass impact on grain yield, barley establishment and annual ryegrass (ARG) populations at Hart in 2008.

	Grain yield (t/ha)		Barley density (plants/m²)		Ryegrass density (plants/m²)	
No ARG	1.05	a	166	a	2	a
ARG sown	0.96	b	164	a	237	b
LSD (5%)	0.1		ns		22.9	

Table 4 shows the mean grain quality characteristics for seeding rate. Seed rate had no impact on grain protein, retention and test weight, although increasing the seed rate above 80 seeds per square meter significantly increased screenings despite all seed rates having screenings above 60%. All seed rates had a receival grade of Feed 4.

Table 4. Seed rate influence on grain quality characteristics at Hart in 2008.

Sowing rate (seeds/m²)	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
80	18.0	a	60.4	a	7.8	a	61.5	a	Feed 4
150	18.4	a	75.7	b	4.4	a	59.7	a	Feed 4
22	18.2	a	77.6	b	4.1	a	59.7	a	Feed 4
LSD (5%)	ns		13.0		ns		ns		

Maritime showed the best grain quality characteristics of all varieties, with protein and screening levels significantly lower than all other varieties (Table 5). Flagship showed significantly higher protein compared to all varieties and, along with Hindmarsh, the highest screenings. Maritime had the highest retention, however all varieties were very low. All varieties, except Maritime, achieved a receival grade of Feed 4.

Table 5. Barley variety grain quality characteristics at Hart in 2008.

Variety	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
Flagship	19.1	c	86.8	c	2.1	c	62.1	a	Feed 4
Fleet	17.7	b	63.4	b	5.7	b	59.4	c	Feed 4
Hindmarsh	17.9	b	86.7	c	2.8	c	58.9	c	Feed 4
Maritime	18.2	a	48.1	a	11.1	a	60.8	b	Feed 3
LSD (5%)	0.2		4.5		2.1		0.5		

The addition of annual ryegrass had no impact on screenings, retention, test weight and overall receival grade (Table 6). The presence of annual ryegrass did significantly reduce grain protein although protein levels were extremely high.

Table 6. Annual ryegrass (ARG) impact on grain quality characteristics at Hart in 2008.

Weeds	Protein (%)		Screenings (%)		Retention (%)		Test weight (kg/hL)		Receival grade
No ARG	18.2	a	70.9	a	5.7	a	60.3	a	Feed 4
ARG sown	18.1	b	71.6	a	5.2	a	60.3	a	Feed 4
LSD (5%)	0.1		ns		ns		ns		

Discussion

Early rainfall allowed good crop establishment at Hart. Rains throughout winter meant high biomass production with crops setting a high grain yield potential. These beneficial conditions were followed with a very dry spring imposing severe drought effects on the crop. As a consequence grain yield and grain quality was very poor.

Although the season finished harshly seed rate had no impact on grain yield. Seed rate also failed to influence annual ryegrass populations in this season at Hart. This may be due to the good start to the season with ample soil moisture allowing the ARG populations to establish not allowing the influence of competition. ARG populations were found to be significantly lower in Flagship and Maritime plots. Flagship has excellent early vigor compared to other varieties and is quick to get established. This trait allows Flagship to compete well with ARG as indicated by reducing ARG populations compared to Hindmarsh and Fleet, as seen in this trial. Maritime also had ARG populations at the same level as Flagship indicating that this variety too has the ability to impose good early competition on ARG. Despite the difference in weed populations all ARG in this trial died due to the extreme conditions endured at the end of the growing season.

Seed rate had no impact on receival quality of the barley. However, a seed rate of 80 seeds per square meter did have significantly lower screenings compared to the higher seed rates. This can be explained due to the competition for moisture through September and October. Maritime displayed the best grain quality of all varieties in this trial. Maritime has inherent plump grains and this trait allowed it to achieve Feed 3 classification.

Trials will continue in 2009 to validate 2007 and 2008 results with different seasonal conditions.

Acknowledgements: Thanks go to the GRDC for funding the research, SARDI Clare staff for trial management, SARDI Waite staff for quality evaluation and the Hart field site group for provision of the land.

Contact: 8303 9337

Chickpeas: weed competition by variety trial

Michael Lines, Larn McMurray, Mark Bennie, John Nairn & Rowan Steele, SARDI
This trial was funded by GRDC

Key Findings:

- As in 2007, dry seasonal conditions did not favor chickpea production in 2008 and consequently early maturity and low grain yields were observed.
- Ryegrass competition of 33 plants/m^2 at maturity reduced grain yields of chickpeas by 48%, and 120 plants/m^2 reduced grain yields by 82%.
- Genesis079 was the highest yielding variety and is well adapted to short season environments.
- These results confirm previous findings showing chickpeas as a poor competitor, and the unsuitability of control measures such as weed-wiping and crop-topping.

Why do the trials?

To look for chickpea plant types which are more competitive with ryegrass. Traits of particular interest included chickpea height, vigour, maturity and plant architecture (eg branching angle).

How was it done?

Plot size	1.5m x 10m	**Fertiliser rate**	MAP 2.5% Zn @ 76kg/ha with seed
Seeding date	29th May 2008	**Inoculant**	Group N granular
Trial design	RCBD with 3 reps		
Seeding rate (1)	50 plants/m^2 (desi and kabuli)		
Varieties (10)	See Table 1		
Treatments (3)	Nil ryegrass	Nil ryegrass (volunteers removed)	
	Low ryegrass	Sown with ryegrass @ 40 plants/m^2	
	High ryegrass	Sown with ryegrass @ 200 plants/m^2	

Table 1: Attributes of varieties included in this trial

	Variety	Early Growth Habit [a]	Early vigour	Canopy Density [b]	Height	Maturity
Kabuli	Almaz	semi-erect	poor	medium	medium	late
	Genesis 079	semi-erect	moderate	medium	short	early
	Genesis 090	semi-erect	good	dense	medium	mid
Desi	CICA503	semi-spread	moderate	medium-thin	medium	mid
	Genesis 509	semi-erect	moderate	thin	medium	mid
	Sonali	semi-erect	good	medium	tall	early
	01482*03HS002	erect	very good	very thin	very tall	mid
	01152-1029	semi-erect	moderate	dense	medium	mid
	01040-1057	erect	good	very dense	tall	mid
	01040-1160-1	semi-erect	moderate	very dense	medium	mid

[a] Early growth habit refers to the initial branching angle, where spread denotes prostrate branching and erect denotes upright branching

[b] Canopy density refers to the density of the mature canopy, and is important in preventing light penetration

Results

Yield

Due to the dry season, and particularly the severe finish to 2008, chickpea yields were very low, averaging just 0.54t/ha without competition. Competition with ryegrass reduced grain yields by 48% in the low treatment and by 82% in the high treatment (Table 2).

All lines decreased in yield as ryegrass density increased, with the exception of Almaz, which yielded similarly (and poorly) at both low and high ryegrass densities (Figure 1). The early flowering Genesis 079 generally yielded consistently higher in each ryegrass treatment. This is a reflection of both the early maturity and its suitability to short season environments.

Breeder's lines 01040-1057 and 01040-1160-1, and commercial variety Genesis 090 showed the lowest yield loss at the low rate of competition (Figure 2). At the high rate of competition breeder's lines 01040-1057 and 01040-1160-1 were once again the least affected, together with Almaz. This may indicate these varieties are more competitive with ryegrass, however as the dry season suppressed plant growth and expression of variation in growth habit, further research is required in a more favourable season to compare these genetic differences.

Figure 1:

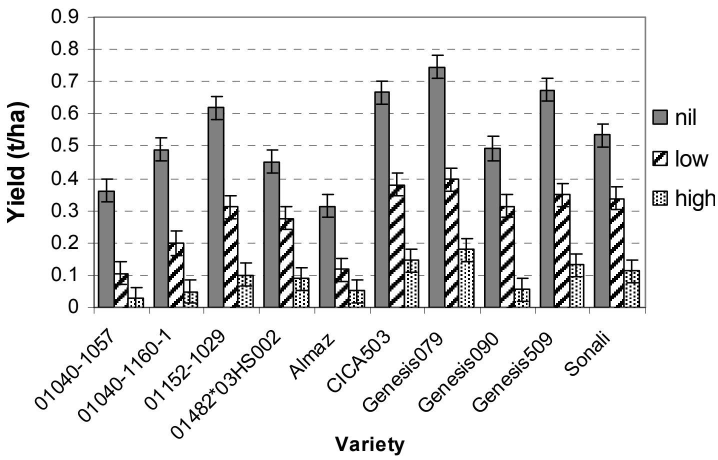

Figure 2:

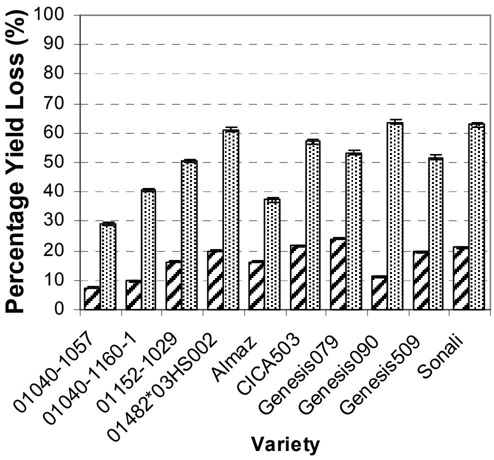

Figure 1: Effect of ryegrass density on the yield of 10 chickpea lines, Hart 2008.
Figure 2: Percentage yield loss of chickpeas under low and high ryegrass densities, Hart 2008.

Table 2: Effect of ryegrass density on various chickpea and ryegrass measurements at Hart, 2008.

Measurement		Ryegrass Density			LSD(0.05)
		Nil	Low	High	
Ryegrass Counts	Plants/m^2	0	33.4	120.5	7.9
	Tillers/m^2	0	138.1	309.5	25.1
	# tillers/plant	0	4.1	3	-
Chickpea Counts (#/m2)	July	48.1	48.2	51.5	ns
	October	49.7	46.7	43.3	3.02
Yield (t/ha)		0.54	0.28	0.095	0.023

Ryegrass counts and tillering

The ability of chickpea lines to suppress tillering in ryegrass was deemed to be one of the most important measurements at the beginning of the trial. However tiller numbers were heavily reduced by the dry season, making comparisons between varieties difficult.

Initial counts (July) were less than target densities, with the low density (target = 40 plants/m^2) measuring 33 plants/m^2, and the high density (200 plants/m^2) measuring just 120 plants/m^2 (Table 2). Comparisons between these two treatments showed that ryegrass tillering was reduced by 27% by the four-fold increase in rye grass plant density.

Almaz showed better tiller suppression than the four breeder's lines, but not more than the other commercial varieties (Figure 3). Findings in 2007 at Turretfield where higher ryegrass tillering and increased chickpea dry matter production occurred showed that Sonali had better tiller suppression than all other varieties tested. Further validation is required of this work.

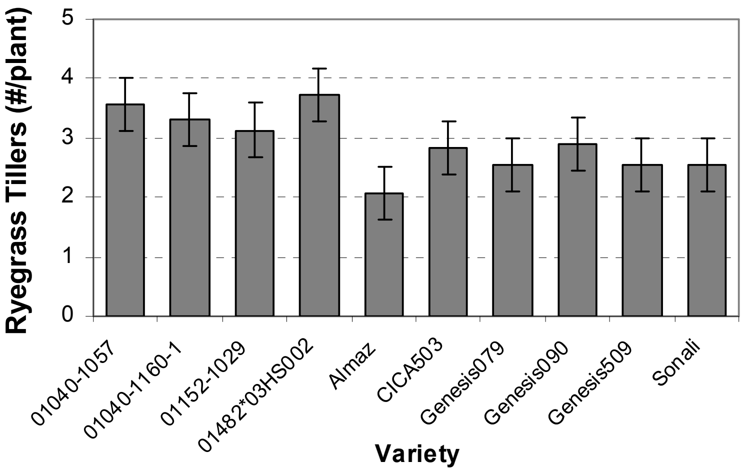

Figure 3: Ryegrass tillering capacity under competition with 10 chickpeas lines, Hart 2008.

Chickpea Density
Initial counts (July) showed no difference in chickpea density between treatments or varieties. There was also no difference in chickpea density between nil and low ryegrass treatments, however thinning of chickpeas was observed at the higher ryegrass density (Table 2), reflecting plant death due to greater competition for soil moisture.

The density of breeder's line 01482*03HS002 was the lowest at the October count, indicating that a greater plant mortality had occurred in this variety. This line was the only chickpea with a combination of erect growth habit and thin canopy, suggesting that this plant type may be less competitive with ryegrass.

Acknowledgements
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Field peas: maximising grain yield through sowing times

Larn McMurray, Jenny Davidson, Michael Lines, John Nairn & Peter Maynard, SARDI

Key Findings:

- Early sowing of field pea is essential for economic yields in dry years in low rainfall environments, providing frost, weed and blackspot risks are considered.
- Kaspa & OZP0602 had lower disease severity and slower build up of blackspot than the old Alma cultivar.
- Strategic applications of foliar fungicides led to a small but significant reduction in blackspot.
- Sowing field peas on the season break will increase blackspot risk however exposure to risk can be reduced through the use of the blackspot predictive tools (Blackspot Manager and DIRI) and careful paddock selection.

Why do the trials?

To identify best sowing time and fungicide strategies for maximum grain yields in field peas. To improve the reliability of the SARDI blackspot disease prediction model and validate the blackspot predictive model 'Blackspot Manager' in SA by incorporating data from replicated trials.

How was it done?

Plot size	1.5m x 10m	**Fertiliser rate**	MAP 2.5% Zn @ 76kg/ha with seed
Sowing date	TOS 1: 1st May 2008	**Inoculant**	-
	TOS 2: 21st May 2008	**Row Spacing**	22.5 cm
	TOS 3: 8th June 2008		
Varieties (seed rate)	Alma(45 plants/m^2), Kaspa, OZP0602 & WAPEA2211 (55 plants/m^2)		
Trial design	Split plot with 3 reps, blocked by sowing date. Variety by fungicide treatments randomised within blocks		

Fungicide Tmts.	**Seed**	**Foliar**
Nil	Apron	None
P-Pickle T (PPT)	Apron + PPT	None
PPT + Mancozeb	Apron + PPT	Mancozeb @ 2 kg/ha – mid veg. July 11 (TOS1); July 30 (TOS2) & August 22 (TOS3)
Single Mancozeb	Apron	Mancozeb @ 2 kg/ha – mid veg. July 11 (TOS1); July 30 (TOS2) & August 22 (TOS3)
Single Mancozeb + Single Chlorothalonil	Apron	Mancozeb @ 2 kg/ha – July 11 (TOS1) July 30 (TOS2) & Aug 22. Chlorothalonil @ 2L/ha –August 22 (TOS1); Sept 4 (TOS2) and October 2 (TOS3)
Fortnightly Bravo	Apron + PPT	Chlorothalonil @ 2L/ha – June 6 & 26, July 11 & 23, August 8 & 22, September 4 & 17, and October 2

Similar trials were also conducted at Turretfield (high rainfall) and Minnipa (low rainfall) and form part of this SAGIT funded research. Results from these trials are also reported in this article.

Results

Disease ratings

Disease levels (blackspot) reached moderate levels in the Hart and Turretfield experiments during winter but failed to progress further during spring due to a lack of rainfall and dry conditions. As in 2007 delayed sowing reduced the amount of blackspot infection and this effect continued throughout the growing season.

The seed treatment P-Pickel T (PPT) had an early effect in reducing disease levels but this suppression generally wore off around 6-8 weeks after sowing. Foliar fungicides also had a small but significant effect on suppressing disease but this effect did not translate into grain yield due to the overriding effects of the dry spring. Anecdotal evidence from application in commercial crops has shown that these small differences have resulted in economical yield gain in more average seasons. Fortnightly fungicide sprays suppressed disease to low levels but this is not an economical practice (Table 1).

Table 1. Effect of seed dressings and fungicides on blackspot severity at 2 sites in SA, 2008.

Treatment	**Turretfield 2008**			**Hart 2008**	
	Disease score in TOS1 13th Aug 08	*Mean disease score of 3 times of sowing* 25th Sept 08		*Mean disease score of 3 times of sowing* 17th Sept 08	
	No. nodes infected	No. nodes infected	No. leaves infected, ( ) =sqrt	No. nodes infected	No. leaves infected
Control	4.2	8.5	10.4 (3.1)	7.7	9.9
P-Picklel T	3.3	7.3	9.2 (2.9)	6.9	9.1
P-Pickel T plus	2.6	7.8	9.4 (2.9)	6.8	8.6
Mancozeb	3.4	7.4	9.3 (2.9)	7.2	9.4
Mancozeb /	3.6	7.4	10.1 (3.0)	6.7	8.4
Fortnightly	0.3	3.7	5.7 (2.2)	1.9	2.7
LSD (P<0.05)	0.5	1.9	- (0.4)	0.9	0.8

Disease spread and intensity was found to start earlier in the old conventional leaf type variety Alma. This variety continued to have greater levels of disease than the other varieties at both infected sites during the season. Of the other three lines evaluated Kaspa generally had higher levels than WA2211 which in turn had higher levels than OZP0602 (Table 2). These results indicated that improved genotypes for blackspot resistance do exist and are being progressed through Pulse Breeding Australia.

Grain Yield

There was no significant benefit of early sowing across all varieties in 2008, unlike in 2007. This was most likely due to frequent but erratic high temperature and frost events in early spring. However, there was no yield penalty from earlier sowing in the new varieties (Kaspa and OZP0602), Table 2.

Also reducing the benefit of early sowing in 2008 was the early favourable season growing conditions (not at Minnipa). The early sowing treatments incurred higher disease levels, increased vegetative production and plant lodging. The latter was particularly evident at the higher rainfall site of Turretfield and in the older conventional type variety Alma.

Table 2: Effect of sowing date and cultivar on blackspot severity and grain yield in SA, 2008.

		Foliar black spot % plot severity, ( )=sqrt %plot sev.					Grain yield (t/ha)				
Site	Sow date	Alma	Kaspa	WA 2211	OZP 0602	Mean	Alma	Kaspa	WA 2211	OZP 0602	Mean
T/field	May 9	8.7 (2.9)	4.9 (2.2)	5.4 (2.2)	3.8 (1.9)	5.7 (2.3)	1.57	2.25	1.8	2.25	1.96
	May 30	3.3 (1.7)	2.1 (1.3)	1.1 (1)	1 (0.8)	1.9 (1.2)	1.74	2.2	1.76	2.43	2.03
Rated	June 20	0.1 (0.1)	0 (0.1)	0 (0)	0 (0)	0 (0.1)	1.59	2.12	2.06	2.09	1.96
31/7	Mean	4 (1.6)	2.3 (1.2)	2.1 (1)	1.62 (1)		1.63	2.19	1.87	2.25	
		lsd (P<0.05) = - , (0.35)					lsd (P<0.05) = 0.28 (0.15 same sow date)				
Hart	May 1	6.8	5.8	5	3.2	5.2	1.21	1.38	1.11	1.51	1.3
	May 21	2.3	1.1	0.8	0.6	1.2	1.2	1.25	1.18	1.47	1.28
Rated	June 8	0.7	0.1	0.2	0.1	0.3	1.09	1.11	1.13	1.26	1.15
23/7	Mean	3.3	2.4	2	1.3		1.17	1.24	1.14	1.42	
		lsd (P<0.05) = 1.2					lsd (P<0.05) = 0.17 (0.1 same sow date)				
							Parafield				
Minnipa	May 20	ND	ND	ND	ND	ND	NS	NS	NS	NS	0.22
	June 13	ND	ND	ND	ND	ND	NS	NS	NS	NS	0.05
Rated	Mean						0.12	0.13	0.14	0.16	
6/8							lsd (P<0.05) = 0.07 (sow date) (0.03 var.)				

NS = not significant, ND = No disease present, - = not evaluated at this site

Grain yields of the late flowering variety Kaspa decreased as sowing date was delayed (Table 2). This result also occurred in the 2007 experiments and has prompted the wide spread earlier commercial sowings of this variety in recent years. Alma was the lowest yielding variety at both sites and showed a variable response to changes in sowing date making it difficult to optimise Alma's grain yield through manipulation of sowing date. The early flowering Kaspa type line, OZP0602, was the highest yielding variety at both sites (15% higher yielding than Kaspa at Hart and 3% at Turretfield). At both sites OZP0602 was higher yielding than Kaspa when sown at the mid sowing time but similar yielding to Kaspa at the early sowing time.

Model validation

Disease infection data were used to update the blackspot prediction model (DIRI). Results were highly correlated in the medium and high rainfall regions but poorly correlated in the low rainfall regions. A new model for DIRI was generated for the low rainfall regions using historical data and produced more favourable results.

These trials were also used to validate 'Blackspot Manager' (a WA department of Agriculture model that predicts the timing of release of airborne spores of blackspot from pea stubble) in SA. This tool was widely used by the SA field pea industry in 2008 to determine early sowing dates with low risk of infection from blackspot. The trials showed that the relationship between the model's spore release predictions and observed disease severity differed at each site (Figure 1). Currently the WA advice with 'Blackspot Manager' is to sow after 50% of spores have been released regardless of area. Findings from these trials indicate that this sowing advice may need to be altered to 75-90% of spore release in higher rainfall regions. Further data are required to validate this result in more favourable seasons.

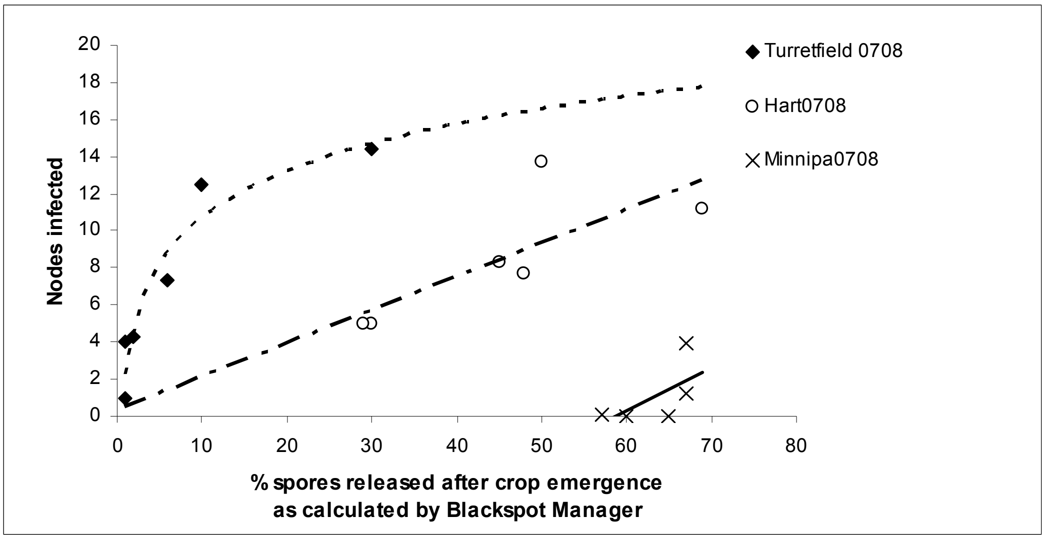


Figure 1. Relationship between final blackspot severity and Blackspot Manager spore release predictions at 3 sites over 2 years in SA

Summary

Early sowing has maximised yields of field peas over the last three years at field sites in SA representing low, medium and high rainfall pea growing areas (Figure 2). Early sowing has been paramount for economical field pea production in low and medium rainfall areas over this period and continues to be the best management strategy providing consideration for black spot, weeds and frost risk occurs. Providing management strategies like using rotational gaps of at least four years and not sowing pea crops next to neighbouring pea stubbles are implemented it is likely greater yield loss will occur from delayed sowing than from blackspot infection across seasons in low and medium rainfall environments.

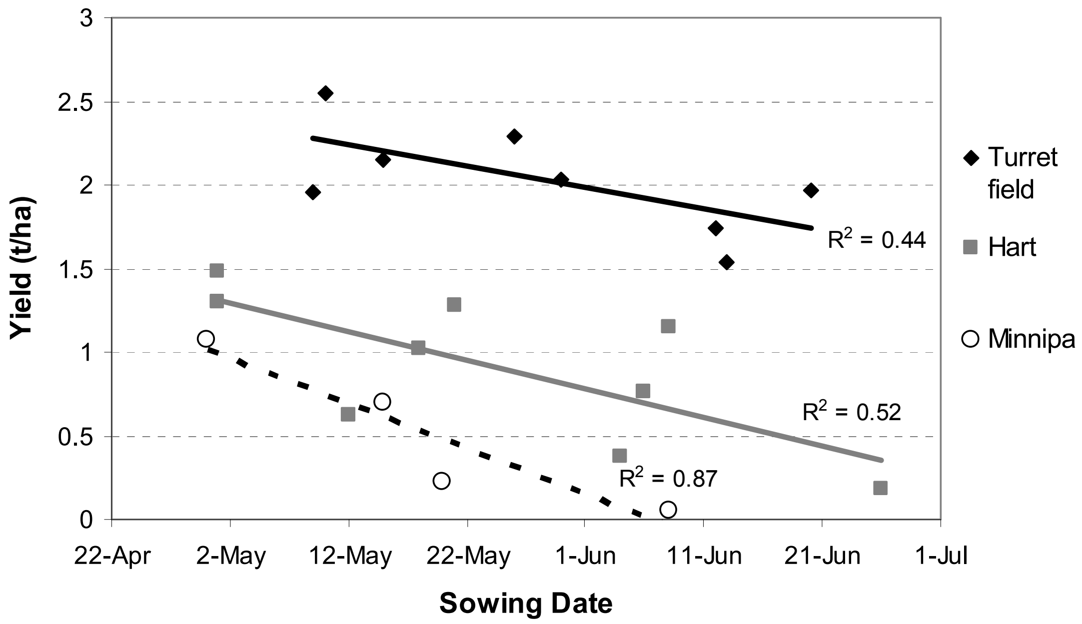


Figure 2: Effect of sowing date on grain yield of field peas at three sites in SA, 2006-2008.

OZP0602 shows high yields, wide adaptation and suitability to SA conditions, particularly to low and medium rainfall areas where it may not need to be sown as early as Kaspa to maximise yields, providing a safer option where sowing needs to be delayed due to disease, frost, weed or excessive growth issues.

'Blackspot Manager' and DIRI are important tools that can assist consultants and growers to make correct management decisions to reduce blackspot risk and have become highly relevant with the current trend of early sowing.

Acknowledgements

SA Grains Industry Trust (SAGIT) for kindly funding this research and GRDC for providing funding of additional measurements.

Wheat canopy management

This trial was funded by GRDC

Key findings

- Nitrogen application timing produced no significant differences to grain yield.
- Grain yield was reduced by 12% with the presence of ryegrass.
- Crop sensors were able to accurately measure crop dry matter.

Why do the trial?

- To improve the nitrogen and water use efficiency of wheat by manipulating canopy size and structure using post sowing applications of nitrogen and different row spacing.
- To maintain yield and quality, while reducing the risks associated with excess early crop growth.
- To compare how different nitrogen strategies effect crop competition with annual ryegrass.
- To compare and investigate the value of different optical crop sensors.

How was it done?

Plot size	450mm (18") spacing 2.7m x 10m 225mm (9") spacing 1.4m x 10m	**Fertiliser**	Single super (0:9:0:11) @ 60kg/ha
Seeding date	22nd May 2008		
Available soil moisture 27th March (0-60cm)	0mm	**Soil nitrogen 27th March (0-60cm)**	117kg/ha

1. The trial was a randomised complete block design with 3 replicates, 2 row spacings, 2 varieties, 2 nitrogen timings and 3 nitrogen rates.

Treatments

Row spacing	225mm (9") 450mm (18")
Varieties	Wyalkatchem Correll
Nitrogen rates	Nil (0kg/ha) 30kg N/ha (65kg urea/ha, 46:0) 60kg N/ha (130kg urea/ha, 46:0)

Nitrogen timings	Incorporated by sowing (IBS)
	Start of stem elongation (GS31)

IBS nitrogen was broadcast by hand and incorporated by sowing.

1st node (GS31) nitrogen was broadcast by hand on the 31st July, the rainfall following the application was,

application was,	31st July	0.4mm
	4th August	2.6mm
	5th August	15.4mm

4 optical crop sensors were used to scan plots at GS22,14 (10th July), GS31 (1st August), GS33 (22nd August) and GS39 (29th September). The sensors used were the Greenseeker, Crop circle, Topcon (prototype) and the Yara N-sensor active light sensor (ALS).

2. The ryegrass competition trial was a randomised complete block design with 2 ryegrass densities and 3 nitrogen timings.

Treatments

Nil ryegrass or 25kg/ha ryegrass incorporated by sowing (IBS).

Nil urea, urea @ 100kg/ha IBS or urea @100kg/ha GS31.

Ryegrass was established in the weed competition trial by broadcasting 25kg/ha ryegrass and incorporating with narrow points prior to sowing.

Plot edge rows were removed prior to harvest.

Ryegrass density was assessed by quadrat plant counts.

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

Results

Wyalkatchem (1.47t/ha) was the highest yielding variety compared to Correll (1.33t/ha) (Table 1).

Grain yield and grain weight were not affected by the application of any nitrogen, while protein increased significantly with an increase in nitrogen rate.

Nitrogen timing had no impact on grain yield, but delaying application of nitrogen until 1st node (GS31) increased protein by an average of 0.4%.

Averaged across both varieties and nitrogen rates there was no significant difference in grain yield or protein between either narrow or wide rows. The narrow row spacing and the high rates of nitrogen reduced grain yield for both Correll and Wyalkatchem. However, at the wider row spacing grain yields were reduced for both varieties and nitrogen rates, with the exception of Wyalkatchem with no nitrogen.

The individual grain weight of Correll sown on narrow row spacing was the lowest in the trial.

Table 1: Grain yield, protein and grain weight for row spacing, variety and nitrogen rate at Hart in 2008.

Row spacing	Variety	Nitrogen rate (kg/ha)	Grain yield (t/ha)	Protein (%)	Grain Weight (mg)
Narrow 225mm (9")	Correll	0	1.59	13.7	25.8
		30	1.50	16.1	24.8
		60	1.40	17.4	23.6
	Wyalkatchem	0	1.48	12.7	25.7
		30	1.63	14.3	27.5
		60	1.52	15.8	27.0
Wide 450mm (18")	Correll	0	1.19	15.9	23.3
		30	1.16	17.5	22.3
		60	1.17	18.3	22.6
	Wyalkatchem	0	1.52	12.9	26.5
		30	1.36	15.2	25.4
		60	1.30	16.4	24.8
LSD (0.05)					
Row spacing			0.3	1.1	ns
Variety			0.1	0.4	0.6
Nitrogen rate			0.1	0.5	ns
Row spacing*Variety			0.2	0.9	ns
Row spacing*Variety*Nitrogen rate			0.2	1.1	1.5

Screenings (less than 2.0mm) were not significantly affected by row spacing, nitrogen timing or rate. Correll had 43.9% screenings and Wyalkatchem had screenings 23.6% (LSD 0.05, 4.9%). The application of 60kg/ha nitrogen increased screenings by 9% from 29% (0kgN/ha) to 38% (60kgN/ha) (LSD 0.05, 6.0%) averaged across both varieties.

Wyalkatchem produced 11% more shoots per square metre than Correll across all treatments (Table 2). It is also clear from Table 2 that as nitrogen rate increases so too does the shoot number regardless of variety, row spacing or nitrogen timing. Sowing on wider rows produced less shoots than narrow rows.

Table 2: Shoot number (shoots per square metre) for variety, row spacing and nitrogen rate at Hart in 2008.

Variety	Row spacing	Nitrogen rate (kg N/ha)		
		0	30	60
Correll	Narrow	413	437	490
	Wide	344	346	435
Wyalkatchem	Narrow	461	530	535
	Wide	403	404	413
LSD (0.05)				
Variety			43	
Row spacing			43	
Nitrogen rate			53	

Sowing on wide rows produced 10% fewer heads compared to narrow rows across all treatments, 305 and 274 heads per square metre respectively. Hence, a variation in shoot number did not influence head number.

Crop sensors: The latest Yara N-sensor with its own light source, was able to measure a relationship with grain yield for Correll wheat at full flag leaf emergence (GS39) (Figure 1). During the growing season the other sensors produced good relationships with crop biomass one of which is displayed in Figure 2.

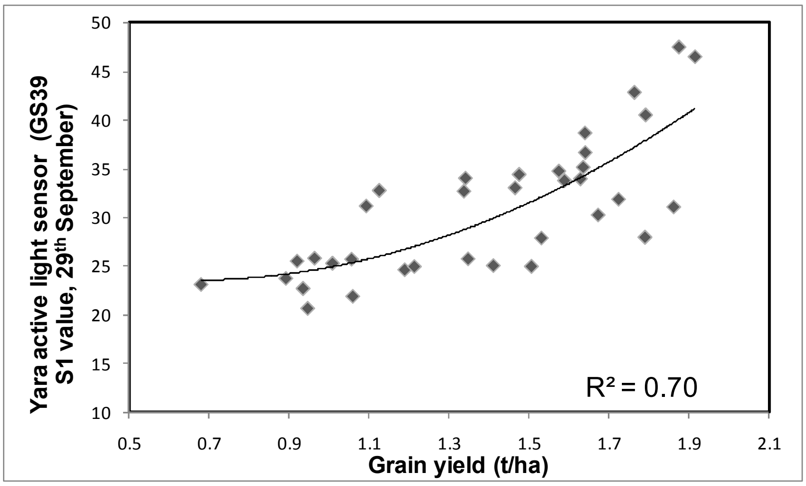


Figure 1: Grain yield (t/ha) and Yara S1 index from the Yara N-sensor (ALS) on Correll wheat at full flag emergence, 29th September at Hart in 2008.

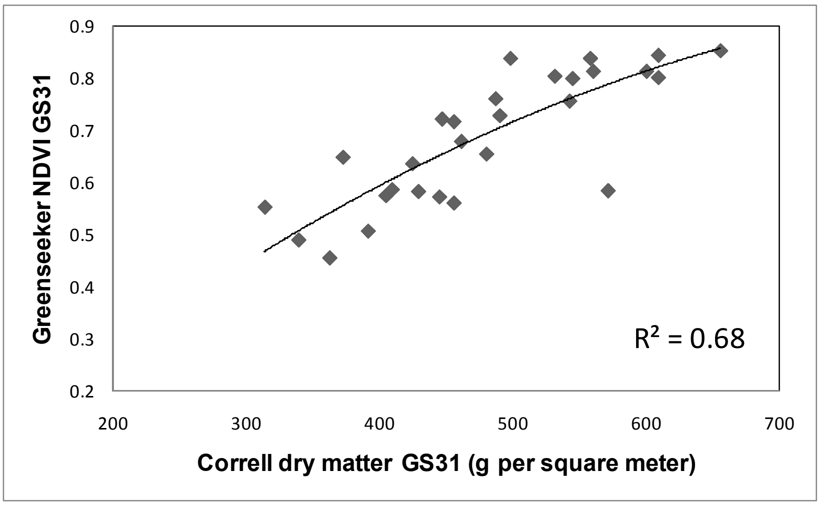


Figure 2: Dry matter production at 1st node (GS31) for Correll treatments and Greenseeker NDVI at Hart in 2008.

Ryegrass competition trial:

318 ryegrass plants per square metre reduced grain yield by 0.2t/ha or 11% (Table 4). Nitrogen timing did not produce significantly different grain yield results.

Table 4: Grain yield (t/ha) for ryegrass treatments averaged across nitrogen timings.

Ryegrass density (plants/m²)	Grain yield (t/ha)
7.2	1.75
318.0	1.54
LSD (0.05)	0.08

The presence of ryegrass or nitrogen timing did not influence grain protein.

Durum management

Funded by San Remo.

Key findings

- The presence of ryegrass reduced grain yields by 25%.
- Reduced sowing rates did not affect the grain yield or quality of new or standard durum varieties.
- A split application of nitrogen at GS31 and GS37 produced a significantly higher yield, 1.3t/ha.
- Growth regulants did not improve grain yield.

Why do the trial?

To measure the effect of crop defoliation, ryegrass, sowing rate and nitrogen timing on the grain yield and quality, of new durum varieties against current industry standards.

To compare the effect of growth regulants on durum grain yield and quality.

How was it done?

Plot size	1.5m x 10m	**Fertiliser**	DAP @ 60kg/ha + 2% Zn Urea applied as per treatment
Seeding date	22nd May 2008		
Available soil moisture 27th March (0-60cm)	0mm	**Soil nitrogen 27th March (0-60cm)**	117kg/ha

There were four trials within the experiment, all randomised complete block designs with 3 replicates.

1) Grazing, ryegrass, nitrogen timing and seeding rate

   – Nil ryegrass or ryegrass incorporated at 25kg/ha

   – Urea @ 100kg/ha (46kgN/ha) incorporated by sowing or broadcast post emergent

   – Plots were defoliated to simulate grazing prior to 1st node (GS31) from 33cm to 4cm high with a walk behind slasher

   – 2 sowing rates were used, 70kg/ha and 140kg/ha

2) New varieties and sowing rates

4 varieties - Jandaroi, Kalka, Hyperno (WID22209) or Saintly (WID22279)

3 sowing rates - 60kg/ha, 100kg/ha or 140kg/ha

3) Nitrogen Timing – post emergent nitrogen application at varying stages of growth.

1.	Nil	
2.	100% at GS31 (1st node)	30th July
3.	100% at GS37 (tip of flag leaf)	21st August
4.	50% GS31 + 50% GS37	30th July and 21st August

Sowing applications of nitrogen were broadcast prior to and incorporated by sowing.
Post emergent applications were broadcast prior to rain.

Rainfall after post-emergent nitrogen application,

1st node (GS31) on 30th July - 31st July 0.4mm, 4th August 2.6mm, 5th August 15.4mm

Tip of flag leaf (GS37) on 21st August - 21st August 2.2mm, 22nd August 3.0mm, 23rd August 0.6mm

4) Application of growth regulants

Applied by hand boom at 1st node on 30th July.

All plot edge rows were removed prior to harvest.

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

The ryegrass density was 303 plants per square metre.

Results

1) Grazing, ryegrass, nitrogen and seeding rate

Grazing did not affect grain yield or quality, which matches previous experimental findings at Hart and other trials. The impact of grazing on ryegrass seed set was not measured as the ryegrass died.

The presence of ryegrass reduced grain yield across all treatments by 25%.

All treatments produced screenings greater than 15%.

Grain protein was higher when the application of nitrogen was delayed until 1st node (16.2%) compared to applying nitrogen at sowing (15.3%).

2) Varieties & sowing rates

Hyperno (WID22209) and Saintly (WID22279) were the highest yielding varieties in the durum management trial, averaging 1.28t/ha and 1.22t/ha respectively (Table 1).
Seeding rate did not affect grain yield or quality for any variety (Table 1).
Kalka (0.86t/ha) was the lowest yielding variety but had the lowest screenings at 5.7%.
There was no difference between varieties or seeding rate for grain protein.

Table 1: Plant density, grain yield, protein and screenings for durum varieties and seeding rates at Hart in 2008.

Variety	Sowing rate (kg/ha)	Plant density (plants/m²)	Grain yield (t/ha)	Protein (%)	Screenings (%)
Hyperno (WID22209)	60	72	1.34	14.3	13
	100	108	1.25	13.6	14
	140	138	1.24	13.7	17
Saintly (WID22279)	60	53	1.25	14.1	16
	100	97	1.22	13.2	21
	140	112	1.19	13.1	22
Jandaroi	60	77	1.02	15.1	28
	100	112	1.17	14.1	22
	140	133	1.06	13.7	30
Kalka	60	72	0.85	14.5	6
	100	106	0.94	14.0	5
	140	126	0.78	13.9	6
LSD (0.05)					
Seeding rate			ns	ns	ns
Variety			0.11	ns	5
Seeding rate*variety			ns	ns	ns

3) Nitrogen timing

The highest yielding nitrogen timing treatment was clearly the split application, 50% at 1st node and 50% at tip of flag (Table 2). This treatment was 0.4t/ha above the other 3 treatments. It is not clear why this treatment produced more grain.
Screenings was not significantly affected by nitrogen timing, the average result was 4.3%.
Protein was not significantly affected nitrogen timing, the average result was 16.5%.

Table 2: Grain yield (t/ha) and nitrogen timing

Nitrogen timing	Grain Yield (t/ha)
Nil	0.90
GS31	0.63
GS37	0.69
50% GS31 + 50% GS37	1.30
LSD (0.05)	0.47

4) Growth regulants

The application of any growth regulant to durum at Hart in 2008 did not affect grain yield or quality.

Phosphorus rate trial

Key findings

- Phosphorus treatment had no significant impact on grain yield, screenings or protein at Hart in 2008.

Why do the trial?

To investigate the impact of phosphorus fertiliser on the grain yield and quality of wheat.

How was it done?

Plot size	1.5m x 10m	**Fertiliser**	All treatments Urea @ 30kg/ha IBS Post emergent urea @ 75 kg/ha urea 29th July 2008 Phosphorus applied as per treatment
Seeding date	23rd May 2008	**Variety**	Derrimut wheat

This trial is a randomised complete block design with 3 replicates of 10 fertiliser treatments (Table 1). Treatments 1 to 4 were re-sown over exactly the same treatments from 2007.

Single superphosphate and urea were sown with the seed.

Biosolids and chicken litter were broadcast by hand prior to sowing.

Table 1: Treatments in the Hart phosphorus rate trial at Hart 2008

Treatment No.	Biosolids or Chicken litter	Single super kg/ha	Total phosphorus kg P/ha
1	0	0	0
2	0	55	5
3	0	110	10
4	0	165	15
5	Biosolids 5t/ha	0	6
6	Biosolids 5t/ha	65	12
7	Chicken litter 3t/ha	0	25
8	Chicken litter 3t/ha	65	31
9	0	0	0
10	0	110	10

Initial soil phosphorus, 0 – 10cm 40mg/kg.

Plots were assessed for grain yield, screenings, and leaf tissue nutrient concentration.

Tissue tests were taken on 31st July at GS14, 22.

Samples of the Biosolids and Chicken litter were analysed for nutrient concentration (Table 2).

Table 2: Fertiliser nutrient concentrations, kg/t.

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

Results

Fertiliser treatment had no significant impact on grain yield or screenings (Table 3).

Treatments 1 to 4 produced lower protein than treatments 5 to 10 due to a different soil nitrogen history. There was no difference between fertiliser treatements.

Table 3: Grain yield (t/ha), protein (%) and screening (%) for phosphorus fertiliser treatments at Hart in 2008.

Treatment	Fertiliser treatment	Grain yield (t/ha)	Protein (%)	Screenings (%)
1	Nil	1.78	15.4	9
2	55kg/ha Single	1.75	14.8	9
3	110kg/ha Single	1.86	14.0	6
4	165kg/ha Single	1.79	14.8	11
5	5t/ha Biosolids	1.60	16.4	8
6	5t/ha Biosolids + 65kg/ha Single	1.60	16.2	11
7	3t/ha Chicken litter	1.73	16.6	10
8	3t/ha Chicken litter + 65kg/ha Single	1.60	16.8	13
9	Nil	1.63	16.2	9
10	110kg/ha Single	1.70	15.7	8
	LSD (0.05)	ns	1.7	ns

Leaf nutrients analysis tests show that there was no direct relationship between phosphorus rate or source and plant leaf phosphorus concentration (Table 4).

Table 4: Tissue test results for 7 treatments showing phosphorus, zinc and potassium levels.

Treatment	Fertiliser treatment	Applied phosphorus	Leaf concentration (ppm)		
		kg P/ha	Phosphorus	Zinc	Potassium
1	Nil 1	0	3800	21	37000
2	55kg/ha Single	5	3600	19	38000
5	5t/ha Biosolids	6	3500	25	40000
6	5t/ha Biosolids + 65kg/ha Single	12	3400	20	38000
7	3t/ha Chicken litter	25	3400	24	40000
8	3t/ha Chicken litter + 65kg/ha Single	31	3200	22	39000
9	Nil 2	0	3300	20	36000

Dry sowing and pre-emergent herbicides

This trial is funded by GRDC in collaboration with the University of Adelaide

Key findings

- The dry sowing treatment had lower crop establishment in all treatments compared to sowing into moist soil.
- No additional herbicide was found in the row after rain for the dry time of sowing.
- For the moist soil sowing treatment there was a greater concentration of herbicide in the inter-row as indicated by the reduced growth of ryegrass.

Why do the trial?

To evaluate the effectiveness of pre-emergent herbicides and crop safety in dry sowing conditions.

How was it done?

Plot size 1.5m x 10m

Fertiliser DAP @ 50kg/ha + 2% Zn

Seeding date Dry sowing 24th April 2008; Wet sowing 1st May 2008

Variety Derrimut wheat

The trial was a randomised complete block design with 3 replicates, 8 herbicide treatments and 2 times of sowing.

The seeding equipment used narrow points on 225mm (9") spacing with press wheels.

The dry time of sowing was on the 24th April just prior to the opening rains on the 27th April 2008 and the wet time of sowing was on the 1st May, shortly after the rain (22.4mm).

The herbicide treatments (Table 1) were applied using a hand boom one hour prior to sowing.

Table 1: Herbicide treatments and active ingredients for the pre-emergent herbicide and dry sowing trial at Hart in 2008.

Herbicide treatment	Active ingredients
Nil	
Trifluralin 480 1.8L/ha	trifluralin 480g/L
Trifluralin 480 3.0L/ha	trifluralin 480g/L
Boxer Gold IBS 2.5L/ha	S-metolachlor 120g/L + prosulfocarb 800g/L
Boxer Gold IBS 3.5L/ha	S-metolachlor 120g/L + prosulfocarb 800g/L
Trifluralin 480 1.4L/ha + Avadex Xtra 1.6L/ha	trifluralin 480g/L + tri-allate 500g/L
Trifluralin 480 1.4L/ha + Dual Gold 500ml/ha IBS	trifluralin 480g/L + S-metolachlor 960g/L
Tri-athlete 2.3L/ha	trifluralin + cinmethylin

For the Boxer Gold treatments soil samples were taken on the seed row (on row) and between the seed rows (inter-row) before and after the rain to measure herbicide movement.

The soil was placed in trays and ryegrass sown. The germination and dry matter of the ryegrass was measured and used against known concentrations of Boxer Gold.

Plant emergence counts were taken on all plots.

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

Results

Plant emergence was not significantly affected by herbicide treatment, but was significantly lower with dry sowing (Table 2).

Grain yield increased significantly in the wet time of sowing. This may be due to the higher plant number.

Protein was 0.5% higher in the dry time of sowing.

Table 2: Plant number (plants per square metre) grain yield (t/ha), protein (%) and time of sowing at Hart in 2008.

Time of sowing	Plant number (plants/m²)	Grain yield (t/ha)	Protein (%)
Dry (24th April)	99	0.93	14.6
Wet (1st May)	148	1.26	14.1
LSD (0.05)	16	0.09	0.4

Pre-emergent herbicides significantly affected grain yield independent for both of sowing times (Table 3). Trifluralin 480 1.8L/ha, Trifluralin 480 1.8L/ha + Avadex Xtra 1.6L/ha and Tri-athlete 2.3L/ha were the highest yielding treatments.

The nil treatment was one of the lowest yielding treatments. This result may be attributed to a higher weed density.

Table 3: Grain yield (t/ha) and herbicide treatment averaged for both times of sowing.

Treatment	Grain Yield (t/ha)
Nil	1.02
Trifluralin 480 1.8L/ha	1.15
Trifluralin 480 3.0L/ha	1.07
Boxer Gold IBS 2.5L/ha	1.07
Boxer Gold IBS 3.5L/ha	1.08
Trifluralin 480 1.4L/ha + Avadex Xtra 1.6L/ha	1.12
Trifluralin 480 1.4L/ha + Dual Gold 500ml/ha IB!	1.09
Tri-athlete 2.3L/ha	1.18
LSD (0.05)	0.09

No additional chemical was washed into the row between the 24th April and the 28th April for the dry sowing treatments. During this time there was a 23mm rain event (27th April) where it was expected that the soluble components of the Boxer Gold would move into the row. This is shown in table 4 where the relative herbicide activity (RHA) is similar for both dry and wet sampling times in the dry time of sowing. RHA is a function of herbicide activity in the inter-row compared to the herbicide activity on the row.

Table 3 shows that during the wet sowing operation more herbicide moved from the row to the inter-row than the in the dry sowing operation. This is affected by the level of soil throw generated by the seeding points and the row spacing. During the dry sowing operation it was noted that the soil was cloddy (clods up to 5cm diameter) and these clods were falling back into the row. The wet sowing operation created a better seed bed and distinct furrows were left behind the seeder.

For the wet sowing treatments there was a greater concentration of herbicide in the inter-row. This is supported by a lower ryegrass germination in the inter-row (Table 4)

Table 4: Bioassay results of soil samples taken from the Boxer Gold 3.5L/ha treatments.

Sowing date	Sampled	Rate	Ryegrass wet weight (g)			Ryegrass germination (%)		
		L/ha	On row	Inter row	RHA	On row	Inter row	RHA
Dry (24 Apr)	Dry (24 Apr)	3.5	2.33	1.29	181	89	61	146
Dry (24 Apr)	Wet (28 Apr)	3.5	4.02	2.14	188	86	75	115
Wet (1 May)	Wet (1 May)	3.5	1.26	0.52	242	80	49	163

RHA=relative herbicide activity in inter row as compared to on-row

Control of ryegrass with pre-emergent herbicides and inter-row sowing

This trial was funded by GRDC and in collaboration with Birchip Cropping Group and the University of Adelaide

Key findings

- There was no significant change in wheat or ryegrass establishment due to sowing systems or position.
- BAY-191 produced the greatest control of ryegrass, 79%.

Why do the trial?

To compare the effect of different pre-emergent herbicides and 2 seeding systems on wheat establishment and ryegrass control.

How was it done?

Plot size	1.5m x 10m	**Fertiliser**	DAP @ 60 kg/ha + 2% Zn Post Emergent Urea @ 75kg/ha on 29th July 2008
Seeding date	27th May 2008	**Variety**	JNZ wheat @ 90kg/ha

The trial was a randomised complete block design with 3 replicates, 2 sowing systems, 2 sowing positions and 7 herbicide treatments.

The trial was sown into wheat stubble established in 2007, using 2cm auto steer.

Table 1: Pre-emergent herbicide treatments and active ingredients for the inter-row sowing trial at Hart in 2008.

Herbicide treatment	Active ingredients
Nil	
Trifluralin 480 1.4L/ha	trifluralin 480g/L
Trifluralin 480 1.4L/ha + Dual Gold 0.5L/ha	trifluralin 480g/L + S-metolachlor 960g/L
Trifluralin 480 1.4L/ha + Avadex Xtra 1.6L/ha	trifluralin 480g/L + tri-allate 500g/L
Boxer Gold 2.5L/ha	S-metolachlor 120g/L + prosulfocarb 800g/L
Tri-athelete 2.3L/ha	trifluralin + cinmethylin
BAY-191 118g/ha	experimantal

Sowing systems:

Knife point – Agmaster press wheel system on 225mm (9”) spacing
Disc – Single disc Austil on 225mm (9”) spacing

Sowing positions:

Inter-row seeding with 2cm accuracy or random sowing

Pre-emergent herbicides were applied on the day of sowing.

The ryegrass used was approximately 30% resistant to trifluralin and was broadcast at 25 kg/ha ahead of seeding.

Crop emergence was measured by counting plants along 2m of row, per plot.
Ryegrass was counted with 0.1 square metre quadrats at 5 sites (total $0.5m^2$) within each plot.

All plots were assessed for grain yield.

Results

There was no significant change in wheat or ryegrass establishment due to sowing system or position. Herbicide treatment did not influence wheat establishment although Tri-athlete treatments tended to reduce emergence.

The greatest ryegrass control (79%), was achieved with the herbicide BAY–191 118g/ha (treatment 1) although this was not significantly different to treatments 3 to 6 (Table 1). It is likely that Trifluralin 480 1.4L/ha + Dual Gold 0.5L/ha (treatment 3) produced only 52% ryegrass control because of the dry start to the growing season.

Trifluralin 480 1.4L/ha alone gave only 17% control of the ryegrass and is typical for the control of resistant ryegrass.

Table 1: Wheat and ryegrass establishment for herbicide treatment averaged for both sowing system and position.

Treatment number	Herbicide treatment	Plants per sq m Wheat	Plants per sq m Ryegrass	Ryegrass % control
1	Nil	168	42	0
2	Trifluralin 480 1.4L/ha	157	35	17
3	Trifluralin 480 1.4L/ha + Dual Gold 0.5L/ha	158	20	52
4	Trifluralin 480 1.4L/ha + Avadex Xtra 1.6L/ha	153	11	74
5	Boxer Gold 2.5L/ha	159	10	76
6	Tri-athelete 2.3L/ha	140	12	71
7	BAY-191 118g/ha	174	9	79
	LSD(0.05)	ns	11	27

Grain yield was not significantly affected by any treatment in the trial averaging 1.03t/ha.

Legume and oilseed herbicide tolerance

Key findings

- New post emergent broadleaf herbicides Torpedo, Conclude, Precept and Velocity generally gave good control of pulses or canola.
- Pre-emergent grass herbicides had no effect on the growth of pulses or canola.

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 @ 60kg/ha

Seeding date 30th May 2008

14 strips of canola, pastures, vetch, chickpeas, faba beans, field peas and lentils were sown. 61 herbicide treatments were applied across these crops at one of 5 timings.

The timings were

Pre sowing (IBS)	30th May
Post seeding pre-emergent	6th June
Early post emergent (3 – 4 node)	4th July
Post emergent (5 node)	18th July
Late post emergent (8 node)	7th 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 conditions.

All pre-emergent herbicides incorporated by sowing had little effect on any of the crops treated. A reminder that registrations for these herbicides are limited or not recommended for many of these crop types.

Broadstrike applied early post emergent to Nugget and Nipper lentils had a moderate to severe effect on both varieties.

Sniper applied early post emergent gave poor control of beans and chick peas. In previous years this has not been the case.

Raptor applied early post emergent at 45g/ha caused only a slight effect in Farah beans but moderate effects were recorded in the Nura beans. There had not been any difference between bean varieties in the recent past when treated with Raptor. This product is only registered for use in field peas and lucerne based pastures(clovers, lucerne, medics, saradellas) when applied post-emergent in South Australia. There is a permit in South Australia for faba beans.

At 0.5L/ha Precept had no effect on Morava vetch and chickpeas, and only a moderate effect on both bean varieties. In 2007 Precept was applied at 1.0L/ha and killed all pulses and canola.

Velocity is a new introduction for 2008 and it did a good job at killing all crops except for Morava vetch where effects were only moderate.

There was no effect of Affinity or atrazine on the 2 vetch varieties. In the previous 3 years there has been at least moderate effects and in 2007 both chemicals caused death in Capello and atrazine killed the Morava.

Most of the knockdown chemicals did a good job on all crops other than the vetch. When glyphosate and Sprayseed were applied alone they both struggled to kill some crops.
Of the 2 double knock treatments glyphosate // Sprayseed 3DAS gave the best result across all crops. The only knockdown treatments that killed the vetch were glufosinate or glyphosate + Cadence. Glufosinate did a good job on all other crops except for the beans and canola.

Legume & Canola Herbicide Tolerance

Timing	No.	Treatment	Rate kg/ha	Pasture			Lentils		Vetch		Chick Peas	Peas	Beans		Canola		
				Angel	Herald	Frontier Balansa	Nugget	Nipper	Morava	Capello	Genesis 090	Kaspa	Nura	Farah	Kimberley	Tornado	44C73
		Treatment	Rate kg/ha	15	15	15	55	45	45	45	80	100	140	140	5	5	5
Pre-Sow 30/05	1	NIL		1	1	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	1	1
	3	Dual Gold	500ml	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	4	BAY-191	166g	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	5	Boxer Gold	2500ml	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	6	Propyzamide	1500g	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	7	Trifluralin + Cynmethylin	1900ml/360ml	1	1	1	2	1	1	1	1	1	1	1	1	1	1
PSPE 06/06	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	Diuron	850g	2	2	4	1	1	1	1	1	1	1	1	3	4	2
	3	Simazine	850g	2	1	4	1	1	1	1	2	1	1	1	1	1	1
	4	Diuron + Simazine	410g/410g	1	1	4	1	1	1	1	1	1	1	1	1	1	1
	5	Metribuzin	280g	3	3	4	1	1	2	2	1	2	2	1	1	1	1
	6	Spinnaker	70g	1	4	5	3	3	1	1	2	2	3	2	5	5	1
	7	Spinnaker + Simazine	40g/850g	3	4	5	2	2	2	2	1	2	2	2	5	5	1
	8	Balance	100g	5	5	5	5	5	3	3	1	3	3	3	5	5	5
	9	Balance + Simazine	100g/830g	5	5	5	5	4	3	3	1	3	3	3	5	5	5
3-4 node 04/07	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	Simazine	850g	2	1	1	1	1	1	1	1	1	1	1	1	1	1
	3	Metribuzin	280g	5	5	5	2	2	2	2	1	1	2	3	5	1	5
	4	Broadstrike	25g	1	1	1	4	3	1	1	1	1	3	2	5	5	1
	5	Brodal Options	150ml	3	3	2	2	1	1	1	1	2	3	3	3	3	1
	6	Brodal Options + MCPA Amine	150ml/150ml	3	3	2	2	1	1	1	1	2	3	3	3	3	3
	7	Sniper 750WG	50g	3	3	1	1	1	1	1	1	1	1	1	1	1	1
	8	Spinnaker + wetter	70g/0.2%	2	4	4	5	4	1	1	5	1	3	3	5	5	1
	9	Raptor + wetter	45g/0.2%	1	4	4	5	5	2	1	5	1	3	2	5	5	1
5 node 18/07	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	Logran	10g/0.1%	3	4	5	5	5	5	5	5	5	5	5	5	5	1
	3	Ally + wetter	7g/0.1%	4	5	5	5	5	2	5	5	5	5	5	5	5	2
	4	Eclipse + Uptake	7g/0.5%	3	5	5	5	5	4	4	4	5	5	5	5	5	1
	5	Torpedo + Uptake	100ml/0.5%	4	4	5	5	5	5	5	5	5	5	5	5	5	5
	6	Conclude + Uptake	700ml/0.5%	3	4	5	5	5	5	5	5	5	5	5	5	5	5
	7	Precept + Hasten	500ml/1%	4	4	3	5	5	1	5	1	4	3	3	5	5	5
	8	Velocity + Hasten	670ml/1%	5	5	4	5	5	3	5	4	5	5	5	5	5	5
	9	Banvel M	1L	5	5	4	5	5	4	5	5	4	5	5	5	5	5
	10	Intervix + Hasten	600ml/1%	3	5	5	5	5	3	3	5	4	4	4	5	5	1
	11	Midas + Hasten	900ml/0.5%	1	5	5	5	5	3	5	4	4	4	4	5	5	3
	12	Hussar OD + wetter	100ml/0.25%	5	5	5	5	5	5	5	5	5	5	5	5	5	2
	13	Crusader + Uptake	500ml/0.5%	3	5	5	5	5	5	5	5	5	5	5	5	5	1
	14	Atlantis OD + Hasten	330ml/0.5%	5	5	5	5	5	4	5	4	5	5	5	5	5	1
	15	Affinity Force + MCPA Amine	100ml/500ml	4	4	4	4	4	1	1	5	4	4	5	5	5	5
	16	Atrazine + Hasten	833g/1%	4	3	4	3	3	1	1	3	4	2	2	3	1	3
	17	Lontrel	150ml	5	5	5	5	5	5	5	5	5	5	5	1	1	1
8 node 07/08	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	MCPA Sodium	700ml	3	3	3	3	4	4	4	3	1	4	4	5	5	5
	3	MCPA Amine	350ml	3	3	3	4	4	4	4	3	1	4	4	5	5	5
	4	Amicide 625	1.2L	4	4	4	5	5	5	5	5	5	5	5	5	5	5
	5	2,4-D Ester	70ml	2	2	3	1	1	1	1	4	1	1	1	3	3	3
5 node 18/07	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	Sprayseed	2L	3	3	3	4	4	2	2	2	4	3	3	5	5	4
	3	Glyphosate	1L	5	5	5	5	5	2	2	4	5	4	4	5	5	5
	4	Glyphosate + LVE 680	1L/500ml	5	5	5	5	5	4	4	5	5	5	5	5	5	5
	5	Glyphosate + Hammer	1L/50ml	5	5	5	5	5	3	3	4	5	4	4	5	5	5
	6	Glyphosate + Goal	1L/100ml	5	5	5	5	5	4	4	5	5	5	5	5	5	5
	7	Glyphosate + Cadence	1L/115g	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	10	Alliance	2L	4	4	4	4	4	3	4	4	5	5	5	5	5	5
	11	Glyphosate // Sprayseed 3DAS	1.2L//1.2L	5	5	5	5	5	2	3	4	5	4	4	5	5	5
	12	Sprayseed // Sprayseed 3DAS	1.2L//1.2L	3	3	3	4	4	4	3	4	5	4	4	5	5	5
	13	Glufosinate	2.5L	5	5	5	5	5	5	5	4	5	4	4	3	5	4
	14	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1

Integrated weed management

This trial is funded by the GRDC and conducted in collaboration with Birchip Cropping Group and the University of Adelaide

Key findings

- The seed catcher treatment reduced the ryegrass seed bank from 2007 most effectively
- Delaying sowing in 2008 from the 29th May until the 6th June decreased the ryegrass population by 55%.

Why do the trial?

To combine existing knowledge with new techniques for effective integrated weed management to control herbicide resistant ryegrass.

How was it done?

Plot size	35m x 13m	**Fertiliser**	DAP @ 75kg/ha + 2% Zn Canola post emergent Nitrogen 4th July Urea @ 100kg/ha
Seeding date	TOS 1 29th May 2008 Delayed sowing 6th June 2008		
Autumn Tickle	24th April 2008		

This trial was a randomised split block design with 3 replicates. It has 4 blocks of additional management practice (nil treatment, delayed sowing, autumn tickle or seed catcher) and 6 management treatments (Table 1). These treatments include low and high sowing rates in combination with low or high use of pre-emergent herbicides

Table 1: Management treatments applied in 2008.

2007 crop	2008 crop	2008 crop emergence plants per sq m	Pre-emergent herbicides
Kalka durum	Correll wheat	186	Trifluralin 480 1.2L/ha
Kalka durum	Correll wheat	196	Trifluralin 480 1.2L/ha + Avadex Xtra 1.2L/ha + Dual Gold 0.35L/ha + Logran 10g/ha
Kalka durum	Correll wheat	252	Trifluralin 480 1.2L/ha
Kalka durum	Correll wheat	259	Trifluralin 480 1.2L/ha + Avadex Xtra 1.2L/ha + Dual Gold 0.35L/ha + Logran 10g/ha
Buckley hay	TT Tornado canola	57	Trifluralin 480 1.2L/ha
TT Tornado canola	Correll wheat	194	Trifluralin 480 1.2L/ha

The additional management practices were:

- Nil treatment - no additional weed management
- Delayed sowing - these blocks were sown 8 days later
- Autumn tickle - blocks were shallow cultivated using 50mm (2") chisel points on 225mm (9") spacing on the 24th April
- Seed catcher - chaff and straw was collected during the previous harvest

This trial was established in 2007. The previous crops are listed in Table 1. Annual ryegrass was broadcast at 25kg/ha and incorporated by sowing. In 2007 the pre-emergent herbicides were applied according to the management treatments in Table 1. The only additional management practice in 2007 was the use of a seed catcher at harvest on selected blocks.

The canola was sprayed with standard post-emergent selective herbicides which gave 100% ryegrass control.

The hay was cut with a walk behind slasher and residues removed from the plot, no ryegrass or wheat re-grew after the hay cut.

In late Autumn 2008, soil samples (0-10cm) were taken from the nil and seed catcher additional treatments to measure the amount of ryegrass in the seed bank.

A ryegrass germination prior to sowing in 2008 was sprayed out with a knock down herbicide combined with the pre-emergent herbicide treatments.

Crop emergence was measured by counting plants along 2m of row, per plot.
Ryegrass was counted with 0.1 square metre quadrats at 5 sites (total $0.5m^2$) within each plot.

Results

2007

Using the seed catcher significantly reduced the seed bank population by an average of 50% compared to the nil treatment (Table 2).

The management treatments used in 2007, such as higher sowing rates or more pre-emergent herbicides had no influence on the ryegrass seed bank.

Table 2: Viable ryegrass in the seed bank in Autumn 2008 at Hart.

2007 crop	Plants per sq m	Pre-emergent herbicides	Viable ryegrass in seedbank 2008 Nil treatment	Seed catcher
Kalka	200	Trifluralin 480 0.8L/ha	197	74
Kalka	200	Trifluralin 480 0.8L/ha + Avadex Xtra 1.2L/ha + Dual Gold 0.35L/ha + Logran 10g/ha	134	95
Kalka	300	Trifluralin 480 0.8L/ha	172	88
Kalka	300	Trifluralin 480 0.8L/ha + Avadex Xtra 1.2L/ha + Dual Gold 0.35L/ha + Logran 10g/ha	261	50
Buckley hay	200	Trifluralin 480 0.8L/ha	113	156
TT Tornado	80	Trifluralin 480 0.8L/ha	164	57
LSD (0.05)	Seed catcher at harvest		23	
	Herbicide		ns	
	Herbicide*Seed catcher		55	

2008

Ryegrass results:

Dry conditions in the years 2007 and 2008 meant that the ryegrass population across the entire trial site was very low. The highest average ryegrass population recorded in July 2008 was 18 plants per square metre.

Wheat at 186 plants per square metre with Trifluralin 480 at 1.2L/ha gave the poorest control of ryegrass (Table 3). Ryegrass control was improved with the addition of extra pre-emergent herbicides by 54% irrespective of other treatments. Increasing the crop density also reduced ryegrass emergence, regardless of pre-emergent herbicide. Increasing the crop density as well as using additional pre-emergent herbicides increased control to 73%. Using a break crop in 2007 also significantly reduced the ryegrass population.

Delaying sowing by 7 days in 2008 reduced the ryegrass population by 55% for all herbicide treatments and break crops, this was the best additional management strategy for reducing ryegrass the population (Table 3). Although the seed catcher was able to reduce the viable ryegrass seed bank numbers (Table 2), there was little difference between the autumn tickle and seed catcher in ryegrass establishment.

Table 3: Crop and ryegrass establishment on 23rd July for 6 management treatments across 4 additional management practices at Hart in 2008.

2007 crop	2008 crop	Pre-emergent herbicides	Crop emergence plants per sq m	Ryegrass emergence plants per sq m				
				No treatment	Autumn tickle	Delayed sowing	Seed catcher	Management average
Kalka durum	Correll wheat	Trifluralin 480 1.2L/ha	186	18	15	12	13	15
Kalka durum	Correll wheat	Trifluralin 480 1.2L/ha + Avadex Xtra 1.2L/ha + Dual Gold 0.35L/ha + Logran 10g/ha	196	9	10	2	7	7
Kalka durum	Correll wheat	Trifluralin 480 1.2L/ha	252	13	7	5	7	8
Kalka durum	Correll wheat	Trifluralin 480 1.2L/ha + Avadex Xtra 1.2L/ha + Dual Gold 0.35L/ha + Logran 10g/ha	259	5	3	2	3	3
Buckley hay	TT Tornado canola	Trifluralin 480 1.2L/ha	57	3	10	3	18	9
TT Tornado canola	Correll wheat	Trifluralin 480 1.2L/ha	194	8	3	3	2	4
			Additional management average	9	8	4	8	
LSD (0.05)	Additional Management		ns		4			
	Management		25		3			
	Additional management*Managmert		ns		8			

Grain yield results:

The only treatment that had any significant influence on wheat grain yield was the pre-emergent herbicide treatment (Table 4). Although the addition of extra pre-emergent herbicides increased the control of ryegrass it reduced wheat grain yield by 11% in 2008.

Table 4: Wheat grain yield (t/ha) for pre-emergent herbicide treatment.

Pre-emergent herbicides	Wheat grain yield (t/ha)
Trifluralin 480 1.2L/ha	1.18
Trifluralin 480 1.2L/ha + Avadex Xtra 1.2L/ha + Dual Gold 0.35L/ha + Logran 10g/ha	1.05
LSD (0.05)	0.13

The average canola grain yield for the IWM trial at Hart in 2008 was 0.05t/ha.

Control of bifora (*bifora testiculata*)

Key findings

- Affinity mixtures consistently gave the best control of bifora.
- Treatments containing diuron or Buctril MA consistently produced reliable control.
- Precept was also one of the more effective treatments.

Why do the trial?

In Southern Australia bifora continues to persist, increasing crop input costs and reducing rotational options, particularly the use of legumes. It has spread easily as a result of contaminated seed, hay, machinery and livestock. In cereals bifora is often able to produce seed late in the growing season and its control has been limited and unreliable in pulse crops.

There is a limited understanding about the biology of bifora seed. Current knowledge suggests that bifora generally has a staggered germination and doesn't germinate if left on the soil surface. Major germination events are usually observed in late winter after seeds have experienced natural cold stratification of the seed-bank. About 75% of bifora seed remains dormant for more than 12 months, causing sporadic infestations in the field for several years.

Previous trial work has shown that early post-emergence in wheat useful early control or suppression is possible with Glean, triasulfuron (e.g Logran), diuron + MCPA mixtures or bromoxynil + MCPA mixtures, usually with Ally or Eclipse. Triasulfuron + terbutryn (e.g Amber Post) also did a good job. For later control Ally or Eclipse with bromoxynil + MCPA mixtures or 2,4-D amine were reasonably effective. Glean (20-25g/ha) was the only registered treatment in cereals at the time these trials were conducted.

In peas and lentils metribuzin (e.g Lexone, Sencor) applied early post-emergence are still the most effective treatments for bifora (80-90% control). While for peas and beans imazethapyr (e.g Spinnaker) will suppress, but not kill bifora.

Field trials were conducted between 2006 and 2008 to compare previous best bet herbicide treatments with newer herbicides such as Affinity, Precept, Conclude, Torpedo and Velocity on the control of bifora. This was done in conjunction with glasshouse studies on the biology of bifora seed.

How was it done?

Herbicide efficacy trials were conducted in 2006 and 2008 at three sites in the Mid-North. These were done in commercial crops with a uniform density of bifora.

The trials were randomised complete block designs with 3 replicates.

The herbicide treatments were applied using a hand boom at 2 bar pressure, using 110 L/ha water with XR110 01 flat fan nozzles. The conditions at the time of application are listed in Table 1.

Table 1. Crop type, bifora growth stage and conditions at the time of application for each year and site.

Crop & Conditions	**2006**		**2008**
	Black Springs	**Blyth**	**Farrell Flat**
Sown crop type	Oats	Wheat	Wheat
Date of application	24th August	26th August	27th August
Growth stage at application	GS30	GS32	GS14, 22
Bifora growth stage	3 – 6 leaf	5 – 8 leaf	2 – 4 leaf
Time of day	2:00pm	1:00pm	3:00pm
Cloud cover	Clear sky	85% cloud cover	Clear sky
Temperature	18^{o}C	19^{o}C	17^{o}C
Humidity	53%	40%	40%
Assessment date (DAT)	29/9 (?)	29/9	8/10 (42)

All plots were assessed for herbicide efficacy based on the level of leaf burn relative to the control with 0 being no leaf burn, and 100% being no green leaf remaining.

Glasshouse studies on the biology of bifora seed were conducted by the University of Adelaide and included temperature and seed coat scarification techniques.

Results

The germination of bifora was found to be strongly increased by cold stratification (chilling) (Figure 1). Cold stratification was able to partially break seed dormancy in bifora. Seeds germinated at 10^{o}C (control) had 2% germination but cold stratification at 4^{o}C for 7 weeks increased seed germination to 19%. This stimulation of germination by exposure to cold is consistent with the behaviour of bifora in the field.

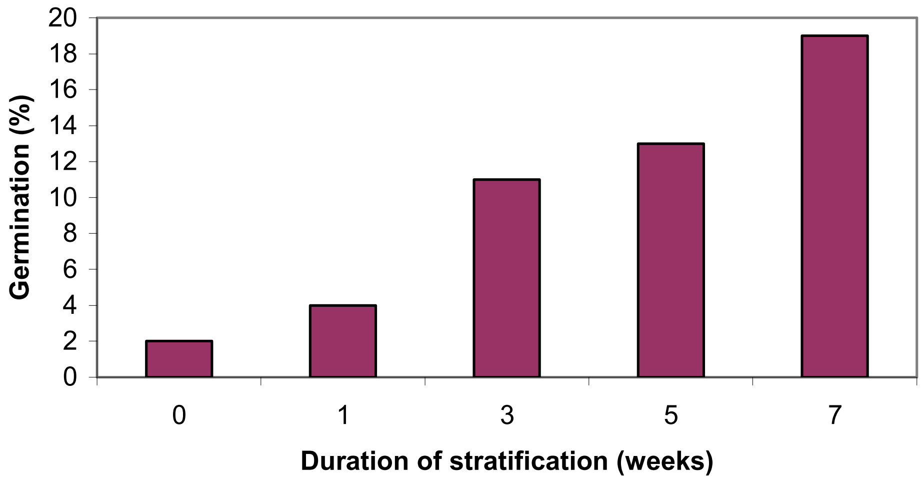


Figure 1. The effect of cold stratification on seed germination in bifora

Affinity mixtures consistently gave the best control of bifora (Table 2). There were no significant differences in control between the addition of either MCPA Amine, 2,4-D Amine or Buctril MA to Affinity. Of these Buctril MA tended to be the best. When mixed with 2,4-D Amine and Ally at a lower rate (40g/ha), Affinity still produced comparable results to Affinity mixtures using the higher rate (60g/ha). Although the addition of ammonium sulphate improved the control, it was not significantly different.

Affinity (60g/ha) and MCPA Amine (500ml/ha) is a registered herbicide mix for the control of bifora in winter cereals.

Table 2. Effect of herbicides on bifora in cereal crops between 2006 and 2008.

Herbicide treatment	2006 Black Springs	2006 Blyth	2008 Farrell Flat
	% Control		
Untreated	0	0	0
Glean 25g + wetter 0.1%	85	59	30
Ally 5g + Diuron 800ml + MCPA LVE 600ml	92	65	87
Ally 5g + Buctril MA 1.0L/ha + wetter 0.1%	78	53	75
Diuron 800ml + Buctril MA 1.0L/ha	78	62	93
2,4-D Amine 1.5L/ha		80	13
Eclipse 7g + 2,4-D Amine 1.0L/ha + wetter 0.1%	67	77	43
Eclipse 7g + 2,4-D Amine 1.0L/ha + wetter 0.1% + AmSO4 2%			30
Eclipse 5g + Ally 5g + Buctril MA 1.0L	78	78	43
Affinity 40g + Ally 5g + 2,4-D Amine 500ml	93	80	90
Affinity 40g + Ally 5g + 2,4-D Amine 500ml + AmSO4 2%		90	97
Affinity 60g + MCPA Amine 500ml	82	82	97
Affinity 60g + 24D Amine 500ml	95	90	90
Affinity 60g + Buctril MA 1.0L/ha	98	80	100
Torpedo 100ml + Uptake 0.5%	49	67	
Torpedo 100ml/ha + MCPA LVE 500ml/ha + Uptake 0.5%			37
Conclude 1.0L/ha + Uptake 0.5%	62	91	
Conclude 1.5L/ha + Uptake 0.5%			37
Midas 900ml + Hasten 0.5%	67	90	30
Velocity 650ml/ha + Hasten 1.0%			77
Precept 1.5L/ha			85
Crusader 500ml/ha + MCPA LVE 500ml/ha + wetter 0.25%			23
Hussar OD 100ml/ha + wetter 0.25%			23
LSD (P<0.05)	13	15	18

The treatments containing diuron or Buctril MA consistently produced reliable results and in some cases were not significantly different from the best treatments, such as at Black Springs in 2006 or Farrell Flat in 2008. Diuron mixed with Ally and MCPA LVE or Buctril MA also gave good results,and is consistent with previous findings.

Mixes containing Eclipse did not give consistent results, with the best control obtained at Blyth in 2006 for all the Eclipse mixtures. In the cases where Eclipse didn't give good control, the plants were very stunted.

Of the latest broadleaf herbicides to be released Conclude gave one excellent result out of three trials, while Torpedo always gave poor control of bifora. In only one year of inclusion (2008) Precept gave control not significantly different to the best treatments, while Velocity also gave very good control.

A high rate of 2,4-D Amine applied alone gave in-consistent results while Hussar, Crusader, and Midas gave poor results, in two of the three trials.

Table 3. Details of herbicides used

Herbicide	Active Constituent
Glean	750 g/kg chlorsulfuron
Ally	600 g/kg metsulfuron methyl
Diuron	500 g/L diuron
MCPA LVE	500 g/L MCPA as ethyl hexyl ester
Buctril MA	200 g/L bromoxynil
	200 g/L as ethyl hexyl ester
2,4-D Amine	625 g/L 2,4-D as dimethylamine and diethanolamine salts
Eclipse	714 g/kg metosulam
Affinity	400 g/kg carfentrazone-ethyl
MCPA Amine	500 g/L MCPA as dimethylamine salt
Torpedo	50 g/L florasulam
	300 g/L clopyralid (Lontrel)
Conclude	30 g/L florasulam
	250 g/L MCPA as ethyl hexyl ester
Midas	289 g/L MCPA as ethyl hexyl ester
	22 g/L imazapic
	7.3 g/L imazapyr
Velocity	37.5 g/L pyrasulfotole
	210 g/L bromoxynil
Precept	25 g/L pyrasulfoltole
	125 g/L MCPA as ethyl hexyl ester
Crusader	30 g/L pyroxsulam
	90 g/L cloquintocet
Hussar	50 g/kg iodosulfuron-methyl sodium

Acknowledgements: GRDC, Gurjeet Gill and Chris Preston (University of Adelaide), Robert Wandel, Andrew Fatchen, and Kym Harvey (Growers).

Spray nozzles for crop topping annual ryegrass

Key findings

- All the spray nozzles trialled gave an equal level of ryegrass seed control.

Why do the trial?

Over the past few seasons growers have been shifting towards the use of spray nozzles that produce larger droplets. There are many benefits for this such as:

- meeting regulations when using 2,4-D amine or ester.
- reducing the risk of spray drift, particularly when using knockdown herbicides alongside crops already emerged.
- increasing the number of spraying opportunities if too windy for flat fan jets.
- losing less chemical before it hits the weeds or soil.

Much work has been conducted on the performance of nozzles on 2 leaf to early tillering grasses focusing on knock down timing prior to sowing and for in crop grass selective herbicides. However, very little work has been done on the influence of droplet size on the efficacy of desiccant herbicides on ryegrass seed heads, for crop topping.

This trial aimed to test the efficacy of a range of droplet sizes on ryegrass seed heads using a commonly used desiccant herbicide (paraquat).

How was it done?

Annual ryegrass was sown at 25kg/ha on the 19th June 2006 into pre-worked soil, and rolled immediately afterwards. DAP at 50kg/ha was pre-drilled into the site.

Spray nozzle treatments were applied on the 21st October using a motor bike and 3m boom at 50cm height. The temperature was 23.7^{o}C, 71% relative humidity and 100% cloud cover.

The ryegrass was at full head emergence and the seed was at the milk to soft dough stage.

4 nozzles (Table 1) were trialled over ryegrass seed heads, with seed at the soft dough stage. Paraquat was used at 800ml/ha in 80L of water/ha of water, applied at 16km/hr. Spraying pressures were 4.5 bar for the AI nozzles and 3 bar for the flat fan nozzles.

Table 1. Spray nozzle type, size, boom pressure and the 4 resultant droplet sizes at Hart in 2007.

Nozzle type	Nozzle size	Pressure	Droplet size
Flat fan XR	025	3	Fine
Low drift	025	3	Medium
Low pressure air induction	025	4.5	Medium / coarse
Amistar nozzle	025	3	Fine

Results

There was no significant difference between droplet sizes for the control of ryegrass heads when using paraquat at 800ml/ha in 80 L/ha water (Figure 1). The low pressure air induction (AI) nozzles were as effective as flat fans for controlling ryegrass seed set.

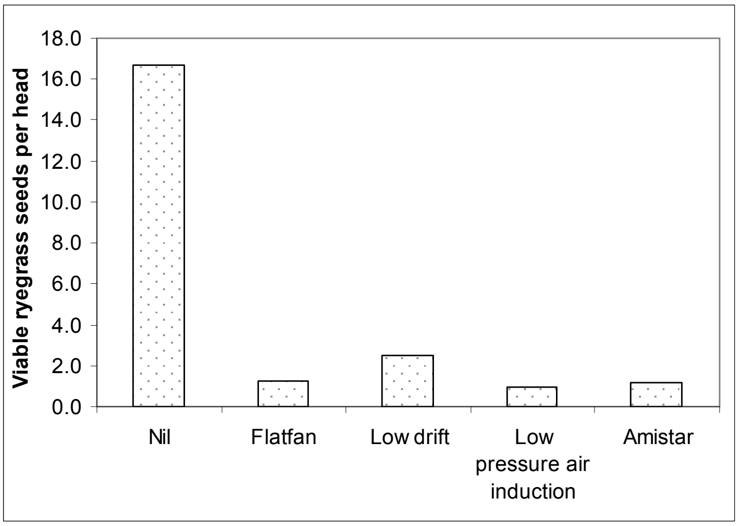


Figure 1. The comparison of 4 different droplet sizes and their control of ryegrass seeds at the milk to soft dough stage (LSD (P<0.05) 0.68).

Acknowledgements: GRDC, Richard Porter (Peracto) and Jason Sabeeney (Syngenta).

Crop topping cereals for annual ryegrass 2006

Funded by the GRDC in collaboration with the Birchip Cropping Group and the University of Adelaide.

Key Findings:

- Glyphosate at either 1.0 or 1.5L/ha applied at the flowering stage of ryegrass was very effective in reducing the viability of seed set.
- Herbicides applied to barley at the soft or firm dough stage of grain fill did not reduce individual grain weight, grain viability or early plant vigour.

Why do the trial?

To investigate the effect of crop topping cereals for annual ryegrass control with non-selective herbicides.
Crop topping is a highly successful and widely used practice for pulse crops, but little or no work has been done on wheat or barley. This strategy offers another tool for controlling annual ryegrass, while reducing the development of herbicide resistance particularly for early maturing varieties or seasons.

How was it done?

A site was selected within a commercial grower paddock of Keel barley. The area had an even distribution of annual ryegrass.

Herbicide treatments were applied by hand boom to 1.5 * 5m plots.

Herbicide treatments:
- Nil
- gylphosate 1.0L/ha + wetter 0.1%
- diquat 0.75L/ha + wetter 0.1%
- diquat 1.5L/ha + wetter 0.1%
- glyphosate 0.5L/ha + wetter 0.1%
- glyphosate 1.5L/ha + wetter 0.1
- diquat 1.13L/ha + wetter 0.1%

Herbicide timings:
Ryegrass flowering - applied on the 9th October 2006. Temperature 21.5°C, Relative humidity 38%.
The barley was at soft dough (indent from a finger nail springs back), and the head was at 48% moisture. The awns had turned white.
The ryegrass was just out of the boot, some had flowered.

Ryegrass seed formed – applied on the 20th October 2006. Temperature 18°C, Relative humidity 42%.
The barley was at firm dough, some green on stem, grain still slightly green on underside.
The head was at 61% moisture.
The ryegrass seed was milky to soft dough.

Sampling and assessment – All plots were sampled at maturity. Random head samples were cut from 10 sites within each plot, such that at least 100 ryegrass and 20 barley heads were collected.

Ryegrass seed heads were threshed in a small thresher, cleaned/aspirated and prepared for germination. 50 ryegrass seeds were germinated per petri dish.

Barley samples were threshed using a small plot harvester. 50 seeds were germinated per petri dish. They were also grown in pots using UC soil mix and measured for early vigour.

Results

Glyphosate at either 1.0 or 1.5L/ha applied at the flowering stage of ryegrass was very effective in reducing the viability of seed set (Table 1). The lower rate of glyphosate (0.5L/ha) was ineffective when applied at the flowering stage. At the later timing of application glyphosate was not effective at any rate.
Diquat did not provide seed set control of ryegrass irrespective of the timing of application.

Herbicide treatments applied to barley at either the soft dough or firm dough stage of grain fill had no significant impact on individual grain weight, the viability of the grain or early plant vigour.

Table 1. The effect of herbicide treatments applied to flowering annual ryegrass on head number, seed emergence and viable seed per head.

FLOWERING Herbicide Treatment	Ryegrass		Barley		
	Germination (%)	Control (%)	Grain weight (mg)	Germination (%)	Dry weight (g)
Nil	65		40.1	96	0.23
glyphosate 0.5L/ha	61	7	37.6	89	0.23
glyphosate 1.0L/ha	11	84	37.6	91	0.23
glyphosate 1.5L/ha	2	97	38.4	95	0.14
diquat 0.75L/ha	61	7	38.3	91	0.23
diquat 1.13L/ha	70	-7	38.0	100	0.25
diquat 1.5L/ha	64	2	37.9	97	0.21
LSD (P<0.05)	0.19		ns	ns	ns

Acknowledgements: The Hart fieldsite group wish to thank Peter and Ben Coles for the use of their barley crop and their cooperation. Also, Lawrence Burke of the University of Adelaide for his work sampling and assessing the treatment effects.

Crop topping cereals for annual ryegrass 2007

Funded by the GRDC in collaboration with the Birchip Cropping Group and the University of Adelaide.

Key Findings:

- Glyphosate and glufosinate applied to flowering annual ryegrass give better control compared to later applications. While paraquat and diquat can be applied later.
- Paraquat 0.8L/ha or glyphosate 2.0L/ha applied to flowering ryegrass gave over 90% control of viable seed set per head.
- Glyphosate at 1.0L/ha or glufosinate above 2.0L/ha gave more than 65% control of ryegrass seed heads.
- Herbicides applied to barley at the soft or firm dough stage of grain fill did not reduce grain number, weight or viability.

Why do the trial?

To investigate the effect of crop topping cereals for annual ryegrass control with non-selective herbicides.
Crop topping is a highly successful and widely used practice for pulse crops, but little or no work has been done on wheat or barley. This strategy offers another tool for controlling annual ryegrass, while reducing the development of herbicide resistance particularly for early maturing varieties or seasons.

How was it done?

A site was selected within a commercial grower paddock of Flagship barley. The area had an even distribution of annual ryegrass.

Herbicide treatments were applied by hand boom to 1.5 * 5m plots.

Herbicide treatments:

- Nil
- glyphosate 1.0L/ha
- diquat 1.5L/ha + wetter 0.1%
- diquat 3.5L/ha + wetter 0.1%
- glufosinate 2.0L/ha
- paraquat 1.6L/ha + wetter 0.1%
- paraquat 0.8L/ha + wetter 0.1%
- Boxer Gold 2.5L/ha
- diquat 2.5L/ha + wetter 0.1%
- glufosinate 1.0L/ha
- glufosinate 3.0L/ha
- glyphosate 2.0L/ha

Herbicide timings:

Ryegrass flowering - applied on the 19th October 2007. Temperature 19°C, Delta T 8.6, Relative humidity 30%.
The barley was at soft dough, and the head was at 52% moisture
Some ryegrass had flowered, some anthers were still in place, no seed was formed.

Ryegrass seed formed – applied on the 7th November 2007. Temperature 20°C, Delta T 7.6, Relative humidity 41%.
The barley was at firm dough, a dent made by a finger nail doesn’t spring back.
The ryegrass seed was full, at soft to firm dough.

Sampling and assessment – All plots were sampled at maturity. Random head samples were cut from 10 sites within each plot, such that at least 100 ryegrass and 20 barley heads were collected. Whole heads were planted in trays of soil, and ryegrass emergence assessed fortnightly. Barley grain was assessed in petri dishes using 100 grains.

Results

Herbicides applied to annual ryegrass at flowering have a much greater effect compared to later, when the ryegrass seed had formed. The exception was paraquat at either application rate.
At flowering, paraquat at a normal or double rate, and glyphosate at a double rate gave over 90% control of viable seed set per ryegrass head (Table 1).
Glyphosate at 1.0L/ha or glufosinate above 2.0L/ha gave more than 65% control. Boxer Gold, and diquat gave significantly poorer control.

Table 1. The effect of herbicide treatments applied to flowering annual ryegrass on head number, seed emergence and viable seed per head.

FLOWERING Herbicide Treatment	Head number	Total seeds emerged	Viable seed per head	
			Seed no	% control
Nil	145	2197	14.2	0
paraquat 0.8L/ha	165	191	1.2	92
glyphosate 1.0L/ha	172	546	3.7	74
Boxer Gold 2.5L/ha	156	2457	15.6	-10
diquat 1.5L/ha	144	1812	13.4	6
diquat 2.5L/ha	192	2152	11.1	22
diquat 3.5L/ha	129	1274	10.2	28
glufosinate 1.0L/ha	169	1936	11.9	16
glufosinate 2.0L/ha	178	843	4.8	66
glufosinate 3.0L/ha	182	658	3.6	75
paraquat 1.6L/ha	160	21	0.1	99
glyphosate 2.0L/ha	185	147	1.0	93
LSD ($P<0.05$)	ns	1200	4.65	

Herbicide treatments applied to barley at either the soft dough or firm dough stage of grain fill had no significant impact on grains filled per head, individual grain weight or the germination percentage of the grain. The flowering results are shown in Table 2.

Table 2. The effect of herbicide treatments applied to barley at the soft dough stage of grain fill on grains filled per head, individual grain weight and germination %.

FLOWERING Herbicide Treatment	Grains per head	Grain weight (mg)	Germination (%)
Nil	16.1	43.0	99.3
paraquat 0.8L/ha	17.1	41.5	98.9
glyphosate 1.0L/ha	16.7	42.7	98.5
Boxer Gold 2.5L/ha	17.7	43.8	99.6
diquat 1.5L/ha	16.6	42.7	98.5
diquat 2.5L/ha	16.8	41.8	98.2
diquat 3.5L/ha	15.4	42.2	98.2
glufosinate 1.0L/ha	19.5	42.9	99.3
glufosinate 2.0L/ha	16.7	43.3	99.3
glufosinate 3.0L/ha	17.2	41.1	100.0
paraquat 1.6L/ha	15.7	40.8	99.6
glyphosate 2.0L/ha	16.6	42.2	99.3
LSD ($P<0.05$)	ns	ns	ns

Acknowledgements: The Hart fieldsite group wish to thank Peter and Ben Coles for the use of their barley crop and their cooperation. Also, Lawrence Burke of the University of Adelaide for his work sampling and assessing the treatment effects.

Controlling ryegrass along fencelines

This trial was funded by the GRDC in collaboration with the University of Adelaide and Plant Science Consulting.

Key findings

- The best control of ryegrass was from Roundup Powermax at 1.5L/ha, giving 70% control.
- High rates of glyphosate can be effective, but nevertheless lead to increased resistance. Different modes of action should be used where possible.

Why do the trial?

Glyphosate resistance occurs when annual ryegrass populations are treated intensively with glyphosate, where no other herbicides are applied, there is minimal or no tillage and little competition from other plants. In 2008 there were 73 populations of annual ryegrass from around Australia with known resistance to glyphosate. Much of the glyphosate resistance is from winter fallow systems in northern NSW, however an increasing number are from fencelines and other uncropped parts of the farm.

This trial was established on a commercial property to investigate the effectiveness of different herbicides on glyphosate resistance ryegrass along a fenceline.

How was it done?

Herbicide efficacy was evaluated in a trial conducted within a commercial paddock in the Mid-North. The paddock was selected for its fenceline ryegrass which showed a low level resistance to glyphosate.

The ryegrass was at 3 leaf to 1st node (GS31) within a commercial crop of oats at 1st node (GS31). The herbicide treatments were applied on 11th of September.

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

The herbicide treatments were applied using a hand boom at 2 bar pressure, using 85 L/ha water with 110^{o} 01 flat fan nozzles.

Herbicide efficacy was assessed on 8th October and was based on the level of stunting, yellowing and plant death relative to the control with 0 being no control, and 100% being full control.

Results

Table 1: Effect of herbicides on ryegrass in a cereal crop, 2008.

Herbicide treatment	% control
Roundup Powermax 1.0L/ha + wetter 0.2%	43
Roundup Powermax 1.5L/ha + wetter 0.2%	70
Roundup Powermax 1.0L/ha + wetter 0.2% + 250ml/ha Goal	60
SpraySeed 1.5L/ha + wetter 0.2%	23
SpraySeed 1.5L/ha + wetter 0.2% + 250ml/ha Goal	18
SpraySeed 1.5L/ha + wetter 0.2% + 6L/ha Diuron	65
Basta 3L/ha + wetter 0.2% + 250ml/ha Goal	58
Alliance 3L/ha	30
Untreated	0
LSD (P<0.05)	15

The best ryegrass control was achieved from Roundup Powermax at 1.5L/ha, giving 70% control (Table 1). Other treatments which were not significantly different were Roundup Powermax at 1.0L/ha with Goal, SpraySeed at 1.5L/ha with 6L/ha Diuron, or Basta 3.0L/ha mixed with Goal 250ml/ha. The addition of Goal to the Roundup gave a significant improvement in control.

SpraySeed applied alone or with Goal was weak on ryegrass, as was the newer herbicide, Alliance.

Table 2: Active ingredients of herbicides used

Herbicide	Active Constituent
Roundup PowerMax	540 g/L glyphosate
Goal	240 g/L oxyfluorfen
SpraySeed	135 g/L paraquat + 115g/L diquat
Diuron	500 g/L diuron
Basta	200 g/L glufosinate-ammonium
Alliance	250 g/L Amitrole + 125g/L paraquat

Cautionary note:
The continual use of glyphosate for fenceline ryegrass control will increase the chance of developing resistance. Different herbicide modes of action should be used where possible.

Acknowledgements: GRDC, Roger Hore (Grower), Peter Boutsalis (Plant Science Consulting) and Chris Preston (University of Adelaide).

Cropping systems

In collaboration with farmers Michael Jaeschke, Matt Dare and SANTFA. Funded by SAGIT.

Key findings

- The disc and the early sown no-till tillage systems produced the highest grain yields, 1.41t/ha and 1.36t/ha respectively.
- The early sown no-till system had the lowest protein and the highest screenings.
- The disc tillage treatment had the least available soil nitrogen in autumn.

Why do the trial?

To compare the performance of 3 seeding systems and 2 nutrition strategies. This is a rotation trial (funded by SAGIT) 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 @ 50kg/ha + 2% Zn
Seeding date	No-till, Early	16th May	**Seeding rate**	100kg/ha JNZ
	Disc	30th May		
	No-till	3rd June		
	Strategic	6th June		

This trial is a randomised complete block design with 3 replicates, each containing 3 tillage treatments and 2 nutrition treatments. The no-till treatment has two times of sowing, aiming to demonstrate the benefits of dry or earlier sowing. The strategic and no-till treatments were sown using local farmers seeding equipment, Michael Jaeschke and Matt Dare. The disc seeding treatments were sown with the SANTFA trial seeder using a Bertini disc. The trial was sown with Clearfield Janz wheat at 100 kg/ha.

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

2007	2006	2005	2004	2003	2002	2001	2000
JNZ Wheat	Kalka Durum	Kaspa Peas	SloopSA Barley	Yitpi Wheat	Janz Wheat	Canola	Malting 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.

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

Nutrition treatments:
Medium & High – due to low rainfall nutrition treatments were not applied in 2008. In previous years urea has been applied post emergent at 60kg/ha for the medium and 120kg/ha for the high nutrition treatment.

Soil nitrogen (0-60cm) was measured in autumn on 27th March and plant tissue tests were conducted at the 4 leaf stage. Dry matter (DM) & crop nitrogen measurements were taken on 25th August 08.

Results

Sowing system produced significant differences in grain yield, grain protein and screening (Table 2).

The disc was the highest yielding treatment in the trial for 2008 (1.41t/ha) but was not significantly different to the early no-till treatment (1.36t/ha).

The strategic treatment produced the highest protein at 17.5% while the early no-till had the lowest at 14.4%.

The early no-till treatment produced the highest screenings in the trial at 11.5%.

Table 2: Grain yield (t/ha), protein (%) and screenings (%) averaged across nutrition treatments.

Tillage	Grain yield (t/ha)	Protein (%)	Screenings (%)
Disc	1.41	16.0	7.3
No-Till	1.06	16.8	6.3
Early No-Till	1.36	14.4	11.5
Strategic	0.94	17.5	8.0
LSD (0.05)	0.23	1.0	2.8

Available soil nitrogen (0-60cm) was 127 and 143kg nitrogen/ha for the medium and high nutrition respectively. Although the high nutrition treatment is 16kg/ha higher, it was not significant.

The disc treatment had 26% less available soil nitrogen in March compared with the no-til and strategic treatments and by the 25th August had 78% more dry matter and 30kg/ha more crop nitrogen than the other treatments (Table 2).

The leaf tissue test results show that there was no difference in leaf zinc or phosphorus due to tillage treatments or nutrition.

Table 2: Available soil nitrogen (0-60cm), tissue test results for zinc (Zn) & phosphorus (P), dry matter (DM) and crop nitrogen (N) results for tillage treatment.

Tillage	Available soil nitrogen (kg N/ha)	Tissue test (%) (4 leaf)		DM (t/ha)	Crop N (kg N/ha)
		Zn	P		
Disc	109.2	27.5	0.4	1.6	65.5
Strategic	148.2	38.5	0.3	0.7	29.5
No-till	148.2	28.0	0.4	0.9	36.0
LSD (P<0.05)	5.1	ns	ns	0.3	12.9

Tramline farming using controlled traffic

Key findings

- There were no significant differences in grain yield or screenings due to the traffic treatments.

Why do the trial?

To compare the performance of a controlled traffic system against a conventional traffic system.

How was it done?

Plot size	33m x 8.5m	**Fertiliser**	DAP @ 50kg/ha + 2% Zn
Seeding date	16th May 2008	**Seeding rate**	100kg/ha JNZ

The trial was a split block design consisting of 3 replicates, each with 2 tillage treatments.

Clearfield JNZ was sown at 100kg/ha. Previous crops are shown in Table 1.

Table 1: Previous crops in the long term controlled traffic trial at Hart.

2007	2006	2005	2004
JNZ Wheat	Kalka Durum	Kaspa Peas	SloopSA Barley

The treatments were,

Controlled traffic (2.05m spacing), seed box and tractor wheels aligned.

Conventional, seed box and tractor wheels aligned, with an additional pass to simulate additional traffic

The trial was sown with the commercial seeding equipment of local farmer, Matt Dare.

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

Results

The traffic treatments made no significant difference to grain yield or screenings.

Table 2: Grain yield (t/ha) and screenings (%< 2.0mm) of JNZ wheat.

Traffic system	Grain yield (t/ha)	Screenings (%)
Controlled traffic	1.0	15.0
Conventional	0.9	11.9
LSD (0.05)	ns	ns

Post emergent weed control - inter-row options

Greg Butler, SANTFA R&D and Jack Desbiolles, Institute of Sustainable Systems and Technologies.

Accurately targeting the weeds and not the crop.

GPS guided auto steer enables tractors to repeatably sow straight lines however not all paddocks are perfect rectangles and occasionally sowing rigs work around trees or rocky outcrops.

Controlling weeds non-selectively in the inter-row during the growing season while preserving crop safety relies heavily on how accurately the position of the weed control implement is maintained relative to the actual crop sowing lines. Guided tractors hold a line through kinks and curves however various implements being towed by an accurately guided tractor may trail a different path due to a number of variables.

Essentially, a trailed implement tracks with its 'centre of resistance' aligned to the tractor 'centre of pull'. An imbalance in tillage forces across the width of the implement, for instance due to poor depth matching and/or variable soil conditions, results in the implement centre of resistance shifting out of line from the centre of pull, which skews the implement sideways until re-alignment is obtained. This implement shift to the side or 'drift' can be constant for a period (eg. working across a slope) or variable and random across the paddock (eg. 'wobbling' according to paddock variability). In order to minimise implement side movement, a strong restoring side force is required, which is typically generated by implement tyres (Stabiliser discs can be added for greater effectiveness). Their restoring torque is most effective when:
i) sufficient weight acts on the wheels
ii) wheel/soil grip is most effective
iii) the wheels are placed at a greater distance from the hitch point (eg. such as longer implement drawbars).
Implement guidance systems have come onto the market using GPS information and steering software to correct implement positioning via steerable wheels or ground engaging discs - eg. Orthman Manufacturing Tracker IV distributed by gps-Ag - Bendigo (www.gps-ag.com.au/products/default.aspx) and *RigGuide* implement steering offered by AgGuide – Toowoomba (www.agguide.com.au/rigguide.htm).

The above issues become a problem for accurate inter-row weed control when different implements are used for seeding and post-emergent weed control, due to their different tracking behind the same tractor, guided with the same accuracy. Typically, post-emergent weed control in inter-row is conducted with fully mounted 3 point linkage implements with a tracking ability fairly closely aligned to the tractor positioning.

We have begun to assess what effects 'kinks' and 'curves' have on inter-row treatments, and whether crop recognition and line adjustment tools provide value when added to implements being pulled by a tractor enabled with 2cm guidance.

Three paddock-like scenarios including straight plots with parallel drift values of up to 9cm, kinked plots simulating up to ±10cm wobble and curved plots on 80-100m radius were established using the Bertini disc-seeder setup on 560mm row spacing and towed via a drawbar hitch with a RTK 2cm accuracy auto-steered tractor.

A month after crop emergence, the inter-row was treated with 1.3L/Ha of Roundup PowerMax applied at 6km/hr through a 3-point linkage spray unit fitted with 440mm wide inter-row shrouds (Diamond – WA).

For the post-emergent weed control operation, alternate plots were treated 'with' or 'without' the assistance of a Local Positioning System – LPS – consisting of a crop recognition and line adjustment tool fitted to the spray unit (*Eco-Dan* guidance system from Denmark - www.eco-dan.com). The Eco-Dan unit relies on a camera system to recognise a green crop row, and a computer controlled hydraulic side-shift incorporated into the 3 point linkage to move the implement side to side over a 200mm range. The Eco-Dan hydraulic side shift ensures the crop row remains in the centre of the cameras field of view.

The results so far have shown that targeted inter-row spray applications in variable paddock conditions are best achieved using a guided tractor with 2cm guidance in addition to a crop recognition and line adjustment tool. The trial showed that crop damage could be fully avoided with the use of the Eco-Dan system even under the more extreme simulations. The side shift capacity of the hydraulic correction system must at least match the level of seed row position inaccuracies expected in the paddock. Other comparable systems include the *Robocrop* vision guidance from Garford Farm Machinery – UK (www.garford.com).

Cost effective farming – financial analysis

Key findings

- In poorer seasons there is no positive economic reward for high nitrogen fertiliser inputs.
- Oats and vetch for either grazing or hay consistently provided positive gross margins.
- Wheat crops which followed a chemical fallow provided the best gross margin in both trials.
- Aim to maximise profits, not necessarily yields.

Why do the trial?

Many growers are choosing to reduce crop inputs and change crop choices because of financial pressures, the result of poor seasons and the uncertainty of commodity prices. In recent years stored soil moisture at sowing and spring rainfall have been low, producing lower than average grain yields and returns.

Farm costs are continuing to rise, particularly the costs of fertiliser and fuel, meaning growers are faced with the prospects of lower margins and higher financial risk. It has increased the need for appropriate rotations and a tactical approach to crop inputs to better match likely crop yields.

Many growers will compare wheat crops side by side, but rarely realise the cost of producing each crop can vary significantly. Individual grower strategy will guide inputs and as clearly shown in a study on the Eyre Peninsula an increase in crop intensity will almost always increases input costs with little or no benefit to profit (Hunt & Lynch, 2005). Studies in Victoria (O'Callaghan) have shown that the management of input costs is having a greater impact on grower returns compared to the influence of grain yield or quality.

This study aimed to assess the financial consequences of changing farming systems and inputs, specifically investigating the impact of changing break crop type and reduced fertiliser inputs on subsequent wheat yields and longer term profitability.

How was it done?

This research was conducted at the Hart fieldsite as two identical trials but within different seasons.

Trial 1: the seasons of 2005 and 2006
Trial 2: the seasons of 2006 and 2007

There were two components to this project:

1) Assessing three input levels of nitrogen fertiliser
    - low nutrition – nitrogen fertiliser applied for below average yields
    - strategic nutrition – crops initially fertiliser for below average yields and adjusted during the season based on soil water measurements, rainfall, seasonal climate forecasts and yield predictions using Yield Prophet
    - high nutrition – nitrogen fertiliser applied for above average yields

2) Assessing six, different two year rotations

Table 1. The crop choices for each rotation conducted over two seasons for two trials at the Hart fieldsite 2005 to 2007.

Trial 1			**Trial 2**	
2005	**2006**		**2006**	**2007**
Frame wheat	Kukri wheat		Frame wheat	Kukri wheat
Keel barley	Kukri wheat		Keel barley	Kukri wheat
TT Tornado canola	Kukri wheat		TT Tornado canola	Kukri wheat
Kaspa peas	Kukri wheat		Kaspa peas	Kukri wheat
Chemical Fallow	Kukri wheat		Chemical Fallow	Kukri wheat
Oats & Vetch	Kukri wheat		Oats & Vetch	Kukri wheat

In the first season (2005 or 2006) of each trial 6 crop types were sown with 3 levels of nutrition, applied in a split plot design with 3 replicates. In the second season (2006 or 2007) of each trial wheat was sown uniformly across all crop types sown in the previous season.

Table 2. Rates of urea (kg/ha) applied to the treatments in trial 1, between 2005 and 2006, at the Hart fieldsite.

	2005			2006		
	Low	**Strategic**	**High**	**Low**	**Strategic**	**High**
Frame wheat			80			
Keel barley		30	60			
TT Tornado canola	30	80	130			
Kukri wheat				20	0	120

Table 3. Rates of urea (kg/ha) applied to the treatments trial 2, between 2006 and 2007, at the Hart fieldsite.

	2006			2007		
	Low	**Strategic**	**High**	**Low**	**Strategic**	**High**
Frame wheat	30		120			
Keel barley	0	50	100			
TT Tornado canola	50	100	150			
Kukri wheat				20	80	140

Soil samples were taken in autumn each year to a depth of 60cm and tested for available nitrogen and moisture in the strategic plots only.

The plots were 3.0m wide and 10m long, with DAP @ 75 kg/ha applied at sowing.

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

Economic assumptions

The following assumptions were used to guide the economic analysis:

- The input levels and yields were valued using 2008 expected prices and costs.
- The inputs and yields used were directly derived from the trials.
- To complete the gross margins, typical farmer costs were used for fuel and oil, repairs and maintenance, and crop insurance.
- When hay was harvested, a local hay-making contract rate of $121/ha was used
- When canola was harvested, it was assumed windrowing was used at a local contract rate of $30/ha.
- The oats and vetch enterprise has been assumed to be either:
    - harvested for hay - in this case the dry matter results were used as a proxy for hay yields; or
    - grazed by a self-replacing merino flock where it was assumed that the first 500kg/ha dry matter was needed for ground cover (not grazed by stock) and that 400kg dry matter was needed per DSE. A local sheep gross margin of $31/dse was used.

Results

As it turned out, the seasons were very poor and so the results provide a valuable insight into the risk of farming in poor seasons.

Specific trial results for each season were previously presented in Hart annual result books (2006 & 2007). Given the series of challenging seasons experienced during the project there was generally very little effect of nitrogen nutrition on grain yield or quality. Hence, the cost of applying post emergent urea to the high and strategic treatments was not economic.
The response of wheat yield and quality to the previous crop was variable with grain yields being significantly higher after the fallow treatment in trial 1 and significantly lower following barley or oats and vetch in trial 2.

Generally there was little difference in available soil nitrogen or moisture between treatments. A key highlight was that very small changes in residual soil moisture were enough to create significant differences in grain yield.

Tables 4 & 5. Grain yield (t/ha), protein (%) and screenings (%) for crop type and nutrition strategy for trial 1 and 2 at the Hart fieldsite.

Crop type	Nutrition Strategy	Trial 1 (2005 & 2006)					
		2005 break crops			2006 wheat		
		Yield (t/ha)	Protein (%)	Screenings (%)	Yield (t/ha)	Protein (%)	Screenings (%)
Keel barley	Low	3.28	9.9	1.8	0.56	16.2	1.8
	Strategic	3.62	10.2	2.0	0.58	15.5	1.9
	High	3.70	11.4	1.9	0.52	16.3	1.9
TT canola	Low	0.84	43.4		0.52	15.5	1.8
	Strategic	0.96	42.2		0.45	16.1	1.7
	High	1.01	41.2		0.42	16.4	2.0
Fallow	Low				0.74	14.1	2.2
	Strategic				0.70	14.3	2.0
	High				0.69	14.3	2.2
Vetch & Oats	Low				0.59	16.0	2.0
	Strategic	3.69			0.48	15.8	1.8
	High				0.51	16.0	2.0
Peas	Low				0.61	15.3	2.0
	Strategic	2.22			0.64	15.3	1.7
	High				0.61	15.2	1.9
Frame wheat	Low	2.39	10.8	2.3	0.33	16.7	4.3
	Strategic	2.37	10.4	2.7	0.36	15.8	3.5
	High	2.64	12.2	2.0	0.32	16.8	3.1
LSD (0.05)							
Previous crop		n/a	n/a	n/a	167.8	1.2	0.4
Nutrition strategy		ns	n/a	n/a	ns	ns	ns
Crop * Nutrition		n/a	n/a	n/a	ns	ns	0.5

Crop type	Nutrition Strategy	Trial 2 (2006 & 2007)					
		2006 break crops			2007 wheat		
		Yield (t/ha)	Protein (%)	Screenings (%)	Yield (t/ha)	Protein (%)	Screenings (%)
Keel barley	Low	0.11	15.6	7.5	1.30	15.8	3.3
	Strategic	0.21	15.5	7.6	1.17	17.2	3.5
	High	0.11	15.7	7.5	1.17	16.8	4.3
TT canola	Low				1.40	17.1	2.4
	Strategic	0.3			1.32	17.3	3.2
	High				1.25	17.2	3.4
Fallow	Low				1.37	17.0	2.4
	Strategic				1.41	16.7	2.2
	High				1.32	17.2	2.4
Vetch & Oats	Low				1.10	17.0	4.1
	Strategic	1.4			0.99	17.7	3.5
	High				1.08	17.3	3.6
Peas	Low				1.26	17.2	2.5
	Strategic	0.3			1.24	17.5	1.8
	High				1.58	16.6	2.6
Frame wheat	Low	0.52	16.4	7.7	1.71	15.6	4.2
	Strategic	0.46	16.3	7.8	1.51	16.0	4.6
	High	0.50	16.1	7.8	1.33	16.7	5.5
LSD (0.05)							
Previous crop					0.25	0.5	1.4
Nutrition strategy					ns	0.4	ns
Crop * Nutrition					ns	ns	ns

In poorer seasons there is no positive economic reward for high nitrogen fertiliser inputs (Figure 1.)

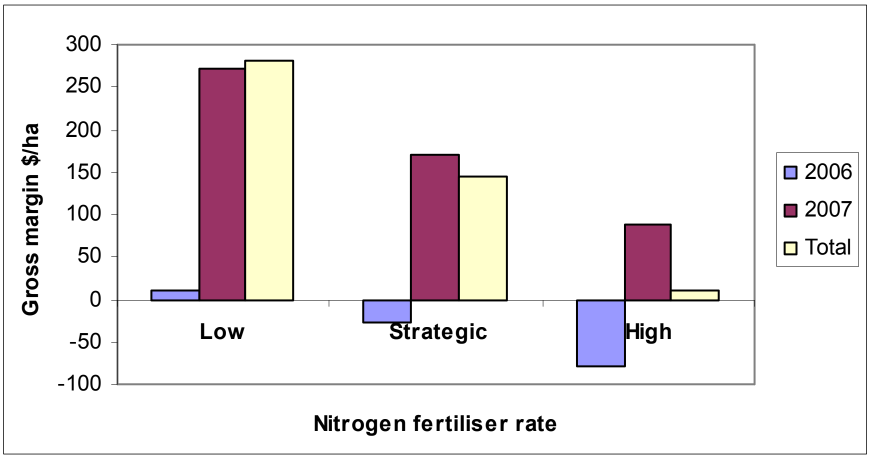


Figure 1. The gross margin response for 1st year wheat, or wheat on wheat, with an increasing amount of nitrogen fertiliser at the Hart fieldsite.

These results indicate very clearly that in poorer seasons such as much of South Australia has been experiencing in recent years, there is significantly higher risks in chasing maximum production by applying a high level of inputs. The strategy of high inputs in poor seasons has a double impact in that costs are higher and yields are poorer, resulting in very poor economic returns for the higher input strategy. A low or strategic approach to nitrogen fertiliser was certainly less costly.

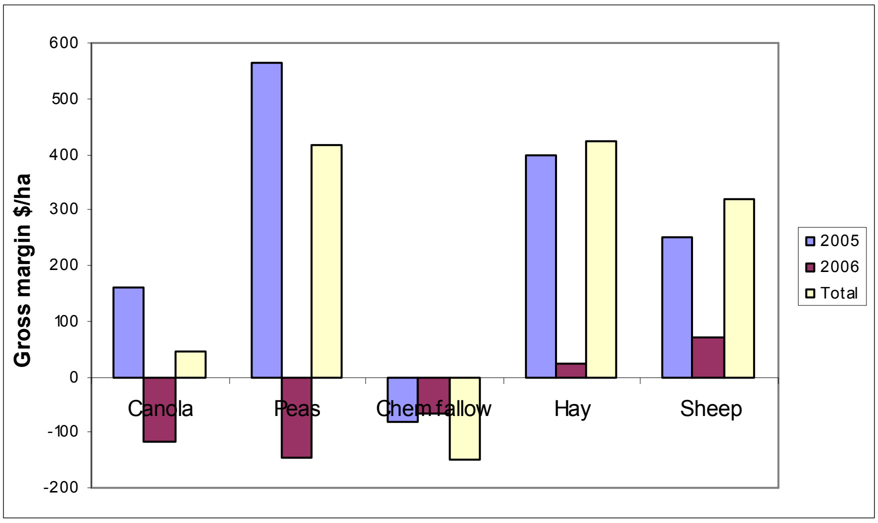


Figure 2. The gross margin response for the break crops grown prior to wheat in trial 1 (2005) and trial 2 (2006) at the low level of nitrogen nutrition at the Hart fieldsite.

For the break crops only oats and vetch for either grazing or hay consistently provided positive gross margins (Figure 2). It highlights that in 2006 the season obviously provided better dry matter production compared to grain production. The cost of the chemical fallow was consistent, as to be expected, and although being negative was not large compared to a poor season for either canola or peas. Canola and pea gross margins were very dependent on the season.

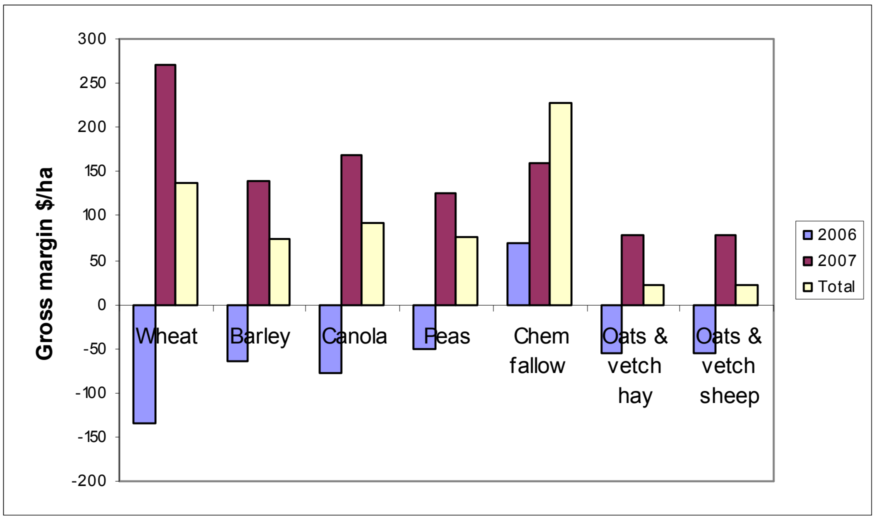


Figure 3. The gross margin response for wheat crops grown after cereal or break crops in trial 1 (2006) and trial 2 (2007) at the strategic level of nutrition at the Hart fieldsite.

For the wheat component of the rotation only the crops which followed a chemical fallow provided the best gross margin in both trials (Figure 3). This is of particular note as the wheat grown on chemical fallow provided the only positive return in 2007. These results occurred because chemical fallow provided one of the lowest losses in the poor season of 2006 and because the wheat responded well in the following year.
The gross margins were positive for all rotations in 2007, with the wheat on wheat rotation being the highest, although this treatment was the most negative in 2006.

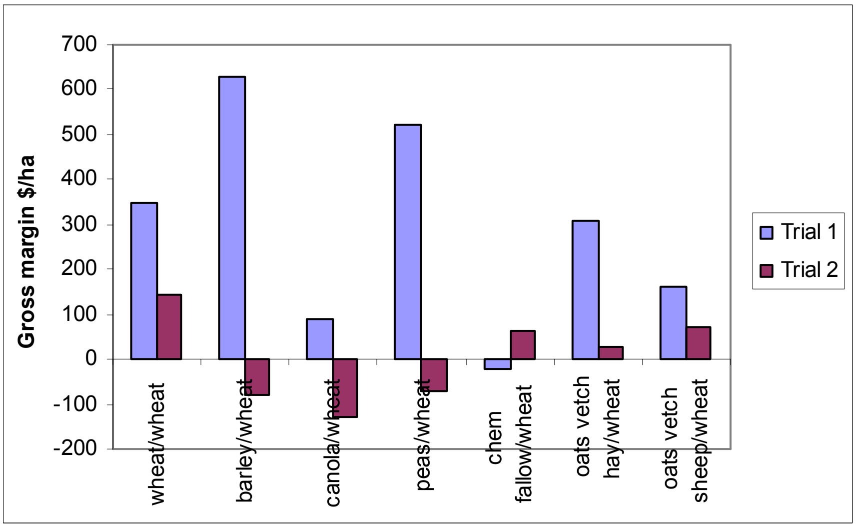


Figure 4. The gross margin response for the 2 year rotation for trial 1 (2005 and 2006) and trial 2 (2006 and 2007) and at the strategic level of nutrition at the Hart fieldsite.

For all levels of nitrogen nutrition the wheat on wheat rotation produced the highest gross margin in both trials. Oats and vetch for hay or grazing also produced positive returns in both seasons, while the chemical fallow also provided a good financial option.
Barley, canola and peas were the most inconsistent options prior to wheat, although the barley and wheat rotation produced the highest total gross margin in trial 1 (Figure 4).

Overall

The main economic finding from this project was that in poorer seasons it did not pay to apply high rates of fertiliser. This caused two problems for economic efficiency:

1) it provided higher costs
2) produced poorer yields and quality, which resulted in poorer gross incomes. In every rotation tested, the high input treatment produced the poorest gross margin.

Oats and vetch for hay or grazing, or chemical fallow were the most reliable break crops. Canola and peas were inconsistent, which aligns with anecdotal grower experiences.

<u>Oats and vetch</u> – Oats and vetch used for either hay or grazing both produced positive gross margins in these poorer seasons and it would be difficult to select one over the other. In the grazing situation if there was an opportunity to spray top the pasture in the spring there is potential for a greater carry over of soil moisture to the following wheat crop.

<u>Fallow</u> - Chemical fallow provides a break crop option for weeds and disease that minimises financial losses and allows for the following wheat crop to provide a positive economic return. While chemical fallow assists in minimising risks the following crop needs to earn significantly higher gross margins for the fallow-wheat to outperform other break crop options and continuous cereals. The farm business also needs to consider the lack of income on the area of fallow during that season.

<u>Oaten hay</u> – this break crop option wasn't a specific treatment in this project, however, the oats and vetch cut for hay was used to represent this crop use. Generally oat crops grown specifically for export hay produce higher dry matter yields compared to oats and vetch. Given that the costs used in this project are similar, the returns are likely to be greater. This would consistently place oaten hay as the most profitable break crop option, even when paying for the use of contractors. However, any rain during hay cutting makes this option very risky and quality downgrading means gross margins can be significantly reduced. Hence, it is only viable on a manageable area.

With the exclusion of chemical fallow there was no significant advantage of a break crop before wheat compared with continuous cereal situation.

The wheat on wheat rotation provided the highest total 2yr gross margin, although within the wheat year of the rotation it was also the most variable. Although the oats and vetch for hay or grazing did not produce the highest total gross margin they were the most reliable options for providing consistent positive returns.

Overall, it is not an effective strategy to be pushing for 100% water use efficiency and maximum grain quality. The careful management of input costs is more likely to have a greater impact on profits compared to grain yield or quality, and minimising losses in the poorer years will provide significant gains.

Farmers wishing to adopt the input levels and rotations indicated as being the best from this trial would also need to consider the impact of machinery requirements, loans, labour and business profitability before making their final decision.

Acknowledgement: Mike Krause.

Yield prophet performance in 2008

Key findings

- In the last simulation on 25th September, it was predicted there was a 50% chance of reaping at least 1.5t/ha of wheat at Hart, the actual wheat grain yield was 1.4t/ha.
- At no point during the 2008 growing season did the yield prophet simulation predict final wheat yields to be greater than 3.5t/ha, even at the highest level of risk (20%).

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.

How was it done?

Seeding date	15th May 2008	**Fertiliser**	DAP @ 50kg/ha + 2% Zn
Variety	Clearfield JNZ		

Soil samples were taken for soil nitrogen and moisture on the 22nd May 2008.

Table 1: Soil conditions at Hart, 22nd May 2008.

Available soil moisture	0mm
Initial soil N	72 kg/ha

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

Results

The Clearfield Janz wheat grain yield was 1.4t/ha.

At the first simulation (6th July 2008) yield prophet predicted that there was a 50% chance of reaping 1.75t/ha. 27mm of rainfall between the 7th and 12th July improved the yield prediction by 0.8t/ha. The predicted yield at the 50% level dropped back to 2.4t/ha and then remained constant until 26th August (Figure 1).

Throughout the growing season the yield prophet simulations at the 50% level were generally 20% higher than the final grain yield.

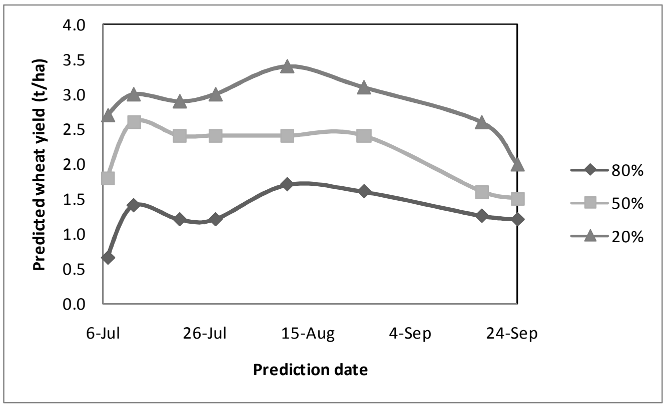


Figure 1: Yield prophet yield predictions from 7th July to 24th September for JNZ wheat sown on 15th May with 50kg/ha DAP. 80%, 50% and 20% represent the chance of reaching the corresponding yield at the date of the simulation.

Plant available water (PAW) did not exceed 45mm to a depth of 1.0m throughout the growing season at Hart. At the time of the first simulation PAW was 0mm (Figure 2). By the end of September PAW fell back to 0mm and crop water stress was high (Figure 3).

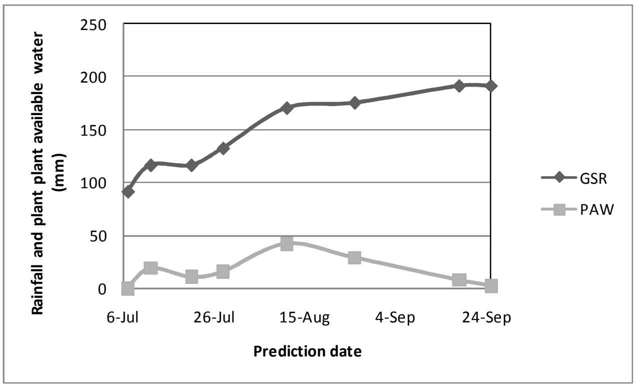


Figure 2: Predicted plant available water and cumulative growing season rainfall from 6th July to 24th September at Hart in 2008.

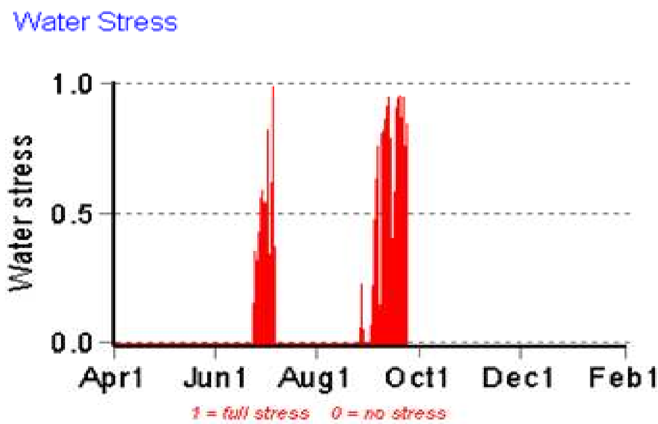


Figure 3: Predicted crop water stress for Clf JNZ at Hart in 2008

Improving water use efficiency

This trial is funded by the GRDC in collaboration with the University of Adelaide and CSIRO

Key findings

- The best WUE for 2008 occured at the Tarlee site for barley, 28.5kg/mm/ha or 141%.
- Frost in August and October reduced WUE at Spalding.

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 increase has presumably come through a combination of:

- Earlier sowing times
- Effective summer weed control
- Stubble retention
- Nitrogen management and reduced sowing rates
- Residual soil moisture

However, the WUE on farms over the Mid North varies considerably, with the understanding for this variation being limited. This trial will investigate the reasons for these differences in WUE by establishing four sites 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
- Tarlee, 550mm, cracking red earth

How was it done?

Plot size	8m x 10m			
Seeding date	Hart 28th May	**Fertiliser**	Hart	DAP@60kg/ha+2% Zn
	Condowie 28th May		Condowie	DAP@40kg/ha+2% Zn
	Spalding 9th May		Spalding	DAP@85kg/ha+2% Zn
	Tarlee 4th June		Tarlee	DAP@130kg/ha+2% Zn

Each the trial was a randomised complete block design with 3 replicates and 5 crops.

The 5 crops were Gladius wheat, Keel barley, Buckley wheat hay, Kaspa peas and Tornado canola. These were grown in rotation to ensure weed free plots are available for wheat in each successive year.

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

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

Hay was cut and removed from the plots by hand and assessed for hay yield.

The grain yield for canola was measured by quadrat cuts and threshing by hand.

Drained upper limit and crop lower limit (wheat) was measured at each site to calculate plant available water (PAW).

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

Tarlee produced the highest wheat and barley yield, 3.56t/ha and 5.07t/ha respectively with Spalding producing the highest wheat protein (Table 1).

Frost at Spalding caused yield loss in the wheat, canola and peas (Table 1 & 2). The high screenings level in the wheat (70%) is also a result of frost. It is likely that the barley was also affected.

Table 1: Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) for wheat and barley at the four water use efficiency trial sites in 2008.

Site	2007 crop	Crop	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
Condowie	Barley + Vetch	Wheat	0.92	13.8	73.6	4
		Barley	1.66	12.9	55.3	38
Hart	Wheat	Wheat	0.93	13.7	78.1	4
		Barley	1.93	12.0	64.4	27
Spalding	Barley	Wheat*	0.62	15.4	70.5	70
		Barley	2.03	10.5	69.3	41
Tarlee	Peas	Wheat	3.56	12.0	73.7	2
		Barley	5.07	9.1	61.6	4

* The wheat at Spalding was frosted, district wheat yields were approximately 2.0t/ha.

Between the four sites the greatest WUE for wheat came from Tarlee producing 22.5kg grain/mm/ha (Table 3). WUE at Spalding was low due to frost. However when using the district average wheat yield WUE was (15.6 kg grain/mm/ha).

WUE for barley in 2008 ranged from 28.5 to 13.7 kg/mm/ha at Tarlee and Spalding sites respectively.

WUE at Hart over the past five years has averaged 14 kg/mm/ha. The lowest was 2.4kg/mm/ha in 2004 and the highest was 28 in 2006 (Figure 1).

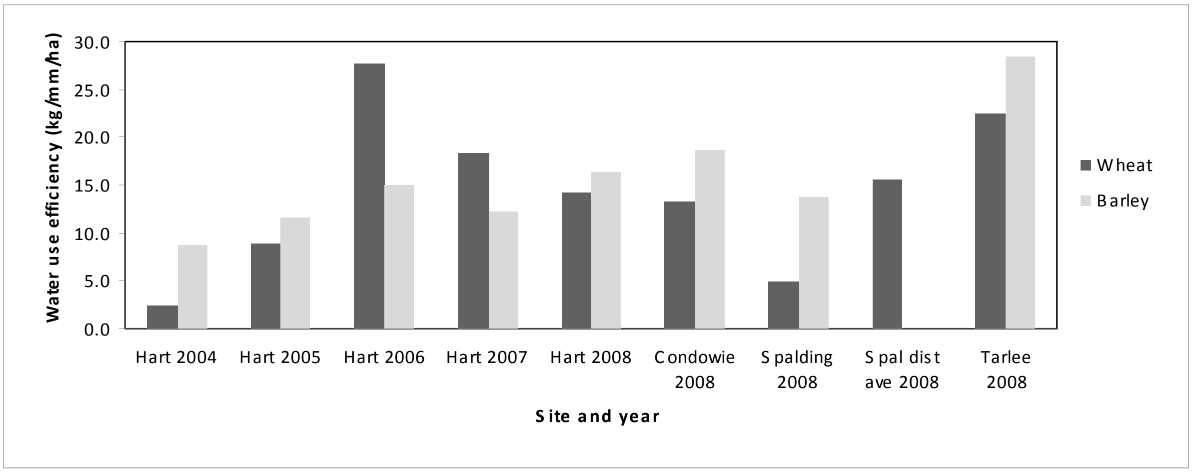


Figure 1: WUE for Hart 2004 to 2008 and Condowie, Spalding and Tarlee 2008.

Table 3: Soil type, total rainfall, growing season rainfall (April – October) (GSR) and water use efficiency for wheat and barley at the four WUE trial sites in 2008.

Site	Soil type	Total rainfall (mm)	GSR	Wheat WUE (kg/mm/ha)	Barley WUE (kg/mm/ha)
Hart	sandy, clay loam	317	208	14.3	16.4
Condowie	sandy loam	278	179	13.3	18.6
Spalding	red brown earth	350	238	4.84*	13.7
Tarlee	cracking red earth	436	268	22.5	28.5

* Using the district average wheat yield WUE = 15.6 kg/mm/ha

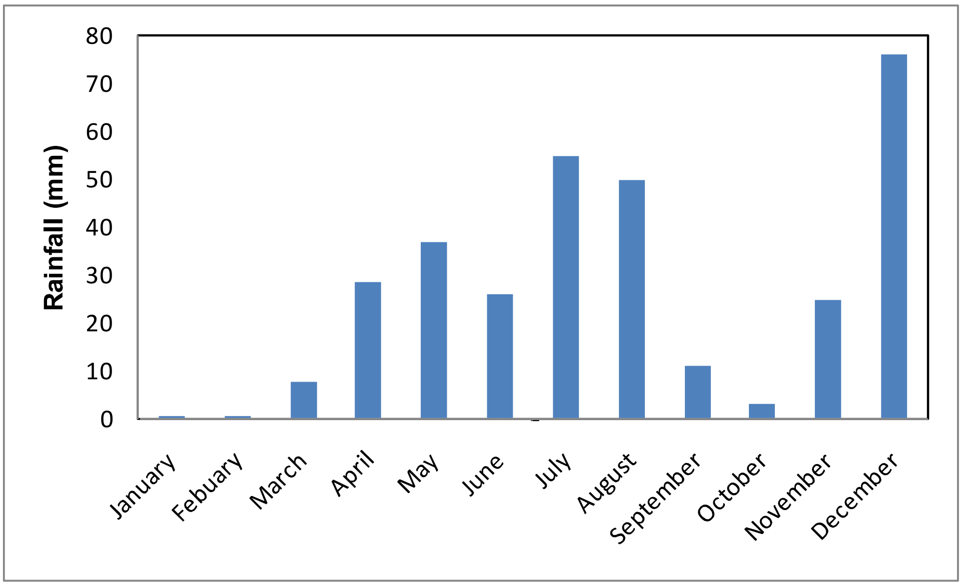
Acknowledgements: Brian Kirchner, Andrew and Rohan Cootes and Mark Hill (Growers).

Rainfall, Hart 2008 (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1					5.4		0.2		0.2			
2				0.2			1.8				8.2	
3				1.2			1.4				2.2	
4								2.6		2.8		
5						0.6		15.4			0.8	3.2
6						4.0	0.6	1.6				
7					0.2	0.2	14.0	6.0	0.4		1.8	1.2
8		0.2					7.8	0.2	0.2		1.2	
9						5.2	2.6	2.4				
10						0.2	1.2	2.0				
11						1.6	0.6	1.4	0.2			
12				1.8		0.2	0.2	0.6				51.6
13						4.0		1.8				9.4
14						0.2			0.2		3.6	10.6
15						0.0	4.8		1.6			
16							0.4	0.2	2.4			
17					23.8			1.0				
18					3.4	5.4	3.6				3.2	
19					1.2	1.6	0.2	0.2			0.8	
20					0.4		2.4					
21						0.4	4.6	2.2				
22						1.0		3.0				
23								0.6	5.6			
24		0.2						0.2				
25			1.6									
26	0.6			0.8		0.2						
27				22.4	2.4		0.4	0.2				
28				0.6			7.4				2.0	
29											0.6	
30			4.4	1.2		1.0		3.6				
31			1.4				0.4	4.2				
Monthly total	**0.6**	**0.4**	**7.4**	**28.2**	**36.8**	**25.8**	**54.6**	**49.4**	**10.8**	**2.8**	**24.4**	**76.0**
Running total	**0.6**	**1.0**	**8.4**	**36.6**	**73.4**	**99.2**	**153.8**	**203.2**	**214.0**	**216.8**	**241.2**	**317.2**
Rain days	**1**	**2**	**3**	**7**	**7**	**16**	**19**	**20**	**8**	**1**	**10**	**5**

Average GSR (Apr-Oct) 305mm
2008 GSR (Apr-Oct) 204mm

Average rainfall 400mm
2008 Total rainfall 317mm

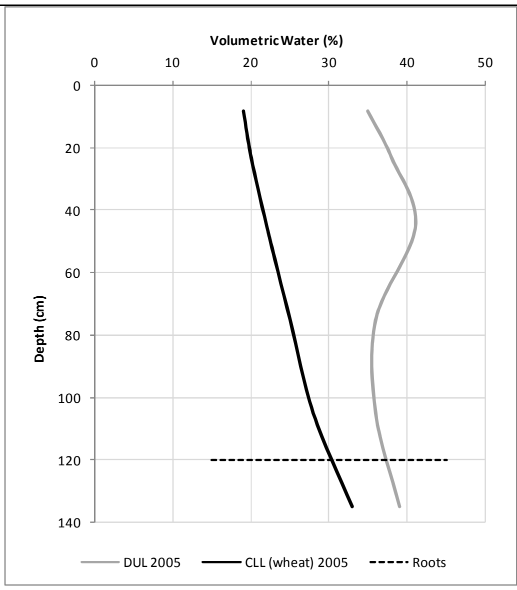


Soil test Hart field site 2008

March 2008

Depth (cm)	0 - 10
Nitrate nitrogen (ppm)	2
Ammonium nitrogen (ppm)	2
Phosporus (ppm)	50
Potassium (ppm)	601
Sulphur (ppm)	9.9
Organic carbon (%)	2.05
Salinity (dS/M)	0.22
pH (calcium chloride)	7.8
pH (water)	8.5
Phosphorus buffering index	121.1

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.