Trial Results 2013

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Interpreting data

Interpretation of statistical data from the trials

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

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

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

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Diary dates

Hart Calendar 2014

Getting The Crop In
Wednesday 12th March 2014

Hart Field Day
Tuesday 16th September 2014

Winter Walk
Tuesday 22nd July 2014

Spring Twilight Walk
Tuesday 21st October 2014

Comparison of wheat varieties

Sarah Noack and Peter Hooper, Hart Field-Site Group Inc

Key Findings

- Mace was the highest yielding commercially available hard wheat at 4.72 t/ha.
- Corack was the highest yielding APW variety at 4.42 t/ha.
- High levels of screenings were observed for Lincoln, Correll and Shield in both 2012 and 2013 at Hart.

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	1.4 m x 10 m	**Fertiliser**	DAP (18:20) + Zn 2% @ 60 kg/ha
Seeding date	18th May 2013		UAN (42:0) @ 75 L/ha, 11th July
			UAN (42:0) @ 70 L/ha, 29th Aug

The trial was a randomised complete block design with 3 replicates and 24 varieties. Fungicides were applied as necessary to keep the crop canopy free of disease ie. stripe rust.

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

Results

Grain yields at Hart in 2013 ranged from 3.51 t/ha for Lincoln and up to 4.72 t/ha for Mace (Table 1). The average wheat yield at Hart in 2013 was 4.07 t/ha, compared to 1.94 t/ha in 2012.

Scout and Cobra also yielded well and were not significantly different to Mace. Varieties closely following these yields included Corack, Emu Rock, Estoc, Axe, RAC-1843 and Phantom.

Wheat grain protein levels ranged from 11.1% (Corack and Mace) to 13.2% (Correll) with a site average of 12.0%. The highest yielding wheat variety Mace was the only AH variety to have a protein level below 11.5% required for Hard 2.

Screening levels ranged from 2.3% (Axe) to 7.9% (Lincoln) with a trial average of 4.5%. Wheat varieties with screening levels above the maximum for APW and Hard of 5% were Lincoln, Shield, Dart, Correll, IGW3424 and Kord CL Plus. Similarly in 2012 high screening levels were also recorded for Lincoln, Correll and Shield.

The only variety to produce a test weight value lower than 74 kg/hL, the minimum required for maximum grade, was Orion (71 kg/hL). The overall test weight values for the site averaged 78.2 kg/hL. Varieties with test weights lower than 76 kg/hL were Cobra, Lincoln and Correll. Similar test weight results were also seen for these three varieties at Hart in 2012.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of wheat varieties at Hart in 2013.

Quality	Variety	Grain yield (t/ha)	% of site average	Protein (%)	% of site average	Test Weight (kg/hL)	% of site average	Screenings (%)	% of site average
AH	Axe	4.30	106	12.3	102	79.8	102	2.3	51
	Catalina	4.08	100	12.4	104	79.9	102	4.4	97
	Cobra	4.47	110	12.0	100	75.2	96	4.2	94
	Correll	3.81	93	13.2	110	74.7	96	5.2	116
	Dart	3.90	96	11.5	96	78.7	101	6.5	144
	Emu Rock	4.36	107	11.9	100	80.0	102	4.5	100
	Gladius	3.81	94	12.9	108	78.1	100	4.1	92
	Grenade CL Plus	3.87	95	11.5	96	79.2	101	3.0	66
	AGT Katana	4.15	102	12.0	100	81.8	105	4.1	91
	Kord CL Plus	3.91	96	12.3	102	77.9	100	5.2	115
	Lincoln	3.51	86	11.8	99	74.6	95	7.9	176
	Mace	4.72	116	11.1	93	79.2	101	4.2	93
	Phantom	4.24	104	11.8	99	78.9	101	4.1	91
	Scout	4.48	110	11.7	98	79.2	101	4.6	102
	Shield	3.88	95	11.5	96	78.5	100	7.4	164
	Wallup	4.01	99	12.4	104	78.2	100	4.2	93
APW	Espada	3.92	96	11.8	98	76.7	98	3.5	77
	Estoc	4.30	106	12.0	100	81.0	104	3.4	76
	Corack	4.42	109	11.1	93	78.7	101	4.0	89
SOFT	Impala	3.78	93	12.1	101	77.1	99	3.8	84
	Orion	3.77	93	11.8	99	71.1	91	4.3	96
Unclassified	RAC-1843	4.25	104	12.1	101	80.2	103	3.4	76
	IGW3424	3.96	97	11.6	97	79.9	102	5.2	116
	LPB09-3278	3.82	94	12.6	105	76.8	98	4.6	102
	Site Average	**4.07**	100	**12.0**	100	**78.2**	100	**4.5**	100
	LSD (P≤0.05)	0.29		0.6		2.5		1.5	

Comparison of barley varieties

Sarah Noack and Peter Hooper, Hart Field-Site Group Inc

Key Findings

- Hindmarsh and Fathom were the highest yielding feed varieties at 5.5 t/ha
- Unclassified lines (currently undergoing malt accreditation) La Trobe (IGB1101) and Compass (WI4593) also yielded 5.5 t/ha.
- Commander and GrangeR were the highest yielding malt varieties yielding 5.3 t/ha and 5.1 t/ha, respectively.
- Buloke, Scope and Charger (CA412402) were the only malt varieties not to meet the minimum retention rate.

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	1.4 m x 10 m	**Fertiliser**	DAP (18:20) Zn 2% @ 60 kg/ha
Seeding date	18th May 2013		UAN (42:0) @ 75 L/ha, 11th July

The trial was a randomised complete block design with 3 replicates and 21 varieties. Fungicides were applied as necessary to keep the crop canopy free of disease ie. net blotch.

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

Results

Hindmarsh, Fathom, and Keel were the highest yielding feed barley varieties at Hart in 2013, ranging from 5.39 - 5.52 t/ha (Table 1). The lowest yielding feed variety was Maritime at 4.52 t/ha. The average yield across all feed varieties was 5.20 t/ha.

The highest yielding malt variety was Commander, 5.25 t/ha. Both La Trobe (IGB1101) and Compass (WI4593) currently unclassified lines (undergoing malting accreditation), were not significantly different to Commander yielding 5.48 t/ha. The average yield for Hart across all malt varieties was 4.86 t/ha.

Grain protein ranged between 10.2% for Oxford and 12.0% for Flinders and Bass. There were no varieties that fell outside the allowable protein range of 9 - 12%.

All malt barley varieties except Navigator and Charger (CA412402) exceeded the minimum test weight specification of 65 kg/hL. All feed barley varieties exceeded the minimum test weight specification for F1 feed barley of 62.5kg/hL.

Barley screenings at the site were on average of 11.4%. Varieties Charger (CA412402) and La Trobe (IGB1101) produced the highest screenings at 26.8% and 21.8%, respectively.

Many of the malt barley varieties produced a retention rate greater than the required 70% for malt barley (Table 1.). Varieties with a retention rate less than 70% were Buloke, Scope, Charger (CA412402) and La Trobe (IGB1101).

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL), screenings and retention (%) of barley varieties at Hart in 2013.

Quality	Variety	Yield t/ha	% of site average	Protein %	% of site average	Test weight kg/hL	% of site average	Screenings %	% of site average	Retention %	% of site average
Feed	Fathom	5.50	109	11.2	101	63.9	96	7.4	65	85.7	111
	Fleet	5.20	103	11.3	102	63.5	96	6.9	60	80.2	104
	Hindmarsh	5.52	110	10.4	93	69.4	105	13.4	118	76.2	99
	Keel	5.39	107	10.8	97	67.8	102	7.7	67	88.1	114
	Maritime	4.52	90	11.6	104	63.5	96	7.3	64	83.5	108
	Oxford	5.08	101	10.2	92	66.8	101	14.0	122	70.6	92
Malting	Buloke	4.80	95	11.2	100	66.2	100	13.9	122	59.0	77
	Commander	5.25	104	10.9	98	67.1	101	11.5	101	82.2	107
	Flagship	4.56	91	10.8	97	68.2	103	11.5	101	74.6	97
	Flinders	4.71	94	12.0	108	67.2	101	7.4	65	77.7	101
	Schooner	4.50	89	10.5	94	67.9	102	10.3	91	77.5	101
	Scope	4.78	95	11.3	102	65.9	99	12.6	111	65.0	84
	Westminster	4.75	94	11.3	101	67.6	102	5.7	50	88.4	115
	Bass	5.04	100	12.0	108	66.2	100	4.5	39	87.6	114
	Navigator	5.01	99	11.0	99	64.1	97	12.6	110	81.4	106
	GrangeR	5.05	100	11.2	101	66.6	100	12.1	106	73.7	96
	Charger (CA412402)	4.98	99	11.5	104	63.3	95	26.8	235	63.7	83
Unclassified	La Trobe (IGB1101)	5.48	109	10.8	97	68.0	103	21.8	191	65.1	85
	Skipper	5.26	104	11.3	101	68.3	103	11.3	99	81.6	106
	Wimmera	4.88	97	11.7	105	66.0	99	14.1	124	70.2	91
	Compass (WI4593)	5.48	109	10.7	96	65.6	99	6.8	60	86.3	112
	Site Average	**5.03**	100	**11.1**	100	**66.3**	100	**11.4**	100	**77.1**	100
	LSD (P≤0.05)	0.24		1.05		1.67		5.99		11.8	

Comparison of durum varieties

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- The grain yield results were very good, averaging 3.72 t/ha for the trial compared to average wheat and barley trial grain yields of 4.07 t/ha and 5.03 t/ha, respectively.
- Test weight values were higher than previous years and screening levels low.

Why do the trial?

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

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	DAP (18:20) + Zn 2% @ 60kg/ha
Seeding date	18th May 2013		UAN (42:0) @ 75 L/ha, 11th July
			UAN (42:0) @ 70 L/ha, 29th August

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

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

Results and Discussion

Saintly was the highest yielding durum variety at Hart in 2013 (3.91 t/ha), along with Tjilkuri at (3.76 t/ha). All other varieties in the trial produced statistically similar yields with an average of 3.72 t/ha (Table 1). The only durum variety to have significantly lower yield compared to all other varieties was Hyperno, 3.54 t/ha.

Across all durum varieties protein ranged from 11.4% (Saintly) to 12.6% (Hyperno), and the average across all varieties was 12.1% (Table 1).

Test weight values for durum varieties at Hart over the past three years have been variable, ranging from 51.6 kg/hL in 2012 to 74.0 kg/hL in 2010. In 2013 the site average test weight was 76.0 kg/hL with Caparoi, Saintly and Tamaroi above the test weight minimum of 76 kg/hL.

Screenings ranged from 2.4% (Caparoi) to 11.7% (Hyperno) with a trial average of 6.4%. Durum varieties below 5% screenings were Caparoi, Saintly and Tamaroi.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) for durum varieties at Hart, 2013.

Variety	Grain yield (t/ha)	% of site average	Protein (%)	% of site average	Test weight (kg/hL)	% of site average	Screenings (%)	% of site average
Caparoi	3.72	100	12.4	103	78.8	104	2.4	37
Hyperno	3.54	95	12.6	104	74.2	98	11.7	182
Saintly	3.91	105	11.4	100	78.3	103	3.2	49
Tamaroi	3.73	100	11.7	97	78.1	103	3.7	58
Tjilkuri	3.76	101	11.8	98	73.5	97	6.7	104
WID802	3.71	100	12.1	100	74.1	98	6.9	107
Yawa	3.71	100	12.1	100	74.7	98	9.8	163
Site Average	**3.72**	100	**12.1**	100	**76.0**	100	**6.4**	100
LSD (P≤0.05)	0.16		0.68		3.90		0.65	

Comparison of cereal forage

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- Greater variation in dry matter production at the water ripe sampling time was observed compared to milky-soft dough
- Dry matter production was highest at milky-soft dough and Moby barley consistently had the lowest.
- Majority of cereal forage varieties had NDF and NDFD levels to meet grade 1 and 2.
- Feed quality did not decline significantly with later cutting.

Why do the trial?

Hay producers now have the opportunity to supply Moby barley hay into the export market through Balco Australia. Moby forage barley is a white seeded awnless barley bred for high quality forage. Although Moby barley has been around for a number of years it is relatively new to farming systems in the Mid-North. This trial was designed to evaluate different commercially available forage crop varieties for dry matter production and feed quality.

How was it done?

Plot size	1.4 m x 10 m	**Fertiliser**	DAP (18:20) + Zn 2% @ 60 kg/ha
Seeding date	18th May 2013		UAN (42:0) @ 75 L/ha, 11th July
			UAN (42:0) @ 70 L/ha, 29th August

The trial was a randomised complete block design consisting of three replicates, and nine crop varieties. Dry matter cuts and feed quality analysis were sampled and analysed at growth stages watery ripe and milky-soft dough.

The first dry matter cut was taken at the watery ripe growth stage. Due to the difference maturities of the varieties selected the date of sampling ranged from 18th September – 1st October. Similarly, for the milky-soft dough cut dates ranged from 1st – 9th October.

Results and Discussion

Dry matter production

At the first time of sampling the average dry matter production for all crops was 7.0 t/ha (Table 1). Tungoo oats, a mid-late maturing variety produced the highest dry matter, 9.1 t/ha, and Buckley wheat also mid maturing variety produced the second highest biomass, 8.1 t/ha. The remaining oat varieties Mulgara, Wintaroo and Yallara all had similar dry matter production > 6000 kg/ha. Commander barley also produced similar dry matter compared to these oat varieties. Both Rufus triticale and Moby barley had the lowest dry matter production at water ripe growth stage.

Dry matter production at milky-soft dough sampling time was less variable compared to the early sampling date and averaged 8.14 t/ha across all the crop types (Table 1). Commander barley, Mulgara and Yallara oats had the highest dry matter production (greater than 8635 kg/ha). The remaining cereal forage varieties did not significantly differ in dry matter production expect for Moby barley (6546 kg/ha) which produced the lowest biomass.

Table 1. Dry matter production for cereal forage crops sampled at growth stages watery ripe and milky dough. Values within a column appended by different letters are significantly different (P≤0.05).

Crop	Variety	Maturity	Dry matter (kg/ha)	
			Watery ripe	**Milky-soft dough**
Barley	Commander	mid	7100^{c}	9232^{a}
	Moby	early	5589^{e}	6546^{d}
Triticale	Rufus	mid	6085^{de}	8005^{bc}
Wheat	Buckley	mid	8146^{b}	7989^{bc}
Oats	Mulgara	mid	6677^{cd}	8635^{abc}
	Tungoo	mid-late	9113^{a}	7920^{c}
	Wintaroo	early-mid	6417^{cde}	8098^{bc}
	Yallara	early-mid	7122^{c}	8676^{ab}

Feed quality analysis

At the watery ripe sampling time Buckley was the only variety to have a NDF level less than 54% (G1). By the second sampling time almost all cereal forage varieties met the NDF level for grade 1, except for Rufus triticale, Wintaroo and Tungoo oats.

The only varieties to make G1 or G2 based on WSC were Buckley wheat sampled at watery ripe and Rufus triticale sampled at milky-soft dough. All remaining varieties ranged from 10.5-14.2% which placed them in grade 4 (>/=12%) or 5 (not applicable). WSC was higher for most varieties when sampled at milky-soft dough stage, the exceptions being Yallara and Tungoo oats and Buckley wheat. Both Buckley wheat and Moby barley had 18.9% and 18.4% WSC, respectively required for grade 3 (>=/18%).

All the first sampling time the NDFD values were higher (55-68%) compared to the second sampling time (46-59%). At the watery ripe sampling time all varieties meet the NDFD level (>/=55%) required to make G1. At the milky-soft dough stage many of these varieties (Rufus, Mulgara, Wintaroo, Buckley and Tungoo) NDFD level had decreased and placed them in G2.

Table 2. Feed quality assessments of dry matter produced for all cereal forage varieties at watery ripe and milky-soft dough at Hart 2013.

Stage	Variety	% Crude Protein	% Neutral Detergent Fibre (NDF)	% Water Sol. Carbs (WSC)	% Simple Sugars (ESC)	NDFD 48hr (%)
Watery Ripe	Rufus	12.0^{a}	64.5^{a}	11.1^{d}	7.7^{c}	60.3
	Commander	12.1^{a}	59.4^{b}	11.3^{d}	6.6^{c}	68.3
	Moby	12.8^{a}	55.1^{cd}	14.2^{c}	7.6^{c}	66.3
	Mulgara	11.6^{a}	57.7^{bc}	12.8^{cd}	7.6^{c}	67.0
	Wintaroo	12.6^{a}	54.7^{cd}	10.5^{d}	6.6^{c}	66.7
	Yallara	10.2^{b}	55.6^{cd}	17.5^{b}	9.7^{b}	62.3
	Buckley	8.4^{c}	53.4^{d}	21.6^{a}	12.7^{a}	55.3
	Tungoo	9.8^{b}	56.0^{bcd}	13.3^{cd}	7.6^{c}	59.3
	LSD (P≤0.05)	1.31	3.43	2.83	1.59	
Milky-Soft Dough	Rufus	7.3^{b}	57.4^{ab}	25.2^{a}	18.5^{a}	52.3
	Commander	9.0^{a}	51.9^{de}	14.7^{c}	9.0^{cd}	59.0
	Moby	8.8^{a}	53.0^{cd}	18.4^{b}	10.2^{c}	55.3
	Mulgara	9.1^{a}	53.7^{bcd}	14.7^{c}	8.2^{de}	51.7
	Wintaroo	8.6^{ab}	56.6^{abc}	14.5^{c}	8.3^{de}	53.0
	Yallara	8.6^{ab}	48.0^{e}	14.8^{c}	7.3^{e}	46.3
	Buckley	8.5^{ab}	54.2^{bcd}	18.9^{b}	11.9^{b}	50.3
	Tungoo	7.8^{ab}	58.7^{a}	12.8^{c}	7.0^{e}	54.0
	LSD (P≤0.05)	1.31	4.14	2.58	1.55	

Cells shaded are for those varieties which met the general criteria for grades 1 or 2.

Acknowledgements

The Hart Field-Site Group wish to thank Pat Guerin, Balco Australia for the feed quality testing associated with this trial work.

Barley time of sowing and depth

Kenton Porker and Rob Wheeler, SARDI

Southern Zone Barley Agronomy Project, funded by GRDC

Key findings

- LaTrobe, GrangeR, and Skipper had reduced emergence from deeper sowing under both dry and wet sowing conditions.
- Varieties differed in their sensitivity to sowing time; variety choice and sowing time influenced grain yield and quality more than sowing depth.
- LaTrobe and Fathom were the highest yielding varieties across both sowing dates.
- Commander and Skipper were the only varieties to suffer a yield penalty from early dry sowing.
- GrangeR yielded similar to Commander at earlier sowing but less when delayed.
- Screenings were greater than 7% and retention less than 70% in LaTrobe across both sowing times, and in Commander and GrangeR at earlier sowing only.
- Skipper was the only variety to achieve malt specifications across both sowing times.

Why do the trial?

In SA, variable autumn/winter rainfall has often delayed the ability to sow early or during the optimum sowing window due to insufficient moisture for seed germination near the soil surface, despite there being adequate moisture at depth from summer rainfall. Growers are increasingly sowing early for timeliness of operation, and are willing to risk sowing into dry topsoil and wait for rain rather than sow deep into a moisture band and risk losses in establishment and early vigour. This trial aimed to compare the competing demands of timeliness of sowing versus sowing to maximise establishment (deep versus dry sowing, or waiting for adequate rainfall later in the season).

How was it done?

Plot size: 1.4m x 10m **Fertiliser:** DAP (18:20) + 2% Zn @ 70kg/ha

<u>Time of Sowing (2)</u>

Sowing 1: 10th May (dry sowing) Sowing 2: 31st May (wet optimal conditions)

<u>Sowing Depth (2):</u> Shallow (20 mm), Deep (60 mm)

<u>Varieties (6):</u> Fleet, Commander, Fathom, Skipper, LaTrobe, GrangeR

This trial investigated the effect of sowing six new varieties *early* (10th May) under two seed bed conditions; *shallow* below the soil surface into dry soil (20 mm) and *deeper* into the moisture band (60 mm) versus waiting until *later* to sow when seed bed conditions were optimal for sowing (31st May). All varieties were sown at the same seed density of 150 seeds per square metre. The trial was a randomised split split plot design consisting of 3 replicates, with shallow and deep sown side by side for each variety and sowing time. Measurements of plant establishment, NDVI, grain yield and all grain quality parameters were conducted and analysed in GenStat.

Results

Plant Establishment

At the first sowing date (10th of May) the seedbed was dry to 40 mm deep with moisture present below this. However, significant rainfall fell in the week following planting. At the second sowing date conditions were ideal for germination with adequate moisture right throughout the seed bed. Establishment was similar at the early dry sowing date compared to later sowing at both sowing depths, most likely due to the rainfall following the dry sowing (Table 1).

Varieties differed in their response to sowing depth. Plant establishment in Fleet, Fathom, and Commander was similar at both sowing depths. In GrangeR, Skipper and LaTrobe establishment was reduced from deeper sowing by 19% in GrangeR and up to 35% in Latrobe (Figure 1). These results are consistent with other trials that have demonstrated shorter coleoptile varieties such as LaTrobe exhibit poorer emergence from depth compared to medium to long coleoptile varieties Fleet, Fathom and Commander. More lab and field validation is needed but preliminary results suggest both Skipper and GrangeR may have a short – medium coleoptile.

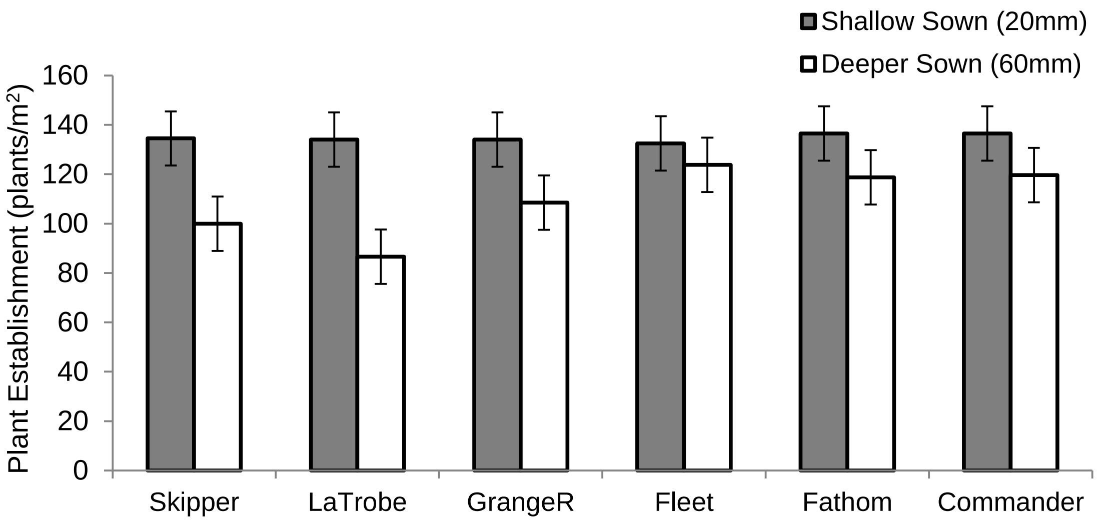

Figure 1. Plant establishment (plants per square metre) of six varieties averaged across both sowing dates when sown shallow (20 mm), and deep (60 mm) at Hart in 2013.

Early Vigour

Crop growth measurements (NDVI) taken six weeks after sowing were more pronounced at early sowing in all varieties. Sowing depth influenced the vigour of some varieties (Figure 2). The trends were consistent with what was observed in plant establishment. With up to 13% reduced vigour and canopy growth from deeper sowing occurring in LaTrobe, and GrangeR, while there were no significant difference in Fleet, Fathom, Skipper, and Commander.

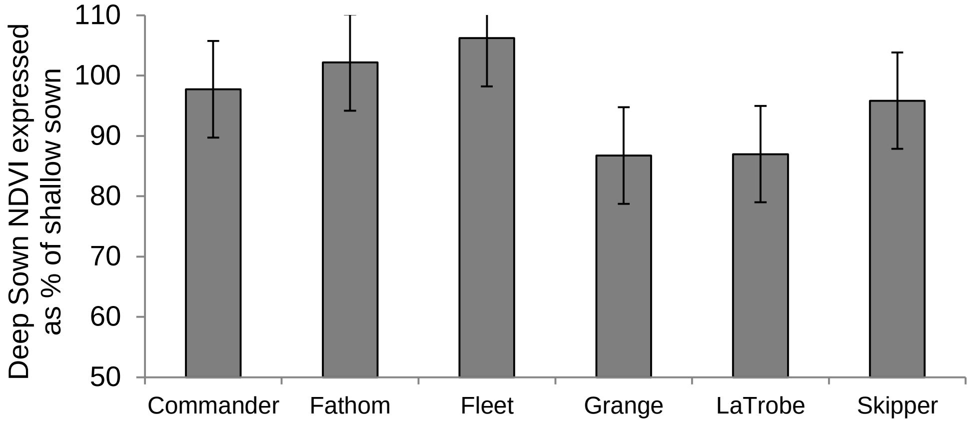

Figure 2. Growth (NDVI) at deeper sowing (60 mm) expressed as a percentage of shallow sown growth averaged cross both sowing times in barley varieties, Hart 2013.

Grain yield and quality

Varieties did not respond differently nor was there any significant effect of sowing depth on final grain yield and any grain quality parameter across all varieties (Table 1). However, varieties did respond differently to sowing date in grain yield, and all quality parameters apart from grain protein.

Fathom and LaTrobe were the equal highest yielding, followed by Fleet at both sowing dates. Commander yielded similar to Fathom and LaTrobe at delayed sowing however both Skipper and Commander suffered a 0.5 t/ha yield penalty from earlier sowing (Table 1).

Table 1. Averages for the interactions between varieties and sowing time (TOS) on grain yield and quality measurements averaged across both sowing depths, Hart 2013.

	Grain Yield t/ha		Screenings % <2.2mm		Retention %>2.5mm		Protein %		Test weight kg/hL	
	TOS 1	TOS 2	TOS 1	TOS 2	TOS 1	TOS 2	TOS 1	TOS 2	TOS 1	TOS 2
Commander	4.56	5.02	8.9	4.5	55.4	72.3	10.4	10.8	67.4	67.4
Fathom	5.42	5.20	3.3	1.4	79.4	84.3	10.0	11.1	68.2	68.3
Fleet	4.86	4.85	3.0	2.4	66.2	74.4	10.6	11.1	66.3	66.2
GrangeR	4.67	4.68	7.3	3.2	60.5	75.7	10.5	10.9	67.8	67.0
LaTrobe	5.40	5.29	7.2	7.8	58.7	52.4	10.1	10.7	69.7	69.3
Skipper	4.44	4.98	4.4	2.8	74.7	79.6	10.4	10.7	69.8	69.3
Variety x TOS LSD(P≤0.05)	0.28		2.4		4.1		NS		0.6	

Varieties differed in their quality response to sowing time. Screenings were greater than the 7% requirement for malt 1 in LaTrobe at both sowing dates, and at the earlier sowing in GrangeR and Commander. Screening levels in Fathom, Fleet, and Skipper were the lowest of all varieties and similar across both sowing dates. The trends in grain retention were very similar to screenings with LaTrobe achieving retentions less than 70% at both sow dates and GrangeR and Commander only at earlier sowing. Varieties did not differ in their protein response. Test weights were superior in Skipper and lowest in Fleet, and in general similar between sowing dates. GrangeR was the only variety to incur a reduction in test weight with delayed sowing (Table 1).

Discussion

Despite differences in varietal sensitivities in plant establishment and growth to sowing depth earlier in the season, this had little effect on grain yield and quality at this site. This demonstrated the ability of barley to compensate and recover yield from less than optimal conditions (deeper sowing, dry seedbed) at sowing and from a wide range of plant densities. Sowing depth was less important than other factors such as sowing time and variety choice on final grain yield and quality at this site in 2013.

The lack of interaction between sowing time and sowing depth across the site maybe explained by significant rainfall post sowing allowing for sufficient germination of any seeds that were sown dry. This may not be the case in other seasons where there is prolonged dry spells during the germination period. These results are encouraging for growers favouring earlier sowing under dry conditions with large cropping programs. However there is some risk, growers should be cautious with varieties such as Hindmarsh and LaTrobe and any variety that possesses a short coleoptile as they are more likely to suffer from deeper sowing.

Growers should still consider variety choice to better align with sowing date. LaTrobe and Fathom were the highest yielding varieties across both dates showing their broad adaptability and have now outclassed Fleet. GrangeR yielded similar to Commander at earlier sowing but less when delayed. GrangeR and Commander differ in phenology. When sown in early May, GrangeR has been shown to flower earlier than Commander and when sown later in May, GrangeR has shown a flowering pattern more similar to Gairdner and later than Commander. Skipper was the only variety to achieve malt specifications across both sowing times. Screenings were greater than 7% and retention less than 70% in LaTrobe across both sowing times, and in Commander and GrangeR at the earlier sowing only.

Dry matter and nutritive quality of pasture species

San Jolly, Productive Nutrition Pty Ltd

Key Findings

- Pasture species were out competed when sown with Fathom barley.
- Even when pasture species were sown as monocultures weed competition reduced biomass production in winter and summer.
- Fathom barley produced the most dry matter and the vetches and peas performed comparatively well.

Why do the trial?

Annual legume pastures have proven to be a highly effective weed management tool in low rainfall areas with the added benefits of nitrogen fixation and providing livestock with a valuable feed resource. However winter feed production is a major determinant of stocking rate and hence profitability of the livestock component of a mixed farming system and the winter productivity of many leguminous species limits stocking rate potential.

The pasture trial for 2013 was established to investigate the dry matter (DM) productivity and nutritive value (NV) of a range of pasture species sown independently or in conjunction with Fathom barley at Hart in winter and summer.

How was it done?

Plot size	3.7 m x 10 m	**Fertiliser**	DAP (18:20) + Zn 2% @ 75 kg/ha
Seeding date	27th May 2013		

The trial was a randomised complete block design with 3 replicates, with 13 varieties sown with or without Fathom barley. The pastures and forage mixtures and sowing rates are detailed in Table 1.

Simulated grazing over half the plots was carried out on 9th of August, 2013 (barley growth stage 32). Plots were mowed using a tractor and slasher cutting to a height of 5-7 cm (photo 1). All dry matter was raked and removed from mowed half plots.

All plots were assessed for dry matter production in both winter (28th August, 2013) and summer (11th December, 2013). Selected treatments were also analysed for feed quality at both these sampling dates.

Table 1. Plot number, species, variety and sowing rates of pastures and cereal at the Hart in 2013.

Plot	Species	Variety	Sowing rate kg/ha	Variety	Sowing rate kg/ha
1	Lucerne	SARDI 5	7		
2	Lucerne	Q31	7		
3	Lucerne	Creeping Lucerne	3		
4	Lucerne	SARDI 7, Series 2	7		
5	Vetch	Capello	45		
6	Vetch	Morava	45		
7	Sulla	Wilpena	12		
8	Clover	Arrow leaf - Zulu 2	10		
9	Balansa	Frontier	5		
10	Clover	SARDI Persian	8		
11	Medic	Angel	10		
12	Forage Pea	Hayman	80		
13	Barley	Fathom	80		
14	Lucerne	SARDI 5	7	Barley - Fathom	80
15	Lucerne	Q31	7	Barley - Fathom	80
16	Lucerne	Creeping Lucerne	3	Barley - Fathom	80
17	Lucerne	SARDI 7, series 2	7	Barley - Fathom	80
18	Vetch	Capello	45	Barley - Fathom	80
19	Vetch	Morava	45	Barley - Fathom	80
20	Sulla	Wilpena	12	Barley - Fathom	80
21	Arrow leaf clover	Zulu 2	10	Barley - Fathom	80
22	Balansa	Frontier	5	Barley - Fathom	80
23	Clover	SARDI Persian	8	Barley - Fathom	80
24	Medic	Angel	10	Barley - Fathom	80
25	Forage Pea	Hayman	80	Barley - Fathom	80

Results and discussion

Monocultures of pastures were cut and analysed for dry matter (DM) production and nutritive value (NV) by the SGS Australia laboratory on the 28th August and 11th of December, 2013. Nutritive value tests included crude protein (CP), metabolisable energy (ME), neutral detergent fibre (NDF), acid detergent fibre (ADF), dry matter digestibility (DMD) and dry organic matter digestibility (DOMD).

Dry matter production

Where species were sown as monocultures and no grazing was simulated (uncut), by August barley had produced the highest amount of DM per ha with no evidence of weed competition. Although Fathom barley produced the most DM/ha (Table 2), the vetches and peas performed comparatively well. The clovers, medics and lucernes barely produced enough dry matter to meet minimum ground cover requirements for soil stability and as such were highly susceptible to invasion by weed species.

Species	Variety	Dry matter (kg/ha)
Barley	Fathom	3214
Vetch	Capello	2380
Vetch	Morava	1718
Forage Pea	Hayman	1345
Clover	SARDI Persian	1066
Balansa	Frontier	869
Medic	Angel	683
Clover	Arrow leaf - Zulu 2	610
Sulla	Wilpena	546
Lucerne	SARDI 7, Series 2	424
Lucerne	Creeping Lucerne	307
Lucerne	Q31	261
Lucerne	SARDI 5	178

Table 2. Species, variety and dry matter production (kg DM/ha) of uncut pastures in August 2013.

Unfortunately the Creeping lucerne was competing with barley and all species with the exception of Fathom barley, Capello vetch and Arrowleaf clover had significant weed competition.

Where the pasture species were sown with barley in a forage mix, winter DM production exceeded 3 t/ha; the vetches and forage peas were able to compete well with barley at 89% and 43% of the mix respectively. However, the remainder of the pasture species were completely out competed by the barley. Angel medic, SARDI Persian clover and Wilpena Sulla were the best of the competitors at 15%, 17% and 17% of the mix, respectively.

Cutting the pasture plots containing monocultures to simulate the effect of winter grazing significantly reduced the DM available at the August cut in all species except Capello vetch which produced 1357 kg DM/ha. Morava vetch was the next most productive species which yielded 893 kg DM/ha; this suggests that Capello vetch is more likely to tolerate winter grazing although by the end of the year the total DM production difference between Capello and Morava was only 300 kg DM/ha.

Where the leguminous pasture species were sown with barley the cereal effectively out competed any weeds however, the pasture monocultures suffered heavy weed infestation (annual ryegrass, Indian hedge mustard, milk thistle and wire weed) in particular balansa clover where the plot was 48% weed species by August (Table 3). SARDI 7 lucerne and Wilpena sulla were less affected (30 & 20% of the plots respectively) however, the weed populations were a significant proportion of the total DM/ha. Weed infestation was much greater where no simulated grazing had taken place (uncut).

Table 3. Total dry matter production (kg/ha) of cut and uncut species and varieties of pastures sown as monocultures at Hart December, 2013.

Species	Variety	*Cut/Uncut	% Weeds	Dry matter (kg/ha)
Barley	Fathom	uncut	0%	6,230
Barley	Fathom	cut	0%	4,020
Vetch	Morava	cut	13%	3,530
Clover	Arrow leaf - Zulu 2	uncut	33%	3,334
Vetch	Morava	uncut	12%	3,191
Vetch	Capello	cut	2%	3,003
Forage Pea	Hayman	uncut	27%	2,995
Vetch	Capello	uncut	4%	2,882
Sulla	Wilpena	uncut	25%	2,773
Balansa	Frontier	uncut	60%	2,771
Clover	Arrow leaf - Zulu 2	cut	27%	2,647
Balansa	Frontier	cut	57%	2,354
Clover	SARDI Persian	cut	47%	2,288
Clover	SARDI Persian	uncut	50%	2,282
Forage Pea	Hayman	cut	47%	2,196
Sulla	Wilpena	cut	23%	2,172
Medic	Angel	uncut	38%	1,865
Lucerne	Q31	cut	48%	1,333
Medic	Angel	cut	32%	1,284
Lucerne	Creeping Lucerne	cut	87%	1,196
Lucerne	SARDI 7, Series 2	cut	32%	1,158
Lucerne	SARDI 5	cut	20%	1,125
Lucerne	Creeping Lucerne	uncut	92%	1,118
Lucerne	SARDI 5	uncut	32%	958
Lucerne	SARDI 7, Series 2	uncut	40%	958
Lucerne	Q31	uncut	52%	917

Cut treatments do not include the portion of dry matter that was cut and removed during the simulated grazing event.

By December all pasture plots sown with barley out-yielded those sown with traditional pasture species such that all the plots were significantly barley-dominant. The vetches and one plot of Arrowleaf clover were the most competitive legume species (Table 4) with medic and balansa clover having been totally overwhelmed by barley.

Table 4. Total annual dry matter production (kg/ha) of cut and uncut species and varieties of pastures sown with barley at Hart December, 2013.

Species	Variety	*Cut/Uncut	Sown species (%)	Barley %	Dry matter (kg/ha)
Medic	Angel	uncut		100%	6,640
Lucerne	Creeping Lucerne	uncut	0%	100%	6,457
Lucerne	SARDI 5	uncut	3%	97%	6,289
Sulla	Wilpena	uncut	7%	93%	6,281
Clover	Arrow leaf - Zulu 2	uncut	13%	87%	6,129
Vetch	Morava	uncut	23%	77%	5,883
Balansa	Frontier	uncut		100%	5,881
Lucerne	Q31	uncut	3%	97%	5,825
Clover	SARDI Persian	cut	2%	98%	5,699
Clover	SARDI Persian	uncut	2%	98%	5,698
Vetch	Capello	uncut	30%	70%	5,485
Lucerne	SARDI 7, series 2	uncut	5%	95%	5,441
Lucerne	SARDI 5	cut	7%	93%	5,268
Forage Pea	Hayman	uncut	2%	98%	5,141
Balansa	Frontier	cut		100%	4,294
Medic	Angel	cut		100%	3,996
Clover	Arrow leaf - Zulu 2	cut	28%	72%	3,927
Sulla	Wilpena	cut	17%	83%	3,915
Lucerne	SARDI 7, series 2	cut	8%	92%	3,899
Lucerne	Q31	cut	8%	92%	3,683
Vetch	Capello	cut	40%	60%	3,446
Forage Pea	Hayman	cut	1%	99%	3,437
Vetch	Morava	cut	28%	72%	3,411
Lucerne	Creeping Lucerne	cut	2%	98%	3,227

**Cut treatments do not include the portion of dry matter that was cut and removed during the simulated grazing event.*

Pasture quality

The benefits of legume break crops in cropping systems are well recognised however in many farming systems livestock complement the grain production as a risk management tool; livestock are valuable contributors to profitability if well managed. The challenge for mixed farmers is to incorporate leguminous monocultures into the system for nitrogen fixation and to more easily control grass weed populations, and to provide a balanced pasture to optimise livestock production.

Grazing pure stands of legume pastures in the winter poses significant nutritional challenges for livestock in terms of nitrate toxicity, ammonia toxicity, mineral deficiencies, twin-lamb disease, loss of body condition and subsequent mortalities.

Lambing ewes require 15% protein during lactation to optimise productivity however as is evident in Table 5, many pasture species exceed this level of protein during winter. Capello and Morava vetch appear the most likely to cause animal health problems if grazed as a monoculture at this time at 31.4% and 33.2% crude protein.

Q31 lucerne and Capello vetch retained sufficient concentrations of protein (16.2 & 14% respectively) after senescence to support weaned lambs in December. However, the digestibility of all the species had declined below that required to optimise growth and weight gain such that supplementation with a high energy cereal grain would be required. There was insufficient pasture available of the creeping lucerne and balansa clover to sample by December.

Table 5. Crude protein concentration (%) and dry matter digestibility (DMD %) of pasture species sown at the Hart in winter and summer.

Species	Variety	Crude protein %		Dry matter digestibility %	
		Winter	Summer	Winter	Summer
Vetch	Morava	33.2	10.7	66.1	52.9
Vetch	Capello	31.4	16.2	69.6	44.6
Lucerne	SARDI 5	28.6	12.6	70.1	64.9
Forage Pea	Hayman	28.1	12.2	70.9	53.4
Lucerne	Creeping Lucerne	26.9	n/a	73.8	n/a
Lucerne	Q31	26.0	14.0	73.6	65.1
Medic	Angel	25.9	8.2	69.1	42.1
Sulla	Wilpena	23.2	11.0	71.3	54.7
Balansa	Frontier	23.0	n/a	74.7	n/a
Lucerne	SARDI 7, Series 2	22.5	12.6	73.0	62.9
Clover	SARDI Persian	22.3	7.8	74.3	52.3
Clover	Arrow leaf - Zulu 2	19.4	12.8	74.5	58.1
Barley	Fathom	11.4	5.3	65.2	65.5

Barley is commonly high in crude protein (25-30%) when sampled in winter however Fathom, being an early maturing variety, had declined significantly in feed value by August such that in the Hart environment a later maturing variety might be a better choice as a grazing option. Although digestibility had declined by December, the grain in the head available to grazing livestock is an excellent complement to the straw and flag of the reminder of the plant material. Forage peas are an excellent grazing option for livestock however optimum grazing time is generally October in most years after which time the feeding value rapidly declines.

Autumn sown, leguminous pasture production in cold, low rainfall environments is significantly challenging when monocultures are required for grass weed control and the Hart trial results support this. Clovers, medics and lucerne do not proliferate in a competitive environment which, unless early selective weed control strategies are implemented, results in poor pasture establishment, productivity and persistence.

The lucerne varieties were well balanced in terms of nutritive value however their productivity would make it difficult to justify their inclusion in a mixed farming system as a short term pasture option; their persistence at Hart is yet to be determined.

As total dry matter production is a key profit driver for the livestock component of a mixed farming system and pasture establishment is an expensive undertaking, pasture species selection should be based on dry matter production potential, winter productivity and persistence (not yet assessed at Hart) rather than the newest variety on the market.

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Photo 1: Simulated grazing over half the plots was carried out on 9th of August, 2013.

Photo 2: (left) plot Morava vetch and (right) Wilpena Sulla sown with barley, taken October 24th, 2013.

Forage peas – a potential new break crop option for SA

Mick Lines & Larn McMurray, SARDI

This research is funded by the South Australian Grains Industry Trust (SAGIT).

Key findings

- Biomass production at Hart in 2013 averaged 4.2 t/ha at the early pod development stage, and 5.0 t/ha at maturity across the trial.
- Kaspa, Morgan and PBA Coogee have generally shown similar biomass levels at flowering in 2013, although Kaspa has shown higher grain yield.
- PBA Hayman produced the highest biomass of all the field pea and vetch varieties at the early pod development stage, particularly when sown early.
- Vetch varieties showed equal or greater biomass to Kaspa, Morgan and PBA Coogee at the early pod development stage, but lower than PBA Hayman.
- Biomass of field pea varieties at flowering was maximised at higher sowing densities (75 and 100 plants/m^2), however this resulted in yield loss at some sites.

Why do the trials?

Work funded by SAGIT has currently been assessing the biomass accumulation and grain yields in comparison with current field pea standards, Kaspa (the predominant grain yield variety in south eastern Australia) and Morgan (a dual purpose field pea variety), as well as several current vetch variety options. Key trial sites in the Mid-North include Hart and Tarlee.

Break crop choice typically considers more than just profitability. Additional considerations include agronomic (eg. weed or disease control objectives, reduced fertiliser (N) requirements, specific crop requirements) and marketing issues (eg. ease of marketing and access to established markets).

Some specific considerations when comparing vetch and field pea as break crop options include the end-use goal (i.e. grain yield, brown manure, hay), post-emergent weed control options, hard seededness and potential to carry through to the following crop, and ease of marketing. Vetches are a versatile break crop that can be used for “forage” (grazing, hay, silage and green/brown manure) or grain production. However, they lack a well-established grain market, have generally low biomass production and weed competition through the winter months compared to other break crops, have few post-emergent in-crop weed control options, and have the potential to contribute to weed burdens in paddocks through the production of “hard” seeds. The development of dual purpose and forage field pea varieties give growers a competitive alternative to vetch and other current break crop options. Dual purpose field pea varieties also give growers the flexibility to react to seasonal conditions eg. frost, drought, or high grain prices for opportunistic grain production.

How was it done?

Plot size 1.75 m x 10 m **Fertiliser rate** MAP (10:22) + 2%Zn @ 90 kg/ha

Trial 1: Comparing performance of field pea and vetch cultivars

Varieties Field peas; Kaspa, Morgan, PBA Hayman and PBA Coogee
Vetch; Morava and Rasina (common vetch), Capello and RM1 (woolly pod vetch)

Sowing dates 13th May and 7th June 2013

Sowing Density Field pea: 50 plants per square metre; vetch: 70 plants per square metre

Trial 2: Maximising biomass potential of field pea varieties through sowing date and plant density

Varieties Field peas; Kaspa, Morgan, PBA Hayman and PBA Coogee

Sowing dates 13th May and 7th June 2013

Plant densities 25, 50, 75 and 100 plants per square metre

Trial designs The trials were set up as split plot design with three replicates. The blocking structure was set up with replicates as the main block, sowing date as whole plot, and varieties and treatments randomised in subplots.

Results

Annual rainfall was 377 mm at Hart in 2013, slightly below the long term average (400 mm). Grain yields averaged 1.9 t/ha across the trials, buoyed by good winter rainfall and mild spring temperatures, despite the dry finish to the season. Early season conditions were favourable for plant growth, with warmer than average temperatures throughout winter, with high yield potential at the start of spring. Low levels of ascochyta and botrytis were observed in field pea and vetch respectively.

Biomass at ten weeks after sowing

Trial 1: Comparing performance of field pea and vetch cultivars

Biomass cuts were performed at ten weeks after sowing (10WAS) to compare early (winter) biomass production of field pea and vetch varieties at Hart and Tarlee. Biomass production during winter is considered important for early weed competition.

Dual purpose varieties Morgan and PBA Coogee showed higher early biomass when sown early compared to PBA Hayman and the vetch varieties. The most commonly grown vetch line, Morava, showed similar early biomass to Kaspa peas. All other vetch varieties produced less early biomass compared to the field peas, except for PBA Hayman. At the late sowing date, field peas showed similar biomass levels, together with Rasina and RM1, while Morava and Capello produced less biomass.

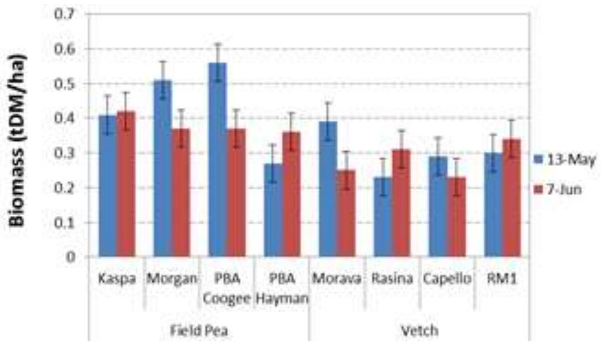

Figure 1. Effect of sowing date on early biomass (10WAS) of field pea and vetch varieties, Hart 2013.

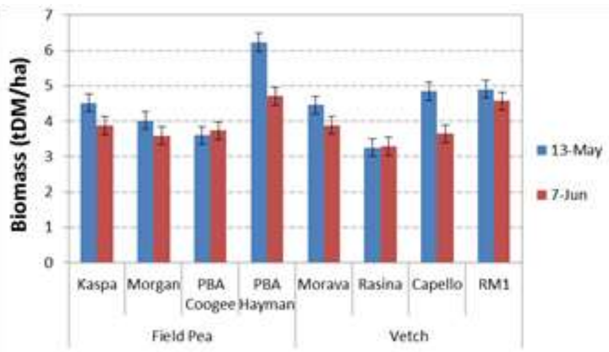

Figure 2. Effect of sowing date on biomass production of field pea and vetch varieties at the early pod development stage (EPDS), Hart 2013.

Biomass at the early pod development stage (EPDS)

Trial 1: Comparing performance of field pea and vetch cultivars

Biomass cuts were taken at early pod development (1-2 flat pods per plant, occurring approximately 10-14 days after flower commencement) as an indication of potential hay production. Biomass averaged 4.2 t/ha at Hart and 5.0 t/ha at Tarlee across all varieties at the early pod development stage (EPDS).

At both sites, PBA Hayman produced significantly higher biomass compared to all other field pea and vetch varieties when sown early. When sowing was delayed PBA Hayman produced substantially less biomass than when it was sown early, producing similar biomass to some vetch varieties but more biomass than other field pea varieties (Figure 2).

PBA Hayman showed the largest response to sowing date, with 24% and 30% reductions in biomass from delayed sowing at the EPDS at Hart and Tarlee, respectively. Kaspa, Morgan and PBA Coogee showed some variability across sites, but generally showed relatively similar biomass at the EPDS. Early sown Kaspa produced more biomass than Morgan and PBA Coogee at the EPDS at Hart, while early sown PBA Coogee showed higher biomass than the other grain varieties at Tarlee.

Trial 2: Maximising biomass potential of field pea varieties through sowing date and plant density

Field peas showed significant variety and sowing density responses for biomass at the EPDS, but no significant response to sowing date (Table 1). The grain and dual purpose pea varieties Kaspa, Morgan and PBA Coogee showed similar biomass at the EPDS at Hart and Tarlee in 2013 (Table 1). As in Trial 1, PBA Hayman showed significantly greater biomass than the other three varieties at the EPDS, ranging from 27-55% greater biomass at this timing.

Sowing density had a significant effect on biomass at the EPDS at Hart and Tarlee (Table 2). The lack of an interaction with variety means that all varieties behaved similarly at the different density treatments. Sowing field peas at 25 plants/m^2 (half the recommended sowing rate for grain production) reduced biomass by 18% at both Hart and Tarlee (Table 2).

Table 1. Biomass production (t/ha) of field pea varieties at the early pod development state (EPDS), Hart and Tarlee, 2013. Significantly different treatments are followed by a different letter.

Site	**Kaspa**	**Morgan**	**PBA Coogee**	**PBA Hayman**	**LSD (P≤0.05)**
Hart	3.61 ^{a}	3.30 ^{a}	3.60 ^{a}	5.11 ^{b}	0.40
Tarlee	3.98 ^{l}	3.81 ^{l}	3.67 ^{l}	5.06 ^{m}	0.53

Table 2. Effect of sowing density (plants per square metre) on biomass production (t/ha) of field peas at the early pod development state (EPDS), Hart and Tarlee, 2013. Significantly different treatments are followed by a different letter.

	Plant Density (plants/m^2)				**LSD**
Site	**25**	**50**	**75**	**100**	**(P≤0.05)**
Hart (both sowing dates)	3.44 ^{a}	3.95 ^{b}	4.02 ^{b}	4.20 ^{b}	0.36
Tarlee (both sowing dates)	3.66 ^{l}	4.17 ^{m}	4.21 ^{m}	4.49 ^{m}	0.32

Biomass at maturity

<u>Trial 1:</u> Comparing performance of field pea and vetch cultivars

At Hart for each sowing date (Figure 3), biomass of all field pea varieties except Morgan was maximised by early sowing. Capello was the only vetch variety to show a sowing date response, where biomass at maturity was maximised from delayed sowing. Field pea varieties showed equal or higher biomass from early sowing, while vetch varieties showed equal or higher biomass from delayed sowing.

Despite showing significantly greater biomass at the EPDS, PBA Hayman showed similar biomass to other field pea varieties at maturity, likely due to its significantly lower grain yield. Kaspa showed equal or greater biomass than all other varieties at maturity, except when sown late at Hart.

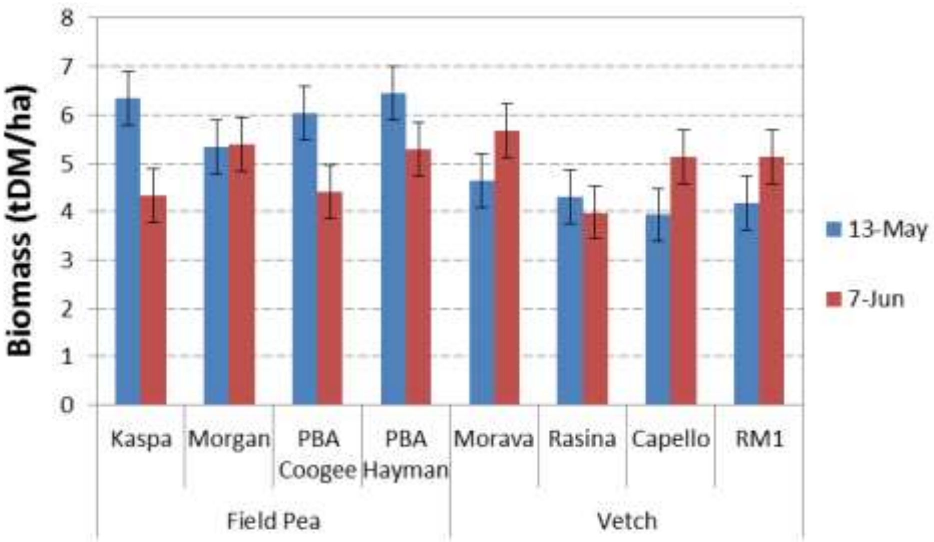

Figure 3. Effect of sowing date on biomass production of field pea and vetch varieties at maturity, Hart 2013.

Grain yield

<u>Trial 1:</u> Comparing performance of field pea and vetch cultivars

Kaspa was the highest yielding variety at both Hart and Tarlee in 2013 (Table 3). Morgan and PBA Coogee produced higher grain yield at Hart and Tarlee than all vetch varieties except Rasina.

Rasina was the highest yielding vetch variety at both Hart and Tarlee, producing 14-28% higher grain yield than Morava. Grain yield of the woolly pod vetches Capello and RM-1 (which should not be used for feeding livestock) was generally lower than common vetches, and similar to PBA Hayman.

<u>Trial 2:</u> Maximising biomass potential of field pea varieties through sowing date and plant density

There was no significant sowing date response on grain yield at Tarlee in 2013. At Hart, Kaspa and Morgan were the only varieties to display a sowing date response, showing higher grain yields from earlier sowing. All other varieties performed similarly at both sowing dates.

At both sites sowing density had a significant effect on grain yield (Table 4). Sowing field peas at 75 plants/m^2 and greater resulted in an 8-10% yield loss at Hart, while the highest density (100 plants/m^2) resulted in a 13% yield loss at Tarlee.

Table 3. Grain yield (t/ha) of field pea and vetch varieties at Hart and Tarlee, 2013. Significantly different treatments are followed by a different letter for each site.

	Crop	Field Pea				Vetch				LSD (P≤0.05)
Site	**Variety**	**Kaspa**	**Morgan**	**PBA Coogee**	**PBA Hayman**	**Morava**	**Rasina**	**Capello**	**RM1**	
Hart	**13 May**	2.71 a	2.23 bcd	2.08 def	1.49 ij	1.72 h	2.12 cde	1.68 hi	1.42 j	0.19
	7 June	2.32 b	1.92 fg	2.03 ef	1.34 j	1.78 gh	2.28 bc	1.63 hi	1.4 j	
Tarlee (both sowing dates)		3.74 a	2.98 b	2.66 c	1.24 e	2.28 d	2.61 c	1.15 e	1.05 e	0.28

Table 4. Effect of sowing density (plants per square metre) on grain yield (t/ha) of field peas at Hart and Tarlee, 2013. Significantly different treatments are followed by a different letter for each site.

	Plant Density (plants/m^2)				LSD
Site	**25**	**50**	**75**	**100**	**(P≤0.05)**
Hart	1.89 AB	1.97 A	1.81 B	1.78 B	0.12
Tarlee	2.31 A	2.38 A	2.21 AB	2.08 B	0.20

Discussion

The warm winter in 2013 was favourable for early biomass production, and high levels of biomass were measured. This is likely to have been of particular benefit to vetch, which generally show restricted growth in cool winters. Field pea varieties at Hart and Tarlee in 2013 showed equal or greater performance to vetch cultivars for the three parameters measured; grain yield and biomass production at flowering and at maturity. In another trial at Minnipa (Upper Eyre Peninsula), vetch showed equal or greater performance to field pea cultivars for these three parameters. Hence, further comparison is required in seasons with closer to average temperatures.

Field peas displayed a substantially larger canopy at ten weeks after sowing compared to vetch, but only showed equal or slightly greater early biomass due to higher moisture content (data not shown). It is possible that the larger canopy and the generally larger biomass of field peas may provide increased competition with weeds compared to vetches.

Later flowering varieties have generally shown higher biomass production at the EPDS than earlier flowering varieties (eg. PBA Hayman and Morava vetch). This characteristic will also promote hay quality by extending the timing of cutting into more favourable (warmer and quicker) curing conditions compared to earlier flowering varieties. This is a significant benefit of the forage field pea variety PBA Hayman, which often flowers 2 or more weeks later than other field pea varieties, and at a similar time to vetch.

PBA Hayman showed significantly higher biomass at flowering than other field pea varieties at Hart and Tarlee in 2013, producing 38-74% greater biomass than Kaspa at flowering when sown early, and 21-27% higher biomass when sown late. Early sown PBA Hayman produced significantly greater biomass than vetch varieties at flowering, but similar at later sowing dates. However, vetch varieties generally showed equal or greater biomass than the grain and dual purpose field pea varieties, Kaspa, Morgan and PBA Coogee.

Kaspa has generally shown similar biomass production at flowering to the dual purpose field pea varieties (Morgan and PBA Coogee) across trials in 2012 and 2013, and has shown equal or greater grain yield. The performance of PBA Coogee has been variable across sites to date, ranging from lower grain yield than Morgan to equal grain yield to Kaspa. PBA Coogee showed lower relative grain yield at Tarlee in 2013, where it produced significantly greater biomass than Kaspa or Morgan. The dry and rapid season finish in 2013 may have caused this variety to “hay off” (where high biomass production leaves insufficient moisture for grain fill) at this site.

Biomass production of field peas at flowering time was maximised by sowing at 50 plants/m^2 (the recommended density for grain production) and greater at Hart and Tarlee. In a trial at Minnipa, increasing the sowing density was required to avoid biomass loss caused by delayed sowing, and late sown plots with high sowing densities were able to achieve biomass yields similar to early sown plots. This information is valuable in situations where sowing is delayed due to either a late season break or where blackspot risk is high due to low summer rainfall. Grain yield was generally not compromised by increasing sowing density at Minnipa, however sowing at 75 plants/m^2 and greater resulted in yield losses at Hart and Tarlee compared to sowing at 50 plants/m^2. Further validation across seasons is required.

New varieties of field pea and vetch are now available which provide alternative forage opportunities. PBA Hayman is a forage field pea variety, which generally has lower grain yield than Morgan (which has been considered a dual purpose variety) but has higher biomass production. PBA Hayman also has improved bacterial blight resistance compared to most other varieties, but lower grain yield, indicating that grain retrieval may be difficult in low rainfall areas. However, due to its lower seed weight (averages 14 g/100 seeds compared with 20-25 g/100 seeds in other varieties) seed requirements for sowing are significantly lower.

PBA Coogee has been released as a dual purpose field pea variety that provides the flexibility of a forage option if frost or drought limits grain yield potential. PBA Coogee has a conventional plant type similar to the variety Parafield but with increased early season growth, more basal branching, longer vines and higher grain yield. It also shows improved tolerance to soil boron and salinity compared to all other field pea varieties, and is resistant to powdery mildew and moderately resistant to bacterial blight.

Volga is a highly rust resistant common vetch variety with good early establishment and early maturity (7-12 days earlier maturing than Rasina). Volga is early flowering, and will reach full flowering in 90-100 days from sowing. So far it is the best adapted vetch variety for grain and hay production in low/mid rainfall areas such as the SA Mallee, Mid North and Eyre Peninsula. Like other common vetch varieties, grain of Volga can be used to feed ruminant stock, whereas grain of woolly pod varieties such as Capello must not be used to feed livestock. Volga is currently undergoing seed bulk-up.

These SAGIT funded trials will continue in 2014, together with similar trials at Tarlee and Hart in the Mid North, and Lameroo in the Mallee. Additionally, nitrogen fixation and feed quality tests will be conducted on samples from the 2013 and 2014 trials. This will provide additional information to grain yield and biomass data, which will give growers a holistic comparison of vetch and field pea break crops in South Australia.

Improving crop competition in wheat and durum

Kenton Porker and Rob Wheeler, SARDI

Durum Weed Agronomy Project, funded by SAGIT in association with SA DGA.

Key findings

- Fathom barley was more competitive than Hindmarsh barley, bread wheat and durum.
- Increasing seeding rate and seed bed utilisation improved crop weed competition (by up to 60%) without a yield penalty or quality downgrading.
- Tjilkuri and Mace sown at 300 seeds/m^2 with a spreader boot achieved similar ARG suppression as Fathom barley sown at 150 seeds/m^2.
- Pre-emergent herbicide application offered the best control of ARG in this trial across all varieties and agronomic management factors.
- Non chemical strategies can significantly enhance crop's competitive ability with weeds and should be integrated with herbicide use.

Why do the trial?

There are few safe and effective grass control herbicide options in durum. Durum has typically been less competitive with annual ryegrass (ARG) than bread wheat and barley. A trial at Hart in 2013, aimed to evaluate the relative competitiveness of durum wheat compared to barley and bread wheat, against annual ryegrass grown under different management practices tailored to influence crop competition. The management factors included variety, seeding rate, increasing seed bed utilisation, row spacing and seed size and vigour.

How was it done?

Plot size: 1.4 m x 10 m

Seeding date: 24th May 2013

Fertiliser: DAP (18:20) + 2% Zn @ 70 kg/ha
50 kg N @ GS31

The trial was a randomised complete block design consisting of 3 replicates, and 21 treatment combinations designed to compete with annual ryegrass (Table 1). The trial was sprayed with a knockdown at sowing and pre-spread with annual ryegrass to establish a consistent level of ryegrass across the site. All 21 treatment combinations were split with half of the plot sprayed with 2.5 L/ha Boxer Gold plus 2 L/ha tri-allate pre-emergent herbicide incorporated by sowing (IBS) and the other half left unsprayed. Mace and Tjilkuri received all additional treatments. Scout, Saintly, Fathom, and Hindmarsh only received standard practice. The standard row spacing was 22.8 cm, and the spreader boot aimed to spread the seed across a 4 cm wide band rather than a single 1 cm wide band (standard).

Table 2. Management treatment combinations of crop type, variety, seeding rate, and additional management used to compete with ryegrass at Hart 2013.

Treatment	Seed rate (seeds/m^2)	Sowing Boot	Management change (relative to standard practice)
1 Standard	200	Standard	Standard (traditional practice)
2	100	Standard	Lower seed rates
3	300	Standard	Higher seed rates
4	100	Spreader boot	Lower seed rates + increased seed bed utilisation
5	200	Spreader boot	Increased seed bed utilisation
6	300	Spreader boot	Higher seed rates + increased seed bed utilisation
7	200	Standard	Narrow Row Spacing (11.5 cm)
8	200	Standard	Increased seed size (large seed size>2.8 mm)
9	200	Standard	Decreased seed size (seed <2.5 mm)

Results and Discussion

Annual rye grass (ARG) establishment

Averaged across all management treatments, there were 63 ARG plants/m^2 when unsprayed and 11 plants/m^2 when sprayed. The management treatments had no significant effect on establishment of ARG.

Crop plant density

Crop plant densities differed between management treatments. Fathom and Hindmarsh barley established similarly and close to their target density of 150 plants/m^2. Plant establishment in the standard treatments of durum and bread wheats (Tjilkuri, Saintly, Scout, and Mace) ranged from 137 – 157 plants/m^2, markedly less than the 200 plants/m^2 target density. All treatments aiming for 100 seeds/m^2 established close to 100 plants/m^2 and the higher density treatments (300 seeds/m^2) all established within the range from 172 – 190 plants/m^2. The effect of herbicide significantly reduced plant establishment by an average of 8% in all treatments.

Crop competition and grain yield - comparison of crop varieties

For all varieties when sprayed with a pre-emergent herbicide (BoxerGold and tri-allate) reduced ARG numbers to the same level, ranging from 5-23 heads/m^2 (Figure 1a). For the unsprayed treatments both Fathom and Hindmarsh barley were the most competitive, reducing ARG numbers to 50 and 79 head/m^2, respectively. Both durum varieties and Scout wheat reduced ARG numbers to 100 heads/m^2. Mace wheat was the least competitive variety in this trial.

Despite large difference in crop competition (Figure 1b) this did not translate to differences in grain yield (Figure 1b) or quality (data not shown).

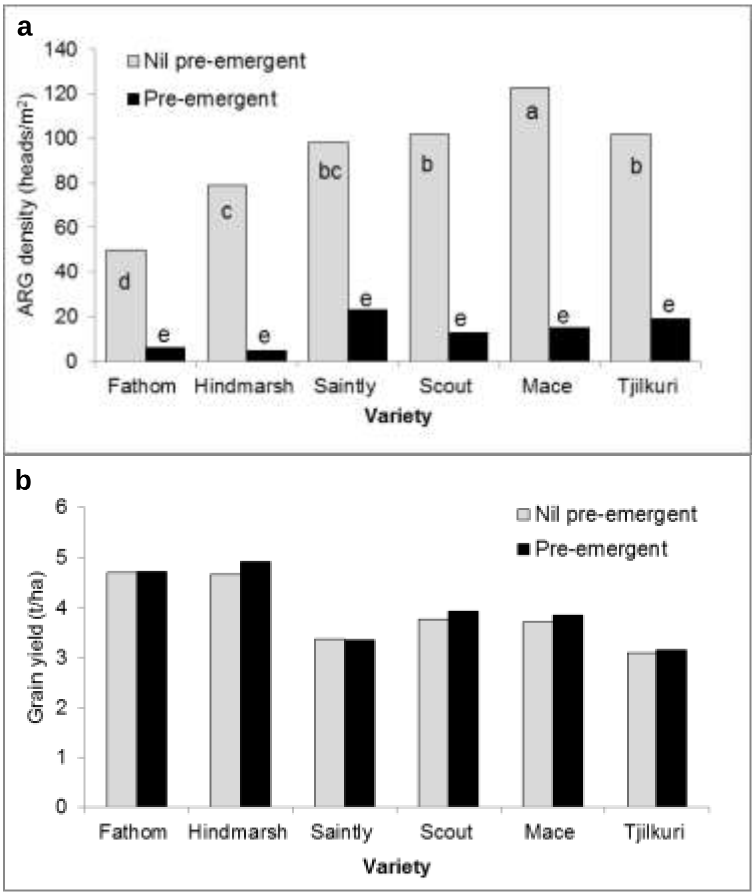

Figure 1. Comparison of varieties sown at standard seeding rates on (a) annual ryegrass plant density (heads/m^2) (treatment x herbicide LSD 21 at P≤0.05) and (b) grain yield (t/ha). Fathom, Hindmarsh, Saintly, Scout, Mace and Tjilkuri @ 150 seeds/m^2.

Crop competition and grain yield - effect of increasing crop density

Both Mace and Tjilkuri were used to look at the effect of increasing seeding rate and seed bed utilisation on the suppression of ARG (Figures 2a and b). For both varieties the combination of a spreader boot and 300 seeds/m^2 without herbicide, gave the best ARG control compared to using a pre-emergent herbicide. Treatments to have the least effect on ARG numbers were the standard and spreader boot at 100 seeds/m^2. Overall, the Tjilkuri durum was poorer at competing with ARG, even with improved control treatments. It should be noted that the actual plant densities were significantly lower than for the 200 and 300 seeds/m^2 targets.

The addition of pre-emergent herbicides gave very good ARG control in this trial and surprisingly the addition of increased crop competition was unable to improve the control further (Figures 2a and b).

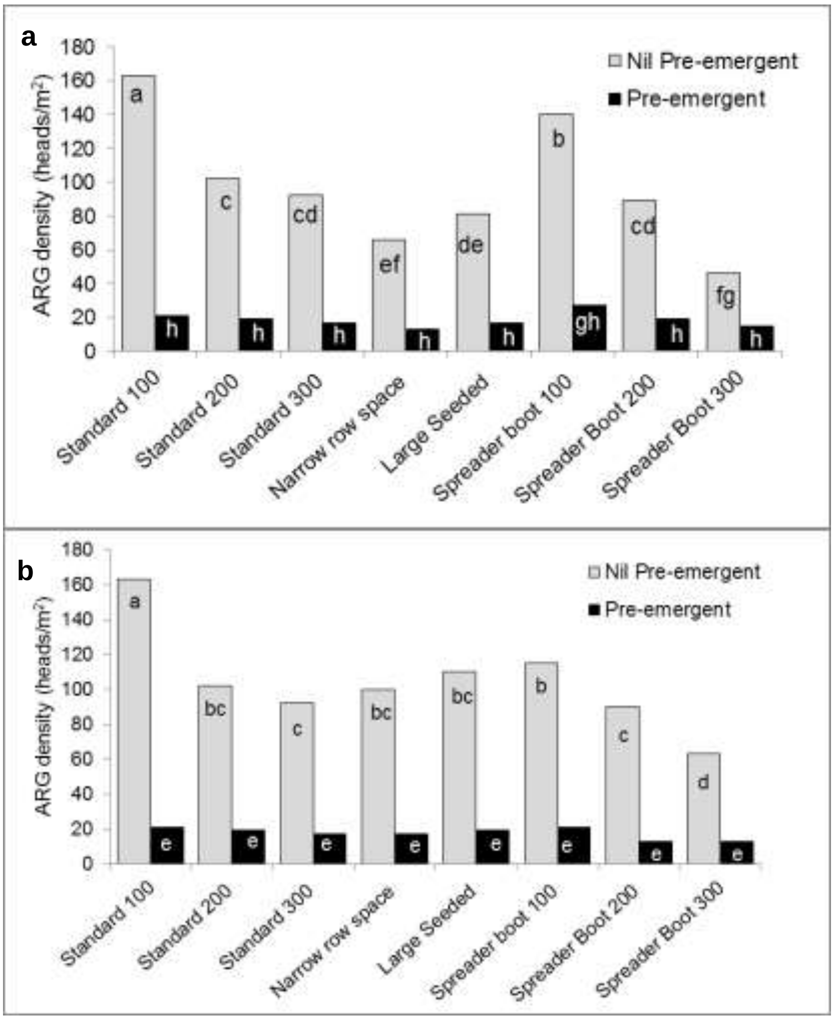

Figure 2. Effects of treatment factors (pre-emergent herbicide, seed size and spread) on annual ryegrass plant density (plants/metre squared) in (a) Mace wheat (b) Tjilkuri durum. (Treatment x herbicide LSD 21 at P≤0.05).

Similar to the comparison of varieties above, large differences in ARG numbers were seen between sprayed and unsprayed treatments. However, this did not have a significant effect on grain yield for Mace or Tjilkuri. The largest yield penalties were seen in Mace using narrow row spacing and the spreader boot at 100 seeds/m^2 which resulted in yield losses of 0.21 and 0.27 t/ha, respectively (Figure 3a).

Mace grain yield was significantly different for seeding rates and seedbed utilisation treatments with large seeded and the seeding rate of 300 seeds/m^2 yielding highest. The lowest yielding treatments were those sown with 100 seeds/m^2. Tjilkuri did not follow this trend and grain yield was similar across all seed rates and seedbed utilisation treatments (Figure 3).

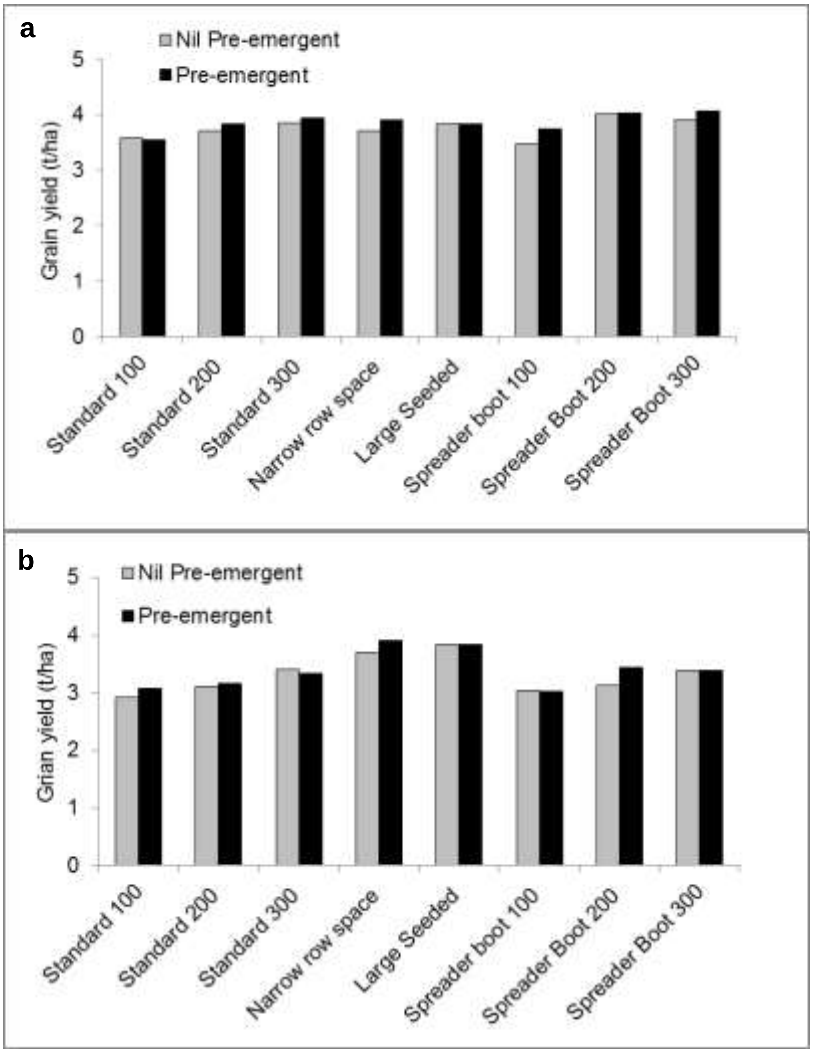

Figure 3. Effects of treatment factors (pre-emergent herbicide, seed size and spread) on grain yield (t/ha) in (a) Mace wheat (b) Tjilkuri durum.

The differences observed in crop competition between unsprayed treatments provide growers with some simple and effective non-chemical strategies to reduced weed pressures. These can then be integrated with herbicide treatments to improve weed control.

Plant growth regulators in wheat

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- Plant growth regulators had no significant impact on wheat grain yield.
- The only grain quality parameter to be influenced by PGR or nitrogen application was grain protein.

Why do the trial?

Plant growth regulators (PGR's) are common inputs for cereal crops in Europe and New Zealand, where their main role is in the prevention of crop lodging. In southern Australia much work has previously been conducted on PGR's, with inconsistent results. Even where crop height is significantly reduced, grain yield and crop water use efficiency is not always increased.

This trial using wheat aimed to measure the effect of plant growth regulants and their interaction with nitrogen on wheat grain yield and quality, in the absence of lodging.

How was it done

Plot size	2 m x 6 m	**Fertiliser**	DAP/Urea (27:12) @ 90 kg/ha
Seeding date	28th May 2013	**Variety**	Emu Rock wheat @ 75 kg/ha rate

Post emergent PGR and nitrogen:

The Hart site commercial crop received 100 kg N/ha on the 15th August.

The PGR treatment (1 L/ha Cycocel + 200 mL/ha Moddus Evo) and nitrogen (46 kg N/ha) was applied on the 14th August. Crop growth stage at the time of PGR application was stem elongation (GS31).

The exact same trial was located in two sections of the Hart commercial crop. Each trial was a randomised complete block design with 3 replicates using Emu Rock wheat.

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

Results

The application of PGRs to wheat significantly reduced the crop height between 10-15 cm. Compared to the treatment where no PGR was added these plots were clearly visible in the commercial crop.

Application of PGRs with or without additional nitrogen did not increase wheat grain yield in either of the PGR trials at Hart (Table 1 and 2). Although not significant, there was a slight reduction in grain yield for treatments where PGR was applied (Table 1 and 2). This is similar to results obtained in 2012 over four sites (Hart, Saddleworth, Condowie and Spalding), where grain yield was the same or in some cases reduced where PGRs were applied.

In both trials differences in grain protein were observed. In the South-West trial (Table 1) grain protein was significantly different for nitrogen and PGR separately. The addition of nitrogen or PGR separately significantly increased grain protein compared to the nil. In the North-East trial the protein results were conflicting. The nil treatment, PGR plus nitrogen and nitrogen alone had the highest protein contents. The addition of PGR alone decreased protein content in this trial.

The application of PGRs or N did not affect grain test weight and very minor differences were observed in screenings (Table 2).

Table 1. The interaction of plant growth regulators (PGRs) and nitrogen on grain yield (t/ha) and quality of Emu Rock wheat in commercial crop (South-West) at Hart in 2013.

Treatments		**Yield**	**Protein**	**Test Wt**	**Screenings**
PGR	**Nitrogen (kg /ha)**	**(t/ha)**	**(%)**	**(kg/hL)**	**(%)**
No	0	2.60	12.6 c	81.6	4.8
No	46	2.40	14.0 a	80.2	4.5
Yes	0	2.30	13.5 b	80.9	5.4
Yes	46	2.45	14.4 a	79.6	4.7
LSD (P≤0.05)	PGR	ns	0.49	ns	ns
	N	ns	0.49	ns	ns
	PGR*N	ns	ns	ns	ns

Table 2. The interaction of plant growth regulators (PGRs) and nitrogen on grain yield (t/ha) and quality of Emu Rock wheat in commercial crop (North-East) at Hart in 2013.

Treatments		**Yield**	**Protein**	**Test Wt**	**Screenings**
PGR	**Nitrogen (kg /ha)**	**(t/ha)**	**(%)**	**(kg/hL)**	**(%)**
No	0	2.49	12.6 a	80.2	5.9 bc
No	46	2.49	12.3 ab	80.9	5.6 c
Yes	0	2.30	11.3 b	81.6	7.9 a
Yes	46	2.37	13.2 a	79.8	6.8 b
LSD (P≤0.05)	PGR	ns	ns	ns	1.09
	N	ns	ns	ns	ns
	PGR*N	ns	1.25	ns	ns

Plant growth regulators in canola

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- Application of PGRs significantly reduced plant height and increased grain yield at Hart in 2013.

Why do the trial?

The application of plant growth regulators (PGRs) to cereal crops is common in many countries such as Europe and New Zealand. Previous PGR trials conducted by the HFSG have focused on cereal crops however; the addition of PGRs to crops such as canola and beans is another emerging area of research.

Similar to the trial above the aim was to measure the effect of PGRs on canola plant height and grain yield.

How was it done?

Plot size	1.4 m x 10 m	**Fertiliser**	DAP (18:20) @ 80 kg/ha + 2% Zn
			UAN (42:0) @ 75 L/ha, 11th July
Seeding date	10th May 2013	**Variety**	45Y82 hybrid canola

Plant growth regulator application:

Experimental PGR treatments were applied on the 14th August as canola plants were ending the stem elongation growth phase (50% of final stem length, buds but no flowers visible).

The trial was a randomised complete block design with 3 replicates. All plots were assessed for grain yield and oil content.

Results

The application of PGRs to canola significantly reduced the crop height between 10-25 cm. Plots where PGR had been applied were clearly visible in the trial. The application of PGRs to canola significantly increased grain yield. Experimental PGR 1 did not increase grain yield compared with the nil treatment however, grain yield increased significantly by 0.21 t/ha and 0.38 t/ha for PGR 2 applied at rate 1 or 2 respectively. Oil content was not affected by PGR application.

Table 1. The effect of PGRs on grain yield (t/ha) and oil content (%) of canola at Hart in 2013.

Treatment	Yield (t/ha)	Oil Content (%)
Nil PGR	1.63 c	43.9 a
Experimental PGR 1	1.71 c	43.4 a
Experimental PGR 2 rate 1	1.84 b	44.1 a
Experimental PGR 2 rate 2	2.01 a	43.6 a
LSD (P≤0.05)	0.12	ns

Retaining hybrid canola seed

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- Early growth of commercial, retained and mix seed treatments was similar.
- In 2013 fluquinconazole had no effect on the yield for any of the varieties.
- The conventional variety Hyola 50 was consistently higher yielding in 2013 (and 2012) when grown from commercial seed.
- The triazine tolerant variety showed no yield difference among the different seed sources in both years of trials.
- Significant yield reductions can result from retaining hybrid seed of some varieties.

Why do the trial?

Many canola varieties are now hybrid, meaning that they rely on a specific gene combination from two selected parents. Hybrid varieties are recommended to be grown from commercially produced seed to ensure maximum production. The seed is expensive (about $26/kg) compared to open pollinated or farmer retained seed ($5/kg) and so can significantly increase the cost of growing canola. Previous trials with open pollinated varieties have shown that they generally do not lose any grain yield or varietal characteristics when grown from farmer retained seed (F1 – first year of harvested seed). However, these were not hybrid varieties.

This trial was conducted to compare the performance of commercial hybrid seed against farmer retained (F1) seed using conventional, triazine and imidazalinone tolerant varieties.

How was it done?

Plot size:	1.4 m x 10 m	**Fertiliser:**	DAP (18:20) 2% Zn @ 75 kg/ha
Seeding date:	18th May 2013		UAN (42:0) @ 75 L/ha, 11th July 2013

Trial was a randomised complete block design consisting of 3 replicates and 18 canola treatments.

Varieties – Hyola 50 (Conventional), Tumby HT (Triazine Tolerant) and 45Y82 (Clearfield) were assessed.

Seed source treatments –

- Commercial - certified commercial seed from bags
- Retained – collected from farmer seed sources and graded
- Commercial/Retained blend - 33% certified commercial seed + 66% farmer seed sources and graded

All the canola plots were sown with the aim of 50 plants per square metre and seeds were treated with or without fluquinconazole (eg. Jockey) at 20 L/t. All plots were assessed for early vigour, plant number, plant height at flowering, grain yield and oil content.

Results and Discussion

Plant growth and height

Early in the growing season the growth of canola treatments was similar (photos displayed at end of article). However, by late flowering differences in total plant height between commercial and retained treatments was visible. For the mixed commercial and retained treatments there was considerable variation in plant height with in these plots. This was compared to the commercial and retained seed treatments on their own which had more uniform plant height.

Varieties Hyola 50 and 45Y82 CL had greater plant height at flowering than HT Tumby, but Hyola 50 showed the greatest height variation between the seed sources (Table 1). The Hyola 50 retained seed had the shortest plant heights for this variety, which were about 10 cm shorter compared to the commercial seed. The retained/commercial mixes for Hyola 50 did not differ compared to the commercial seed. The mixing of commercial and retained seed sources increased the plant height so that it was no longer different compared to commercially obtained seed.

For 45Y82 CL treatments plant height did not differ between treatments (Table 1). Similarly, for HT Tumby there were small differences in plant height however, the overall plant height only ranged from 81-89 cm.

Table 1. The plant height of three canola varieties, from commercial, retained or mixed seed sources, with or without fluquinconazole seed treatment. Measurements were taken at late flowering, 30th August 2013, at Hart. A plant height annotated by a different letter is significantly different from another (variety × seed source LSD P≤0.05 = 6.47).

Treatment	Hyola 50	HT Tumby	45Y82 CL
	Plant height (cm)		
Commercial + fluquinconazole	103.8 a	88.8 cde	111.6 a
Retained + fluquinconazole	89.6 cd	83.5 def	98.3 ab
Commercial (33%)+ Retained (66%) + fluquinconazole	96.9 ab	82.9 ef	108.0 a
Commercial	103.3 a	81.2 f	109.7 a
Retained	92.3 bd	86.9 cdef	96.9 ab
Commercial (33%) + Retained (66%)	101.0 a	81.4 f	106.5 a

Grain yield and oil content

Similar to the results obtained in the canola agronomy trial at Hart in 2012 the variety Hyola 50 resulted in the greatest variation in grain yield between treatments (Table 2). The commercial and commercial/retained mix plus fluquinconazole gave the highest yield 1.73 t/ha and 1.56 t/ha, respectively. Both the retained and mix seed sources without fluquinconazole produced lower yields, ranging from 1.33 - 1.49 t/ha.

HT Tumby showed no significant differences in grain yield for the different seed sources (Table 2). For the variety 45Y82 CL the commercial and retained / commercial mix yielded the highest (1.47-1.59 t/ha). The retained seed for 45Y82 CL was the lowest yielding treatment with (1.35 t/ha) and without (1.41 t/ha) fluquinconazole were lower yielding compared with the commercial. The results show that for this variety a mix between retained and commercial seed was able to yield similar to commercially obtained seed.

There was no significant interaction between fluquinconazole applied to the seed for any varieties in 2013. Internal blackleg infection was not scored however, visual observations showed increased internal infection when the sowing seed was retained.

Table 2. The grain yield (t/ha) of three canola varieties, from commercial, retained or mixed seed sources and with or without fluquinconazole seed treatment, at Hart 2013. Significant differences in grain yield for each canola variety are followed by a different letter.

Treatment	Hyola 50	Tumby TT yield t/ha	45Y82 CL
Commercial + fluquinconazole	1.73 a	1.08	1.59 a
Retained + fluquinconazole	1.38 bc	1.00	1.35 c
Commercial/Retained Mix + fluquinconazole	1.56 ab	1.04	1.47 ab
Commercial	1.73 a	1.00	1.58 a
Retained	1.33 c	0.97	1.41 bc
Commercial/Retained Mix	1.49 bc	1.00	1.48 ab
LSD (P≤0.05)	0.21	ns	0.12

Overall, yield loss from sowing a commercial/retained mix ranged from 4 to 14% and retained seed ranged from 7 to 23% in 2013 (Table 3). Slightly different results were seen in 2012 for Hyola 50 where yield loss was 16 to 30% and Tumby TT and 45Y82 CL yielded similar or greater than commercial seed (Table 3).

Table 3. Trial results from Hart in 2012 and 2013 showing yield as % of Commercial + fluquinconazole treatment (standard).

	2013			2012		
Treatment	Hyola 50	Tumby TT	45Y82 CL	Hyola 50	Tumby TT	45Y82 CL
	% of Commercial + fluquinconazole					
Commercial + fluquinconazole	**100**	**100**	**100**	**100**	**100**	**100**
Retained + fluquinconazole	80	93	85	84	94	104
Commercial/Retained Mix + fluquinconazole	90	96	92	-	-	-
Commercial	100	93	99	101	92	131
Retained	77	90	89	70	104	104
Commercial/Retained Mix	86	93	93	-	-	-

There were no significant differences between any of the treatments for oil content (Table 4). This is in agreement with the results from Hart in 2012 where oil content was not affected when retained seed was sown.

Table 4. The oil content (%) of three canola varieties, from commercial, retained or mixed seed sources and with or without fluquinconazole seed treatment, at Hart 2013. There was no significant difference between any treatment interactions.

Treatment	Hyola 50	Tumby TT	45Y82 CL
		Oil content (%)	
Commercial + fluquinconazole	44.4	40.9	43.1
Retained + fluquinconazole	44.5	41.2	43.0
Commercial/Retained Mix + fluquinconazole	44.2	41.7	42.9
Commercial	44.3	41.2	43.4
Retained	43.6	41.1	42.9
Commercial/Retained Mix	44.7	41.4	42.7
LSD (P≤0.05)	ns	ns	ns

Financial returns from different seed sources

Relative financial returns for 2012 and 2013 yield data were calculated (Table 5) based on the following assumptions; grain price $500/t, commercial hybrid premium $6/t, grading and fungicide coating for retained seed $6/ha, $26/kg commercial seed (seeding rate 2.5 kg/ha) and a cost of production $300/ha (excluding seed cost). On a tonne to tonne comparison of commercial and retained seed the cost is around $60/ha more when sowing commercial seed.

In 2012 and 2013 commercial seed was more profitable for Hyola 50 compared to retained or the commercial/retained blend (Table 5). In 2013 for HT Tumby there was $5/ha increase in return for retained seed and the mix, respectively. The same trend was seen for HT Tumby in 2012.

For the variety 45Y82 CL the results in 2012 were conflicting between commercial and retained seed plus or minus fluquinconazole. However, in 2013 there was almost $100/ha greater return for commercial over retained or mix seed plus fluquinconazole.

Table 5. Difference in $ return in 2012 and 2013 from commercial and retained seed at Hart.

	2013			2012		
Treatment	Hyola 50	HT Tumby	45Y82 CL	Hyola 50	HT Tumby	45Y82 CL
			$/ha return			
Commercial + fluquinconazole	**510**	**181**	**440**	**75**	**-97**	**-26**
Retained + fluquinconazole	384	194	369	59	-56	44
Commercial/Retained Mix + fluquinconazole	454	194	364			
Commercial	510	141	434	80	-117	80
Retained	359	179	399	-1	-31	44
Commercial/Retained Mix	419	174	414			

FUNGICIDE **NO FUNGICIDE**

Hyola 50 Commercial 16th July

FUNGICIDE **NO FUNGICIDE**

TT Tumby Commercial 16th July

FUNGICIDE **NO FUNGICIDE**

45Y82 Commercial 16th July

FUNGICIDE **NO FUNGICIDE**

Hyola 50 Retained 16th July

FUNGICIDE **NO FUNGICIDE**

TT Tumby Retained 16th July

FUNGICIDE **NO FUNGICIDE**

45Y82 Retained 16th July

FUNGICIDE **NO FUNGICIDE**

Hyola 50 CS/RS Mix 16th July

FUNGICIDE **NO FUNGICIDE**

TT Tumby CS/RS Mix 16th July

FUNGICIDE **NO FUNGICIDE**

45Y82 CS/RS Mix 16th July

Crystal green: a potential phosphorus replacement

Sarah Noack and Peter Hooper, Hart Field-Site Group

This trial has been coordinated and conducted in collaboration with Greg Butler, SANTFA.

Key Findings

- In the first year of trials (2012) a 75 kg/ha rate of Crystal Green significantly increased lentil yield by 18% compared to the nil (100%) and DAP treatments.
- In the second year of trials no carry-over effect of Crystal Green or DAP was observed on wheat grain yield.

Why do the trial?

Crystal Green (also known as struvite) is a product produced from urban waste water. Phosphorus (P), magnesium (Mg) and a low amount of nitrogen (N) are the main nutrients in Crystal Green. With increasing interest in removing phosphorus (P) from waste water, recovery of P in Crystal Green and using it as a P fertiliser has gained interest. Crystal Green has a low solubility in water and therefore is often suggested to be a slow-release supply of P.

This experiment was designed to compare Crystal Green with traditional DAP and urea applications alone and in combination. In the second year of trials the carry-over or slow-release properties of Crystal Green were evaluated on grain yield and quality.

How was it done?

Plot size	1.4 m x 10 m	**Fertiliser**	None residual effects of 2012 treatments
Seeding date	12th June 2013		
		Variety	Scout wheat @ 70 kg/ha

Method

This trial was established in 2012 at Hart, where the Crystal Green was compared to MAP at two rates, 25 kg/ha and 75 kg/ha in a lentil production trial (Graph 1). The trial was designed using three randomised replicates.

In 2013 the same plots were over sown with Scout wheat to look at the residual effects of the fertiliser treatments. All plots in 2013 were assessed for grain yield, test weight, protein and screenings.

Results

In 2013 the trial aimed to assess the P nutritional carry-over of the fertiliser treatments applied in 2012. Grain yield ranged from 4.1 - 4.4 t/ha, averaging 4.2 t/ha across the whole trial. There was no significant effect of any fertiliser treatments on grain yield, test weight or screenings (Table 1). The only grain quality parameter to display any difference was grain protein. Crystal Green alone or applied with urea produced the highest protein levels 12.4 - 12.9%.

Based on these results Crystal Green applied alone or with urea or DAP in 2012 did not carry-over a significant amount of nutrients in 2013 to improve grain yield, when compared to the nil treatment. None of the fertiliser treatments increased grain yield compared to the nil treatment.

Table 1. Effect of fertiliser treatments applied in 2012 on grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) in Scout wheat at Hart in 2013.

2012 Treatments	**Nitrogen**	**Phosphours**	**Grain yield**	**Protein**	**Screenings**
	kg/ha		**(t/ha)**	**(%)**	**(%)**
1. Nil (seed only)			4.1	11.9	2.2
2. DAP + TSP equiv CG 35 kg/ha	2	11	4.1	11.8	2.1
3. DAP + TSP equiv CG 100 kg/ha	5	32	4.3	11.5	2.1
4. DAP 35 kg/ha	6	13	4.2	11.7	2.1
5. DAP 100 kg/ha	18	36	4.2	11.7	2.1
6. CG 35 kg/ha	2	10	4.3	11.4	1.8
7. CG 100 kg/ha	5	28	4.3	12.4	2.9
8. CG + Urea equiv DAP 35 kg/ha	6	7	4.4	12.5	2.0
9. CG + Urea equiv DAP 100 kg/ha	18	20	4.4	12.9	2.5
LSD ($P \leq 0.05$)			ns	0.91	ns

CG = Crystal Green
TSP = triple super phosphate

Managing stubble and nutrition to increase soil carbon

Sarah Noack and Peter Hooper, Hart Field-Site Group

This trial was funded by the Australian Government Department of Agriculture (formerly DAFF) and conducted in collaboration with Harm van Rees, Crop Facts and Ag Excellence Alliance.

Key findings

- The addition of extra nutrients did not increase yield, therefore it is expected that more nitrogen, phosphorus and sulphur remained in soil to breakdown stubble.
- Tillage practices (removed, worked or standing) also have no effect on grain yield or quality in both years of trials.

Why do the trial?

Soil organic matter comes from the decay of plant material (eg. stubble) and animal waste and is made up of a number of different fractions which are more or less available in soil. Only the charcoal and humus fraction are regarded as permanent (slow to breakdown) in soil. The main reason for a grower to increase their soil humus level is to keep more carbon (C) stored when moving into an emerging carbon economy.

Research has shown that when trying to increase soil humus levels it not only about increasing soil C, but also other nutrients such as nitrogen (N), phosphorus (P) and sulphur (S). The problem is plant material such as stubble is primarily C with much smaller amounts of N, P and S. The aim of this trial was to add normal and higher amounts of nutrients (N, P and S) to different stubble managements (standing, worked and removed) to see if soil humus level would be increased.

How was it done?

Plot size	2.7 m x 12 m	**Crop type**	Fathom barley
Seeding date	7th June 2013	**Fertiliser**	Normal nutrition DAP (18:20) + Zn 2% @ 60 kg/ha High nutrition DAP (18:20) + Zn 2% @ 85 kg/ha, SOA (21:0:24) @ 4.5 kg/ha and urea (46:0) @ 11 kg/ha

Methods

The trial was a randomised complete block design with three stubble managements (standing, worked and removed), two fertiliser rates (normal and high) and four replicates.

The trial was established at Hart in 2012 and the same treatments were overlayed in 2013. Stubble load at the beginning of 2013 was 1.5 t/ha.

Results

In both 2012 and 2013 there was no difference in grain yield, protein, test weight and screenings for stubble management or nutrition analysed as an interaction or alone (Table 1 and 2).

Since there was no grain yield or protein increase for the high nutrient treatments the additional nutrients must have remained in the soil as they were not exported with the crop. The exact fate of these nutrients is unknown however, they potentially contributed to the formation of soil humus. Future analysis of soil humus content before and after two years of trials will reveal if this hypothesis is correct.

From an agronomic point of view there was no yield benefit in adding more N, P and S. If the soil tests results reveal an increase in soil humus there would be a benefit of adding extra nutrients under a C trading scheme.

Table 1. Grain yield, protein, test weight and screening levels for wheat grown in oat stubble at Hart in 2012.

Stubble	Nutrition	Grain yield t/ha	Protein %	Test weight kg/hL	Screenings %
Removed	High	2.05	11.9	78.5	3.6
	Normal	1.83	11.5	76.8	5.2
Standing	High	1.77	12.3	75.0	6.2
	Normal	1.69	11.6	76.3	5.7
Worked	High	1.76	12.1	75.9	7.0
	Normal	1.87	11.7	75.5	6.2
	LSD (P≤0.05)	ns	ns	ns	ns

Table 2. Grain yield, protein, test weight and screening levels for Fathom barley grown in wheat stubble at Hart in 2013.

Stubble	Nutrition	Yield t/ha	Protein %	Test weight kg/hL	Screenings %
Removed	High	5.89	12.9	63.9	6.3
	Normal	5.95	12.8	64.5	5.6
Standing	High	6.00	13.3	64.6	4.8
	Normal	5.82	12.4	65.5	4.2
Worked	High	5.88	12.9	64.6	6.4
	Normal	5.86	12.7	64.4	5.6
	LSD (P≤0.05)	ns	ns	ns	ns

Nitrogen management and yield dynamics of canola

Amritbir Riar, Gurjeet Gill and Glenn McDonald, The University of Adelaide

Key findings

- Grain yield was driven by biomass production rather than harvest index.
- Timing of nitrogen had relatively little impact on yield or nitrogen response.
- Nitrogen rate had little effect on total crop water use.
- Nitrogen use efficiency and water use efficiency were improved with additional water availability (irrigated treatment).

Background

Water and nitrogen (N) availability are the most critical factors for sustaining canola productivity but often water use efficiency (WUE) and N use efficiency (NUE) are low in South Australia. Canola has a high N requirement and how best to manage N in an environment where rainfall is variable is a challenging problem. Relatively little work has been done to look at ways to improve NUE and to understand how N strategies affects canola water use. Consequently the aim of this study was to investigate how different N management strategies affect growth, yield and WUE under different water regimes.

Methodology

Field trials were undertaken at Roseworthy and Tarlee in 2013 to investigate the effect of N management on growth, yield, N and water use efficiency of canola. A medium maturity Clearfield canola cultivar (Hyola 575CL) was sown on 17^{th} of May 2013 at Roseworthy and 4^{th} May 2013 at Tarlee under five different N application strategies: three N rates (0, 100 and 200 kg/N ha) (as granular urea) with the N applied just after emergence or equally split at the rosette stage, green bud appearance and at first flower.

At Roseworthy 60 mm of irrigation was applied at the early rosette stage to create different amounts of soil water. Irrigation increased the soil water to a depth of 100 cm. Treatments were replicated six times at Tarlee and three times at Roseworthy. Initial and final soil moisture contents to a depth of 120 cm at Roseworthy and Tarlee were measured by sampling with a 4 cm hydraulic core and the soil water measurements were used to estimate seasonal water use in the different nitrogen treatments. Crop biomass and grain yield were measured at maturity. Agronomic efficiency of N use was calculated as the increase in yield per kg N applied. Growing season (April to October) rainfall was 287 mm at Roseworthy and 431 mm at Tarlee (Figure 1).

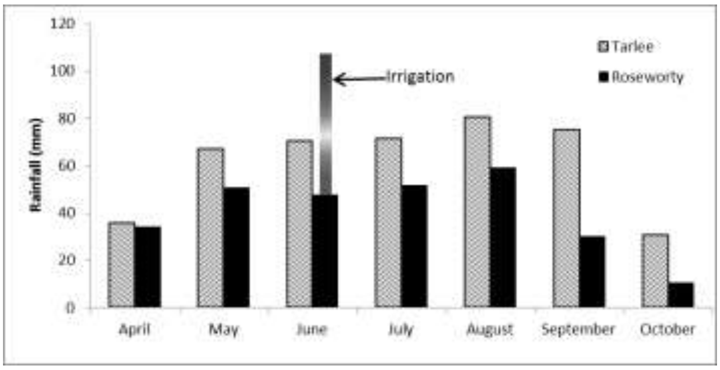

Figure 1. Growing season rainfall for Tarlee and Roseworthy, 2013.

Results

Grain yield and yield dynamics

Applying N increased the grain yield by up to 20% at Tarlee and up to 83% at Roseworthy. There was no significant difference between rate and timing of N on the yield response. In the irrigated treatment, N applications produced significantly higher yield and total dry matter compared with the control but all N treatments were similar to each other.

Under rainfed conditions at Roseworthy, only 200 kg N/ha in one application produced a significantly higher total dry matter than the control however, there was no significant difference between applying 100 or 200 kg N/ha. At Tarlee, all N treatments and the control produced statistically similar total dry matter. Responses in grain yield were affected mainly by changes in crop dry matter production because there was very little difference in the harvest index among the treatments or between the two trial sites. On average canola converted about 23-24% of its biomass into grain yield at Roseworthy and about 27% at Tarlee. Interestingly with additional water application grain yield improved by 49% with an increase of 41% in total dry matter without any considerable improvement in harvest index.

Oil content was generally higher at Tarlee than at Roseworthy. Irrespective of the site and irrigation treatment adding N decreased oil content and this effect was influenced by the timing of application (Tables 1 and 2). Generally there was no improvement in oil content when N was applied as either a split application or single application.

Water use efficiency and agronomic efficiency

The amount of N applied did not influence crop water use (Table 3). At Roseworthy the irrigated treatment used 62 mm more water than the rainfed treatment (Table 2). The average WUE of the rainfed crop was 7.4 kg/ha/mm and the WUE of the irrigated crop was 8.7 kg/ha/mm (Table 1, 2 & 3). The additional water from irrigation was used almost twice as efficiently as the seasonal (WUE = 13 kg/ha/mm) (Table 2). At Tarlee, there was about 15 mm more water used by the crops when N was applied but no difference among the N treatments was noticed (Table 3). Average WUE at Tarlee was 8.0 kg/ha/mm which was slightly higher than that measured in the rainfed treatment at Roseworthy (7.4 kg/ha/mm). Overall, WUE was not significantly affected by N rate or application timing.

At both sites 200 kg N/ha dried the profile more by maturity compare to no nitrogen treatment (Figure 2). At Tarlee water use was limited to largely 70 cm without N (Figure 2a) whereas with N water use was seen up to 110 cm. At Roseworthy, water use was limited to 70 cm in irrigated and at 50 cm in rainfed treatment for N and without N (Figure 2b and c).

Agronomic efficiency (yield increase per unit N applied) fell at the higher rate of N at Roseworthy with an improvement with additional irrigation over rainfed conditions. At Tarlee, single application of 100 kg N/ha gave higher agronomic efficiency than split application of 100 kg N/ha but it reverse in the case of 200 kg N/ha.

Summary

This study on canola under different water regimes with N showed that grain yield was mainly driven by the biomass production. It also revealed that the timing of N had little impact on yield but split application showed the improvement in oil content. Canola crops extracted water to 60-80 cm and adding N dried the profile more by maturity compare to no N but had little effect on total water use. Nitrogen use efficiency and WUE were improved by the additional water availability.

Table 1. Grain yield, total dry mater (TDM), harvest index and oil content of canola as affected by N treatments at Roseworthy and Tarlee for rainfed treatments.

	Grain yield (kg/ha)		**TDM (kg/ha)**		**Harvest index**		**Oil content (%)**	
N Treatments	Roseworthy	Tarlee	Roseworthy	Tarlee	Roseworthy	Tarlee	Roseworthy	Tarlee
0	1310^{b}	2356^{b}	5587^{b}	8555	0.24^{ab}	0.28^{a}	44.7^{a}	44.8^{a}
100, single	1745^{a}	2832^{a}	8002^{a}	10283	0.22^{cd}	0.29^{a}	42.5^{b}	43.9^{c}
100, 3 split	1736^{a}	2542^{a}	7473^{a}	10329	0.23^{bc}	0.25^{a}	42.0^{b}	44.4^{ab}
200, single	2074^{a}	2848^{a}	8272^{a}	10828	0.25^{a}	0.26^{a}	42.2^{b}	44.1^{bc}
200, 3 split	1866^{a}	2726^{a}	8812^{a}	9534	0.21^{d}	0.28^{a}	41.9^{b}	43.7^{c}
LSD (P≤0.05)	448	$327^{\#}$	1995	NS	0.02	NS	0.89	0.46

**LSD = least significant difference for timing x N, # significant at P≤0.10*

Table 2. Effect of irrigation on grain yield, total dry matter (TDM), oil content, water use (WU) and water use efficiency (WUE) at Roseworthy.*

	Grain yield (kg/ha)	**TDM (kg/ha)**	**Oil content (%)**	**Water use (mm)**	**WUE (kg/ha/mm)**
Irrigated	2604	10826	42.76	299	8.73
Rainfed	1746	7629	42.67	237	7.52
LSD (P≤0.05)	193	1995	NS	54	1.39

**there was no significant interaction between N rate and timing in GY, TDM, oil content, WU and WUE for Roseworthy.*

Table 3. Agronomic efficiency (AE), water use (WU), and water use efficiency (WUE) of canola as affected N treatments at Roseworthy and Tarlee.

	Agronomic N efficiency (kg/kg)			**Water use (mm)**			**Water use efficiency (kg/ha/mm)**		
N treatment	Roseworthy		Tarlee	Roseworthy		Tarlee	Roseworthy		Tarlee
	Irrigated	Rainfed	Rainfed	Irrigated	Rainfed	Rainfed	Irrigated	Rainfed	Rainfed
0				293	235	320	5.75	5.69	7.34
100, single	9.14	4.35	4.76	301	232	337	8.59	7.6	8.4
100, 3split	11.36	4.26	1.86	294	226	331	9.57	8.01	7.7
200, 3split	5.96	3.82	2.46	294	253	338	9.72	8.51	8.44
200, single	7.00	2.78	1.85	314	240	335	10.01	7.81	8.18
LSD (P≤0.05)				42.9		$11^{\#}$	2.5		NS

**LSD = least significant difference for timing x N, # significant at P≤0.10*

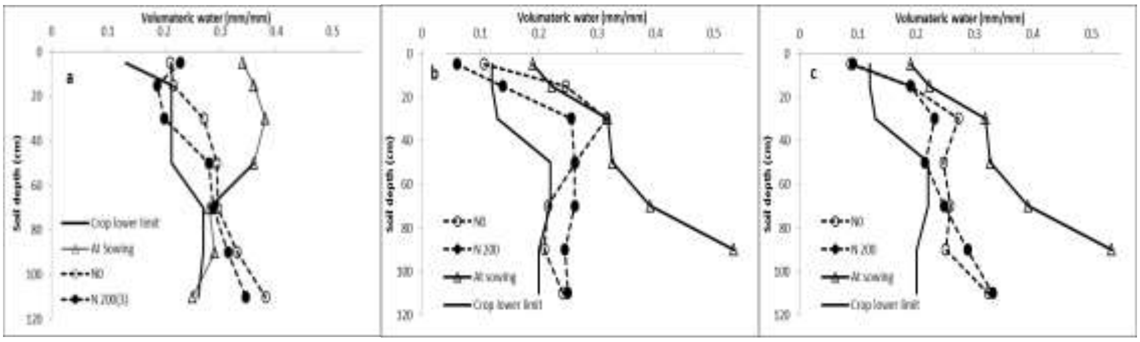

Figure 2. Water use patterns at maturity in 0-120 cm soil profile under nil N and 200 kg N/ha at (a) Tarlee dry land (b) Roseworthy dry land and (c) Roseworthy Irrigated.

Nitrogen and phosphorus fertiliser additives and replacement products

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- For all treatments grain yield or quality was not increased compared to conventional fertiliser applications of 80 kg/ha urea alone or 60 kg/ha urea plus 50 kg/ha DAP.
- Treatments selected for nitrogen and phosphorus tissue tests showed no difference in nutrient concentrations.

Why do the trial?

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

How was it done?

Plot size	1.4 m x 10 m	**Fertiliser**	Nitrogen and phosphorus applied as per treatment listed in Table 1.
Seeding date	7^{th} June 2013	**Variety**	Emu Rock wheat @ 70 kg/ha

Methods

Conventional fertiliser treatments included urea only and urea plus DAP (18:20). The remaining fertiliser treatments were selected based on their suggested ability to improve plant uptake of nitrogen and phosphorus or as a direct nutrient input (Table 1).

The initial Colwell soil phosphorus (30^{th} May 2013) was 59 mg/kg and DGT-P of 89 µg/L in the top 0 -10 cm. Both phosphorus tests indicate the trial site was above critical limit for yield response.

The phosphorus buffering index (PBI) was 102. Soil available sulphur was measured using KCl at 40ºC and measured as 1.6 mg/kg which is below the critical limit for this test of 6.5 mg/kg.

Soil nitrogen level measured for this trial was 65 kg N/ha (0-90 cm), sampled 30^{th} May, 2013.

Tissue phosphorus and nitrogen were assessed for specific treatments by removing youngest emerging leaf blade (18/9/13), oven drying and analysed by Waite Analytical Services.

Plots were assessed each year for grain yield, protein, test weight and screenings (2 mm screen).

Table 1. Summary of products trialed, whether they were used as a fertiliser addition or replacement and the main mode of action/purpose for the use in the trial at Hart in 2013.

	Treatment	Fertiliser addition or replacement	Reason for addition
1	80 kg/ha urea ONLY		Standard grower practice
2	60 kg/ha urea + 50 kg/ha DAP		Standard grower practice
3	80 kg/ha urea + 15 kg S/ha (as gypsum)	Addition	Sulphur addition
4	80 kg/ha urea + 30 kg S/ha (as gypsum)	Addition	Sulphur addition
5	73 kg urea + 15 kg S/ha (as SOA)	Addition	Sulphur addition
6	66 kg urea + 30 kg S/ha (as SOA)	Addition	Sulphur addition
7	Urea with Entec @ 80 kg/ha	Replacement	Ammonium stabiliser to limit nitrogen losses
8	60 kg urea + R.U.M – 5 L/ha @ mid-tillering	Addition	Foliar nitrogen (plus other nutrients)
9	60 kg urea + 50 kg DAP + Super Strike	Addition	Phosphorus (plus other nutrients) seed treatment
10	60 kg urea + 50 kg DAP + Jump Start	Addition	Phosphate inoculant that releases ‘bound’ soil P.
11	60 kg urea + 50 kg DAP + Balance & Grow 2L/ha	Addition	Foliar growth nutrient
12	Bounce Back @ 150 kg/ha	Replacement	Organic fertiliser (3:2:2 N:P:K) and other nutrients
13	60 kg/ha urea + 50 kg/ha DAP + 50 kg/ha biochar	Addition	Soil amendment
14	Biochar Complete @ 150 kg/ha	Replacement	Biochar blended with poultry litter
15	80 kg urea +Entrench– 2.5 L/ha @ 2-3 leaf	Addition	Nitrogen stabiliser
16	80 kg urea + Entrench – 2.5 L/ha @ GS31	Addition	Nitrogen stabiliser

Results

Results for tissue nitrogen ranged from 3.3% - 3.8%. The addition of sulphate of ammonia, Entec urea or eNtrench did not significantly increase tissue nitrogen concentration compared to an application of 80 kg/ha urea (Table 2). The same conclusion was drawn from tissue phosphorus concentrations. The addition of Superstrike and Jumpstart did not increase tissue phosphorus when added to urea plus DAP. Biochar complete maintained a tissue phosphorus concentration similar to urea plus DAP. However, given the initial soil phosphorus test was above the critical limit for growth response, soil phosphorus reserves were adequate for plant growth without additional fertiliser.

Table 2. Nitrogen and phosphorus leaf tissue concentrations for selected fertiliser treatments.

Treatment	Nitrogen %	Phosphorus mg/kg
1. Urea	3.3	
4. Gypsum high	3.5	
7. Entec urea	3.7	
15. eNtrench time 1	3.8	
16. eNtrench time 2	3.4	
2. Urea + DAP		3267
9. SuperStrike		3200
10. Jumpstart		3133
14. Biochar complete		3167
LSD ($P \leq 0.05$)	ns	ns

Grain yield and quality were not significantly improved for any treatment compared to urea only or urea plus DAP, yielding 3.88 t/ha and 4.22 t/ha, respectively (Table 3). Nitrogen products selected (slow release nitrogen, nitrification inhibitors and foliar additions) did not significantly alter grain yield or protein.

The addition of sulphur though applications of gypsum and sulphate of ammonia did not improve grain yield or quality, indicating adequate soil sulphur levels in this trial.

The initial soil phosphorus level was above the critical limit so it is unlikely that any products would result in a yield response, as observed in this trial. A previous phosphorus rate trial at Hart showed it took five years to run down soil phosphorus reserves before a yield response to phosphorus fertiliser was observed. These results highlight the importance of soil testing as fertiliser will provide a portion of the phosphorus for plant uptake with the majority coming from soil reserves.

Table 3. Grain yield (t/ha), screenings (%), protein (%) and test weight (kg/hL) at Hart in 2013.

Treatment	Yield (t/ha)	Screenings (%)	Protein (%)	Test wt (kg/hL)
1 Urea	3.88	8.6	10.5	82.6
2 Urea +DAP	4.26	8.1	10.5	82.7
3 Gypsum low	4.24	7.1	11.2	82.6
4 Gypsum high	4.01	8.6	10.4	82.8
5 SOA low	3.99	7.6	9.8	83.3
6 SOA medium	4.41	7.7	10.3	83.1
7 Entec urea	4.53	8.2	10.8	82.5
8 Beaulieu R.U.M	4.14	7.1	11.4	82.3
9 SuperStrike	4.29	8.1	10.3	83.0
10 Jumpstart	4.27	7.6	10.5	82.7
11 Balance and Grow	4.15	7.1	12.8	82.3
12 Bounce Back	3.90	7.8	10.0	82.8
13 Biochar	3.80	8.1	9.8	82.8
14 Biochar complete	3.87	7.8	10.7	82.7
15 eNtrench time 1	4.17	7.6	11.2	82.3
16 eNtrench time 2	4.11	7.5	10.7	82.5
LSD ($P \leq 0.05$)	ns	ns	ns	ns

2013

Hart Field Day

Hart site visitors:
South Eastern Premium Wheat Growers Association (SEPWA) (top right)
and GRDC Southern Panel (above left and above right).

Hart Winter Walk (above & left).
Fence line weed control workshop (below).

Clethodim tolerance in canola

Michael Zerner and Rob Wheeler, SARDI

Funding support from SAGIT is gratefully acknowledged for this research.

Key findings

- Grain yield losses of up to 40% can be caused by clethodim at particular rates and timings.
- Early application timings appear the best to avoid crop damage.
- Variation does exist between varieties across all herbicide tolerant crop types (Conventional, Clearfield and Triazine Tolerant) in their level of sensitivity to clethodim.
- Flower distortion was the major clethodim damage symptom observed, which led to poor pod development resulting in yield reductions.

Why do the trial?

Clethodim is a very important herbicide in the control of annual ryegrass in southern Australia. In recent times, label rate changes have occurred to enable higher rates of up to 500 mL/ha to be used for increased levels of weed control. This rate increase applies to canola, pulse crops and pasture legumes. Since the use of this higher rate of clethodim, a number of crop effects have been reported, particularly in canola. Observed symptoms include, delayed flowering, distorted flower buds and possible grain yield suppression. Symptoms appear to be more severe from later application timings. Other factors that may influence crop effects include herbicide rate, crop stress at herbicide application and possible varietal differences in tolerance.

Given the widespread importance of the use of clethodim in the farming rotation and increased application rates to combat herbicide resistant annual ryegrass, a field trial at Hart was established to identify the level of crop tolerance to these rates in canola. The level of actual yield losses that may occur from the use of high clethodim rates is relatively unknown.

How it was done?

Plot size:	1.4 m x 10 m	**Fertiliser:**	DAP (18:20) 2% Zn @ 60 kg/ha
Seeding date:	18th May 2013		UAN (42:0) @ 75 L/ha, 11th July 2013

The trial was established as a split-plot design with three replicates. Three canola varieties were used; AV Garnet (conventional), ATR Gem (triazine tolerant) and Hyola 474 CL (Clearfield) to investigate the influence of clethodim rate and timing. Nine clethodim treatments were applied to each variety as listed below in Table 1. This trial was solely aimed at investigating the impact of clethodim on crop safety rather than weed control.

Spray treatments for each growth stage were applied on the same day for each variety. As a result the exact growth stage at the time of application for each variety may have differed slightly, despite all varieties used in this trial being of very similar maturity. Following each spray application NDVI readings using a Greenseeker and visual damage scores were recorded.

Table 1. Clethodim treatments applied at Hart during 2013.

Clethodim Treatments
1. Untreated control
2. 0.5 L/ha applied at 4-leaf growth stage
3. 1.0 L/ha applied at 4-leaf growth stage
4. 0.5 L/ha applied at 8-leaf growth stage
5. 1.0 L/ha applied at 8-leaf growth stage
6. 0.25 L/ha applied at 4-leaf and 8-leaf growth stages (0.5 L/ha in total)
7. 0.5 L/ha applied at 4-leaf and 8-leaf growth stages (1 L/ha in total)
8. 0.5 L/ha applied at bud initiation (ie. first visible green buds)
9. 1.0 L/ha applied at bud initiation

Application of clethodim at 1 L/ha is not a registered rate and was undertaken for experimental purposes.

Results

The trial results reflected the sensitivity of canola to high rates of clethodim. Of the varieties tested the conventional type variety Garnet appeared to show a greater level of tolerance to clethodim than the other varieties. Both Gem (TT) and Hyola 474 CL were very similar in their response to clethodim, both incurring almost 40% yield losses in the most damaging clethodim treatment.

Table 2. Effect of clethodim applied at different timings and rates on canola flower damage assessed as a visual score (0%= no damage, 100% = killed flowers) at Hart during 2013.

Application timing	**Clethodim rate**	**ATR Gem**	**AV Garnet**	**Hyola 474 CL**
		% flower damage		
	Untreated	0	0	0
4 leaf	0.5 L/ha	0	0	0
	1.0 L/ha	0	0	5
8 leaf	0.5 L/ha	0	0	0
	1.0 L/ha	5	5	5
4 leaf and 8 leaf split	0.25 L/ha + 0.25 L/ha	0	0	0
	0.5 L/ha + 0.5 L/ha	5	0	5
Bud initiation	0.5 L/ha	10	0	15
	1.0 L/ha	40	5	55

Of the various clethodim timings, the latest application time caused the most visual crop damage (Table 2) resulting in the largest grain yield losses (Table 3). Applications within current label recommendations of up until flower buds become visible appear relatively safe in this trial. As all treatments sprayed with a single label rate application of 0.5 L/ha up to the 8-leaf growth stage were not significantly different from the unsprayed control for any variety.

Early sprays (4-leaf growth stage) at rates up to 1.0 L/ha had no significant implications on grain yield for any variety (Table 3). The next timing at 8-leaf was safe when applied at 0.5 L/ha, but when rates exceeded this, significant yield losses occurred,up to 13% in TT Gem and Hyola 474 CL. The more tolerant variety Garnet was unaffected at the higher rate at the same growth stage. The split application appeared to improve the safety of the 1.0 L/ha treatment when it is applied over two applications rather than in one application at the later 8-leaf timing. Yield losses were reduced to 9% in Hyola 474 CL and TT Gem was not significantly affected for the split application.

The latest timing treatment used in this study at bud initiation which is outside current label recommendations was found to be highly damaging causing significant yield reductions in all varieties (Table 3). TT Gem and Hyola 474 CL were both significantly affected at both rates with yield losses ranging from 13% (0.5 L/ha) up to 39% (1.0 L/ha). Garnet again showed increased tolerance at this timing where it was unaffected at 0.5 L/ha and only a 10% yield reduction at the higher rate.

These findings in grain yields closely matched visual scoring of damage symptoms during the season (Table 2). A range of symptoms were observed, the first of which was a slight change in the colour of the crop canopy. The more damaged or sensitive plots become paler green in colour as compared to the untreated control plots. There were no visual changes in overall crop biomass or any significant change in NDVI between treatments in this particular trial. As the crop further develops to reach flowering the damage symptoms become more pronounced. The flower buds become distorted and fail to open up fully leading to poor pod development (Figure 1), which in turn resulted in reduced grain yields. The grain yield losses were strongly correlated to the severity of the observed visual symptoms.

Table 3. Effect of clethodim applied at different timings and rates on the grain yield of canola at Hart during 2013. Highlighted values indicate significantly less than untreated (P≤0.05).

Application timing	**Clethodim rate**	**ATR Gem**	**AV Garnet**	**Hyola 474 CL**
Untreated		1.11 t/ha	1.37 t/ha	1.69 t/ha
		grain yield % of control		
4 leaf	0.5 L/ha	98	99	100
	1.0 L/ha	94	106	96
8 leaf	0.5 L/ha	99	104	96
	1.0 L/ha	87	106	87
4 leaf and 8 leaf split	0.25 L/ha + 0.25 L/ha	91	102	92
	0.5 L/ha + 0.5 L/ha	95	103	91
Bud initiation	0.5 L/ha	80	97	87
	1.0 L/ha	61	90	61

Figure 1. Hyola 474 CL at flowering showing no crop damage in untreated plot (left) and high degree of flower distortion in 1 L/ha clethodim applied at 8-leaf stage (right).

Implications

Increased application rates of clethodim have created concern due to crop damage in canola, which is the most sensitive crop of those registered for clethodim use. This trial at Hart has shown that late timings (bud initiation) of clethodim can result in severe yield losses, therefore care should be taken to apply at correct growth stages and application rates. Applications exceeding 0.5 L/ha are at high risk of causing yield reductions in most canola varieties. From the trial results it is evident that the early application at 4-leaf growth stage of canola was the safest on the crop but this may not be always the best time of application for targeting weed control. For example, a large proportion of the weed population may germinate later, requiring additional follow up sprays or delaying initial spray applications. Or higher use rates might be required to achieve acceptable control of weed populations developing resistance. This may require a compromise in rates and timings to best control weeds while minimising the risk of crop damage. There appears to be differences in clethodim tolerance between varieties. Such that varietal selection may be a contributing factor in minimising clethodim damage in canola. Further research is still required to establish ratings for varieties based on their level of clethodim tolerance.

Control of clethodim resistant annual ryegrass in break crops

Sam Kleemann, The University of Adelaide
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Key findings

- Excellent annual ryegrass control (>85%) with propyzamide either as split application (IBS followed by PSPE) or as a mixture with tri-allate.
- Atrazine also gave effective control this season with rainfall assisting activity (>79%).
- Early crop vigour was suppressed with Outlook & the higher split rate (1 kg/ha IBS followed by 1 kg/ha PSPE) of propyzamide.
- UAN at 20 kg/ha caused some leaf burning, however the crop recovered.

Why do the trial?

Surveys of ryegrass collected from farmer fields at harvest have shown a growing problem with clethodim (Select) resistance in annual ryegrass populations in South Australia. A recent survey (Sainin et al. 2013) showed about 40% of paddocks in the Mid-North of South Australia contained clethodim resistant annual ryegrass in 2008.

The loss of clethodim due to resistance means there are limited post-emergent herbicide options for annual ryegrass control in break crops. Consequently trials have been undertaken to evaluate the efficacy & crop safety of alternate pre- and post-emergent herbicides and their mixtures for the control of ryegrass in break crops.

How was it done?

Plot size	1.4 m × 10 m	**Fertiliser**	DAP (18:20) Zn 2% @ 75 kg/ha
			UAN (42:0) 75 L/ha 11th July 2013
Seeding date	13th of May 2013	**Variety**	ATR Gem TT canola

The trial was established as a randomised complete block design with 3 replicates & 17 herbicide treatments (Table 1).

To ensure even annual ryegrass establishment across the trial site annual ryegrass seed was broadcast at 25 kg/ha ahead of seeding & tickled in with a shallow pass with the seeder prior to herbicide application. The ryegrass was previously harvested from commercial paddocks and had low-medium resistance to clethodim.

A standard knife-point press wheel system was used to sow the trial on 22.5 cm (9") row spacings.

Pre-sowing herbicides were applied within an hour of sowing & incorporated by sowing (IBS) the post-sowing pre-emergence (PSPE) herbicides were applied on the 16th May and 3-4 leaf herbicides were applied on 7th July. At the time of the 3-4 leaf herbicide applications, plant available water (PAW) moisture was around 130 mm and 0.6 mm rainfall was received over the next day followed by 11.4 mm 5 days after application.

See Table 1 for the herbicide treatments included in the trial.

Results

At the first time of assessment (early July) majority of the herbicide treatments had significantly reduced annual ryegrass emergence (Table 1). The propyzamide either IBS or as a split application (IBS followed by PSPE) and as a mixture with tri-allate gave excellent control (>90%). Herbicide treatments including atrazine were also very effective this season with rainfall assisting activity (>79%).

In the 2013 Hart trial, herbicide treatments giving better than 90% overall control of annual ryegrass were:

- Propyzamide 1 kg IBS + 1 kg PSPE
- Tri-allate 2 L + propyzamide 1 kg IBS + clethodim (treatments 11, 14 and 17) however, at the time of the July assessment the effect of clethodim was not apparent (ie just tri-allate + propyzamide).

There were also a number herbicide treatments which had poor control (<60%). Herbicide applications which resulted in less effective control were Outlook (IBS+PSPE) and Dual Gold (IBS+PSPE).

At the early time of assessment crop vigour was also assessed. Majority of the herbicide applications had little effect on crop growth compared to the control. Both Outlook and propyzamide gave greatest crop damaged with rating of 3.8 and 3.2, respectively. Other treatments which resulted in slight crop damage were combinations of tri-allate, propyzamide, atrazine or clethodim giving scores of 6-7 (Table 1). Symptoms of clethodim damage were not apparent at this early time of assessment, as clethodim applications were only applied one week prior. For more details on the tolerance of canola to clethodim please refer to the following article in the trials results book "*Clethodim tolerance in canola"*.

Final ryegrass head numbers were significantly lower (less than 40 heads per square metre) for tri-allate when applied with clethodim, atrazine and/or propyzamide (Table 1). This is consistent with the earlier annual ryegrass assessments. Propyzamide IBS + PSPE at the 0.5 or 1 kg/ha rate also had a final head number below 40 heads per square metre. Atrazine in a tank mix with clethodim produced similar annual ryegrass control, but when UAN was also added the ryegrass control improved significantly.

Table 1. Effect of different herbicides on annual ryegrass plant (plants per square metre) and head density (heads per square metre) and crop vigour at Hart, 2013. Crop vigour was assessed as a visual score (10 = good vigour and 1 = poor vigour).

Herbicide treatment	July Crop vigour	Annual ryegrass July plants/m^2	Annual ryegrass July (% control)	Annual ryegrass October heads/m^2
1. Nil	9.2	64	-	148
2. Tri-allate 3.2 L/ha + Dual Gold 0.5 L/ha IBS	7.7	9	86	87
3. Trifluralin 2 L/ha + Tri-allate 3.2 L/ha IBS	8.0	8	87	63
4. Outlook 0.7 L/ha IBS + 0.5 L/ha PSPE	3.8	27	58	95
5. Propyzamide 1 kg/ha IBS	8.8	19	70	93
6. Propyzamide 0.5 kg/ha IBS + 0.5 kg/ha PSPE	7.3	10	84	42
7. Propyzamide 1 kg/ha IBS + 1 kg/ha PSPE	3.2	5	92	6
8. Dual Gold 0.25 L/ha IBS + 0.25 L/ha PSPE	8.3	48	25	70
9. Experimental 1	7.0	9	86	56
10. Tri-allate 2 L/ha + clethodim 500 mL/ha	8.2	11	83	81
11. Tri-allate 2 L/ha + propyzamide 1 kg/ha IBS + clethodim 500 mL/ha	6.5	3	96	24
12. Tri-allate 2 L/ha + atrazine 1.2 kg/ha PSPE + clethodim 500 mL/ha	6.5	13	79	45
13. Tri-allate 2 L/ha + propyzamide 1 kg/ha IBS + clethodim 500 mL/ha + Liase 2%	7.0	3	96	3
14. Tri-allate 2 L/ha + atrazine 1.2 kg/ha PSPE + clethodim 500 mL/ha + Liase 2%	7.3	5	92	6
15. Tri-allate 2 L/ha + clethodim 500 mL/ha + 20 L/ha UAN	8.2	19	70	60
16. Tri-allate 2 L/ha + propyzamide 1 kg/ha IBS + clethodim 500 mL/ha +20 L/ha UAN	8.0	3	96	9
17. Tri-allate 2 L/ha + atrazine 1.2 kg/ha PSPE + clethodim 500 mL/ha + 20 L/ha UAN	8.2	11	83	18
LSD ($P \leq 0.05$)	1.9	11.9		39.1

Treatments 10-18 were applied at annual ryegrass 3-4 leaf and canola 3-4 leaf. Application of clethodim to treatments 10-17 would not have been assessed at the early sampling time (July) as were only applied 15 days prior.

Group B tolerant crops

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- New crop varieties have been recently released that have improved tolerance to imidazoline (imi) herbicides.
- Group B tolerant varieties showed slight damage symptoms to herbicides registered for use. Damage to non-group B tolerant varieties was observed in many treatments.

Why do the trial?

To compare the tolerance of the new varieties to a range of group B herbicides relative to conventional non-tolerant varieties. To also measure the efficacy of herbicides for controlling crop volunteers with group B tolerance.

How was it done?

Plot size	2 m x 3 m	**Fertiliser**	MAP (10:22) + Zn 2% @ 75 kg/ha
Seeding date	27th May 2013		

The crops included:

- Two strips of canola were sown - AV Garnet (not tolerant) & Clearfield 44Y84 (tolerant).
- Two strips of barley were sown - Buloke (not tolerant) & Scope (tolerant).
- Two strips of wheat were sown - Gladius (not tolerant), Grenade CL plus (tolerant).
- Two strips of lentils were sown - Flash (not tolerant) & Hurricane (tolerant).

The herbicide treatments for all the crops included:

- Two residual group B herbicide treatments were applied prior to sowing.
- Six group B post emergent (3-4 leaf or node) herbicide treatments applied 18th July 2013.
- One group B plus Group I post emergent (3-4 leaf or node) herbicide treatment applied 18th July 2013.

Treatments were visually assessed and scored for herbicide damage symptoms 5 weeks after application.

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 between seasons and depend on soil and weather conditions at the time of application.

The residual herbicide treatments showed no effect to the tolerant lines of wheat, barley and lentils with only slight effect on the tolerant canola variety. Herbicide damage to the non-tolerant lines ranged from no effect (for wheat and barley) to moderate/severe in the residual treatments for canola and lentils.

For the tolerant wheat the post emergent applications of group B herbicides gave no effect. Similar crop ratings for barley were also observed across all group B herbicides except, for Midas (group B + I) which showed slight effects.

Post emergent Intervix (both 750 mL and 1500 mL) and Midas produced slight to moderate effect in the tolerant canola. OnDuty and Raptor produced no effect in the tolerant canola variety.

PBA Hurricane (formally CIPAL 1101) is a new variety released for improved tolerance to group B herbicides, similar to PBA Herald XT. In this trial PBA Hurricane showed no effect to group B herbicides, expect moderate crop damage from the Midas treatment.

For all post emergent herbicides treatments both the non-tolerant wheat and canola varieties resulted in severe effects. The non-tolerant barley and lentils showed moderate effect to Raptor, experimental 1 and 2 and severe effects to Intervix, OnDuty and Midas treatments.

		Canola		Wheat		Barley		Lentil	
		Tol	Not Tol	Tol	Not Tol	Tol	Not Tol	Tol	Not Tol
Timing	Herbicide	44Y84	Garnet	Grenade CL	Gladius	Scope	Buloke	Hurricane	Flash
	Nil	1	1	1	1	1	1	1	1
Residual	10 g Logran	2	4	1	1	1	1	1	4
Residual	180 mL Intervix	1	1	1	1	1	1	1	2
3-4leaf	Intervix 750 mL + Hasten	2	4	1	4	1	4	1	4
3-4leaf	Intervix 1500 mL + Hasten	2	4	1	4	1	4	1	4
3-4leaf	Onduty 55 g + Hasten	1	4	1	4	1	4	1	4
3-4leaf	Midas 900 mL + Hasten	3	4	1	4	2	4	3	4
3-4leaf	Raptor 45 g + BS1000	1	4	1	4	1	3	1	3

Crop damage ratings:
1 = no effect 2 = slight effect 3 = moderate effect 4 = severe effect 5 = death

Legume and oilseed herbicide tolerance

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- Simazine and metribuzin produced more crop effect compared to normal, especially in lentils.
- For all the PSPE application treatments 50% more product significantly increased the crop damage.
- The double knock of glyphosate followed by SpraySeed gave excellent control.

Why do the trial?

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

How was it done?

Plot size	2 m x 3 m	**Fertiliser**	MAP (10:22) + 2% Zinc @ 75 kg/ha
Seeding date	27th May 2013		

Thirteen strips of canola, pasture, vetch, chickpea, faba bean, field pea and lentils were sown. Sixty herbicide treatments were applied across these crops at 5 different timings.

The timings were:

Incorporated by sowing (IBS)	27th May
Post seeding pre-emergent (PSPE)	27th May
Early post emergent (3-4 node)	20th June
Post emergent (5-6 node)	8th July
Late post emergent (9 node)	25th July
Knock-down (4 node)	30th July

Treatments were visually assessed and scored for herbicide effects 4 and 6 weeks after application (Table 1).

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 between seasons and depend on soil and weather conditions at time of application.

Pre-emergent herbicides Boxer Gold, Sakura and propyzamide (more commonly known as Kerb or Edge) were incorporated by sowing (IBS) in 2013. It should be noted that for these pre-emergent herbicide, many are not currently registered for many of the crop types in the trial.

Sakura and Boxer Gold produced slight to severe effects on all three canola and pasture varieties, while Avadex Extend was relatively safe. Sakura produced some crop effects on most of the legumes, especially beans. Propyzamide was recorded to give no damage symptoms for any of the canola or legume varieties (except the balansa clover). These results are similar to 2012 for propyzamide applied IBS and 2011 applied as an early post emergent application.

Diuron at the standard 850 g/ha was safe in peas, beans, chickpeas, vetch and lentils (Table 1). Whereas, simazine and metribuzin produced more crop effect compared to normal, especially in lentils. This is likely to be a result of the wet conditions after sowing. For all the PSPE application treatments 50% more product significantly increased the crop damage, especially for simazine and metribuzin. This may be a useful indicator of the crop damage possible from heavy rain following herbicide application or use on lighter soils.

At the 3rd node stage simazine and Broadstrike were the safest herbicide options. At both rates, metribuzin, Brodal and Sniper produced significant crop damage to all included legumes (Table 1).

In the post emergent treatments a range of herbicides produced very good control of all the non-herbicide tolerant legume species. For the herbicide tolerant Hurricane lentils Eclipse, Logran, Ally, Intervix, Hussar and Atlantis all produced no more than a slight effect.

Frontier balansa clover was significantly damaged by most herbicides, except for Spinnaker and Broadstrike. The group B tolerant Angel medic showed very good tolerance to PSPE or post Spinnaker and Raptor. However, as shown in previous trials it does not tolerate Logran, Ally or Eclipse. Intervix, Hussar, Crusader, Atlantis and Broadstrike only damage it slightly.

All the knockdown treatments gave good control on legumes and canola. The double knock of glyphosate followed by SpraySeed gave excellent control.

Table 1. Crop damage ratings for legume and oil seed herbicide tolerance trial at Hart 2013.

<u>*Crop damage ratings:*</u>

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

				Canola			Bean	Pea	C/pea	Vetch		Lentil		Pasture		
				CL44Y84	ATR Gem	Conv, Garnet	Farah	Gunya	Genesis 090	Capello	Rasina	Hurricane	Flash	Sulla	Frontier	Angel
Number	**Timing**	**Treatment**	**Rate kg/ha**	5	5	5	140	100	80	45	45	45	55	15	15	10
1		NIL		1	1	1	1	1	1	1	1	1	1	1	1	1
2		Boxer Gold	2500 mL	2	3	4	1	1	1	1	1	1	1	2	4	1
3		Sakura	118 g	2	3	4	3	2	1	2	2	2	2	2	4	2
4	**IBS**	Propyzamide	1000 mL	1	1	1	1	1	1	1	1	1	1	1	3	1
5	27-05-13	Experimental 1	115 g/ha	2	2	2	1	1	1	1	2	2	1	1	2	1
6		Experimental 2	120g/ha	4	4	4	2	2	1	3	3	4	4	4	4	3
7		Avadex Xtend	2700 mL	2	2	1	1	1	1	1	1	2	2	2	1	1
8		Experimental 3	1000 mL	3	4	4	2	2	2	4	3	4	4	4	5	4
9		Diuron	850 g	4	4	4	1	1	1	1	1	1	1	1	5	4
10		Diuron	1275 g	5	5	5	2	2	3	1	1	2	2	2	5	5
11		Simazine	850 g	4	1	5	1	2	2	2	2	3	3	3	5	4
12		Simazine	1275 g	5	1	5	2	3	3	3	2	4	4	4	5	4
13		Diuron + Simazine	410 g /410 g	4	2	5	1	2	2	1	1	2	2	2	5	3
14		Metribuzin	280 g	5	1	5	2	2	2	1	1	2	2	2	3	3
15	**PSPE**	Metribuzin	420 g	5	2	5	3	3	3	4	3	3	3	3	4	4
16	27-05-13	Terbyne	1000 g	4	2	5	2	1	2	1	1	2	2	2	5	5
17		Terbyne	1500 g	5	3	5	2	1	2	2	2	3	3	3	5	5
18		Spinnaker	100g	2	4	4	1	1	1	1	1	1	1	1	1	1
19		Spinnaker + Simazine	40 g/850 g	4	3	4	1	1	1	1	1	2	4	4	5	4
20		Balance	100 g	4	4	4	4	3	1	4	4	4	4	4	5	4
21		Balance + Simazine	100 g /830 g	5	4	5	5	5	2	5	4	4	4	4	5	5
22		NIL		1	1	1	1	1	1	1	1	1	1	1	1	1
23		Simazine	850 g	3	1	2	1	1	2	1	1	1	2	3	5	2
24		Simazine	1275 g	3	1	4	2	3	2	2	2	2	2	3	5	3
25		Metribuzin	280 g	5	1	5	3	3	3	4	3	3	4	4	5	5
26		Metribuzin	420 g	5	1	5	5	4	4	5	4	5	5	5	5	5
27		Broadstrike	25 g	1	4	4	3	1	2	2	1	2	2	1	1	1
28	**3 Node**	Brodal Options	150 mL	4	5	4	4	2	4	4	4	3	3	4	3	3
29	20-06-13	Brodal Options	225 mL	4	5	5	4	3	4	4	4	3	3	5	3	3
30		Brodal Options + MCPA Amine	150 mL/150 mL	5	5	5	4	3	4	4	3	3	3	5	2	2
31		Sniper 750W	50 g	4	4	4	4	3	4	3	3	3	3	4	3	3
32		Spinnaker + wetter	70 g/0.2%	1	5	4	2	1	3	2	3	1	4	2	1	1
33		Raptor + wetter	45 g/0.2%	1	5	5	1	1	2	2	2	1	4	2	4	1
34		NIL		1	1	1	1	1	1	1	1	1	1	1	1	1
35		Logran + wetter	10 g/0.1%	1	4	4	4	4	3	4	4	2	4	3	4	3
36		Ally + wetter	7 g/0.1%	1	4	4	4	4	3	4	2	2	3	3	4	3
37		Eclipse SC + wetter	50 mL/0.5%	1	4	4	4	4	4	3	3	1	3	3	4	3
38		Ecopar + MCPA Amine	400 mL/500 mL	3	4	4	4	4	4	3	3	1	3	2	3	2
39		Affinity Force + MCPA Amine	100 mL/500 mL	5	5	5	5	4	5	3	3	4	4	4	4	3
40		Conclude + Uptake	700 mL/0.5%	3	4	4	4	4	4	4	4	4	4	4	4	2
41		Precept + Hasten	750 mL/1%	4	4	4	4	3	4	3	3	3	4	2	3	4
42	**5-6 Node**	Velocity + Hasten	670 mL/1%	5	5	5	4	5	4	4	4	4	4	5	4	4
43	08-07-13	Flight EC	720 mL	4	5	4	4	4	4	4	4	3	4	4	3	3
44		Banvel M	1000 mL	3	3	3	4	4	4	4	4	4	4	3	4	2
45		Intervix + Hasten	600 mL/1%	1	4	4	2	3	2	3	3	1	2	4	4	1
46		Hussar OD + wetter	100 mL/0.25%	1	4	4	4	3	3	4	4	2	4	3	4	2
47		Crusader + wetter	500 mL/0.25%	1	4	4	4	3	3	4	4	3	3	3	5	2
48		Atlantis OD + Hasten	330 mL/0.5%	1	4	4	4	3	3	3	3	1	2	3	4	2
49		Atrazine + Hasten	833 g/1%	3	1	3	3	3	3	2	2	3	3	3	4	3
50		Lontrel 600	150 mL	1	1	1	4	3	4	4	3	4	4	1	4	3
51		Starane	300 mL	1	1	1	3	3	4	3	3	4	4	1	1	2
52		MCPA Sodium	700 mL	3	3	3	4	2	2	3	3	3	3	2	2	2
53	**9 Node**	MCPA Amine	350 mL	3	3	3	4	2	3	3	3	3	3	2	3	2
54	25-07-13	Amicide Advance 700	1200 mL	4	4	4	4	4	4	4	4	4	4	4	3	2
55		2,4-D Ester	70 mL	3	4	3	4	4	3	3	3	3	3	2	3	1
56		NIL		1	1	1	1	1	1	1	1	1	1	1	1	1
57	**4 Node**	Sprayseed	2000 mL	5	5	5	4	4	4	4	4	4	4	5	5	5
58	30-07-13	Gramoxone	1000 mL	4	4	4	3	4	4	3	4	4	4	4	4	4
59	**knock-down**	Glyphosphate	1000 mL	4	5	4	4	4	4	4	3	5	5	5	5	5
60		Glyphosphate // Sprayseed 3DAS	1200 mL//1200 mL	5	5	5	5	5	5	5	5	5	5	5	5	5

Crown rot resistance and yield loss

Margaret Evans and Hugh Wallwork, SARDI

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Key Findings:

- Some new durum lines show promise of improved resistance to crown rot.
- Yield loss in Hindmarsh in this trial is a reminder that barley can also exhibit yield loss from crown rot.
- Percentage yield loss from crown rot may only be small in a good season, but this can equate to significant production loss.
- Knowing the risk of yield loss from crown rot in paddocks prior to sowing is an important management strategy.

Why do the trial?

To evaluate resistance to crown rot and yield losses from crown rot in commercial cultivars of bread wheat, durum wheat and barley.

How was it done?

The trial was direct drilled in plots of 6 rows x 7 m. Sterilised durum wheat grain colonised by *Fusarium pseudograminearum* (application rate of 2 g / m row) was mixed with seed prior to sowing to screen for resistance. To assess yield loss, a second, uninoculated plot was included for selected entries. Four replicates were used in a randomised block design. Durum breeding lines developed by Hugh Wallwork and Dr Jason Able, University of Adelaide (UAD and WID lines), were assessed for resistance only. For many of these lines, limited seed was available and only three replicates were sown.

Plant samples were collected from 4 x 0.25 m rows per plot on October 21st at early grainfill. White heads and total heads were counted to give % white heads and main stems were assessed for severity of crown rot symptoms. Crown rot severity on main stems was scored visually on the following scale:

0 = 0%	No yield loss
1 = 1-10%	Possibility of minor yield loss
2 = 10-25%	Possibility of some yield loss
3 = 25-50%	Possibility of significant yield loss
4 = 50-75%	Significant yield loss likely
5 > 75%	High yield loss likely

Results

Plant establishment was good in all plots and weeds and other diseases were not an issue.

Rainfall for June-August was well above average and resulted in good plant growth and excellent yields in the trial. Bread wheat yields ranged from 3.8 to 5.5 t/ha, durum wheat yields ranged from 3.3 to 4.0 t/ha and barley yields ranged from 5.1 to 6.4 t/ha.

Rainfall for September-October was 40% lower than the long term average and it is likely that plants would have experienced low-level moisture stress during flowering and early grain fill.

The basal stem browning and white head expression associated with crown rot were both low. Basal stem browning scores averaged 1.06 (range 0.11-2.13) in inoculated plots, which is below the severity score (2.0 – 2.5) normally associated with yield loss from crown rot. Basal stem browning was also present in uninoculated plots, where scores averaged 0.82 (range 0.08-1.8). Whiteheads were present at an average of 0.8% (range 0-4%) in inoculated plots and 0.5% (range 0-2%) in uninoculated plots.

Cereals with MR, MS and MS-S disease ratings did not exhibit yield losses (Table 1). Bread wheat entries with an S rating and durum entries (VS) generally exhibited similar levels of yield loss, with the durum cultivar Tjilkuri having the highest (15%) yield loss. Tamaroi unexpectedly had no yield loss. Yield losses in other cultivars ranged from 2% to 6%, with actual yield losses between 0.10 t/ha and 0.32 t/ha (Table 1). The mid-season barley cultivars Commander and Schooner did not exhibit yield loss in the crown rot inoculated plots, but Hindmarsh (early season) exhibited a 5% yield loss.

In general, the rankings of commercial cultivars were consistent with their currently accepted disease ratings as given in the Cereal Variety Disease Guide (Table 2). A number of the durum lines, notably, 1333-56, 1349-29 and WID902 had lower basal stem browning scores than did the commercial durum cultivars (Table 2).

Table 1. Yield reductions in cereal plots inoculated with crown rot at Hart in 2013.

Entry	Cereal type	Disease rating*	No. of rep's	Yield loss %	Yield loss t/ha	Disease score	White heads (%)
2-49	Wheat	MR	4	0	0	0.11	0
Sunco	Wheat	MS	2	0	0	0.48	0
Kukri	Wheat	MS	3	0	0	0.51	0
Bevy	Rye	-	3	0	0	1.37	1
Emu Rock	Wheat	MSS	4	0	0	0.52	0
Tahara	Triticale	-	4	0	0	1.14	0
Tamaroi	Durum	VS	3	0	0	1.67	3
Commander	Barley	-	4	0	0	1.56	0
Schooner	Barley	-	4	0	0	2.13	0
Mace	Wheat	S	4	2	0.12	0.45	0
UAD0951096	Durum	VS	4	3	0.10	1.35	0
Scout	Wheat	MSS	4	3	0.15	0.88	0
Grenade	Wheat	S	3	4	0.15	1.22	2
Hyperno	Durum	VS	3	5	0.19	1.23	1
WID902	Durum	VS	3	5	0.21	1.06	0
Phantom	Wheat	MS	2	5	0.23	0.52	1
Hindmarsh	Barley	-	2	5	0.32	1.83	0
Shield	Wheat	S	3	6	0.28	0.54	0
WID802	Durum	VS	4	6	0.31	1.66	3
Tjilkuri	Durum	VS	4	15	0.46	1.79	1

** Disease ratings are from the Cereal Variety Disease Guide. MR = moderately resistant; MS = moderately susceptible; MS-S = moderately susceptible to susceptible; S = susceptible; VS = very susceptible.*

Discussion

Although crown rot symptoms were limited in 2013, some yield loss from crown rot might have been expected, particularly in durum wheat, given good early growth and low-level moisture stress during grain fill. This is a reminder that crown rot can cause yield losses even in a good year and that in a good season % yield loss may only be small (less than 7% in this trial) but the actual yield loss can be significant (as high as 0.32 t/ha in this trial). Regardless of the season, it is important to know the risk of yield loss from crown rot in paddocks prior to sowing in order to reduce losses from this disease.

Some of the new durum lines show promise of having improved resistance to crown rot when compared with current commercial cultivars. Further field screening is needed to validate these findings, but the progress being made toward improved resistance to crown in durum breeding programs is encouraging.

Barley is not resistant to crown rot, but usually does not show yield loss. This is not a tolerance mechanism and barley is thought to escape significant damage by filling grain at a time when moisture stress is not occurring. If moisture stress does occur when barley is at a susceptible growth stage, then it may also incur yield losses as seen with Hindmarsh in this trial. As barley is usually high yielding, small percentage yield losses can be economically significant.

Table 2. Resistance screening for bread wheat and durum at Hart in 2013.

Entry	Cereal type	Disease rating	No. of rep's	Disease score	White heads (%)
2-49	Wheat	MR	4	0.11	0
Sunco	Wheat	MS	2	0.48	0
Kukri	Wheat	MS	3	0.51	0
Mace	Wheat	S	4	0.45	0
Emu Rock	Wheat	MSS	4	0.52	0
Phantom	Wheat	MS	2	0.52	1
Shield	Wheat	S	3	0.54	0
Janz	Wheat	S	4	0.60	0
Gladius	Wheat	S	3	0.81	3
Scout	Wheat	MSS	4	0.88	0
Grenade	Wheat	S	3	1.22	2
1333-56	Durum	-	2	0.61	0
1349-29	Durum	-	3	1.06	0
WID902	Durum	-	3	1.06	0
1349-27	Durum	-	3	1.07	0
UAD1152020	Durum	-	3	1.21	3
Hyperno	**Durum**	**VS**	**3**	**1.23**	**1**
1333-24	Durum	-	3	1.25	1
Yawa	**Durum**	**VS**	**2**	**1.28**	**2**
UAD0951096	Durum	-	4	1.35	0
1347-13	Durum	-	3	1.44	4
1349-24	Durum	-	1	1.44	2
1349-49	Durum	-	3	1.45	0
WID802	**Durum**	**VS**	**4**	**1.66**	**3**
Tamaroi	**Durum**	**VS**	**3**	**1.67**	**3**
Tjilkuri	**Durum**	**VS**	**4**	**1.79**	**1**

** Disease ratings are from the Cereal Variety Disease Guide. MR = moderately resistant; MS = moderately susceptible; MS-S = moderately susceptible to susceptible; S = susceptible; VS = very susceptible.*

Disease dynamics in a changing farm environment

Dr Rohan Kimber and Dr Jenny Davidson, SARDI

Acknowledgements: GRDC, TREND SA (Transect for Environmental Monitoring and Decision Making) and Dr Hugh Wallwork (SARDI)

Key Findings:

- A combination of old and new technology is being used to detect and analyse airborne fungal spore patterns affecting cereal and pulse grain crops.
- Intense spore showers were detected for blackspot of field pea and NFNB of barley, but negligible for YLS of wheat, at the experimental site at Hart during the 2013 season.
- Spore dispersal patterns of blackspot of field pea fitted with Blackspot Manager predictions.

Why do the trial?

To understand growth patterns of yellow leaf spot (YLS) (*Pyrenophora tritici-repentis*) on wheat and net form net blotch (NFNB) (*Pyrenophora teres f teres*) on barley in relation to a changing farming environment. The timing of release, dispersal patterns and environmental triggers for dispersal of spores from primary and secondary inoculum sources will form the basis for disease modelling and forecasting, potentially assisting in the development of improved strategies for fungicide application as well as managing inoculum sources. The development of molecular tests for detection of species-specific fungal spores is enabling us to combine simple spore trapping devices with new diagnostic techniques. This allows detailed examination of disease dynamics over the growing season and analysis of the relationship between spore release and climate drivers.

How was it done?

The timing and intensity of spore release for YLS and NFNB were monitored from infested wheat and barley stubble, respectively. A model pathogen, blackspot (*Didymella pinodes*) of field pea, was included for comparative purposes. Monitoring was conducted in the field at five geographical locations as part of an environmental transect for climate: **Urrbrae** (Waite Campus), **Belair** (Adelaide Hills), **Hart** (FD site), **Port Germein** and **Orroroo**. These locations were selected to reflect differences in growing season climates. At each site, infested stubble of each host/pathogen was set out within a 3 x 3 m grid array; the layout was identical at each site. A Burkard volumetric spore trap was placed within the centre of the grid, to capture air- and splash-borne spores. The trap captured air-borne particles over a total 30 week monitoring period from April 11th to November 6th, 2013. Samples were collected in 30-36 day cycles and returned to the laboratory, desiccated and stored at 22^{o}C.

Analyses of the 2013 data are in progress. At the end of the season, a daily segment of tape (9.5 x 9.5 mm) was excised for every 3 trapping days throughout the 30 week period to allow a dot-point analysis of spore release over time. The quantity of spores deposited on these selected samples were detected using molecular assays specific to *P. tritici-repentis, P. teres f teres* and the blackspot complex developed by SARDI's Root Disease Testing Service (RDTS). These results will be validated with trap plant data collected at the Waite Campus and correlated to climate variables (eg. temperature and rainfall).

Results and Discussion

Tapes have been processed and molecular assays performed on samples from the Hart spore trap in 2013. Preliminary results from the molecular assays showed a high correlation (R^2=0.97) between the quantitative controls and detection levels of the model blackspot pathogen, confirming the sensitivity and accuracy of the technique. The assay was able to detect very low levels of spores on trap samples. Some interesting trends can be observed at this preliminary stage of data analysis:

- Airborne spores of YLS were very low, or undetected, throughout the 2013 season at Hart (Fig 1.). This may reflect the short dispersal distances by the pathogen or low level of inoculum on the infested stubble collected in 2012.
- A peak of NFNB spores was detected in the first two weeks of October. Few NFNB spores were detected in the remainder of the growing season. Early season spore dispersal patterns (from February) will be examined in 2014.
- The highest peaks for airborne spores of the model pathogen, Blackspot of field pea, occurred mid May to early June (primary ascospore release from infested stubble) and again in early October (spring ascospore release from infected crops). The result in May – June correlated with predictions of the Blackspot Manager for the Hart district in 2013.

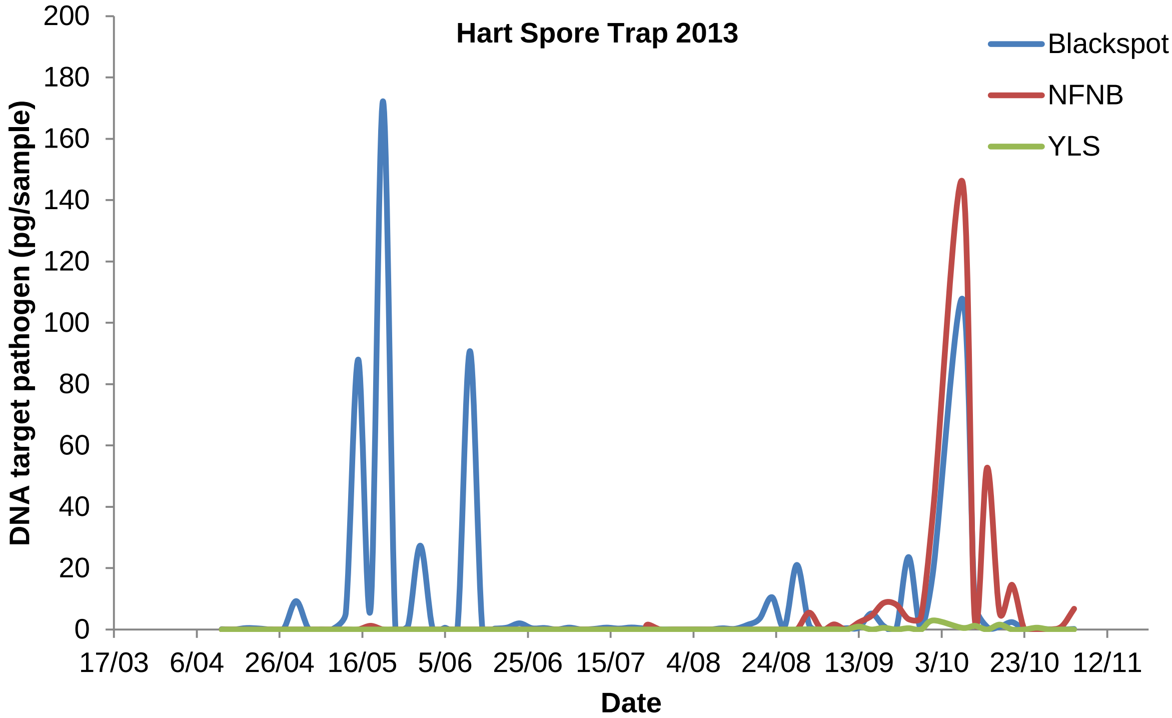

Figure 1. Quantified DNA (pg/sample) extracted of YLS, NFNB and blackspot pathogens captured over time by a volumetric spore trap located at the Hart field site in 2013.

Control standards are currently being completed for YLS and NFNB so spore numbers can be derived from quantified DNA data (pg/sample) on spore tapes. Other trapping sites for 2013 are being processed for comparative analysis. This study aims to establish relationships between fungal spore release patterns and climate triggers to provide valuable information on disease dynamics in a changing farming environment. The data generated could allow improved strategies in disease management and forecasting.

Effective crop rotations

Peter Hooper, Hart Field-Site Group

This trial was funded by the GRDC as part of the water use efficiency initiative and conducted in collaboration with Chris Lawson and Victor Sadras, SARDI, and Glenn McDonald , The University of Adelaide.

Key findings

- Wheat following wheaten hay produced the highest grain yield, averaging 3.22 t/ha.
- The highest gross margin for the 4 years was from the standard rotation, which included field peas and canola.
- The greatest limitation to rotation productivity was from brome and barley grass, especially in the continuous cereal rotation.

Why do the trial?

This long term trial was part of the Hart water use efficiency project and aimed to look at the overall crop rotation, as compared to the wheat year alone. This is because in a rotation sequence wheat consistently follows a legume or pasture so the measured water use efficiency will often be very good. However, the water use for the total rotation may not be as high, i.e consecutive wheat or barley crops.

This trial aimed to assess three rotations used in the Mid-North, especially those incorporating export hay or continuous cereals.

How was it done?

Plot size 4 m × 10 m **Fertiliser** DAP (18:20) Zn 2% @ 80kg/ha

Rotations 1) Standard – Wheat, barley, barley, peas, TT canola

2) Cereal – Wheat, barley, wheat, wheat, barley

3) Hay – Wheat, wheaten hay, barley, wheaten hay, barley

This long term trial was conducted between 2008 and 2012, and was a randomised complete block design with three replicates. Three rotations were trialled and each of the five crops within each rotation was sown each year. The sowing time coincided with other trials at Hart, usually around mid to late May. The varieties used represented typical varieties for the area and nitrogen management and weed control were conducted as needed during the growing season.

A standard knife-point press wheel system was used to sow the plots on 22.5 cm (9”) row spacing.

All cereal grain plots were assessed for grain yield, protein and screenings. Soil water was measured prior to seeding each year.

Results

Only marginal differences in stored soil water (less than 15 mm) could be measured at the beginning of each season, even following field peas or export hay. The differences between the crop types were not significant.

After 2 to 3 years of the trial, the continuous cereal rotation had developed much higher levels of brome grass and barley grass. This weed pressure would have reduced the grain yield in these plots and is likely to have also increased levels of root disease.

The results for wheat alone produced a range in grain yields between 1.66 t/ha (wheat following TT canola in 2012) and 4.25 t/ha (wheat following TT canola in 2010) (Table 1 and see Table 3 for all results). The grain yield of wheat following wheaten hay was significantly higher, averaging 3.22 t/ha (Table 1). This was followed by wheat on canola and then wheat on wheat or barley. Although pre-season moisture measurements did not show any significant differences, it is likely that there was some residual moisture.

Grain protein ranged from 8.1% (wheat on wheat 2011) to 15.9% (wheat on canola 2012). Wheat following canola generally had higher grain protein as a result of the preceding pea crop and higher nitrogen rates applied to the canola. Wheat following barley consistently had the lowest protein levels, and highlighted the need for higher fertiliser rates in the absence of a legume crop within the rotation.

Table 1. The grain yield and protein of wheat following either wheat, barley, TT canola or wheaten hay in the long term rotation trial between 2009 and 2012 at Hart.

Crop	Year								Average
	2009		2010		2011		2012		
	Yield t/ha	Protein %	Yield t/ha	Protein %	Yield t/ha	Protein %	Yield t/ha	Protein %	
Wheat	2.69	10.8	3.60	8.2	3.08	11.8	1.88	11.2	2.81
Barley	2.47	10.0	3.46	8.3	3.29	10.8	1.66	11.1	2.72
TT Canola	2.43	11.1	4.25	10.2	3.71	12.7	1.64	15.9	3.01
Wheat Hay	3.07	10.7	3.51	8.7	3.19	11.6	3.10	11.7	3.22

Across the three rotations there was little difference between total crop water use. For each season between 2009 and 2012 none of the rotations consistently produced the highest gross margin (Table 2). Average gross margins for each year ranged from -$60/ha (continuous cereal in 2012) to $413/ha (continuous cereal in 2010). The standard rotation produced the highest cumulative gross margin of $4051, although there was surprisingly little difference between all the rotations.

Overall, this trial has shown that each of the rotations were water efficient and profitable. Weeds were the biggest limitation of the continuous cereal rotation, however the introduction of group B tolerant crops and new pre-emergent herbicides will help to reduce this problem. It also showed that the inclusion of a legume component within a rotation was not essential, however it was very useful for weed management and improving grain protein.

Table 2. Average and total gross margin $/ha for each rotation from 2009 to 2012 at Hart.

Rotation	2009 Average	2009 Total	2010 Average	2010 Total	2011 Average	2011 Total	2012 Average	2012 Total	Total
Cereal	192	959	223	1116	413	2063	-60	-302	3837
Hay	200	1002	141	706	306	1531	77	384	3624
Standard	169	846	263	1315	403	2014	-25	-124	4051

The calculations use the Rural Solutions farm gross margin guide for prices and costs. Production costs used were $485/ha for wheat, $450/ha for barley, $470/ha for canola, $550/ha for hay and $450/ha for peas. All of these costs include contract harvesting and freight rates, otherwise the costs associated with hay making become significantly higher.

This is a very simple method for calculating gross margin and did not take into account the likelihood that more nitrogen fertiliser and pre-emergent grass herbicide would be required on the cereal rotation and less on the standard. Also the wheaten hay yields were slightly lower compared to the district oaten hay yields.

Table 3. Grain and hay yields for each rotation and year of the trial between 2008 and 2012 at the Hart.

Rotation	2008 Crop	2008 Yield t/ha	2009 Crop	2009 Yield t/ha	2010 Crop	2010 Yield t/ha	2011 Crop	2011 Yield t/ha	2012 Crop	2012 Yield t/ha
Cereal	Wheat	0.79	Barley	3.48	Wheat	2.86	Wheat	3.08	Barley	2.30
Cereal	Barley	1.92	Wheat	2.52	Wheat	3.59	Barley	3.57	Wheat	1.88
Cereal	Wheat	0.75	Wheat	2.69	Barley	4.68	Wheat	3.55	Barley	2.40
Cereal	Wheat	0.65	Barley	3.24	Wheat	4.06	Barley	3.53	Wheat	1.61
Cereal	Barley	1.97	Wheat	2.43	Barley	5.07	Wheat	3.04	Wheat	1.71
Wheat Hay	Barley	1.77	Wheat Hay	4.03	Wheat	3.51	Wheat Hay	5.32	Barley	1.70
Wheat Hay	Wheat Hay	3.90	Wheat	3.07	Wheat Hay	5.42	Barley	3.94	Barley	3.10
Wheat Hay	Wheat	0.92	Wheat Hay	4.03	Barley	4.92	Barley	4.14	Wheat Hay	6.20
Wheat Hay	Wheat Hay	3.90	Barley	3.19	Barley	4.21	Wheat Hay	5.32	Wheat	3.10
Wheat Hay	Barley	1.93	Barley	3.60	Wheat Hay	5.42	Wheat	3.19	Wheat Hay	6.20
Standard	Peas	0.47	TT Canola	0.92	Wheat	4.25	Barley	3.88	Barley	1.30
Standard	TT Canola	0.73	Wheat	2.43	Barley	5.03	Barley	3.97	Peas	1.50
Standard	Wheat	0.89	Barley	3.93	Barley	4.80	Peas	3.10	TT Canola	1.40
Standard	Barley	1.96	Barley	3.61	Peas	2.35	TT Canola	2.00	Wheat	1.64
Standard	Barley	2.10	Peas	1.90	TT Canola	2.03	Wheat	3.71	Barley	2.10

Full stubble retention: effect on crop growth and growing conditions

Sarah Noack and Peter Hooper, Hart Field-Site Group
Mick Lines and Victor Sadras, SARDI
Glenn McDonald, The University of Adelaide

Funded by South Australian Grains Industry Trust (SAGIT) and Caring for Our Country in collaboration with farmers Matt Dare and Ashley & Tom Robinson.

Key findings

- There were no significant differences in lentil grain yield among seeding system or stubble treatments.
- Stripper and conventional stubble treatments resulted in taller and more erect plants with higher pods, improving harvestability.

Why do the trial?

It is estimated that less than 20% of growers use a full stubble retention system due to risks (eg. pests and disease) and costs associated with the practice, which limit its adoption. Stubble retention however, is important for improving soil health and preventing land degradation.

The outcomes of recent research are conflicting. Various reports have shown yield decline from full stubble retention, due to reduced interception of sun light, lower soil temperatures and increased pest activity. Other research has shown that stubble retention may increase cereal and legume grain yields by improving crop growing conditions, availability of water, nitrogen or a combination of these factors. The actual outcome, however, is likely to depend on the management of stubble (level and timing of ground cover), soil type, and interactions with rainfall, soil nitrogen and fertiliser management.

In order to improve no-till cropping system performance, a better understanding of residue management and its impact on crop production is needed. The trial data presented here is the first of a three year project investigating the effect of full stubble retention compared with other stubble management methods and seeding technologies.

How was it done?

Plot size	21 m × 50 m (disc seeder) 25 m × 50 m (knife-point seeder)	**Fertiliser**	DAP (18:20) Zn 2% @ 70kg/ha
Seeding date	28th of May 2013	**Variety**	PBA Blitz lentils @ 50 kg/ha

The trial was established as a randomised complete block design with three replicates and five stubble × seeding treatments (Table 1). The disc treatment was sown using a John Deere 1890 Disc Machine on 15.2 cm (6”) row spacing. The knife-point treatments were sowing using a Flexicoil 5000 on 25.0 cm (10”) row spacing.

Table 1. Treatment details, stubble height and seeding equipment used for each treatment.

Treatment	Stubble description	Seeding equipment
Conventional/ knife-point	Harvested at intermediate height **30 cm** and stubble retained	Knife point
Baled	Harvested using stripper front and straw windrowed **5 cm high**, baled and removed	Disc
Short	Harvested at short height **15 cm** and stubble retained	Disc
Conventional/disc	Harvested at intermediate height **30 cm** and stubble retained	Disc
Stripper front	Standing stubble, harvested using a stripper front, height **~60 cm.**	Disc

Also see Figure 1.

Results

Crop establishment

There was no significant difference in crop establishment (plants per square metre) among stubble treatments or seeding system for lentils in this trial (Table 2). Both the stripper front and short stubble treatments contained the lowest plant number however; the variation in this measurement was too high to observe any statistical differences.

Table 2. Summary of crop measurements establishment (plants per square metre), plant and pod height at maturity, lodging and grain yield.

Stubble treatment	Establishment (plants/m^2)	Plant height (cm)	Pod height (cm)	Lodging*	Yield (t/ha)
Conventional/knife point	120	50.0 a	21.4 a	8-9	2.8
Baled	110	29.5 d	8.6 c	2-3	2.2
Short	96	35.4 c	13.6 b	2-3	2.6
Conventional/disc	100	42.8 b	15.1 b	8-9	2.8
Stripper	86	47.8 ab	16.4 b	7-8	2.7
LSD ($P \leq 0.05$)	ns	5.4	3.8	-	ns

**Crop lodging scored as 9 equals erect to 1 completely flat on the ground*

Plant height, pod height from soil surface (harvestability) and lodging at harvest

Plant and pod height was highest for the conventional/knife-point treatment (Table 2). This was followed by stripper and conventional/disc which was higher compared to the short and baled stubble treatments. The shorter plant height for the baled and short stubble treatments may be attributed to the lack of stubble to support the growth of lentil plants. Evidence for this was also the high lodging score for these treatments (Table 2). Overall the stripper and conventional stubble treatments resulted in taller and more erect plants with higher pods improving harvestability.

The conventional stubble treatment was sown with the disc and knife-point seeder, yielding 2.8 t/ha. Plots sown with the knife-point seeder had a greater plant height and higher pods. This was most likely a result of the disc seeder using a narrower row spacing and flattening more stubble, compared to the knife-point which was inter-row sown.

Grain yield

There were no significant differences in lentil yield between seeding system and / or stubble treatment. Grain yield ranged from 2.2 - 2.8 t/ha with baled stubble having lowest yield and both knife point and disc conventional stubble having the highest yield.

Wind, temperature and humidity measurements

Measurements for wind speed (km/hr), temperature (ºC) and humidity (RH%) were taken throughout the growing season and all data displayed is the average data for one sampling time.

Figure 1. Lentils growing in short 15 cm stubble (left) and stripper front stubble (right).

The effect of stubble height on the relative change in wind speed between 0 and 100 cm is shown for two different sampling times in Figure 2. The data shows at 80 and 60 cm from the soil surface reductions in wind speed started to occur. The greatest wind speed reductions were observed in the 0-40 cm height zone from the soil surface. This was the case for either sampling time at low (Figure 2a) or high wind speed (Figure 2b).

These preliminary results show that as stubble height increased wind speed was reduced. Interestingly there was little difference between the baled and short (15 cm) treatments and 30cm of stubble height was required to significantly reduce wind speed. Further investigation of stubble heights will occur in 2014.

The baled and short treatments were on average 56% of the 100 cm wind speed at the 20 cm height (Figure 2b). While at the same height the conventional and stripper treatments were at least 50% better at reducing wind speed. This data shows that wind speed in the zone of plant growth will be affected by stubble height and taller stubble treatments offer plants greater protection.

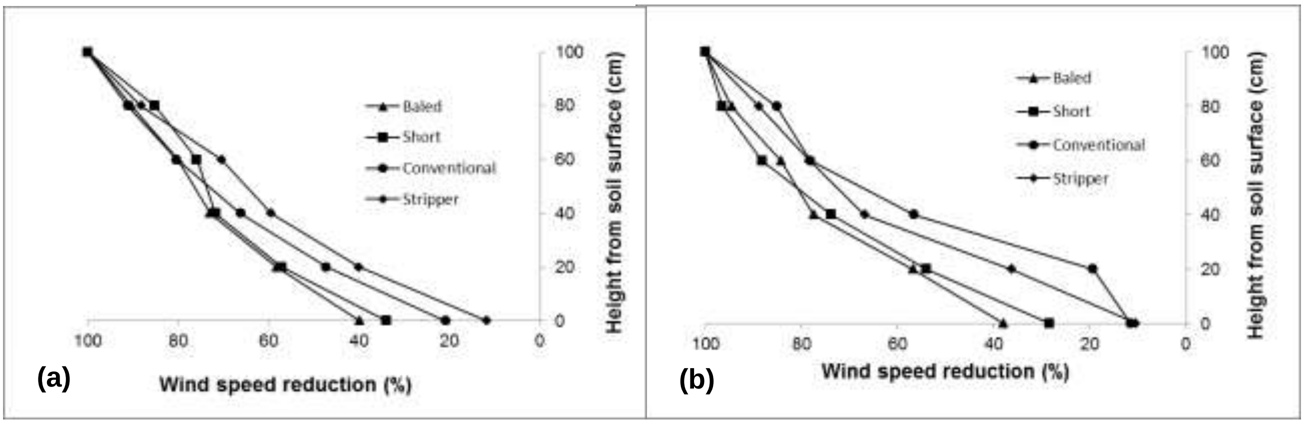

Figure 2. Wind measurements taken on a (a) a low wind speed (6-10 km/hr) and (b) high wind speed (20-30 km/hr).

Temperature and humidity measurements showed a similar trend across all stubble treatments (Figure 3). There was a 1 to 2°C difference between the stripper and baled stubble at 40 cm however, below this height temperature differences were small. At the time these measurements were taken the crop was well established (15 - 20 cm high) and may have shaded the surface masking the effect of stubble on temperature and humidity.

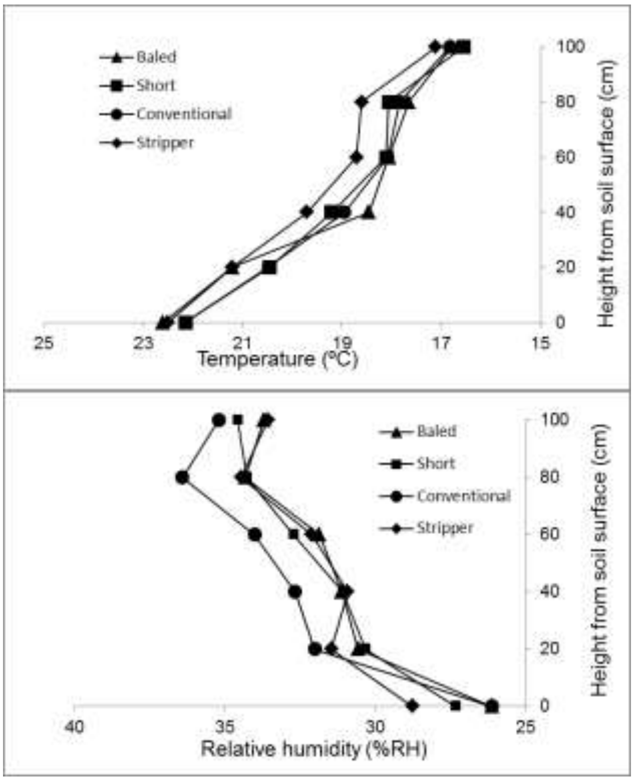

Figure 3. Temperature and relative humidity readings for stubble treatments in 2013.

Pinery stubble management trial

Mick Lines and Larn McMurray, SARDI

This research is funded by the Grains Research and Development Corporation and Southern Pulse Agronomy.

Agronomic trial work conducted in 2010-2012 by the Southern Pulse Agronomy project in the Pinery region has shown that substantial yield benefits can be achieved through inter-row sowing of lentil into retained cereal stubble. Rainfall and soil type varied over the three seasons of trials, but consistencies include alkaline soil (pH 8-8.5) and shallow soil depth (20-50 cm soil over a heavy limestone layer).

A small-plot field trial was set up at Pinery in 2013 to investigate whether additional benefits can be achieved by sowing inter-row into stubble reaped with a stripper front. Wheat stubbles measured 60 cm in height and 5.6 t/ha in biomass. Stubble treatments (executed pre-sowing) included removed stubble, slashed stubble, standing stubble 30 cm tall and standing stubble 60 cm tall. The lentil variety PBA Blitz was chosen, having shown the greatest response to stubble management in previous trials. The trial was sown with a knife-point cone seeder on 10 inch (25 cm) row spacings, and rolled immediately post sowing.

Significant early insect (mandalotus weevil) damage was noted, particularly in the standing stubble treatments where more than 50% of plants had been defoliated (Table 3). However damage levels were similar in the removed and slashed treatments. This finding highlights the importance of pest protection and vigilant monitoring in retained stubble systems, which provide a favourable habitat for a wide range of insects and pests. Final grain yield showed a 58% yield advantage from sowing into slashed stubble compared to removed stubble (Table 3). No benefit was generated by sowing into standing stubble compared to removed stubble, most likely due to the increased levels of damage caused by insect pests in this treatment. As in previous seasons, standing stubble generated a significant improvement in lodging resistance (Table 3), representing potential harvestability benefits in lentil.

Table 3. Grain yield (t/ha) and lodging score (1-9) of lentils varieties sown in four stubble management practices at Pinery, South Australia in 2013.*

Stubble Treatment	Removed	Slashed	Standing 30cm	Standing 60cm	LSD ($P\leq0.05$)
^Plant defoliation (%)	23 a	29 a	46 b	57 b	16
Grain yield (t/ha)	1.80 a	2.85 b	1.96 a	1.92 a	0.69
Lodging score*	5.0 a	4.7 a	7.3 b	7.3 b	1.5

** Lodging score: 1= prostrate, 9 = erect,*
^ % of plants with leaves defoliated due to mandalotus weevil damage

Trials will be continued at Hart and at Pinery in 2014 to further characterise the effect of stubble management on growth and grain yield of lentils. Large plot trials will be conducted at both locations, while the Southern Region Pulse Agronomy project will also be repeating small plot trials identifying the effect of stubble architecture on growth and grain yield of field pea, lentil and chickpea.

Long-term cropping systems trial

Sarah Noack and Peter Hooper, Hart Field-Site Group

Funded by South Australian Grains Industry Trust (SAGIT) and conducted in collaboration with farmers Michael Jaeschke, Justin Wundke and Tom and Ashley Robinson.

Key findings

- Wheat grain yield was not significantly different between seeding systems or level of nitrogen, averaging 5 t/ha.
- The high nutrition treatment increased grain protein.
- The high nutrition treatments had accumulated 28 kg N/ha more soil available nitrogen compared to the medium treatments to a depth of 60 cm.

Why do the trial?

To compare the performance of three seeding systems and two nitrogen nutrition strategies. This is a rotation trial to assess the longer term effect of seeding systems and higher fertiliser input systems.

How was it done?

Plot size	35 m x 13 m	**Fertiliser**	DAP/urea (27:12) @ 90 kg/ha
Seeding date	Disc: 28th May No-till: 28th May Strategic: 28th May	**High nutrition**	UAN (42:0) @ 70 L/ha and Twin Zinc @ 0.5 L/ha 14th August
		Medium nutrition	No extra fertiliser applied
		Variety	Cobra wheat @ 100 kg/ha

This trial is a randomised complete block design with three replicates, each containing three tillage treatments and two nitrogen nutrition treatments. The disc, strategic and no-till treatments were sown using local farmers Tom Robinson, Michael Jaeschke and Justin Wundke's seeding equipment, respectively.

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

2000	2001	2002	2003	2004	2005	2006
Sloop Barley	Canola	Janz Wheat	Yitpi Wheat	SloopSA Barley	Kaspa Peas	Kalka Durum

2007	2008	2009	2010	2011	2012
JNZ Wheat	JNZ Wheat	Flagship barley	Clearfield canola	Correll wheat	Gunyah peas

Tillage treatments:

Disc – sown into standing stubble with John Deere 1980 single discs at 152 mm (6") row spacing, closer wheels and press wheels.

Strategic – worked up pre-seeding, sown with 100 mm (4") wide points at 200 mm (8") row spacing with finger harrows.

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

Nutrition treatments:

Medium – No extra fertiliser applied post seeding.

High – Extra nitrogen and zinc were applied to the plots post seeding.

Soil nitrogen (0-60 cm) was measured on 30th May in all plots.

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

All plots were assessed for grain yield, protein, screenings and test weight.

Results

Soil available nitrogen to 60 cm was measured in autumn and ranged between 127 kg N/ha (no-till, medium) and 179 kg N/ha (strategic, high) between the tillage treatments (Table 1). The high nutrition treatments had accumulated 29 kg N/ha more soil available nitrogen compared to the medium treatments to a depth of 60 cm. These results are consistent with those measured in previous years, in 2011 and 2012 where the values were 28 kg N/ha and 45 kg N/ha, respectively.

Crop emergence was variable for the disc seeder, and the no-till seeder produced more consistent plant numbers. The strategic treatment has been removed from all analysis due to poor crop emergence and heavy weed burden later in the season, making these plots non-representative of the tillage treatment.

Nutiriton	Tillage	Available soil nitrogen (kg N/ha)	Emergence (plants/m^2)
High	Disc	164	178
	No-Till	166	149
	Strategic	179	-
Medium	Disc	153	124
	No-Till	127	144
	Strategic	140	-
LSD (P≤0.05)			
Tillage		ns	ns
Nutiriton		ns	ns
Tillage * Nuitrition		ns	ns

Table 1. Available soil nitrogen (kg/ha) and crop emergence (plants per square metre) for nutrition and tillage treatments at Hart in 2013.

Tillage treatment did not significantly influence the grain yield or quality of Cobra wheat in this trial at Hart in 2013 (Table 2). The average grain yield for disc and no-till treatments was 5.0 t/ha. In the previous year's differences in grain yield have been attributed to different sowing dates for the seeding treatments. In 2013 both no-till and disc treatments were sown on the same day. This finding supports the general conclusion from the previous 12 years of this trial, which is no one seeding systems consistently yields higher than another.

Table 2. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) for nutrition and tillage treatments at Hart in 2013.

Nutiriton	Tillage	Grain Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
High	Disc	4.8	13.8	73.6	6.6
	No-Till	5.0	12.9	70.3	7.4
Medium	Disc	5.2	12.4	73.4	4.7
	No-Till	5.0	12.5	73.1	5.1
LSD (P≤0.05)					
Tillage		ns	ns	ns	ns
Nutiriton		ns	0.64	1.77	ns
Tillage * Nuitrition		ns	ns	ns	ns

Nutrition did not affect grain yield however, differences in protein and test weight were observed (Table 2). Grain protein was significantly higher (13.4%) in the higher nutrition treatments than the medium treatments (12.5%). This may be explained by the higher soil nitrogen (Table 1) in the high nutrition treatments compared to the medium. Similar observations were also seen for Correll wheat in 2011. Test weight for both nutrition treatment was below 74 kg/hL, the minimum required for the maximum grade. The medium treatment produced higher test weight (73.5 kg/hL) compared to the high nutrition treatment (71.7 kg/hL).

Photos: (left) Stephen Ball speaker at the cropping systems trial at the Hart Field Day, (top right) Justin Wundke seeding the no-till treatment (bottom right) Tom Robinson seeding the disc treatments.

Soil biology of Hart cropping systems trial

Katherine Linsell[1], A. Marcelle Stirling[2], Anthony Cheshire[3], Alan McKay[1], Graham Stirling[2] Kathy Ophel Keller[1]

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The soil biology research is funded by a Grains Research and Development Corporation (GRDC) project DAS00111.

Key Findings

- Tillage had a significant effect on free-living nematode populations but the effects were different in different years.
- Fertiliser addition had no significant effect on nematode populations.
- Higher amounts of the crown rot fungus, *Fusarium pseudograminearum*, and stem nematode, *Ditylenchus*, in the disc than the no till treatments due to better pathogen dispersal in no-till.

Why do the trial?

This is a rotation trial to assess the longer term effect of seeding systems and fertiliser inputs on biological soil health, by analysing nematode communities. In addition we assessed changes in soil biology pre-and post-sowing and between bulk and rhizosphere soil.

Nematodes are significant pests of cereal crops, but soils also contain non-parasitic free living nematodes (FLN). These FLN, provide a wealth of information on a soil's biological status and are therefore useful indicators of soil health. Free-living nematodes are important in nutrient cycling within the soil as they feed on soil microbes (bacteria and fungi) releasing nitrogenous compounds and other compounds which are then available to plants.

The composition of nematode communities, so the presence or absence of certain species, can provide information of the microbial status of the soil. A 'healthy soil' generally has well structured, mature and stable nematode communities and the predominant nematodes will be free-living species, with a diverse range and a good balance between bacterial and fungal feeders and will also contain omnivorous and predatory nematodes.

How was it done?

This trial is a randomised complete block design with 3 replicates, each containing 3 seeding treatments and 2 nitrogen nutrition treatments (as outlined in the article 'Long-term cropping systems trial). In this soil biology study only 2 tillage treatments were analysed, disc and no-till.

The treatments were sampled pre-sowing after the initial opening rains in April 2012 and 2013. The same treatments were also sampled pre and post sowing in July 2013. Both bulk soil and rhizosphere soils were collected in the 2013 post sowing samples.

The trial was planted with wheat (Correll) in 2011, peas (Gunyah) in 2012 and wheat (Cobra) in 2013 @ 100 kg/ha.

Tillage treatments	2012 & 2013
Disc	**2012** - sown into standing stubble with Serafin Baldan single discs on 250mm (10") row spacing, closer wheels and press wheels. **2013** - sown into standing stubble with John Deere 1980 single discs at 152 mm (6") row spacing, closer wheels and press wheels.
No-till	sown into standing stubble in 1 pass with Flexicoil PD 5700 drill, narrow points with 300mm (12") row spacing and press wheels.

Nutrition treatments	2012	2013
Medium	DAP @ 90kg/ha at seeding and no extra fertiliser applied post seeding	DAP @ 90kg/ha at seeding & no extra fertiliser applied post seeding
High	DAP @ 90kg/ha at seeding and no extra fertiliser applied post seeding	DAP @ 90kg/ha at seeding and UAN (46:0) @ 70 L/ha & Twin Zinc @ 0.5 L/ha on 14/8/2013

Three plots from each treatment were sampled and consisted of 30 cores (about 1.2 kg soil) collected with a 25 mm diameter corer at a depth of 0–10 cm. The soil was sub divided into three portions for manual nematode analysis, DNA nematode analysis and soil chemical analysis.

Several indices were also calculated to characterise nematode communities. Soil was also dried and DNA was extracted and analysed using PreDictaB tests by the SARDI's Root Disease Testing Service.

Results and Discussion

Measurements taken from the cropping systems trial in 2012 and 2013 showed tillage has a significant effect on nematode communities however, fertiliser had no effect. In 2012 the disc treatments were dominated by more fungi compared to bacteria. While the no-till treatment soils had high numbers of fungal feeders but also bacterial opportunists taking advantage of the flux of bacteria and fungi associated with the decomposition of the stubble.

The fungal pathogen, *Fusarium pseudograminearum*, the causal agent of crown rot in wheat, was the main driver of this tillage effect. Crown rot inoculum was much more abundant in the disc than no-till treatments (Table 1). The levels of this pathogen were very high and fell into the high disease risk category as determined by PreDictaB ratings (Table 1). In addition, a similar trend was observed with the stem nematode (*Ditylenchus)*, which was also more abundant in disc seeded plots (Table 1).

It could be suggested that the no-till treatments may encounter lower populations of both crown rot and stem nematode as there is greater disturbance of both soil and stubble during sowing. For disc treatments there is less soil disturbance allowing pathogen populations to proliferate.

Table 1. PreDicta B DNA quantification of (a) common fungal pathogens and (b) parasitic nematodes in the different tillage treatments at Hart, 2013. Pathogen levels are reported in terms of picograms of DNA per gram of soil, except for stem nematode which is per 100g soil, which correlates to disease risk categories. Risk categories should be used as a guide only as they may be subject to regional and seasonal differences.

(a) common fungal pathogens

Time	Tillage	Take-all	Take-all Risk	Rhizoctonia	Rhizotoctonia Risk	Crown Rot	Crown Rot Risk
Pre-sowing	Disc	2.72	*	0.58	*	1037.20	High
Pre-sowing	No-till	1.59	*	4.54	*	38.82	Low
Pre & Post-sowing	Disc	3.03	*	0.42	*	665.37	High
Pre & Post-sowing	No-till	2.25	*	4.28	*	16.40	Low
Post-sowing	Disc	2.96	*	0.00	*	93.08	Medium
Post-sowing	No-till	2.57	*	11.11	Low	8.95	Low

(b) parasitic nematodes

Time	Tillage	CCN	CCN Risk	P. neglectus	P. neglectus Risk	P. thornei	P. thornei Risk	Stem nematode	Stem nematode Risk
Pre-sowing	Disc	0.08	*	4.44	Low	10.62	Low	46.10	High
Pre-sowing	No-till	0.13	*	5.22	Low	8.54	Low	3.49	Low
Pre & Post-sowing	Disc	0.00	*	2.66	Low	5.16	Low	2.86	Low
Pre & Post-sowing	No-till	0.01	*	1.80	Low	5.01	Low	0.23	*
Post-sowing	Disc	0.00	*	2.60	Low	2.69	Low	0.90	Low
Post-sowing	No-till	0.02	*	1.69	Low	2.34	Low	0.14	*

CCN = Cereal cyst nematode
P. neglectus and P. thornei (both root lesion nematodes)
**below detection limit*

Long-term stubble retention and reduced tillage

Peter Hooper, Hart Field-Site Group

This trial was funded by the GRDC water use efficiency initiative and conducted in collaboration with Victor Sadras, SARDI, and Glenn McDonald from the University of Adelaide.

Key findings

- Crop water use and soil analysis values were very similar between the sites comparing long term reduced tillage and stubble retention.
- Reduced tillage and stubble retention has significantly contributed to increasing organic carbon levels at these sites.
- The grain yields of wheat were greatest at the sites with higher water use efficiency for each location.

Why do the trial?

A clear variation has developed between growers and their approach to sustainable farming. Some examples include growers reducing the input of organic matter by removing straw after harvest, producing less dry matter with delayed applications of nitrogen, and included export hay into rotations. In contrast to this other growers have maximised the input of organic matter through a long term adoption of reduced tillage and stubble retention. The long term effects of these differences, especially in relation to soil moisture and soil quality have not been measured.

How was it done?

Plot size 7 m × 10 m

Table 1. Sowing date and fertiliser rate of the A and B trial sites, for each location.

	Sites A & B	Sowing date	Fertiliser
2010	Condowie	29th April	35 kg/ha DAP Zn
	Saddleworth	7th May	80 kg/ha DAP Zn
	Spalding	6th May	40 kg/ha DAP Zn
2011	Condowie	21st May	40 kg/ha DAP Zn
	Saddleworth	16th June	90 kg/ha DAP Zn
	Spalding	19th May	150 kg/ha 32:10
	(Site B sown with commercial equipment)		
2012	Condowie	21st May	65 kg DAP Zn
	Saddleworth	18th May	100 kg/ha DAP Zn
	Spalding	17th May	80 kg/ha DAP Zn

Three permanent regional sites (Condowie, Saddleworth and Spalding) were established in 2010 within selected grower paddocks. The locations were selected such that they covered a range of soil types and rainfall amounts within the Mid-North of South Australia.

At each location, rotation trials were established in two paddocks which were separated by a difference in water use efficiency over the past 10 years. At each location one grower had been using long term reduced tillage and stubble retention practices (for more than 20 years, site A) while the other grower had only a shorter history for these practices (less than 5 years, site B). At two of the locations, the trial sites were separated by a road, while at the Spalding location the distance between the sites was 100 m.

A randomised complete block design with three replicates was used to conduct a rotation trial at each site and location, totalling 6 individual sites. A rotation was utilised to keep the site free of weeds and to provide a similar cropping history, for a standard comparison.

A standard knife-point press wheel system was used to sow the plots on 22 cm (9") row spacing.

All plots were assessed for grain yield and quality.

The matching sites at each location were sown with the same seeder, at the same time, using the same seed and same fertiliser. Nitrogen management and weed control were conducted as needed during the growing season and was also treated the same for the matching sites.

Results

Extensive soil analysis (drained upper limit, bulk density, nutrients, soil strength and water infiltration) at each of the sites showed only marginal differences between the site A and B paddocks. The site A paddocks had higher levels of organic carbon, this difference was greatest at Spalding and Condowie and could be a result of more than 20 years of reduced tillage and stubble retention. However, in some cases the site B paddocks had faster water infiltration and more penetrable soil (Tables 2 to 4). Root disease levels were not different between the sites.

At each site the measured soil strength was very similar. In fact, at the Saddleworth and Spalding sites the soil was easier to penetrate in the site B paddock. Saddleworth had the softest soil of the sites. Results for the rate of water infiltration were similar with the Spalding and Saddleworth site B paddocks having the fastest rate of infiltration. The Condowie site had the overall fastest rate of water infiltration.

Table 2. Penetrometer readings from each site. The values are the number of hits needed to reach the listed target depths.

Location	Depth (cm)	Site A	Site B
Saddleworth	0-5	3.8	2.4
	5-10	13.9	10.7
	10-15	24.2	24.0
Spalding	0-5	5.8	4.9
	5-10	16.1	11.2
	10-15	31.5	31.1
Condowie	0-5	3.0	4.2
	5-10	13.5	13.2
	10-15	40.7	34.3

Table 3. Water infiltration readings from each site. The value is the time taken (seconds) to reach each target depth, in seconds.

Location	Depth (cm)	Site A	Site B
Saddleworth	10	161.0	129.6
	13	84.5	37.5
	15	116.8	103.4
	18	58.5	30.5
Spalding	10	96.7	63.7
	13	66.0	38.7
	15	76.3	42.7
	18	34.3	18.3
Condowie	10	4.5	5.0
	13	5.0	4.9
	15	11.8	11.1
	18	29.0	na
	20	na	34.4

Table 4. Soil test analysis results for each site A and B, at each location, at the 0-10cm depth.

Analysis test	Saddleworth		Spalding		Condowie	
	Site A	Site B	Site A	Site B	Site A	Site B
Phosphorus (Colwell ppm)	31	28	41	63	44	31
Organic carbon (%)	1.81	1.76	2.37	1.74	1.84	1.13
EC (dS/m)	0.24	0.19	0.28	0.19	0.25	0.14
pH ($CaCl_2$)	7.1	7.3	5.8	4.7	7.9	8.0
pH (H_2O)	7.6	7.8	6.2	5.4	8.5	8.7

The rate of crop growth and leaf area expansion was similar between the site A and B paddocks throughout the project, although final dry matter production was lower for some of the site B paddocks. Measurements of crop water use show similar results between the site A and B paddocks and showed that in these productive farming systems 50 to 60% of the early season water loss is still through soil evaporation.

Table 5. The grain yield (t/ha) of wheat and barley at each trial site between 2010 and 2012.

Site	Crop	2010		2011		2012	
		Site A	Site B	Site A	Site B	Site A	Site B
Condowie	Wheat	2.9	2.9	1.91	1.41	2.60	2.20
	Barley	3.1	4.4	1.77	0.37	na	na
Spalding	Wheat	6.9	7.5	4.84	4.08	3.20	2.40
	Barley	7.4	8.4	5.02	3.45	na	na
Saddleworth	Wheat	4.5	4.1	5.38	5.36	4.10	4.00
	Barley	5.6	4.9	4.71	4.76	na	na

Table 6. The grain protein (%) of wheat and barley at each site between 2010 and 2012.

Site	Crop	2010		2011		2012	
		Site A	Site B	Site A	Site B	Site A	Site B
Condowie	Wheat	10.9	na	12.6	11.5	10.8	10.0
	Barley	11.1	na	12.0	12.2	na	na
Spalding	Wheat	10.4	10.8	12.9	14.8	13.7	13.6
	Barley	10.6	10.5	12.0	11.7	na	na
Saddleworth	Wheat	8.0	9.0	11.0	10.0	6.4	9.5
	Barley	9.1	9.4	12.3	12.3	na	na

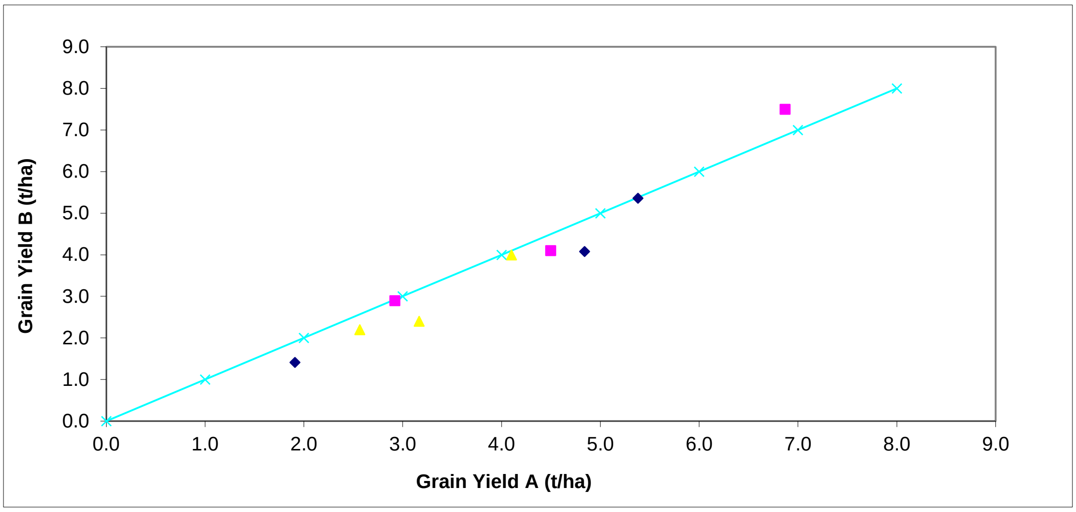

Figure 1. The grain yield of wheat at site A compared to site B for each site and season between 2010 and 2012.

The grain yield (Table 5) and total nitrogen offtake (Table 6) was similar between the sites, with the site A paddocks producing slightly higher yields (Figure 1).

By removing the commonly discussed variables of time of seeding, seeding rate, fertiliser rate, seeding equipment and crop rotation these paddock comparisons have shown that long term reduced tillage and stubble retention has contributed small improvements to crop water use, grain yield and quality. More significantly they have clearly shown that timeliness of operation, attention to detail and good rotation play a far greater role in obtaining optimum water use efficiency.

Yield Prophet® performance in 2013

Sarah Noack and Peter Hooper, Hart Field-Site Group

Key findings

- Yield prophet accurately predicted a final grain yield of Mace wheat near 4.7 t/ha.

Why do the trial?

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

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

This early prediction of grain yield potential means it can be used to directly influence crop input decisions. No other tool is currently available to growers, which can provide information of this accuracy at such a useful time of the season.

How was it done?

Seeding date	1st May 2013	**Fertiliser**	30 kg N/ha 1st May 35 kg N/ha 20th July
Variety	Mace wheat @ 180 plants per square metre		

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

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

Results

The grain yield for Mace wheat sown on the 1st May at Hart in 2013 was 4.7 t/ha. This final grain yield closely matched the Yield Prophet® prediction (Figure 1) of 5.0 t/ha, made in mid-August.

At the first simulation, 24th June 2013, the Yield Prophet® simulation predicted that Mace wheat sown on the 1st May would yield 4.6 t/ha in 50% of years. The predicted grain yield then increased by 0.5 t/ha by the 23rd of July due to an increase in rainfall of almost 70 mm. This yield was closely maintained up until early October.

The Yield Prophet® simulation on the 1st October for grain yield, given an average (50%) finish to the season, was 5.0 t/ha as was the finish for 80% of years. For majority of the season Hart rainfall ranged from decile 8 to 9 which meant the variation in grain yield between 20%, 50% and 80% of years was reduced compared to drier seasons (Figure 1).

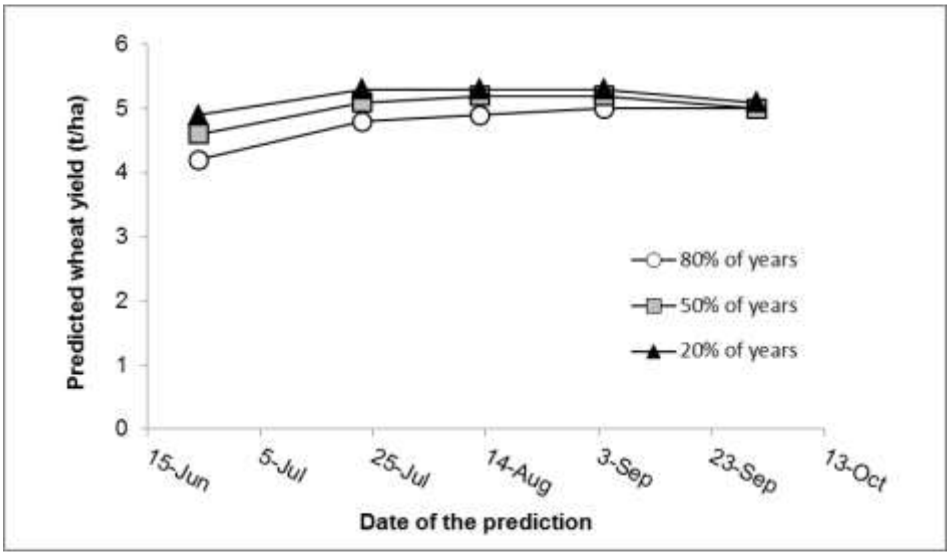

Figure 1. Yield Prophet® predictions from 26th June to the 1st October for Mace wheat sown on the 1st May. 80%, 50% and 20% represent the chance of reaching the corresponding yield at the date of the simulation.

At time of sowing, plant available water (PAW) measured 0 mm (0-90 cm) due to the lack of summer rainfall at the end of 2012 and start of 2013. Plant available water had increased significantly when the first Yield Prophet® simulation was run on 26th of June (Figure 2). Plant available water slowly decreased until mid-August due to lack of rainfall towards the end of the season. At the final simulation date of 1st of October there was still 59 mm of PAW (Figure 2). The 2013 season favoured earlier districts resulting in above average yields and grain quality. Additional rainfall in many of the later districts was required to finish the season and reduce screening levels, although generally grain yield and quality were good.

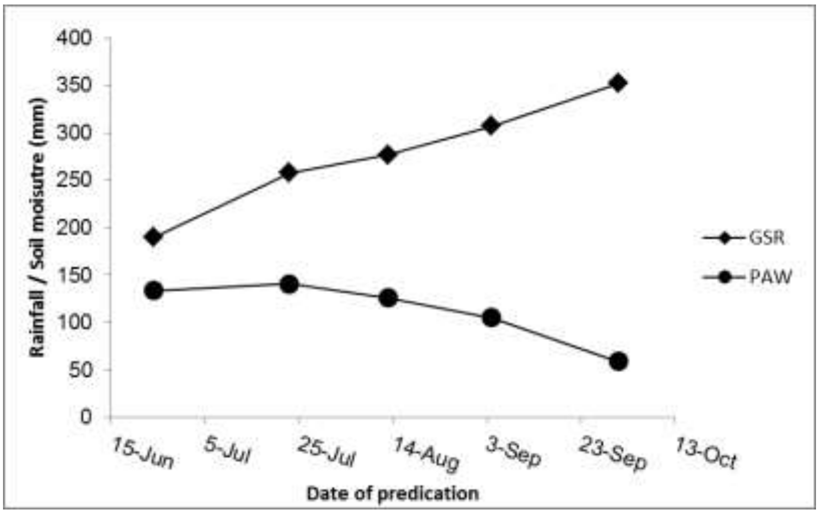

Figure 2. Predicted plant available water (PAW) and recorded cumilative growing season rainfall from 26th of June to 1st of October at Hart in 2013.

Increasing economic returns of agronomic management using precision agriculture

Michael Wells, Precision Cropping Technologies
Peter Treloar and Felicity Turner

Funding for this research from the South Australian Grains Industry Trust (SAGIT) is gratefully acknowledged.

Key findings

- EM38 successfully mapped differences in soil water properties across the paddock.
- Positive response to fertiliser in wheat on wheat and higher yielding season.
- Barley yield decreased with increasing rates of nitrogen and phosphorus fertiliser.

Soil Moisture and EM38

Targeted soil moisture sampling at the end of 2011 illustrated a strong correlation between crop lower limit and EM38. Sampling was repeated in August 2012 and July 2013 when reasonable levels of rainfall should have filled the profile through to 80 cm. As seen in Figure 1, the soil was at field capacity a month earlier in 2013 due to a wet winter.

This highlights the potential to use EM38 to create long term management zones based on soil water characteristics and for in-season nitrogen (N) applications to become much more targeted, especially late in the season.

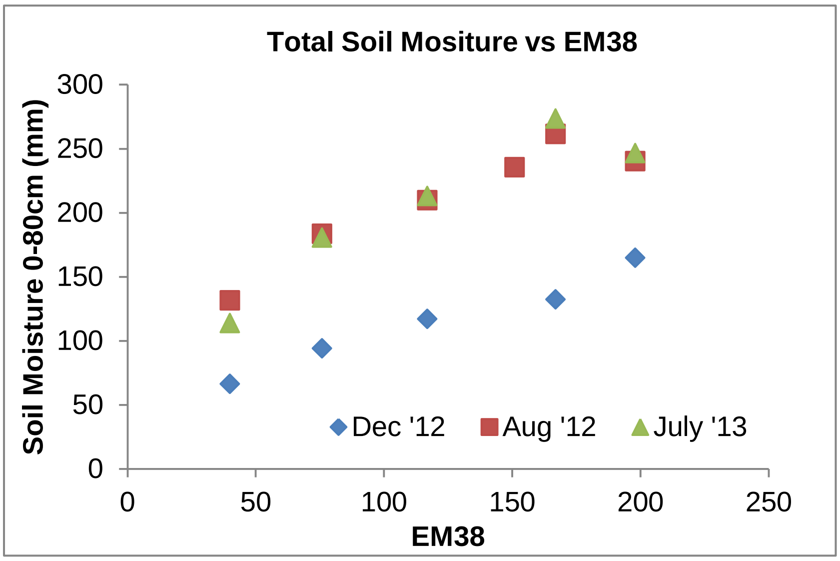

Figure 1. Total soil moisture versus EM38 at different sampling points from August 2012 to July 2013.

Barley and wheat trials, 2013

In the trials higher fertiliser rates reduced the grain yield of Fleet barley (Figure 2a). This decline in yield with fertiliser rate increased as the soil texture got heavier and with higher subsoil constraints (ie higher EM values). This is likely due to higher dry matter prodcution in treatments with additional fertiliser, which could not be converted to grain yield due to the warm and dry finish in 2013.

In Figure 2b there was a positve result (0.4 t/ha, 8% increase) to fertiliser, which might be due to the paddock being wheat on wheat. The highest response was in the lowest EM zone, which fits with the soil water findings that show the lowest EM has the lowest constraints. In the medium and high EM zones there was little difference between the fertiliser rates for wheat (Figure 2b).

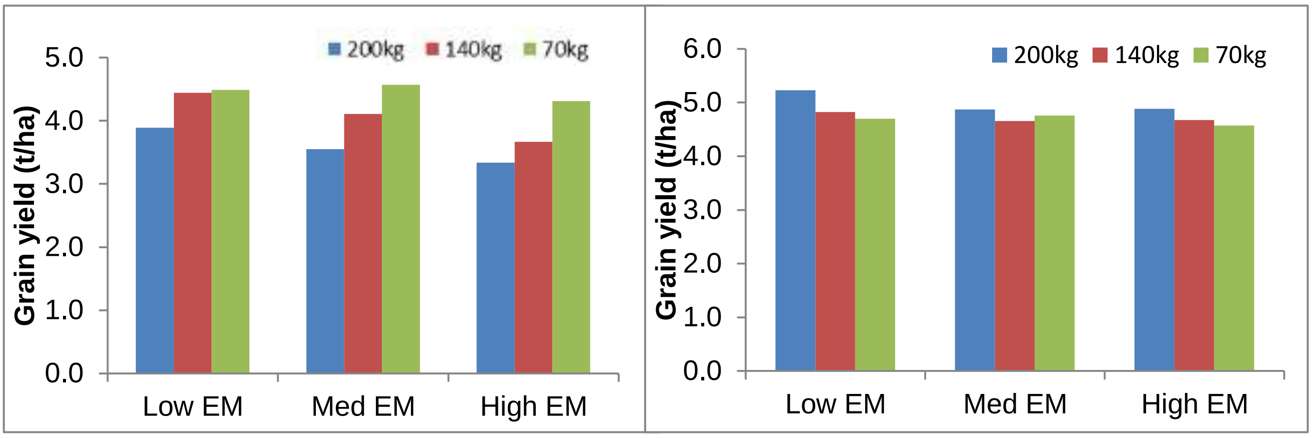

Figure 2. Response of Fleet barley (a) and Mace wheat (b) to increased fertiliser applications (28:12 DAP Urea blend) in low (30), medium (53) and high (94) EM zones.

Conclusions

Wheat responded to addition nitrogen and phosphorus fertiliser, where there were low soil constraints. The grain yield increase in each zone to higher rates of fertiliser is likely due to the paddock being wheat on wheat and starting with lower soil nutrient levels ie. nitrogen. For the barley the opposite trend was seen where there was a negative correlation between grain yield and fertiliser rate.

From a risk management point of view larger benefits are likely to be gained from extra fertiliser in areas with lower EM soils. Past trial work by our group has shown that in wetter springs the higher EM soils tend to look after themselves, due to a buildup of residual nutrition.

Contacts

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HARVEST 2012 /13

The Harrington Seed Destructor (HSD) was trialled on farm with growers across the Mid-North (above). *Funded by GRDC.*

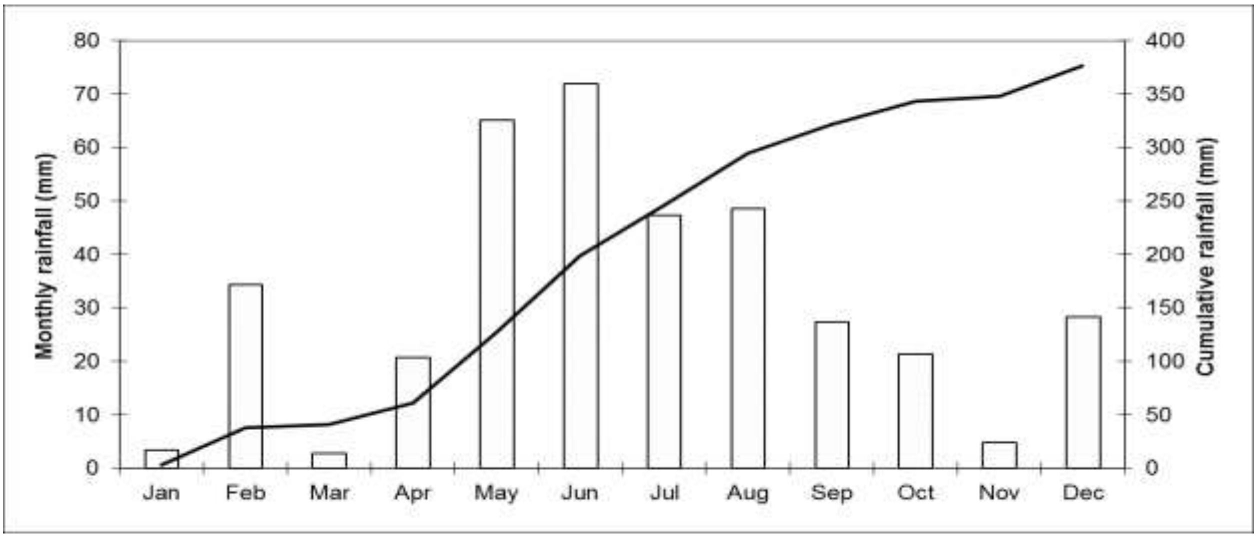
Seeding at Hart

Seeding at Hart with the team from SARDI and local growers in the commercial crop and cropping systems trial.

Hart rainfall chart 2013

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1		2.4			0.4	35.8				8		0.2
2				0.2		4.4	0.2					0.6
3								2.2				1.4
4						0.2	0.2	5				14.8
5							3.4	1.2				2
6							0.2					
7						2	0.4	4.8				
8							0.2				1.8	
9											0.2	5.2
10						0.2						4
11										1		
12					6.8	11.4		2.8		0.2		
13					2.2	2.4	11.6	0.2	16.8	1.8		
14					6.2	7.2	1.2	1.2	0.2	7		
15	3				2.6		1.2	2	0.2	0.2		
16		11.4			22.4	0.2	0.2		2.8			
17					0.2		0.2	3.2	2.2	2.6		
18						0.2	9	1.2	2			
19	0.4				0.2	0.2	1.6	4.8	0.6			
20							6.2	1	0.2			
21				5.6		2.2	2.2	3				
22		0.4		1.4	12.6	5.2	5	1	0.2	0.4		
23				0.2	6.6		1	1.6				0.2
24							0.4	1.8		0.2		
25								1				
26		0.6			0.2		0.2	0.2	2			
27						0.2						
28		19.6	1.6				1.2	0.2	0.2			
29				10			0.6	3.2			2.8	
30				3.4	2.2	0.2	1	6.8				
31			1.2		2.6			0.2				
Montly total	3.4	34.4	2.8	20.8	65.2	72.0	47.4	48.6	27.4	21.4	4.8	28.4
Running total	3.4	37.8	40.6	61.4	126.6	198.6	246.0	294.6	322.0	343.4	348.2	376.6

Hart rainfall graph 2013



Average GSR (Apr-Oct)	305 mm	Average rainfall	400 mm
2013 GSR (Apr-Oct)	303 mm	2013 total rainfall	377 mm
2013 GSR (Apr-Oct)+summer	336 mm		

Hart site – soil test 2013

Northern quarter

Depth (cm)	**0 - 10**
Sampled 30/5/2013	
Phosporus (ppm) (Cowel P)	59
DGT – P (µg/L)	89
Phosphorus buffering index	102
KCl 40°C (Sulphur) (mg/kg)	1.6
Soil nitrogen (0-90 cm) (kg/ha)	**65**
Sampled March 2010	
Potassium (ppm)	579
Salinity (EC dS/m)	0.14
Organic carbon (%)	1.80
pH (calcium chloride)	7.4
pH (water)	8.2

Notes

agfert
Quality Fertilisers

DAP ZinCote 1%

Premium
Cropping Range

Agfert's Premium Cropping Range will consist of a range of products with superior nutrient levels and handling properties to the standard fertiliser range.

Also Available in MAP ZinCote 1%

DAP ZinCote 1% is Agfert Fertilisers first premium compound product to be released as part of its Premium Cropping Range. New technology allows Agfert to get 1% zinc evenly applied to every granule, ensuring even and consistent distribution of Zinc throughout the furrow. The Zinc used in DAP ZinCote 1% is in a controlled release form supplying zinc to the plant gradually throughout the growing season.

Contact Derryn Stringer on (08) 8862 1866
for more information & to work out your fertiliser requirements.

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