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Contents

Interpretation of statistical data from the trials

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

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

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

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

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Diary dates

Hart Calendar 2012

Getting The Crop In
seminar
Wednesday 14th March 2012

HART FIELD DAY
Tuesday 18th September 2012

Winter Walk
Tuesday 24th July 2012

Spring Twilight Walk
Tuesday 16th October 2012

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Comparison of wheat varieties

Key findings

- Mace was the highest yielding commercially available hard wheat variety at Hart in 2011, yielding 3.82 t/ha. Espada, Kord CL Plus, Scout and Wyalkatchem were the highest yielding APW varieties, averaging 3.32 t/ha.

Why do the trial?

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

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	28:13 @ 90 kg/ha UAN @ 70 L/ha, 29th July
Seeding date	28th May 2011		

The trial was a randomised complete block design with 3 replicates and 27 varieties. Fungicides were applied as necessary to keep the crop canopy free of disease ie. stripe rust.

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

Results

Grain yields ranged from 2.80 t/ha (Lincoln) to 3.82 t/ha (Mace) at Hart in 2011 (Table 1).

Across all varieties Mace (3.82 t/ha) was the highest yielding, while the average grain yield for the site was 3.27 t/ha. The numbered line IGW3119 (3.58 t/ha) also performed well and was not significantly different to Mace. There was no significant difference between yields of the remaining varieties with all yielding above 3.0 t/ha, except for Lincoln (2.80 t/ha) and Yitpi (2.89 t/ha).

Wheat grain protein levels ranged from 9.3% (Mace and Impala) to 11.7% (Lincoln) with an average of 10.7%. Grain protein generally decreased with increasing grain yields (Figure 1) which is not an unusual occurrence.

The only variety producing a test weight lower than 74 kg/hL, the minimum required for maximum grade was the soft wheat variety Orion. There was no significant difference between test weights for the remaining varieties.

Axe, Wyalkatchem, IGW3119, Justica CL Plus, Espada and Gladius produced the lowest screenings at Hart in 2011 with an average of 0.65%. Correll produced the highest screenings at 1.9% and the average screenings across all varieties at Hart in 2011 was 1.0%.

Figure 1. Relationship between grain yield (t/ha) and protein (%) in wheat at Hart in 2011.

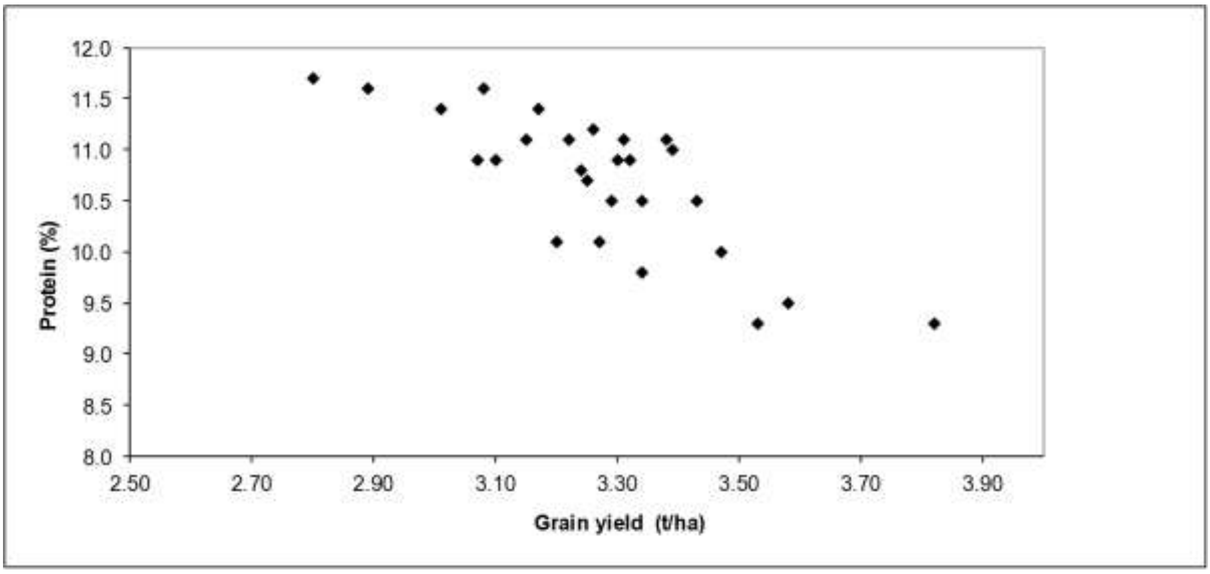

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of wheat varieties at Hart in 2011.

Quality	Variety	Grain yield (t/ha)	% of Gladius	Protein (%)	% of Gladius	Test weight (kg/hL)	% of Gladius	Screenings (%)	% of Gladius
AH	Axe	3.43	101	10.5	95	80.1	103	0.5	73
	Catalina	3.07	91	10.9	98	80.1	103	1.2	159
	Clearfield JNZ	3.15	93	11.1	100	79.3	102	0.8	107
	Correll	3.26	96	11.2	101	76.9	99	1.9	258
	Emu Rock (IGW3167)	3.34	99	10.5	95	78.6	101	1.5	205
	Derrimut	3.47	103	10.0	90	79.0	102	0.9	127
	Gladius	**3.38**	**100**	**11.1**	**100**	**77.7**	**100**	**0.7**	**100**
	AGT Katana	3.10	92	10.9	98	80.2	103	0.9	126
	Lincoln	2.80	83	11.7	105	78.0	100	1.5	205
	Mace	3.82	113	9.3	84	80.2	103	1.0	133
	Peake	3.25	96	10.7	96	77.4	100	1.2	164
	Yitpi	2.89	86	11.6	105	79.9	103	0.8	114
	Young	3.30	98	10.9	98	79.1	102	1.4	196
APW	Espada	3.39	100	11.0	99	79.0	102	0.7	92
	Estoc	3.17	94	11.4	103	81.1	104	0.8	114
	Justica CL Plus	3.08	91	11.6	105	78.0	100	0.7	92
	Kord CL Plus	3.31	98	11.1	100	79.2	102	0.8	105
	Pugsley	3.22	95	11.1	100	81.3	105	0.8	114
	Scout	3.29	97	10.5	95	79.0	102	1.1	151
	Corack (VW2316)	3.34	99	9.8	88	78.9	102	1.1	151
	Wyalkatchem	3.27	97	10.1	91	79.0	102	0.6	78
ASW	Magenta	3.01	89	11.4	103	77.0	99	1.2	164
SOFT	Barham	3.20	95	10.1	91	75.8	98	1.0	133
	Impala (C51021)	3.53	104	9.3	84	77.6	100	0.9	123
	Orion	3.24	96	10.8	97	73.0	94	1.6	219
Unclassified	IGW3119	3.58	106	9.5	86	80.5	104	0.7	92
	LPB07-104	3.32	98	10.9	98	79.0	102	1.0	137
	Site mean	3.27	97	10.7	96	78.7	101	1.0	138
	LSD (0.05)	0.32	9	0.95	9	0.88	1.1	0.41	56

Comparison of barley varieties

Key findings

- Feed varieties Hindmarsh, Fleet, Keel and Fathom; and malting varieties Commander and Buloke were the highest yielding barley varieties at Hart in 2011, averaging 3.50 t/ha.
- No varieties produced screenings in excess of 5%.
- All malting varieties achieved retention above the required 86%.

Why do the trial?
To compare the performance of new barley varieties and lines against the current industry standards.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	DAP Zn 2% @ 90 kg/ha UAN @ 70 L/ha, 29th July
Seeding date	30th May 2011		

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. net blotch.

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

Results
The feed varieties Hindmarsh (3.66 t/ha), Fleet (3.55 t/ha), Keel (3.50 t/ha) and Fathom (3.43 t/ha); and malting varieties Commander (3.39 t/ha) and Buloke (3.24 t/ha) were the highest yielding barley varieties at Hart in 2011 (Table 1). The average grain yield across all feed varieties was 3.18 t/ha compared to 2.97 t/ha for the malting varieties.

Grain protein ranged between 10.0% for Carl 1238 and Navigator (both unclassified) and 12.2% for the feed variety Shepherd. The average protein level for all varieties was 11.0%.

All malt varieties achieved test weights above the required 65 kg/hl minimum for malting specification, with Westminster producing the highest (70.3 kg/hl). Capstan, Fleet, Keel, Yarra, and Fathom are feed varieties which did not meet the test weight specifications for the maximum grade.

Average screenings for the trial were 0.9%.The highest variety screenings were Oxford (2.6%) and Commander (1.3%). All malting varieties produced retention greater than the required 86%.

Table1: Grain yield (t/ha), protein (%), test weight (kg/hL), screenings and retention (%) of barley varieties at Hart in 2011.

Quality	Variety	Grain yield (t/ha)	% of Sloop SA	Protein (%)	% of Sloop SA	Test weight (kg/hL)	% of Sloop SA	Screenings (%)	% of Sloop SA	Retention (%)	% of Sloop SA
Feed	Capstan	3.27	108	11.4	104	64.6	95	1.4	203	86.0	91
	Fleet	3.55	117	11.6	106	62.1	91	0.4	62	96.3	102
	Fathom (WI4483)	3.43	113	10.3	95	63.8	94	0.5	80	95.9	102
	Grange	2.67	88	11.7	107	67.3	99	1.5	217	91.6	97
	Hindmarsh	3.66	121	10.3	95	66.3	97	0.9	136	93.9	99
	Keel	3.50	116	10.5	96	63.1	93	1.6	243	91.0	96
	Macquarie	2.97	98	11.3	103	69.6	102	0.7	106	92.4	98
	Maritime	2.77	91	10.8	99	65.1	96	0.4	56	98.4	104
	Oxford	2.75	91	10.9	100	69.1	101	2.6	385	88.6	94
	Scope (VBHT0805)	3.17	105	11.6	106	66.9	98	0.6	89	92.4	98
	Shepherd	2.70	89	12.2	112	67.2	99	0.6	89	96.3	102
	Yarra	3.27	108	11.0	100	63.5	93	0.6	89	93.9	99
Malt	Buloke	3.24	107	11.1	102	66.1	97	0.6	89	89.6	95
	Commander	3.39	112	10.2	94	66.3	97	1.3	193	93.6	99
	Flagship	3.12	103	11.4	104	69.0	101	0.6	89	92.0	97
	Gairdner	2.79	92	11.2	102	69.0	101	0.7	104	92.9	98
	Schooner	2.97	98	10.4	95	66.4	98	0.6	89	93.0	99
	SloopSA	**3.03**	**100**	**10.9**	**100**	**68.1**	**100**	**0.7**	**100**	**94.4**	**100**
	Westminster	2.47	82	12.0	110	70.3	103	0.9	133	92.4	98
Yet to be classified	Carl 1238	3.04	100	10.0	91	67.2	99	0.6	89	92.3	98
	Wimmera (VBO432)	2.93	97	11.2	102	68.5	101	0.6	89	92.6	98
	Bass (WARBAR2315)	3.12	103	11.9	109	67.3	99	0.4	59	98.4	104
	WARBAR2537	2.80	92	11.2	102	68.9	101	1.3	196	95.1	101
	Navigator (WI4262)	2.80	92	10.0	91	68.4	100	0.7	101	95.4	101
	Site mean	3.06	101	11.0	101	66.8	98	0.9	129	93.3	99
	LSD (0.05)	0.26	9	1.08	10	0.88	1.3	1.1	157	3.5	4

Comparison of durum varieties

Key findings

- The yield results in this trial did not reveal statistically significant differences, although Saintly was the highest yielding variety at 3.16 t/ha.
- WID803 produces significantly higher screenings, 3.8%.

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**	28:13 @ 90 kg/ha UAN @ 70 L/ha 29th July
Seeding date	28th May 2011		

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

Plot edge rows were removed prior to harvest.

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

Results
Saintly was the highest yielding durum variety at Hart in 2011 (3.16 t/ha) although all varieties in the trial produced statistically similar yields with an average of 2.93 t/ha (Table 1).

Across all durum varieties protein ranged from 11.4% (Saintly) to 12.2% (Tamaroi), and the average across all varieties was 11.9%.

Test weights for all durum varieties in 2010 were above 74.0 kg/hl. It is not apparent why the test weight results for this year's trial have averaged only 64.8 kg/hl.

Screenings ranged from 0.8% (Caparoi) to 3.8% (WID803) with a trial average of 2.1%. WID803 and Hyperno had significantly higher screenings levels compared to all other varieties. The spread of results in this trial is similar to the 2010 results in which WID803 and Hyperno respectively were also the two highest ranked for screenings.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) for durum varieties at Hart in 2011.

Variety	Grain yield (t/ha)	% of Tamaroi	Protein (%)	% of Tamaroi	Test weight (kg/hL)	% of Tamaroi	Screenings (%)	% of Tamaroi
Caparoi	2.85	104	11.8	97	67.1	103	0.8	52
Hyperno	2.83	103	12.1	99	64.1	99	3.0	185
Saintly	3.16	115	11.4	94	65.3	101	2.0	127
Tamaroi	**2.74**	**100**	**12.2**	**100**	**65.0**	**100**	**1.6**	**100**
Tjilkuri (WID801)	2.92	107	11.7	96	64.4	99	1.2	74
WID802	2.99	109	12.1	99	63.4	98	2.4	149
WID803	3.02	110	11.8	97	64.5	99	3.8	234
Site mean	2.93	107	11.9	97	64.8	100	2.1	132
LSD (0.05)	ns	ns	ns	ns	0.8	1.2	0.7	44

Comparison of triticale varieties

Key findings

- Chopper, Berkshire and Bogong were the highest yielding triticale varieties at Hart in 2011, averaging 3.5 t/ha.

Why do the trial?

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

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	28:13 @ 90 kg/ha UAN @ 70 L/ha, 29th July
Seeding date	28th May 2011		

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

Plot edge rows were removed prior to harvest.

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

Results

Chopper (3.60 t/ha), Bogong (3.54 t/ha) and Berkshire (3.49 t/ha) were the highest yielding triticale varieties at Hart in 2011 (Table 1).

Triticale protein ranged from 8.1% (Bogong) to 11.7% (Jaywick) and the average across all varieties was 10.5%. Hawkeye also produced a high level of protein (11.5%).

Berkshire and Bogong (75.9 kg/hL) produced the highest test weights in the trial with the average being 73.4 kg/hL.

Screenings ranged from 0.9% (Rufus & Chopper) to 1.5% (Jaywick) and averaged 1.2% in this trial.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) for triticale varieties at Hart in 2011.

Variety	Grain yield (t/ha)	% of Tahara	Protein (%)	% of Tahara	Test weight (kg/hL)	% of Tahara	Screenings (%)	% of Tahara
Berkshire	3.49	108	9.7	86	75.9	104	1.3	93
Bogong	3.54	109	8.1	73	75.5	104	1.3	93
Chopper	3.60	111	10.8	97	71.3	98	0.9	64
Hawkeye	3.18	98	11.5	103	74.3	102	1.2	86
Jaywick	3.03	94	11.7	104	71.9	99	1.5	107
Rufus	3.06	94	9.5	85	73.4	101	0.9	64
Tahara	**3.24**	**100**	**11.2**	**100**	**72.7**	**100**	**1.4**	100
Tickit	3.31	102	11.3	101	72.5	100	1.2	86
Site mean	3.31	102	10.5	94	73.4	101	1.2	87
LSD (0.05)	0.16	5	0.4	4	0.8	1	0.2	14

Comparison of oat varieties

Key findings

- The grain variety Echidna and numbered varieties WAOAT2354 and WAOAT2332 were the highest grain yielding oat varieties, averaging 3.53 t/ha.
- The average grain yield for hay varieties (2.27 t/ha) was significantly lower compared with the average yields for grain varieties (3.13 t/ha).

Why do the trial?

To compare the grain yield performance of new oat varieties and lines against the current industry standards.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	DAP Zn 2% @ 90 kg/ha UAN @ 70 L/ha, 29th July
Seeding date	30th May 2011		

The trial was a randomised complete block design with 3 replicates and 20 varieties.

Plot edge rows were removed prior to harvest.

Results

The grain variety Echidna (3.56 t/ha) and two numbered lines – WAOAT2332 (3.46 t/ha) and WAOAT2354 (3.58 t/ha) were the highest yielding oat varieties at Hart in 2011 (Table 1).

The average yield of hay varieties (2.27 t/ha) was predictably lower compared to average yield of grain varieties (3.13 t/ha).

Table 1. Grain yield (t/ha) for oat varieties at Hart in 2011.

Variety	Grain Yield (t/ha)	% of Wallaroo
03142-62	3.32	136
Brusher	2.21	90
Echidna	3.56	145
Euro	3.14	128
Kangaroo	2.26	92
Kojonup	3.01	123
Mitika	3.31	135
Mulgara	2.24	91
Possum	3.28	134
Potoroo	3.28	134
SV97181-1	3.37	138
SV97200-3	2.92	119
SV98146-2	3.07	125
Tammar	2.41	98
Tungoo	2.28	93
Wallaroo	**2.45**	**100**
WAOAT23	3.46	141
WAOAT235	3.58	146
Wintaroo	2.25	92
Yallara	3.04	124
Site mean	2.92	119
LSD (0.05)	0.16	7

Phosphorus rate trial and alternative fertilisers

Key findings

- A response to fertiliser after 5 years of no phosphorus applications.
- Alternative phosphorus sources such as biosolids, chicken litter or biochar, produced significantly lower yields compared to phosphorus fertiliser.
- Biosolids and chicken litter significantly increased leaf and grain zinc concentrations.

Why do the trial?
To investigate the impact of conventional phosphorus fertilisers and alternative sources of phosphorus on the grain yield and quality of wheat.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	Urea @ 35 kg/ha at sowing Phosphorus applied as per treatment
Seeding date	20th June 2011	**Variety**	Wyalkatchem wheat @ 80 kg/ha

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

Treatments were re-sown over the same treatments from 2007, 2008, 2009 and 2010.

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

A single application of biosolids and chicken litter were broadcast prior to sowing in 2008.

No further fertiliser has been added to these treatments. The biosolids + 65 kg/ha single super, and chicken litter + 65 kg/ha single super treatments had a repeated application of 65 kg/ha single super in 2009, 2010 and 2011. In season foliar phosphorus treatments were added in 2010 and 2011.

Treatments were re-sown over the same treatments areas each year since 2008.

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

A seed and foliar combination phosphorus treatment plus either 5 or 10 kg of granular phosphorus were added treatments for 2011. All other previously applied treatments of biochar or phosphorus solubiliser were repeated in 2011.
Treatments were sown into standing barley stubble from the 2010 trial.

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

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

Assessments were also conducted in 2011 for dry matter yield, leaf and grain nutrient concentrations.

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

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

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

Results

In the long term phosphorus experiment (Trial 1) the grain yield ranged between 2.5 t/ha (nil phosphorus) to 3.0 t/ha (15 kg P/ha). All applications of phosphorus were higher yielding compared to nil phosphorus. This is statistically significant at the 95% level.

After 5 years of receiving no phosphorus this is the first significant response to the addition of phosphorus, increasing further with fertiliser rate.

Protein levels whilst not significantly different, did decline with increases in grain yield in this treatment.

Table 2. Trial 1.Grain yield (t/ha), protein (%), test weight (kg/hL), retention (%) and screenings (%) at Hart in 2011.

Treatment	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
Nil	2.5	11.8	76.4	1.1
5kg/ha P	2.7	11.5	78.4	0.8
10kg/ha P	2.9	11.3	78.2	1.1
15kg/ha P	3.0	11.2	78.0	0.8
LSD (0.05)	0.3	ns	ns	ns

In trial 2 the addition of 6 or 10 kg P/ha for the past 4 seasons also significantly increased grain yield compared with no phosphorus. The biosolid or chicken litter treatments alone were lower yielding as were the foliar treatments. There are significant differences between grain protein levels but this would appear to be more as a relationship to yield rather than in response to phosphorus treatments.

There were no significant differences in grain test weight or screenings which are attributable to treatments.

Table 3. Trial 2. Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) at Hart in 2011.

Treatment	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
Nil	2.2	12.4	80.3	0.4
5t/ha Biosolids	2.5	12.2	79.5	0.6
5t/ha Biosolids + 6kg/ha P	2.7	11.5	79.1	0.8
3t/ha Chicken litter	2.3	12.4	79.3	0.4
3t/ha Chicken litter + 6kg/ha P	2.7	11.9	80.0	0.5
10kg/ha	2.9	11.7	79.7	0.5
Foliar 1	2.5	11.6	79.7	0.5
Foliar 2	2.6	11.7	79.7	0.5
LSD (0.05)	0.2	0.2	ns	0.2

In trial 3 grain yields ranged between 2.0 t/ha and 2.6 t/ha, with no significant difference in grain quality between the treatments. All treatments receiving 5 or 10 kg P/ha for the past 3 seasons were significantly higher yielding (2.4 t/ha) compared to no phosphorus fertiliser (2.1 t/ha). The addition of biochar, phosphorus solubilisers or foliar phosphorus applications did not increase grain yield.

Table 4. Trial 3. Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) at Hart in 2011.

Treatment	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
Nil	2.0	12.9	77.2	0.7
5kg/ha P	2.4	11.9	78.0	0.8
10kg/ha P	2.5	11.9	77.5	0.7
500kg/ha Biochar	2.0	11.8	78.1	0.8
500kg/ha Biochar + 5kg/ha P	2.3	11.7	78.0	0.6
500kg/ha Biochar + 10kg/ha P	2.5	11.7	78.7	0.7
500kg/ha Biochar + Liquid P	2.4	12.3	78.2	0.6
P solubiliser	2.2	12.0	76.0	1.0
P solubiliser + 5kg/ha P	2.2	12.0	78.1	0.9
P solubiliser + 10kg/ha P	2.5	11.8	77.7	0.8
Seed + foliar + 5 kg P	2.3	12.1	77.7	0.8
Seed + foliar + 10 kg P	2.6	12.0	78.3	0.8
LSD (0.05)	0.2	0.8	ns	ns

Dry matter production (Table 5) was significantly higher in treatments with the highest rates of phosphorus applied over the years of the trial, producing up to 6.24 t/ha (15 kg P/ha).

Phosphorus applications of 10 or 15 kg/ha over the past 4 to 5 years produced significantly higher concentrations of phosphorus, sulphur and potassium in the youngest leaves, compared to no phosphorus or organic amendments (Table 5). Those treatments also increased the potassium content of the grain.

However, zinc nutrient concentrations in both the leaves and grain were significantly higher for the biosolid and chicken litter treatments in 2011 (Table 6). This can be traced to the zinc concentrations present in the 2008 applications (see Table 1). No zinc supplements have been included in any other treatments in these phosphorus trials.

Table 5. Dry matter (t/ha), and leaf nutrient concentrations (ppm) for long term phosphorus treatments at Hart in 2011.

Treatment		Dry Matter t/ha	Leaf nutrient concentration (ppm) Zinc	Potassium	Phosphorus	Sulphur
Nil	Trial 1	4.17	21.6	3.11	0.24	0.32
5 kg P		4.89	19.9	3.10	0.25	0.33
10 kg P		6.01	17.8	3.09	0.26	0.36
15 kg P		6.24	17.4	3.16	0.28	0.35
Biosolids 5t/ha	Trial 2	4.91	23.3	3.03	0.24	0.33
Chicken litter 3 t/ha		4.93	21.9	3.00	0.23	0.33
Nil		3.73	20.1	2.99	0.23	0.32
10 kg P		4.99	18.1	3.24	0.25	0.36
Foliar		5.02	19.0	3.12	0.23	0.32
LSD (0.05)		1.2	1.7	0.13	0.02	0.02

Table 6. Grain nutrient concentrations (ppm) at Hart in 2011.

Treatment		Grain nutrient concentration (ppm) Zinc	Potassium	Phosphorus	Sulphur
Nil	Trial 1	22.3	3733	2533	1623
5 kg P		18.7	3767	2600	1610
10 kg P		16.5	3933	2700	1613
15 kg P		14.7	4000	2700	1553
Biosolids 5t/ha	Trial 2	25.3	3667	2500	1630
Chicken litter 3 t/ha		25.2	3700	2533	1670
Nil		21.7	3567	2500	1627
10 kg P		16.6	3733	2433	1597
Foliar		19.5	3533	2433	1620
LSD (0.05)		1.9	182.1	ns	ns

Soil phosphorus measurements in Autumn 2011 showed that 10 kg P/ha applied since 2007 had maintained soil phosphorus levels. Soil phosphorus level has significantly declined with the addition of 0 or 5 kg P/ha/yr, while 15 kg P/ha has increased soil phosphorus levels.

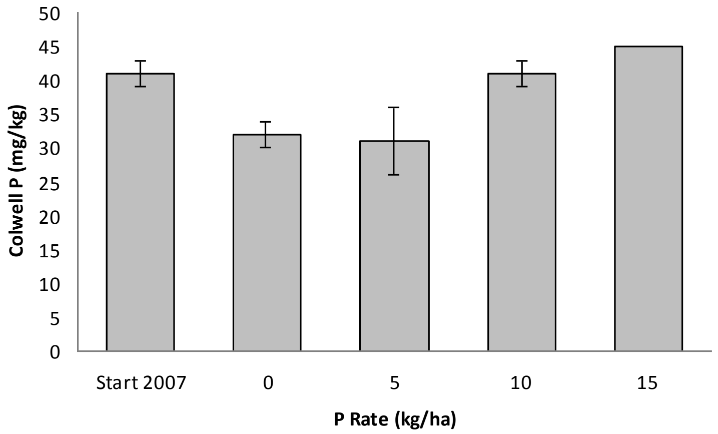

Figure 1. Soil Colwell phosphorus (0-10cm) levels measured in the Autumn of 2007 and then in 2011 for phosphorus rates between 0 and 15 kg/ha/yr at the Hart field site.

Durum agronomy – varietal response to nitrogen

An SA Durum Grower's Association initiative, funded by GRDC
Compiled by Kenton Porker and Rob Wheeler, SARDI

Key findings

- Varieties responded similarly in yield and many quality measurements to applied nitrogen, but showed large differences in grain screenings.
- Large amounts of early applied nitrogen predisposed WID803 with inherent small grain to quality downgrading due to high screenings, varieties with inherent larger grain (Tjilkuri and Caparoi) were not downgraded across N treatments.
- The strategic approach to nitrogen management was a more effective method to maintain grain size and achieve 13% protein rather than applying all nitroen at stem elongation.

Why do the trial?
Over the last few years, it has been difficult to achieve the required 13% protein for DR1 in new durum varieties due to their higher yield potential, suggesting they require more nitrogen (N). However, when higher nitrogen rates and earlier applications of N are used it can often lead to increases in grain screening levels. This trial has examined appropriate management combinations of variety, nitrogen rate and timing, to achieve 13% protein and to minimise downgrading due to excessive screenings.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	28:13 + 2% Zn IBS @ 100 kg/ha
Seeding date	27th May 2011		

Trial was a randomised complete block design consisting of 3 replicates, 4 durum varieties and 7 nitrogen treatments.

4 varieties - Caparoi, Tjilkuri, WID803 (breeder line), Hyperno.

7 nitrogen treatments (applied as urea) – Nil, 40kgN, 80KgN, 120kgN, 180kgN (all at GS31), Strategy 1 (60kgN@GS31 + 40kgN@GS59), and Strategy 2 (60kgN@GS31 + 80kgN@GS59).

Results
Varieties responded similarly in grain yield to nitrogen treatments. Averaged across the trial WID803, Tjilkuri, and Caparoi all yielded similarly, while Hyperno was lower at 2.5t/ha (Table 1). The nitrogen treatments also had no significant effect on grain yield (Table 2).

Table 1. Grain yield, grain weight, protein, and test weight averaged across all nitrogen treatments for durum variety at Hart 2011.

Variety	Grain Yield (t/ha)	1000 Grain weight (mg)	Protein (%)	Test Weight (kg/hL)
Caparoi	2.7	38.8	13.8	83.0
Hyperno	2.5	32.3	14.3	78.7
Tjilkuri	2.7	34.5	13.8	79.0
WID 803	2.8	28.0	13.9	78.0
LSD (0.05)	0.12	0.94	0.28	0.62

Varieties responded similarly to applied N for grain weight, protein, and test weight. However, these grain quality measurements were affected by differences within varieties (Table 1) and the additive effect of nitrogen treatments (Table 2).

Table 2. Grain yield, grain weight, protein, and test weight averaged across all varieties for nitrogen treatment at Hart, 2011.

Nitrogen Treatment	Grain Yield (t/ha)	1000 Grain weight (mg)	Protein (%)	Test Weight (kg/hL)
Nil N	2.7	36.8	10.5	82.0
40kgN@GS31	2.7	34.0	13.2	80.3
80kgN@GS31	2.7	32.7	14.2	79.4
120kgN@GS31	2.6	32.1	15.0	78.5
160kgN@GS31	2.6	31.5	15.7	78.2
Strategy 1 (60kgN@GS31 + 40@GS59)	2.7	33.5	14.3	79.4
Strategy 2 (60kgN@GS31 + 80kgN@GS59)	2.7	33.3	14.7	79.7
LSD (0.05)	NS	1.0	0.38	0.84

Caparoi had superior grain and test weights and Hyperno the highest protein (Table 1).

The effect of increasing N rate at GS31 was detrimental to grain size and test weight in all varieties. The highest N application rate reduced grain weight by 5.3mg, and test weight by 3.8kg relative to nil N. However, there were no significant differences in grain size between the strategic and the lowest N treatments despite the application of 60 and 100 more units of N, suggesting the later timing of N was not so detrimental to grain size.

Averaged across all varieties grain protein was 10.5% when no nitrogen was applied and increased to 13.2% with 40kgN applied and on average, increased 0.83% with every extra 40kgN thereafter at GS31. Strategic 1 and 2 produced 14.3% and 14.7% protein respectively, only a 0.4% increase in protein with the extra 40kg.

In contrast to other quality measurements, varieties responded differently to applied nitrogen for grain screenings (Figure 1). Caparoi screenings remained unchanged across all N treatments averaging 0.6% while, Tjilkuri and Hyperno remained relatively stable but incurred a small increase of 1% at the highest N rate relative to no applied N, reaching 2.3 and 4.6% respectively.

WID803 produced 3.5% screenings in the nil N treatment but increased by 1% with every extra 40kg of N, to reach 9.8% in the highest N treatment (160kgN).

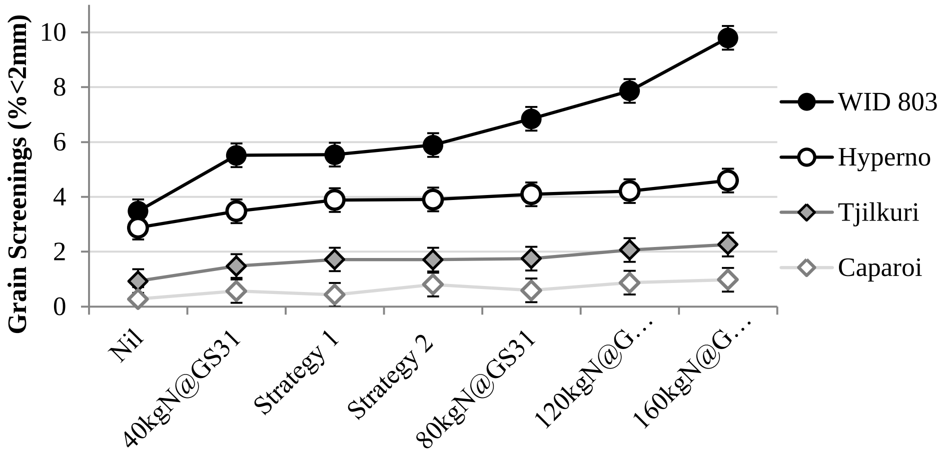

Figure 1. Durum varietal interactions with nitrogen treatments on grain screening levels (% < 2mm sieve) at Hart, 2011

The two strategic treatments which applied 100kg and 140kg of N respectively, split between two timings, had no effect on screenings (compared to no applied N) in Caparoi, Tjilkuri, and Hyperno but raised screenings in WID803 (5.5% & 5.9%). However, when compared with the other N treatments that applied similar amounts of N but all at GS31 (ie 80kg, and 120kg) in WID803, the strategic approach resulted in lower screening levels.

Summary

In terms of grain yield, the trial site was unresponsive to applied N.

On similar sites, previous experiments have shown that under optimal growing conditions, varieties are not likely to differ in their yield and quality response to N. However, dry conditions during September and high temperatures during grain fill at Hart in 2011 were conducive to higher than expected proteins and grain screening levels. Whilst not yield responsive, additional N was still required in order to achieve 13% protein, all varieties required an extra 40 kgN to reach the target protein (13%). However this extra N predisposed WID803 which has inherently smaller grain, to quality downgrading due to high screenings. There is a significant relationship between screenings and protein, highlighting the difficulty in increasing protein whilst maintaining grain size in small grained varieties such as WID803.

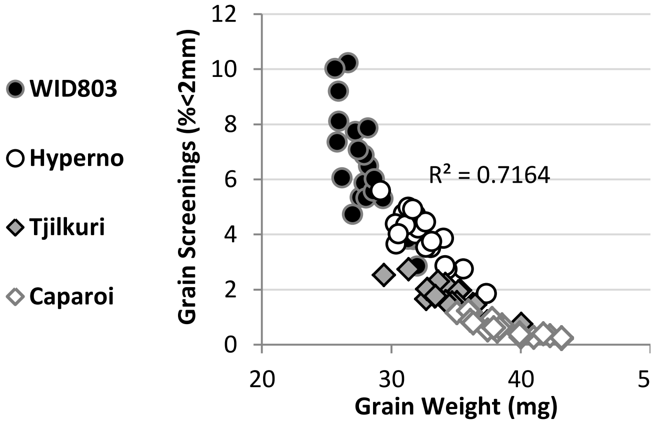

Figure 2 Relationship between grain weight and screenings in new durum varieties at Hart, 2011

The influence of variety was still very significant, as varieties with inherently smaller grain size such as WID803 and Hyperno were still more prone to excessive small grains at any nitrogen treatment. This research showed that grain shape rather than grain weight is more correlated with grain screenings levels. Tjilkuri and Hyperno are similar in grain weight but under similar conditions Tjilkuri has consistently less screenings than Hyperno (Figure 3) ie. Tjilkuri has a longer and thinner grain shape compared with Hyperno.

Due to the strong link between N supply and available soil moisture on grain size and protein, varieties with inherently larger grain size such as Tjilkuri and Caparoi are less likely to be downgraded for grain screenings in unfavourable finishing conditions. Large amounts of early N should be avoided on small grained varieties like WID803 to avoid possible quality downgrading in paddocks high in background N and in less favourable environments. From these results it can be concluded that variety choice and the strategic application of N (ie. withholding N until later in the season and using split applications) are the most effective methods to increase the chance of achieving Durum 1 grade in environments that typically can experience harsh finishing conditions.

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

Hart Spring Walk 2011

Barley agronomy – nitrogen management in new barley varieties

Southern Barley Agronomy Project, funded by GRDC
Compiled by Kenton Porker, and Rob Wheeler, SARDI

Key findings

- Higher grain yields were achieved in all varieties from early sowing in 2011.
- Buloke and Commander were not yield responsive to nitrogen despite early biomass responses at both sowing dates.
- Hindmarsh was more responsive to nitrogen than Buloke and Commander, showing an average 0.6 t/ha response to nitrogen across both sowing dates.
- Grain protein exceeded 12% with delayed sowing, while the strategic approach to applied N achieved protein levels less than 12% at earlier sowing in Buloke and Commander.

Why do the trial?
New higher yielding malt varieties Buloke and Commander have been downgraded more frequently for low protein than other varieties in recent years. In order to increase the frequency in which they achieve malt they may require a different approach to nitrogen management. This trial therefore aims to examine the appropriate management combinations of sowing date, nitrogen rate and timing required to maximise yield and quality in new malt varieties and food variety Hindmarsh.

How was it done?
Plot size: 1.4m x 10m
Seeding dates: 20th May (early), 14th June (late)

Fertiliser: single super @ 100kg/ha

The trial was a randomised complete block design consisting of 3 replicates, 2 sowing dates, 3 barley varieties and 6 nitrogen (N) treatments:
2 sow dates – early 20th May, late 14th June
3 varieties – Buloke (malt), Commander (malt) and Hindmarsh (food grade)
6 nitrogen treatments (applied as urea), 100% = 80kgN/ha

1. No applied N (nil)
2. 100% IBS
3. 50% IBS, 50 % GS30
4. 100 % GS30
5. 50%GS30 + 50% GS37

6. Strategic N – NDVI determined rates	Early sowing (20th May)	• Buloke & Commander - 40kgN@GS30 & 20 kgN@GS37 • Hindmarsh - 40kgN@GS30 & 40kgN@GS37
	Later sowing (14th June)	• Buloke & Commander - 40kgN @GS30 • Hindmarsh - 75kg N@ GS30

The 100% N IBS treatment was used in each variety as an N-rich reference treatment for the GreenSeeker NDVI crop sensor. This was used to determine the in season response to N and hence provide an estimate of the likely final yield response to N. Using these references points a N rate recommendation was calculated for the strategic treatment using the following Oklahoma State University methodology:

1. Estimate of yield potential (ie. Yield Prophet)
2. Estimating the Responsiveness to Applied N -
    a. In season response index (RI) = NDVI N-rich/NDVI unfertilised paddock
    b. estimation of yield with applied N = RI x Yield with no N applied
3. N rate to be applied = [Grain N content of fertilised crop – Grain N content of unfertilised crop] / Nitrogen use efficiency (ie. 40% in Australia).

Results

Sowing Date x Variety interactions (Table 1):
When sown on the 20th May, Hindmarsh was highest yielding at 3.8 t/ha while Buloke and Commander yielded similarly at 3.3 and 3.2 t/ha respectively. At later sowing (14th June), the variety rankings were unchanged, but Buloke suffered the greatest yield penalty (0.5 t/ha) and Commander the least (0.3 t/ha).

Relative to 20th May sowing, 14th June sowing increased protein in all varieties to be above the 12% maximum for malting, an increase in Buloke of 1%, 0.8% in Commander, and 0.5% in Hindmarsh.

In the other quality measurements Commander was the only variety unaffected by sowing date. Hindmarsh and Buloke each had slightly higher screenings, lower retentions and lower test weights at early sowing, but not significant enough to change final receival grade.

Table 3. The effect of variety and sowing date on grain yield, protein, screenings, retention, and test weight at Hart, 2011.

Measurement	**Sow date**	**Variety**			**LSD (5%)**
		Buloke	***Commander***	***Hindmarsh***	
Grain Yield (t/ha)	Early	3.2	3.3	3.8	0.24
	Late	2.6	3.0	3.1	
Protein (%)	Early	11.7	11.4	11.5	0.39
	Late	12.7	12.2	12	
Screenings (%<2.2mm)	Early	1.1	0.6	1.1	0.40
	Late	0.8	0.9	0.5	
Retention (%>2.5mm)	Early	77.2	93.4	85.7	3.61
	Late	81.6	92	90	
Test weight (kg/hL)	Early	68.4	69.3	68.7	0.46
	Late	69.5	69	69.5	

Nitrogen x Variety interactions:
For Commander and Buloke there was no significant yield response to N within any treatment, while Hindmarsh was responsive to N in all treatments apart from the later split application of N at GS30 and 37 (Figure 1). All other treatments on average improved yield by approx 0.6t/ha in Hindmarsh. When there was no applied N, Commander and Hindmarsh yielded similarly and likewise Commander and Buloke yielded similarly with the later applications of N. Varieties responded similarly to applied N for all grain quality parameters measured (Table 2).

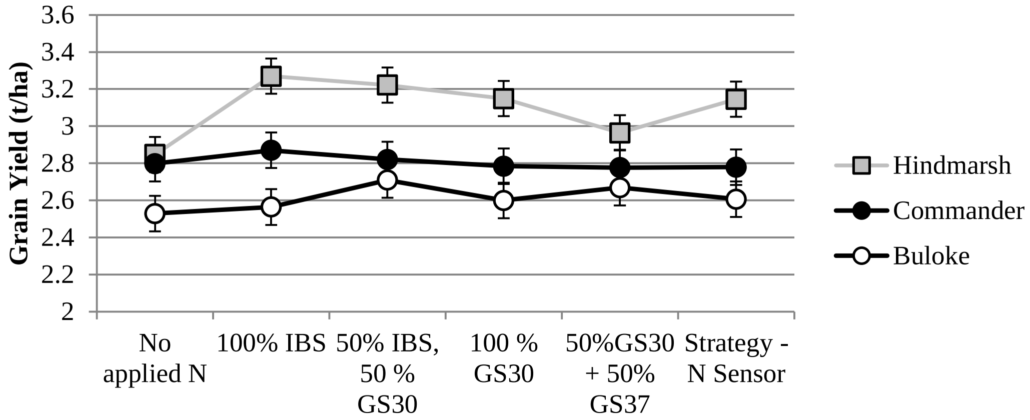

Figure 2. The effect of variety, applied nitrogen rate, and time of sowing on grain yield at Hart, 2011.

Time of Sowing x Nitrogen interactions:

Across all varieties, grain yield responses to nitrogen were similar at each sowing date, concluding that variety had a greater effect on N response than sowing date (Figure 1). Grain protein was the only quality parameter affected by the combination of sowing date and N treatment (table 2). Protein was lower with earlier sowing in all N treatments apart from treatment 3 which exhibited similar protein levels between both sow dates. N was required in order to achieve proteins greater than 9% at early sowing with the GS30 timings increasing protein by the greatest amount. Across both sowing dates other quality parameters were affected by the combined affects of variety (Table 1) and N treatments (Table 2).

Table 4. The effect of sowing date and applied N treatment on grain protein, screenings, retention, and test weight of barley at Hart, 2011

N treatment	Protein (%)		Screenings (%<2.2mm)	Retention (%>2.5mm)	Test Weight (kg/hL)
	Earlier sown	***Later sown***			
1. No applied N	8.8	10.3	0.5	92.8	69.4
2. 100% IBS	11.7	12.6	1.1	83.2	68.5
3. 50% IBS, 50 % GS30	12.1	12.2	0.9	82.0	69.2
4. 100 % GS30	12.5	12.9	1.0	85.5	69.3
5. 50%GS30 + 50% GS37	11.9	12.7	0.7	88.4	69.2
6. Strategic - N sensor	11.9	13.0	0.7	88.0	68.9
LSD (5%)	*0.3*		*0.3*	*3.9*	*0.6*

Summary

At the Hart site time of sowing of barley was important for maximising yield and quality in 2011. Rainfall from mid August to late September was below average leaving crops reliant on stored moisture; this favoured earlier sowing in all varieties. Early biomass responses to N observed in Commander and Buloke, did not translate to yield responses (Figure 2), and led to higher than expected protein levels. To maximise grain yield, sowing date was more important than N management in new malt varieties Buloke and Commander while the combination of sowing date and N management was important in the early maturing food variety Hindmarsh as it was more responsive to N than both Buloke and Commander.

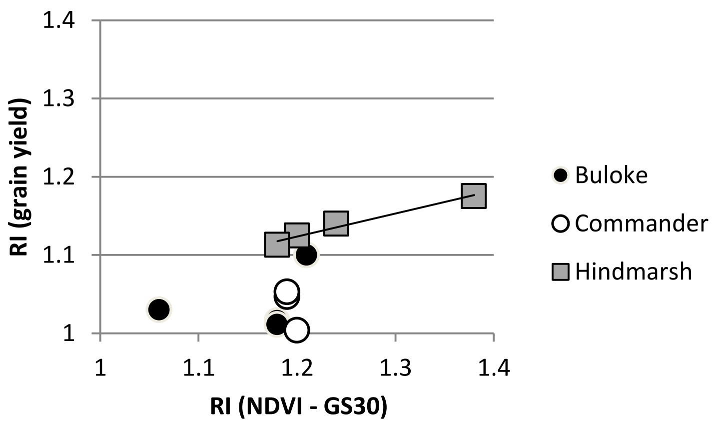

Figure 3. Relationship between the in season response index (NDVI) and final grain yield response index averaged across both sowing dates at Hart, 2011.

In previous wet spring seasons such as 2010 it was difficult to achieve protein levels above the 9% required for malting quality in Buloke and Commander. In such seasons delaying nitrogen with strategic applications (matching growth response to season conditions) across all sowing dates was an effective method to improve protein. Delayed sowing can increase protein; however this strategy is risky as it can result in lower yields by exposing crops to later season moisture stress and higher protein as shown in this trial. Equally, earlier sowing can lead to lower protein level in good years such as 2010.

However at earlier sowing dates there is more opportunity to manipulate the crop canopy with N management to improve protein. Although protein levels were high in 2011, early sowing along with a strategic approach to N still achieved the required protein for malt 1 in Buloke and Commander.

Earlier sowing coupled with a strategic approach to N management may provide the best long term management strategy to consistently achieve max yield and quality requirements in Buloke and Commander. Consistent with other N trials these results imply Hindmarsh is more responsive to N and may require more N than Buloke and Commander at earlier growth stages to fulfil its N requirement in order to maximise yield. Whilst the current demonstrated NDVI method for determining N rates shows promise, work will continue to develop a more reliable tool to determine N rates in barley.

Acknowledgements

Thanks to GRDC for funding this research, SARDI Clare staff for trial management and the Hart field site group for provision of the land and extension of the work.

Salt tolerance in barley

Ehsan Tavakkoli and Glenn McDonald, The University of Adelaide

Key findings

- The absence of sodium and chloride significantly contributed to salt tolerance and grain yield production in barley varieties examined in this trial.

Introduction

Broadacre cropping in Australia is based on rain fed systems in a semiarid environment, where the efficient uptake and use of water is the main driver of productivity. However, more than 60% of the 20 million ha of cropping soils in Australia are sodic. Saline subsoils adversely affect the ability of crops to use subsoil water and this imposes a significant constraint on productivity.

The aim of this work was to examine differences in salt tolerance between barley varieties.

Materials and Methods

Field study

Plot size	1.4 x 10m	**Fertilizer**	DAP @ 60 kg/ha + 2% Zn Urea @ 50 kg/ha 10th August
Seeding date	12th May 2009		

A field trial was conducted to assess the genotypic variation among 13 barley varieties in response to salinity stress at Hart.

At Zadoks growth stages (ZGS) 45 (booting), 65 (50% anthesis) and 92 (grain ripe), five randomly-selected plants from each plot were sampled. The plants were washed and separated into the upper and lower leaves of the main stem for dry weight measurements, ionic analysis, leaf osmotic potential and organic solutes.

At ZGS65, ten soil cores were randomly taken from a soil depth of 0–100 cm. Electrical conductivity (EC_e), pH, soluble sodium, calcium and magnesium were determined in a saturated paste extract.

Results

There was a wide range in plant grain yield and sodium and chloride concentrations among the 13 varieties. Grain yield ranged from 3.3 t/ha in Maritime to 5.5 t/ha in Capstan. Significant varietal variation occurred in sodium and chloride concentrations as well as osmotic potential of the flag leaf blade (Figure 2). Sodium concentrations varied widely, ranging from 345 to 556 mmol kg^{-1} dry matter. Also, chloride concentration varied about 1.5-fold ranging from 415 to 670 mmol kg^{-1} dry matter. Leaf sodium and chloride concentrations and osmotic potential were lower for the higher yielding varieties.

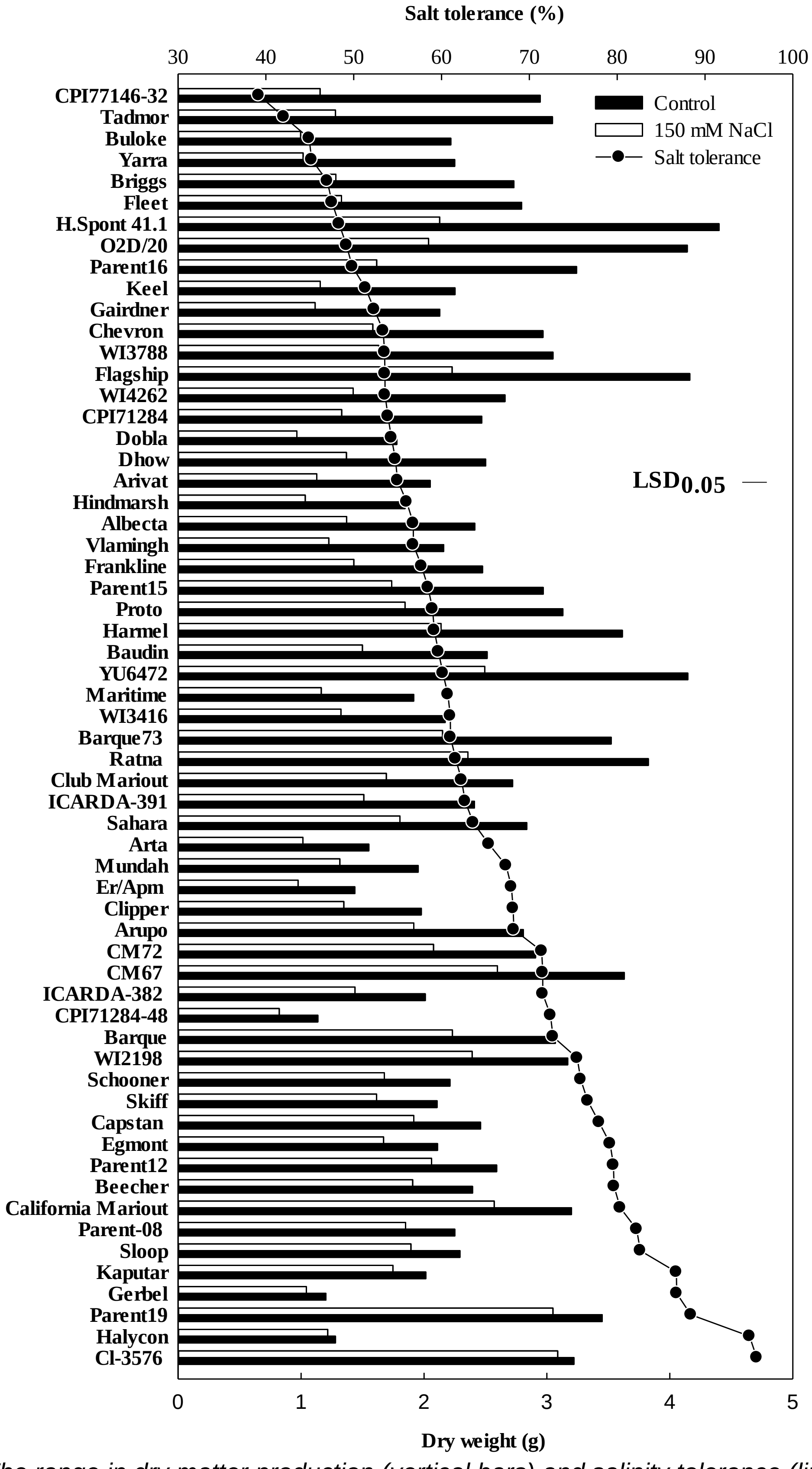

Figure 1. The range in dry matter production (vertical bars) and salinity tolerance (line-scatter plot) of 60 genotypes of barley grown in supported hydroponic system for 7 weeks. The salt tolerance was calculated as the ratio of dry matter production under 150 mM NaCl treatment (white bars) to control condition (black bars). The coefficient of variation of experiment was 4.15%. Values are means (n=4).

Differences in dry matter production and salinity tolerance have been shown to occur between different barley varieties as illustrated in Figure 1. Whilst the results shown are for 60 varieties grown under hydroponic conditions, they do nonetheless illustrate the range of differences which potentially exist between the 13 varieties included in the Hart trial.

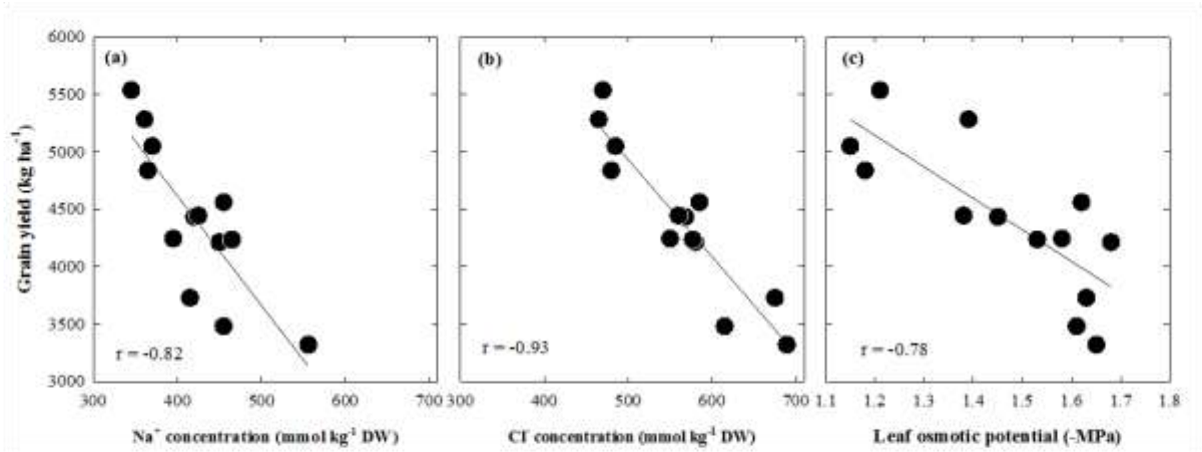

Figure 2. The relationship between grain yield and leaf concentration of (a) Sodium (Na^+) concentration, (mmol kg^{-1} DW); (b) Chloride (Cl^-) concentration, (mmol kg^{-1} DW); and (c) leaf osmotic potential (-MPa) of 13 barley genotypes grown at Hart site in 2009. The results are from youngest emerged leaves at ZGS 65. Fitted curves are derived from linear regression. The horizontal and vertical bars are LSD at 95% for the ion explanatory and dependent variable respectively. Values are averages (n=4).

Acknowledgements
This work was supported by a grant from the Grains Research and Development Corporation and by the University of Adelaide.

Maximising grain yield of field peas

Funded by the GRDC and conducted as part of the Southern Pulse Agronomy program.
Mick Lines, Jenny Davidson & Larn McMurray, SARDI

Key findings

- Average grain yield was higher at Hart in 2011 (2.9t/ha) compared to 2010 (2.5t/ha) and 2009 (2.4t/ha).
- Similarly to previous favourable seasons, no sowing time response was observed in 2011.
- Blackspot severity was low in 2011 because spore release was high prior to sowing and emergence.
- A 4% yield increase was achieved through fungicide applications but this was not economical in 2011.
- Recently released PBA varieties Gunyah, Twilight, Oura and Percy all performed similarly to Kaspa.
- Potential releases OZP0819 and OZP0903 both yielded 8% higher than Kaspa, while Alma was the lowest yielding variety, 7% below Kaspa.

Why do the trials?

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

How was it done?

Plot size	1.5m x 10m	**Fertiliser rate**	MAP @ 75kg/ha with seed
Sowing date	TOS 1: 20th May 2011	**Inoculant**	-
	TOS 2: 14th June 2011	**Row Spacing**	22.5 cm
Varieties (seed rate)	Alma & PBA Percy (45 pl./m^2) Kaspa, PBA Gunyah, PBA Twilight, PBA Oura, OZP0819 & OZP0903 (55 pl./m^2)		
Fungicide Tmts	Nil Mancozeb (2kg/ha) @ 9 node + early flower		
Trial design	Split plot with 3 reps, blocked by rep then sowing date.		

Results

Foliar disease

The severity of blackspot in 2011 was a lower than in previous years. This was due to the early release of spores from pea stubble, facilitated by high summer rainfall, so that most spores were dispersed prior to field pea emergence. The blackspot infection levels were rated at the end of August as the number of nodes girdled with disease. There was significantly more disease in the first time of sowing (average of 5.6 diseased nodes) compared to the second time of sowing (average of 0.2 diseased nodes). There were also significant differences between varieties (Table 1) with most blackspot recorded in Alma and least recorded in PBA Gunyah, PBA Percy and OZP0903.

There was no significant interaction for blackspot severity between varieties and time of sowing. Scores showed no significant difference in disease severity between fungicide treated and untreated plots, however a small yield response was noted, as outlined below.

Table 1: Blackspot severity of field pea cultivars (averaged across fungicide treatments and sowing dates), rated August 27th, and grain yield at Hart, 2011.

Variety	Blackspot (# nodes infected)	Grain yield (t/ha)
Alma	3.6 c	2.57 a
Kaspa	3.1 bc	2.76 b
PBA Gunyah	2.5 a	2.91 bc
PBA Twilight	3.1 bc	2.89 bc
PBA Oura	2.7 ab	2.9 bc
PBA Percy	2.6 ab	2.91 bc
OZP0819	2.8 ab	2.98 c
OZP0903	2.5 ab	2.99 c
LSD (P<0.05)	0.5	0.18

Grain yield

Grain yield of field peas averaged 2.9t/ha at Hart in 2011, slightly higher than in the previous favourable seasons of 2009 (2.4t/ha) and 2010 (2.5t/ha). Grain yield showed no response to sowing time in 2011 due to generally low blackspot severity (less than 6 infected nodes does not generally cause yield loss) and a favourable season finish, so that neither sowing date was favoured.

All varieties performed similarly to the site mean except Alma, which was the lowest performing variety (Table 1) at 7% lower than Kaspa. Recent releases PBA Gunyah, PBA Twilight, PBA Oura and PBA Percy all performed similarly to Kaspa, while potential releases OZP0819 (erect, white pea) and OZP0903 (high yield potential) yielded 8% greater than Kaspa. At present prices of ~$270/tonne this represents a gross increase of ~$60/ha. OZP0903 was also the highest yielding line in the 2010 trial, although OZP0819 was not included.

A grain yield response of 0.12t/ha was observed from the application of fungicides. Neither interactions of fungicide with sowing date or variety were significant, meaning that the treatment response was similar at both sowing dates and across all varieties.

Treatment with Mancozeb (2kg/ha) at 9 node and early flower resulted in a 4% increase in yield across all varieties (Table 2). This corresponded to an average 120kg/ha increase in yield, or $33/ha, which means this practice was not economic in 2011 as it has been in previous years under higher disease pressures.

Treatment	Yield (t/ha)
Nil	2.80 a
Fungicide	2.92 b
LSD (P<0.05)	0.09

Table 2: Grain yield of field peas untreated or treated with fungicide, Hart 2011.

Blackspot Manager Model validation

Field pea stubble infested with blackspot was collected from the Hart Field Day site after the harvest of the 2010 field pea fungicide by variety trial from cv. Kaspa. The stubble was placed into nylon mesh pouches and placed on the ground at Hart in early January 2011. Pouches were sampled fortnightly beginning 14th January until 29th June and sent to DAFWA Pulse Pathology Lab at Northam WA for ascospore counts of the blackspot fungus, *Didymella pinodes*. Ascospores were observed in the first pouch sampled in January; this early release was due to significant rainfall events in summer that allowed pseudothecia to mature. Ascospore numbers peaked earlier than in other years, on 9th March and were last observed on 27th May (Figure 1). This data has been used to validate Blackspot Manager in South Australia. Model predictions of ascospore release for blackspot in 10 regions of South Australia were made available on the DAFWA website prior to sowing.

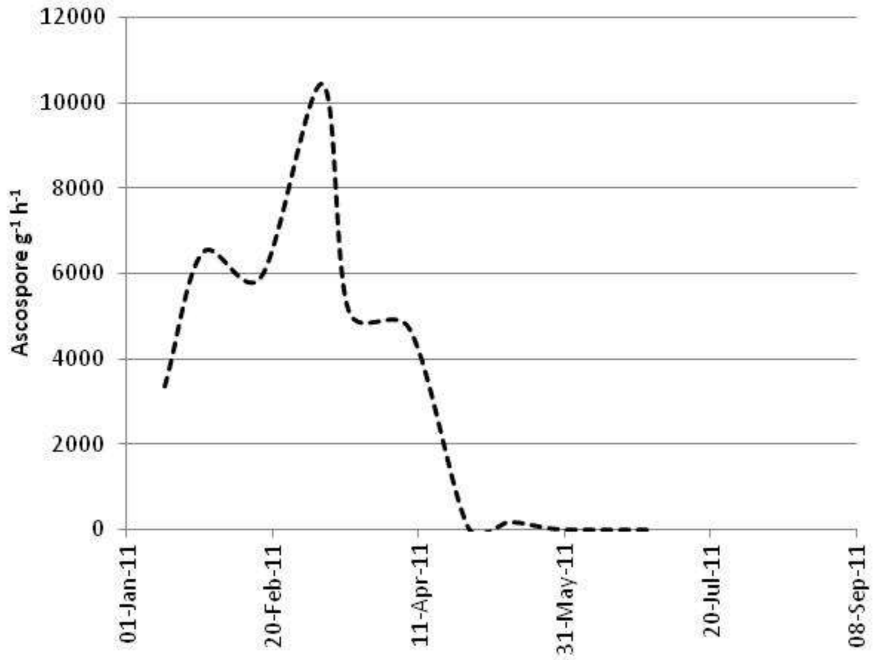

Figure 1. Blackspot spores trapped from pea stubble per fortnight from Hart incubation in 2011

Summary

Despite only average growing season rainfall, yields in 2011 (average 2.9t/ha) were improved by stored soil moisture from summer rainfall, low disease levels and generally favourable growing conditions, and performed significantly higher than the wetter seasons of 2009 (2.4t/ha) and 2010 (2.5t/ha) where growing season rainfall was higher but disease was more prevalent. These favourable growing conditions are also likely responsible for the lack of sowing date response in 2011.

The earlier flowering and maturing recent PBA releases, Gunyah, Twilight, Oura and Percy, all performed similarly to Kaspa, demonstrating their flexibility in a season which generally favoured later maturing varieties. Over the recent run of favourable seasons these varieties have generally performed slightly lower than Kaspa, however long term data (2005-2011) shows similar or slightly higher yield, and regional benefits generally associated with lower rainfall areas and in years when delayed sowing is required.

The bacterial blight tolerant 2011 releases PBA Oura and PBA Percy are available for 2012 sowings. PBA Oura has a semi-leafless plant type similar to Kaspa, while PBA Percy has a conventional plant type and is susceptible to lodging similar to Parafield, but neither possesses the round seed shape or pod shatter resistance traits like Kaspa, PBA Gunyah or PBA Twilight. PBA Percy has a higher bacterial resistance rating and shows less yield loss from this disease than PBA Oura and Parafield (7% compared to 12% and 15%, respectively). However PBA Oura is the highest yielding variety with improved tolerance to this disease in all districts of the state, and long term yields show a 5-11% yield advantage over Kaspa in the Mid North, South East and Murray Mallee regions, with similar yields to Kaspa elsewhere.

The potential releases OZP0819 and OZP0903 were the highest yielding lines in the trial last year. OZP0903 was also the highest yielding line in the 2010 trial, while OZP0819 was not included. These lines show a lot of promise as new varieties for their high yield potential and also their agronomic and disease resistance profiles.

Fungicides for control of blackspot in field peas are generally not economic unless the blackspot risk is severe. If field peas are sown according to recommendations of Blackspot Manager, i.e. after 50% of spores have been released, then the disease is unlikely to reach severe levels. If the peas are sown before the peak spore release e.g. the spores are released in late May or June and peas are sown mid May, then foliar fungicides are warranted for disease control. Trials in previous years have shown that potential yield needs to be at least 2.0 t/ha for foliar fungicides to be economic in field peas even when blackspot is severe. Whilst yields were high in 2011, blackspot severity was generally low, and application of fungicides was not economic in 2011.

Blackspot Manager has been successful at predicting blackspot spore releases over the last couple of seasons, and predictions for 2012 will be available from late March on the website www.agric.wa.gov.au/cropdiseases. Preliminary observations suggest that blackspot risk will be higher and spores will be released later this year as a result of lower summer rainfall.

Acknowledgements

GRDC for kindly funding this research.

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

Peter Hooper for collecting blackspot infected stubble and posting pouches to DAFWA throughout the season.

Lentil agronomy

Key findings

- Lentil and field pea yields were similar at Hart in 2011 and averaged 2t/ha.
- Sowing date and site location significantly affected variety yield performance with early sowing favouring higher yields at the 'poorer' site.
- The late September rain was critical for the yield of later flowering varieties at the late sowing date and the western site but was of limited benefit to the early maturing PBA Blitz.
- PBA Jumbo was the highest yielding lentil variety when sown early and PBA Blitz and Nipper were generally the lowest yielding varieties in 2011 at Hart.

Why do the trials?

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

How was it done?

Plot size	1.5m x 10m	**Fertiliser rate**	MAP 2%Zn @ 90kg/ha
Sowing date	TOS 1: 20th May 2011 TOS 2: 14th June 2011	**Inoculant** **Row Spacing**	- 22.5 cm (9")

Varieties (plant density)	PBA Gunyah (OZP0602) @ 55 plants/sq m & PBA Blitz (CIPAL610), PBA Flash (CIPAL411), PBA Jumbo, Nipper, Nugget all @ 120 plants/sq m
Sites	West – shallow, hard setting and more hostile East – well structured, deeper and more friable
Trial design	Split plot with 3 reps; blocked by site, then rep, then sowing date.
Fungicides	All plots were treated with Carbendazim @ 500 mL/ha at canopy closure

Results

Both sowing date and site location influenced lentil variety yield performance at Hart in 2011. Lentil grain yields ranged from 2.6 t/ha produced by PBA Jumbo sown in May at the eastern site to 1.37 t/ha produced by Nipper sown in June at the western site (Table 1). Grain yields of the field pea check variety PBA Gunyah were similar at both sowing dates at the eastern site (2.4-2.5 t/ha) and dropped away to 1.4 t/ha with the June sowing at the western site.

All varieties incurred a yield loss at the western site when sowing date was delayed. However, only PBA Jumbo and Nipper incurred a yield loss with a delay in sowing at the eastern site. Generally grain yields were lower at the western site than those achieved at the corresponding sowing date at the eastern site. Further to this grain yields of PBA Blitz, Nugget and the field pea PBA Gunyah were lower when sown in May at the western site than those achieved when sown in June at the eastern site. All other varieties achieved similar yields between the June sowing date at the eastern site and the May sowing date at the western site.

At the eastern site the field pea PBA Gunyah was the highest yielding variety when sown in June and along with PBA Jumbo the highest yielding variety sown in May. PBA Blitz was the lowest yielding variety at the May sowing date and along with Nipper the lowest sown in June. PBA Flash, PBA Jumbo and Nugget were the highest yielding lentil varieties at the June sowing date at this site.
At the lower yielding western site PBA Jumbo and the field pea were again the highest yielding varieties and PBA Blitz the lowest when sown in May. At the June sowing all lentil varieties except for the low yielding Nipper had similar yields with PBA Jumbo achieving higher grain yields than the field pea.

Table 1: Grain yield (t/ha) for lentil and pea varieties in the lentil agronomy trial at Hart in 2011.

Variety	Grain yield (t/ha) Eastern Site Sown		Western Site Sown		Variety mean
	20th May	14th June	20th May	14th June	
PBA Blitz	1.89	1.98	1.72	1.53	1.78
PBA Flash	2.29	2.15	2.01	1.57	2.00
PBA Gunyah	2.43	2.54	2.04	1.40	2.10
PBA Jumbo	2.60	2.17	2.23	1.73	2.18
Nipper	2.22	1.89	1.93	1.37	1.85
Nugget	2.37	2.21	1.97	1.60	2.04
Site mean	2.23		1.76		
TOS mean	2.14 (20th May)		1.84 (14th June)		
Site*TOS mean	2.30	2.16	1.98	1.53	
LSD (0.05)					
Site			0.15		
TOS			0.09		
Variety			0.10		
Site*TOS			0.16		
Site*Variety			0.18		
TOS*Variety			0.15		
Site*TOS*Variety			0.23		

Summary

Overall lentil and pea grain yields averaged 1.99 t/ha across all sites and treatments and performed similarly at Hart in 2011. There was no significant level of foliar disease observed and the major yield limiting factor was the timing of the late rain event in September. The increased grain yield achieved at the eastern site, which is characterised by improved soil structure at depth and lower in salt levels than the western site, highlights the importance of paddock selection to maximise pulse yields in these regions.

Sowing date had a large impact at the western site whereby yields were reduced for all varieties as sowing date was delayed from 20th May until 14th June. However, it was of lesser value at the more favourable eastern site. At the eastern site only PBA Jumbo and Nipper, both shorter in plant height with good ascochyta blight disease resistance, responded favourably to the later sowing date.

The significant rain event in late September after a 6 week dry period was critical for lentil yields in 2011. In particular it was of significant benefit to the late flowering and mid to late maturing varieties of PBA Jumbo, Nugget and Nipper at the June sowing date as they had not commenced flowering at this stage (Table 2). Conversely this late rain event was of limited use to PBA Blitz in 2011 due to its early flowering and maturing pattern. PBA Jumbo was the highest yielding lentil variety when sown early at both sites however was only similar yielding to other varieties as sowing date was delayed including PBA Blitz at the western site. The late flowering and shorter plant height variety Nipper also had low relative yields at the later sowing date. Despite its lower relative performance at Hart in 2011 PBA Blitz is an early maturing, disease resistant lentil with a medium to large seed that has a key role in maximising yields in short season areas and in dry years. It is also the lentil variety most suited to the agronomic practice of crop topping.

Table 2: Start of flowering dates for lentil and pea varieties in the lentil agronomy trial at Hart in 2011

Variety	Start of flowering dates			
	Eastern Site Sown		Western Site Sown	
	20th May	14th June	20th May	14th June
PBA Blitz	24-Aug	11-Sep	26-Aug	11-Sep
PBA Flash	31-Aug	16-Sep	30-Aug	25-Sep
PBA Gunyah	19-Aug	7-Sep	20-Aug	7-Sep
PBA Jumbo	2-Sep	18-Sep	1-Sep	25-Sep
Nipper	16-Sep	25-Sep	11-Sep	26-Sep
Nugget	5-Sep	20-Sep	5-Sep	25-Sep

Phosphorus rate trial

Barley agronomy

Barley agronomy

Barley agronomy

Durum agronomy

Durum agronomy

Controlling wild oats

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

Key findings

- One year of full wild oat control reduced the wild oat seedbank to 8 seeds per square metre in 2010.
- A selective post emergent herbicide or an early hay cut were the most effective strategies for reducing the wild oat seedbank.

Why do the trial?

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

This trial aims to evaluate the effect of long term management strategies on the wild oat seedbank and measure the efficacy of various control techniques. Specifically, the trial will demonstrate the value of single year and back-to-back years of seed set control, pre-emergent and post emergent herbicides, hay cutting and chaff cart for driving down the wild oat seed bank.

Herbicide resistance and wild oats – Peter Boutsalis, Plant Science Consulting

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

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

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

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

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

How was it done?

This trial was established in a grower paddock, north of Clare (White Hut) on an existing patch of wild oats in 2009. The majority of wild oat seed was within 2cm of soil depth, some being on the soil surface, and the oats are 100% susceptible to group A post emergent selective herbicides. The trial was established as a randomised complete block design with 3 replicates.

In 2009, the trial was sown to Catalina wheat and in 2010 Commander barley, and wild oat control treatments were applied to the same plots each year. The herbicides treatments were applied IBS (incorporated by sowing) prior to sowing with a commercial seeder (i.e. knife-point & press wheels).

Treatments:

1) nil
2) Trifluralin 1.5L/ha (incorporated by sowing - IBS)
3) Trifluralin 1.5L/ha and Avadex Xtra 2.0L/ha (IBS)
4) Trifluralin 1.5L/ha and Avadex Xtra 2.0L/ha (IBS) + Axial 200ml/ha (GS39)
5) Trifluralin 1.5L/ha (IBS) + early hay cut
6) Trifluralin 1.5L/ha (IBS) + chaff cart
7) Trifluralin 1.5L/ha (IBS – 2009 and 2010) + Axial 200ml/ha (GS39 2009 only)
8) Trifluralin 1.5L/ha (IBS – 2009 and 2010) + Axial 200ml/ha (GS39 2009 and 2010)

Wild oats were counted 4 to 6 weeks after sowing using a 20 cm × 30 cm quadrat from 4 random locations within each plot.

The initial seedbank at the site in 2009 was 400 wild oat seed per square metre to 10cm of soil depth and 150 plants per square metre emerged in the nil treatments after sowing.

The hay cut was performed at the beginning of the hay cutting season, and the chaff cart was simulated by removing wild oat heads at the beginning of harvest as determined by district practice in both cases.

Results

Clear differences in the wild oat seedbank have been shown for the different management strategies applied in 2009 and 2010 (Figure 1). With no control the wild oat seed density increased from 400 seeds per square metre in 2009 to 8092 seeds per square metre in 2011, a 20 fold increase. Similar increases in the wild oat seedbank were measured for trifluralin applied alone or when mixed with Avadex Xtra, which provided limited wild oat control.

When Axial was included as a late selective post emergent application the seedbank declined to less than 64% of the original 2009 level (400 seeds per square metre). This treatment may not be as effective on wild oats with resistance to group A herbicides.

One year of full wild oat control reduced the wild oat seedbank to 8 seeds per square metre in 2010. While the trial average was only 8 seeds per square metre, 19 wild oat plants per square metre was counted 4 weeks after sowing and without control meant the seedbank increased significantly in 2011. 2 years of full control has reduced the seedbank down to about 500 seeds per square metre, which is unexplainably higher than the initial seedbank of 400 seeds per square metre.

Of the cultural control practices the early hay cut was an effective strategy for reducing the wild oat seedbank. The cut done early and did not include raking or super conditioning, which might increase wild oat seed shed. The simulated chaff cart treatment was applied early in the harvesting window, but had limited success as many of the wild oats had already dropped seed by the time of harvest.

The success of these control treatments might also be influenced by the competitiveness of the crop, soil type, growing season rainfall and finish to the season. So, in seasons with a mild finish or later districts it is likely that more wild oat seed will be set.

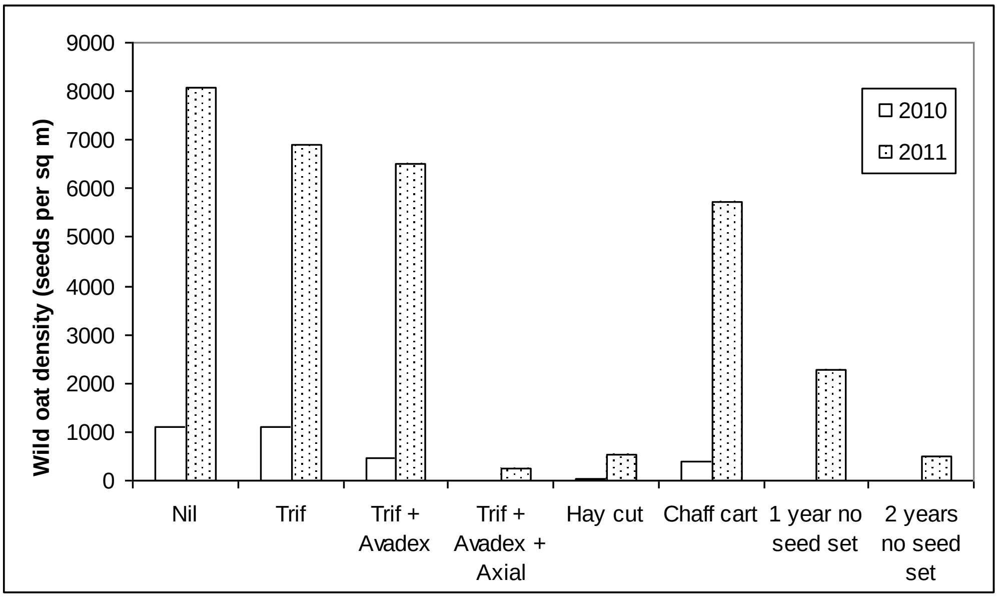

Figure 1. The effect of different management strategies on pre-sowing (March) wild oat seed density at Clare in 2010 and 2011.

Acknowledgments

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

Control of annual ryegrass with pre-emergence herbicides

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University of Adelaide, School of Agriculture, Food & Wine, Waite Campus
Peter Hooper, Hart Field-Site Group

Key findings

- Boxer Gold alone or in combination with trifluralin and / or Avadex Xtra provided consistent pre-emergence control of ryegrass, as did trifluralin & Avadex Xtra.
- Although ryegrass control with new pre-emergent herbicide Sakura was lower than in previous years, its tank mixture with Avadex Xtra provided excellent control (86%).
- Boxer Gold & Dual Gold applied PSPE appeared to provide some additional in-row control of ryegrass.

Why do the trial?

Given the importance placed on trifluralin for controlling annual ryegrass under current farming practices & growing incidence of ryegrass resistant to this Group D herbicide, there is an urgent need to identify alternate pre-emergent herbicide options. Consequently trials have been undertaken over several seasons (2003 to present) at the Hart field site to evaluate the efficacy & crop safety of alternate pre-emergent herbicides & their mixtures for the control of ryegrass in wheat.

How was it done?

Plot size	1.4 m × 10 m	**Fertiliser**	DAP Zn @ 90 kg/ha
Seeding date	30th May 2011	**Variety**	Guardian wheat

The trial was established as a randomised complete block design with 3 replicates and 13 herbicide treatments (Table 2). Active ingredients of the herbicides used in the trial are listed in Table 1.

To ensure uniform ryegrass establishment across the trial site ryegrass seed was broadcast at 25 kg/ha ahead of seeding and tickled in with a shallow pass with the seeder prior to herbicide application. The ryegrass was from commercial paddocks with approximately 30% resistance to trifluralin.

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 and incorporated by sowing (IBS) the post-sowing pre-emergence (PSPE) herbicides were applied within a few days of sowing.

Table 1: Pre-emergent herbicides & their active ingredients

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

Table 2: Pre-emergent herbicides, rates & timings

Treatments	
1	Nil (untreated control)
2	Trifluralin 480 1.5 L/ha (IBS)
3	Avadex Xtra 3.0 L/ha (IBS)
4	Sakura 118 g/ha (IBS)
5	Outlook 1.0 L/ha (IBS)
6	Boxer Gold 2.5 L/ha (IBS)
7	Syngenta Exp (IBS)
8	Trifluralin 480 1.5 L/ha + Avadex Xtra 2.0 L/ha (IBS)
9	Avadex Xtra 2.0 L/ha + Boxer Gold 2.5 L/ha(IBS)
10	Avadex Xtra 2.0 L/ha + Sakura 118 g/ha (IBS)
11	Trifluralin 480 1.5 L/ha + Avadex Xtra 2.0 L/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)
12	Trifluralin 480 1.5 L/ha + Avadex Xtra 2.0 L/ha (IBS) + Boxer Gold 1.5 L/ha (PSPE)
13	Boxer Gold 2.0 L/ha (IBS) + Boxer Gold 1.5 L/ha (PSPE)

Results

All the herbicide treatments had good crop safety under the knife point press wheel system, however Outlook an experimental herbicide developed by Nufarm will not be released for use in wheat because of concerns of crop damage.

All herbicide treatments reduced ryegrass emergence with overall control ranging from 59% (Sakura) to 90% (trifluralin 1.5 L/ha, IBS + Avadex Xtra 2.0 L/ha, IBS + Boxer Gold 1.5 L/ha PSPE), respectively (Table 3). Although Sakura provided lower levels of ryegrass control this year, its overall performance over the past five years (2006 to 2010) has been excellent (Figure 1), particularly when applied as a tank mixture with Avadex Xtra.

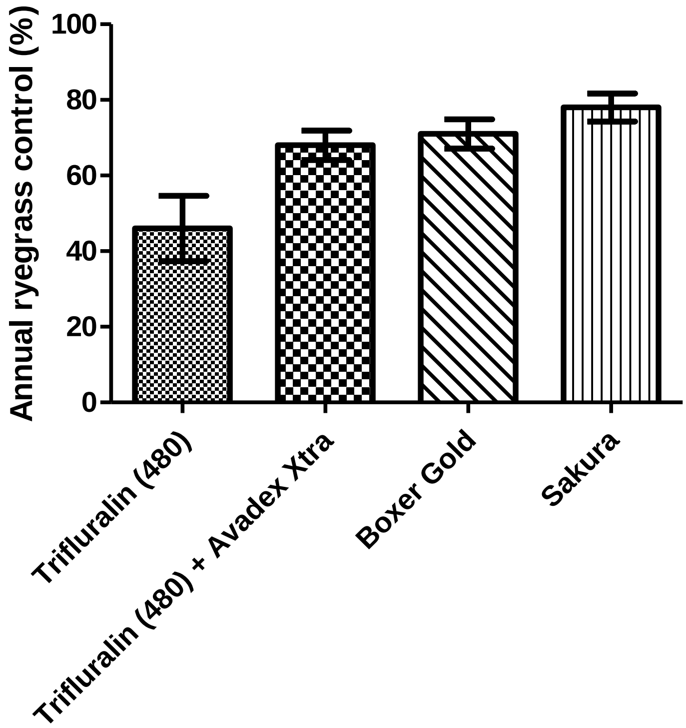

Figure 1: Annual ryegrass % control for pre-emergent herbicide treatments at Hart in the years from 2006 to 2010. Nb: Trifluralin (480) was applied at either 1.4 or 1.5 L/ha & Avadex Xtra at 1.5 L/ha from 2006 to 2009 & 2.0 L/ha in 2010. Bars represent standard error (SE) of mean.

In the 2011 Hart trial, treatments giving better than 80% overall control of ryegrass were:

- Trifluralin (480) 1.5 L/ha + Avadex Xtra 2.0 L/ha (IBS)
- Avadex Xtra 2.0 L/ha + Boxer Gold 2.5 L/ha (IBS)
- Avadex Xtra 2.0 L/ha + Sakura 118 g/ha (IBS)
- Trifluralin (480) 1.5 L/ha + Avadex Xtra 2.0 L/ha (IBS) + Dual Gold 0.5 L/ha (PSPE)
- Trifluralin (480) 1.5 L/ha + Avadex Xtra 2.0 L/ha (IBS) + Boxer Gold 1.5 L/ha (PSPE)
- Boxer Gold 2.0 L/ha (IBS) + Boxer Gold 1.5 L/ha (PSPE).

Not surprisingly trifluralin (480) alone provided only 65% overall control of ryegrass, which is to be expected given the ryegrass sown was 30% resistant to the herbicide. Furthermore, trifluralin & Avadex Xtra alone provided only 53% to 57% control of ryegrass in the crop row. Ryegrass control in the crop row was always poorer (67%) than in between rows (83%) where herbicide is concentrated from soil thrown from the crop row zone at sowing.

However, all PSPE treatments (averaging 82% control) were significantly better compared to IBS treatments alone (averaging 60% control) at controlling ryegrass in the crop row. This is consistent with the results from last season which also showed there was some benefit to in-row ryegrass control from split herbicide applications. Of the IBS treatments, mixtures of Avadex Xtra with either Boxer Gold or Sakura provided the highest levels of in-row ryegrass control (75 to 79%).

Final ryegrass head numbers were significantly lower (less than 50 heads/sq m) for treatments combining two herbicides at sowing (not including trifluralin) or for those including a post sowing pre emergence treatment. (Table 3).

The final grain yield of wheat decreased proportionally with increase in ryegrass density as is to be expected (Table 3).

In summary, the trial has again shown there are a number of effective pre-emergent herbicide options available for the effective control of Group D resistant ryegrass. PSPE herbicide options improved ryegrass control in the crop row. However, these present a higher risk to crop safety, depending on soil type & rainfall after application. Furthermore, although both Boxer Gold & Sakura (to be released next year) provide alternative modes of action to trifluralin, they should be used in conjunction with robust management strategies that use a diverse rotation of crops, herbicides and non-chemical strategies (eg. chaff carts) so as to prolong the life of existing and new chemical groups against ryegrass.

Acknowledgements
This trial was funded by GRDC & conducted in collaboration with Birchip Cropping Group, The University of Adelaide & the Hart Field-Site Group.

Table 3: Pre-emergent herbicide treatments, ryegrass plant density (plants/sq m) & % control at Hart in 2011. Density values are expressed as the number of ryegrass plants in a square m in the crop row (In-row) or between the crop rows (Between rows). Values in brackets are % control relative to unsprayed NIL.

Herbicide treatments	July In-row		July Between rows		July Average		August Average		September Ryegrass heads/sq m	Grain yield (t/ha)
	Annual ryegrass plants/sq m & (% control)									
1 NIL	208		492		350		531		364	1.89
2 Tri 480 1.5 L/ha (IBS)	97	53	128	74	113	68	183	65	231	2.19
3 Ava 3.0 L/ha (IBS)	125	40	106	79	115	67	183	65	114	2.44
4 Sak 118 g/ha (IBS)	156	25	250	49	203	42	218	59	160	2.28
5 Out 1.0 L/ha (IBS)	83	60	100	80	92	74	171	68	80	2.36
6 BG 2.5 L/ha (IBS)	97	53	64	87	81	77	143	73	66	2.43
7 Syn Exp (IBS)	94	55	92	81	93	73	121	77	148	2.25
8 Tri 480 1.5 L/ha + Ava 2.0 L/ha (IBS)	42	80	64	87	53	85	104	80	86	2.48
9 Ava 2.0 L/ha + BG 2.5 L/ha(IBS)	69	67	33	93	51	85	64	88	34	2.67
10 Ava 2.0 L/ha + Sak 118 g/ha (IBS)	67	68	50	90	58	83	74	86	50	2.68
11 Tri 480 1.5 L/ha + Ava 2.0 L/ha (IBS) + DG 0.5 L/ha (PSPE)	33	84	58	88	46	87	108	80	44	2.60
12 Tri 480 1.5 L/ha + Ava 2.0 L/ha (IBS) + BG 1.5 L/ha (PSPE)	28	87	19	96	24	93	51	90	24	2.79
13 BG 2.0 L/ha (IBS) + BG 1.5 L/ha (PSPE)	36	83	53	89	44	87	85	84	42	2.61
LSD (0.05)	54		68		47		59		63	0.28

Annual ryegrass assessment was performed on 1st of Jul & 12th of Aug, 5 & 11 weeks after sowing

Post sowing application of residual herbicides and annual ryegrass control

This trial is funded by the GRDC and is part of a collaborative project.

Key findings

- Compared to the pre-emergent ryegrass control trial, conducted alongside, the post emergent application results were very poor, below 60% control.
- Boxer Gold applied post sowing pre-emergence at either 1.5 or 2.5 L/ha produced the greatest in-row ryegrass control (78%).

Why do the trial?

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

Regardless of herbicide efficacy a common paddock observation is the lack of residual ryegrass control. In 2009 the ryegrass control trial clearly showed that pre-emergent herbicides applied after sowing and before emergence (PSPE) were the most effective for not only improving in-row ryegrass control, but also extending the control.

This trial also aims to investigate the potential efficacy of pre-emergent herbicides applied post sowing on ryegrass control. It aims to measure if the period of residual ryegrass control can be extended and also if in-row ryegrass control can be improved.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	DAP @ 90 kg/ha
Seeding date	30th May 2011	**Variety**	Guardian wheat @ 80 kg/ha

The trial was a randomised complete block design with 3 herbicides, 2 application timings, 2 herbicide rates and 3 replicates.

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

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

Herbicides rates applied:

- Boxer Gold @ 1.5 L/ha or 2.5 L/ha
- Sakura @ 80 g/ha or 118 g/ha
- Dual Gold @ 350 ml/ha or 500 ml/ha

Post-sow pre-emergent (PSPE) herbicides were applied on the 31st May, 1 day after sowing. The site received 12mm of rainfall 4 days after the PSPE applications.

Post emergent application treatments were applied on the 26th July, when the ryegrass growth stage was between 1.5 and 2.5 leaves. The site received 8mm of rainfall 4 days after the treatments were applied.

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

Results

Average ryegrass control ranged from 20% (Dual Gold, 500ml/ha, 2 leaf) to 60% (Sakura, 118 g/ha, PSPE) (Figure 1). Compared to the pre-emergent ryegrass control trial, conducted alongside, these results are very poor. In the pre-emergent trial trifluralin applied alone produced at least 60% ryegrass control.

Dual Gold at any rate or timing, or Sakura applied at the 2 leaf ryegrass stage produced significantly lower ryegrass control compared to Boxer Gold at any rate or timing. Boxer Gold applied PSPE or at the 2 leaf ryegrass stage and Sakura applied PSPE produced the best average ryegrass control, 56% (Figure 1).

Boxer Gold applied PSPE at either 1.5 or 2.5 L/ha produced the greatest in-row ryegrass control (78%).

All the herbicide treatments had good crop safety, no damage or reduction in crop emergence was recorded. This might be due to the low amount of rainfall following the herbicide applications in 2011.

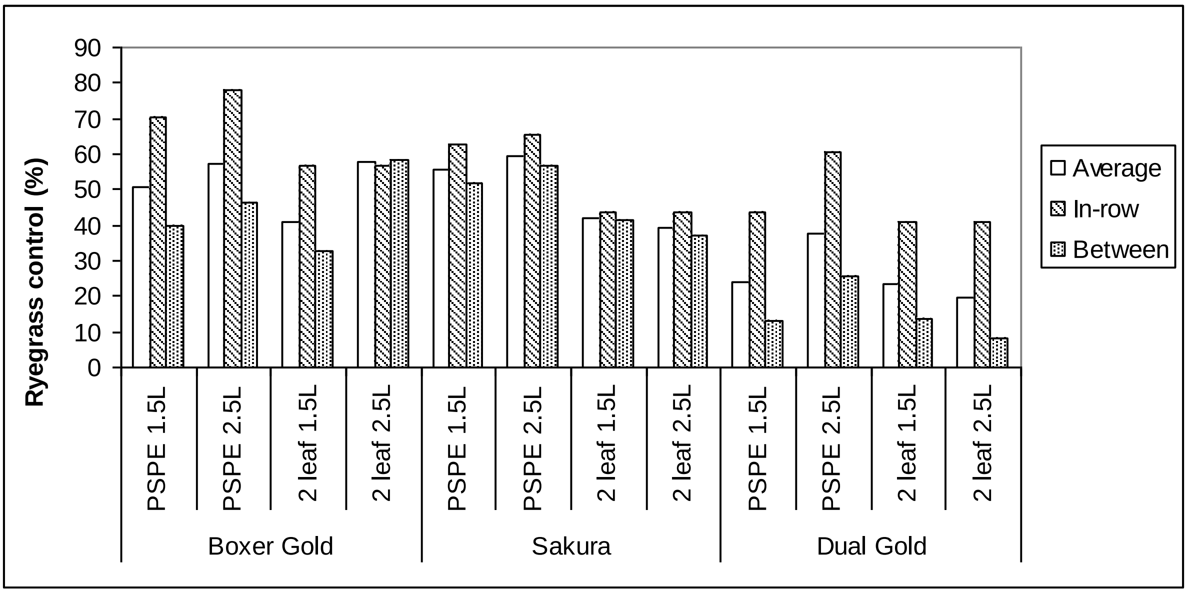

Figure 1. Effect of post emergent herbicide treatments applied post sowing pre emergence or at the 2 leaf growth stage on ryegrass (% control) at Hart in 2011.

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

Managing ryegrass populations

Key findings

- Attention to detail regardless of ryegrass control strategy, is important to ensure ryegrass seed set is minimised.
- Ryegrass numbers can be reduced from very high levels by implementing successive years of control, regardless of the tactics utilised.
- In favourable seasons low ryegrass plant numbers that are left uncontrolled have the ability to set prolific amounts of seed.

Why do the trial?
To evaluate integrated weed management strategies for the long-term control of annual ryegrass.

How was it done?
Ryegrass counts were carried out in the same locations of selected paddocks between 2006 and 2011. Multiple quadrant counts were taken along transects just before harvest each season. Each farmer used a range of control systems as part of an integrated weed management approach to managing ryegrass numbers.

10 paddocks were selected with patches of high ryegrass densities from growers using a range of ryegrass control strategies. While growers were selected based on their preferred strategies for controlling ryegrass, each grower used multiple options throughout the project. These included: export oaten hay, legume or oilseed break crops, short term pasture (1 yr), chaff catching, continuous cereal.

Results
The data collected throughout the project did not produce any new ryegrass control solutions or strategies. Rather, the results clearly reinforced existing principles developed and promoted in previous projects. More recent control options such as export oaten hay or chaff catching provided equivalent ryegrass control compared to older techniques.

Of the ryegrass control options monitored there was no strategy that clearly provided improved results compared to another. No system was able to consistently drive down ryegrass numbers (Figure 1).

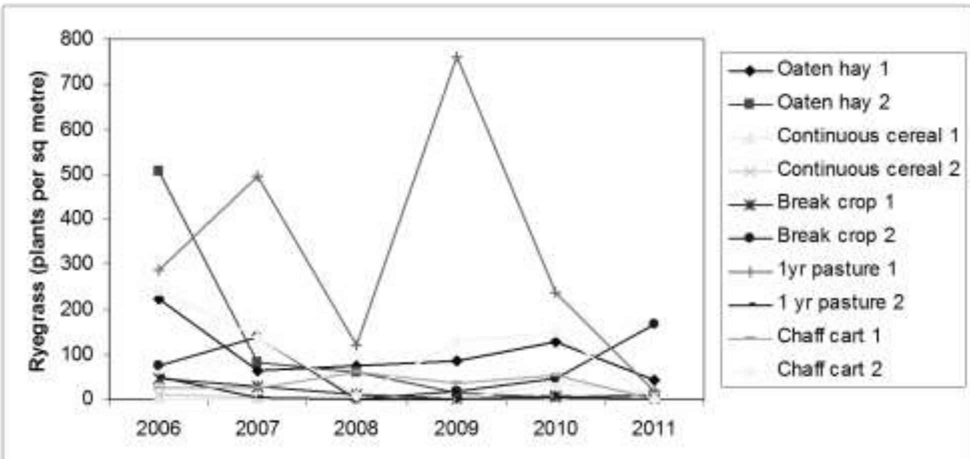

Figure 1. Ryegrass numbers for 5 control strategies and 10 paddocks in the Mid North from 2006 to 2011.

Low ryegrass numbers (ie less than 50 plants per square metre) are easier to maintain at manageable levels and might only require intermittent control. One year of ryegrass control (including seed set control) will significantly decrease the ryegrass seedbank

Once high numbers are reduced they are a lot easier to manage and keep at low levels. A one year break (control of ryegrass seed set) can have a big effect on plant numbers in the paddock the following season. In situations of high ryegrass numbers often 2 or 3 break crops might be required to satisfactorily reduce the ryegrass seed bank (Figure 2). A rough guide is that ryegrass plant numbers need to be below 50 plants per square metre to avoid another break crop.

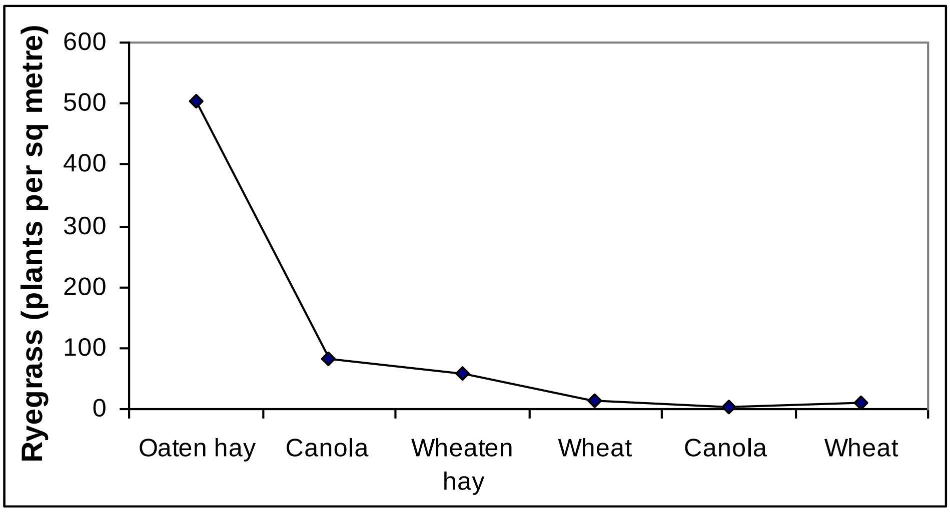

Figure 2. Ryegrass control using three consecutive break crops in the Mid North between 2006 and 2011.

Timeliness and attention to detail were important features of paddocks where ryegrass numbers were successfully reduced. This included strategies such like crop topping, which wasn't utilised in Figure 3, hence ryegrass number increased following the bean crops.

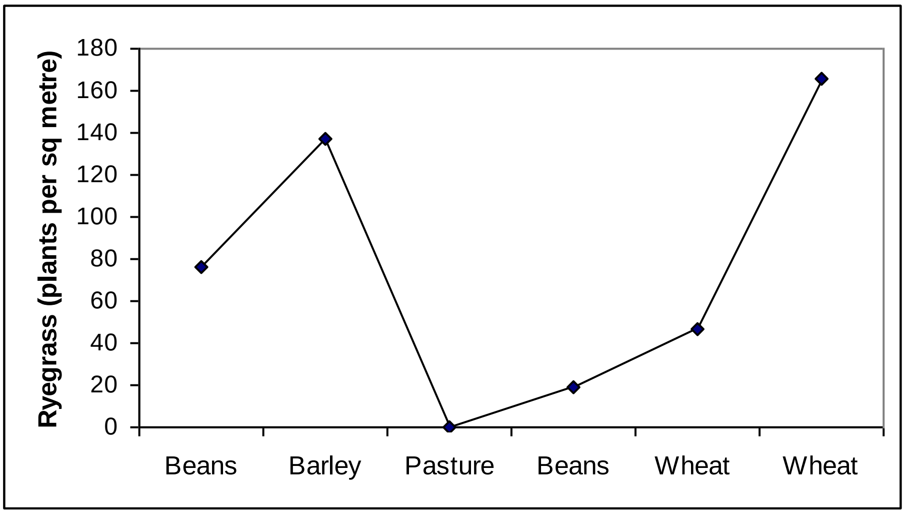

Figure 3. Ryegrass control using legume break crops in the Mid North between 2006 and 2011.

Ryegrass plant numbers can increase quickly (Figure 4). After two successive wheat crops a third cereal crop (barley) resulted in a 6 fold increase in ryegrass numbers. Timeliness when deciding to implement a control system is important. Implementing a control system after two successive wheat crops should have further reduced ryegrass plant numbers and avoided a blow-out in the following barley crop. A two year break of legume pasture followed by canola was then required to reduce ryegrass plant numbers in the paddock from 761 in 2009 to 17 in 2011 (2).

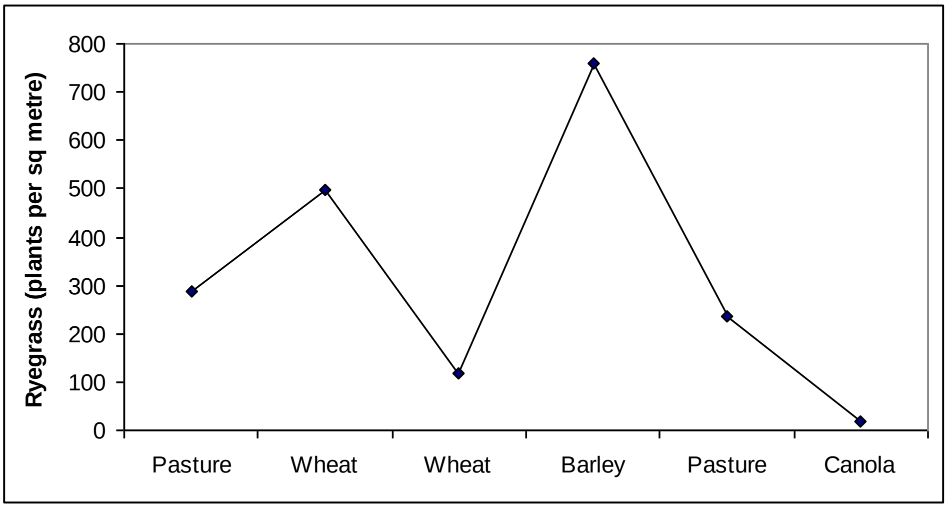

Figure 4. Changes in ryegrass plant numbers between 2006 and 2011 using 1 year pasture or canola break crops.

Seasonal conditions and the regional environment will have an impact on the success of ryegrass control techniques. Of the monitored paddocks the continuous cereal rotations were more likely to occur in lower rainfall areas.

Additional information relating to ryegrass control.

- Later districts and / or late season rainfall can influence the number and viability of ryegrass seed set.
- Attention to detail is still the key. Monitoring, follow up assessment of control system, late season seed set control of escapes if required.
- Three years complete control maybe required if very high plant numbers and to allow for exhaustion of seed bank.

Additional practices can also be implemented to improve control.

- Burning stubbles or windrows
- Crop topping cereals
- Crop topping pulses
- Spraying under canola windrows
- Competitive crops - early sowing, increased seeding rates

Legume and oilseed herbicide tolerance

Key findings

- Good soil moisture conditions allowed clear separation of relatively safe and more damaging treatments.
- Many results from 2010 were replicated in 2011.
- Spinnaker at all application timings and Raptor at 4 node appeared to be more damaging to beans than in previous years.

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	2m x 3m	**Fertiliser**	MAP @ 90 kg/ha + 2% Zinc
Seeding date	28th May 2011		

12 strips of canola, pasture, vetch, chickpea, faba bean, field pea and lentils were sown. 54 herbicide treatments were applied across these crops at 4 different timings.

The timings were

Post seeding pre-emergent (PSPE)	31st May
Early post emergent (4 node)	12th July
Post emergent (7 node)	26th July
Late post emergent (10 node)	19th August

Treatments were visually assessed and scored for herbicide effects 4-5 weeks after application.

Crop damage ratings were:

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

Results

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

Of the PSPE treatments Balance (registered only in Chickpeas) was the most effective, with results ranging from high levels of damage to beans, peas and Rasina vetch to complete control of all canola, pasture and lentils. No damage symptoms were present in the Genesis 090 Chickpeas.

With the exception of chickpeas and beans at the PSPE timing, metribuzin was damaging to all varieties to varying degrees at the PSPE and 4 node timings. It appeared to be particularly damaging at the early post emergent application timing, especially in lentils.

Spinnaker had moderate damage effects on beans when applied PSPE on its own at 70g/ha or when applied at 40g/ha with 850 g/ha simazine. Spinnaker and Raptor both produced high levels of damage when applied to beans at the 4 node stage.

The pre-emergent herbicides Boxer Gold and Sakura were applied early post emergent in 2011. Sakura produced slight effects on 2 of the 3 canola varieties. Whilst Boxer Gold applied at early post emergent timing had no effect on canola but had a slight effect on Capello vetch and Scimitar medic. Propyzamide (500g/kg) more commonly known as Kerb or Edge was included in the trial for the first time in 2011. It was applied at the early post emergent stage and no damage symptoms were scored in any of the canola or legume varieties. It should be pointed out that for these pre-emergent herbicides many are not currently registered for many of the varieties in the trial.

Clearfield canola as expected was not affected by Intervix. Intervix only had moderate damage levels on peas, Rasina vetch and Scimitar medic. This result reinforces label recommendations on Intervix to the addition of clopyralid (Lontrel) for improved control of legumes.

There was little differentiation between knockdown herbicides in 2011, with majority providing good levels of control on legumes and canola. Genesis 090 chickpeas and Rasina vetch were the most difficult varieties to get total control with knockdown herbicides. Sprayseed alone was only rated as moderate effect on vetch and lentils. The 50ml spike of Hammer (400g/L) added to glyphosate has resulted in reduced damage in Rasina vetch in the last two seasons results.

Wilpena (*Sulla hedysarum*) was included in the trial in 2010. Over the past two seasons it has shown similar tolerance to the post sowing pre-emergent treatments compared to the other pasture entries. Wilpena has also shown little damage to the early post emergent treatments of simazine and Broadstrike. It has also shown improved tolerance to metribuzin, but was affected more by Brodal Options or Sniper.

MCPA Sodium at 700 ml/ha produced a slight effect on peas in 2011.

Legume & Canola Herbicide Tolerance				Canola			Bean	Pea	C/pea	Vetch		Lentil	Pasture		
				44C79	Cobbler TT	Garnet	Farah	Gunyah	Genesis 090	Capello	Rasina	Flash	Frontier Balansa	Bolmiter	Sulla
		Sown: 28/05/2011													
		Treatment	Rate kg/ha	10	10	10	45	45	45	80	100	40	5	5	5
PSPE (31/05/2011)	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Diuron	350g	3	1	1	1	1	1	1	1	1	2	1	1
	3	Simazine	350g	5	1	3	1	2	1	2	1	1	5	4	4
	4	Diuron + Simazine	410g/410g	5	2	3	1	2	1	2	1	1	5	3	3
	5	Metribuzin	280g	5	3	5	1	2	1	2	2	2	5	4	3
	6	Terbyne	1000g	5	1	5	1	1	1	1	1	1	5	4	4
	7	Spinnaker	70g	1	5	5	3	1	2	3	3	3	3	2	3
	8	Spinnaker + Simazine	40g/850g	5	5	5	3	1	1	3	3	3	5	4	4
	9	Balance	100g	5	5	5	4	4	1	5	4	5	5	5	5
	10	Balance + Simazine	100g/830g	5	5	5	4	4	1	5	5	5	5	5	5
4 node 12/07/2011	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Simazine	350g	1	1	1	1	1	1	1	1	1	1	1	1
	3	Metribuzin	280g	4	2	4	4	2	4	3	3	3	4	4	2
	4	Broadstrike	25g	1	4	4	4	2	1	3	3	1	1	1	1
	5	Brodal Options	150ml	4	1	1	1	1	3	2	2	1	2	3	4
	6	Brodal Options + MCPA Amine	150ml/150ml	4	4	3	3	1	3	3	3	2	3	3	4
	7	Sniper 750WG	50g	1	1	1	1	1	2	2	2	2	3	3	4
	8	Spinnaker + wetter	70g/0.2%	2	3	4	4	1	3	2	2	3	2	2	3
	9	Raptor + wetter	45g/0.2%	1	3	4	4	1	4	3	3	4	2	2	2
	10	Boxer Gold	2.5L	1	1	1	1	1	1	2	1	1	1	2	1
	11	Sakura	118g	2	2	1	1	1	1	1	1	1	1	1	1
	12	Propyzamide	1.5kg	1	1	1	1	1	1	1	1	1	1	1	1
7 node 23/07/2011	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Logran + wetter	10g/0.1%	1	5	5	5	4	4	5	5	4	5	3	3
	3	Ally + wetter	7g/0.1%	1	5	5	5	5	5	5	3	5	5	4	4
	4	Eclipse SC + Uptake	50ml/0.5%	1	5	5	5	4	4	4	4	4	5	3	3
	5	Ecopar + MCPA Amine	400ml/500ml	2	5	5	5	2	3	2	2	2	2	2	2
		Affinity Force + MCPA Amine	100ml/500ml	3	3	3	3	2	3	2	2	2	3	3	3
	6	Conclude + Uptake	700ml/0.5%	5	4	4	4	4	4	5	4	5	5	4	5
	7	Precept + Hasten	750ml/1%	5	5	5	5	3	3	5	3	5	4	4	4
	8	Velocity + Hasten	670ml/1%	5	5	5	5	5	4	5	5	4	5	5	4
		Flight EC	720ml	5	5	5	5	2	3	2	2	2	3	3	4
	9	Banvel M	1L	4	4	4	4	3	4	5	5	4	3	4	4
	10	Intervix + Hasten	600ml/1%	1	5	5	5	3	4	4	3	4	5	3	4
	12	Hussar OD + wetter	100ml/0.25%	2	5	5	5	5	5	5	5	5	5	4	4
	13	Crusader + wetter	500ml/0.25%	1	4	4	4	5	5	5	5	5	5	2	4
	14	Atlantis OD + Hasten	330ml/0.5%	1	5	5	5	4	5	4	4	4	4	4	4
	15	Atrazine + Hasten	833g/1%	4	1	3	3	2	3	1	1	1	5	4	3
		Lontrel 600	150ml	1	1	1	1	4	5	4	4	4	5	5	5
	17	Starane	300ml	1	1	1	1	2	3	3	3	3	1	1	1
10 node 10/08/2011	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	MCPA Sodium	700ml	4	4	4	4	2	3	4	4	4	1	2	4
	3	MCPA Amine	350ml	4	4	4	4	1	3	4	4	4	1	2	4
	4	Amicide Advance 700	1.2L	5	5	5	5	4	4	5	5	5	3	4	4
	5	2,4-D Ester	70ml	3	3	3	3	2	3	3	3	3	1	2	3
4 node 12/07/2011	1	NIL		1	1	1	1	1	1	1	1	1	1	1	1
	2	Sprayseed	2L	4	4	4	4	4	4	3	3	3	4	4	4
	3	Glyphosate	1L	5	5	5	5	4	4	4	4	5	5	5	5
	4	Glyphosate + LVE 680	1L/500ml	5	5	5	5	5	4	5	4	5	5	5	5
		Glyphosate + Amicide Advance 7	1L/650ml	5	5	5	5	5	4	5	5	5	5	5	5
	5	Glyphosate + Hammer	1L/50ml	5	5	5	5	5	4	4	3	5	5	5	5
	7	Glyphosate + Cadence	1L/115g	5	5	5	5	5	4	5	4	5	5	5	5
	8	Glyphosate + Pyresta	1L/400ml	5	5	5	5	5	4	4	4	5	5	5	5
		Glyphosate + Sharpen	1L/18g	5	5	5	5	5	4	4	4	5	5	5	5
		Glyphosate + Valor	1L/30g	5	5	5	5	5	4	4	4	5	5	5	5
	9	Glyphosate // Sprayseed 3DAS	1.2L//1.2L	5	5	5	5	5	4	4	4	5	5	5	5
	11	Basta	2.5L	5	5	5	5	5	4	5	5	5	5	5	5
		Alliance	2L	5	5	5	5	5	4	5	4	5	5	5	5
	12	NIL		1	1	1	1	1	1	1	1	1	1	1	1

Group B tolerant crops

Key findings

- New crop varieties have been recently released that have improved tolerance to imidazoline (imi) herbicides.
- Group B tolerant varieties showed no 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	2m x 3m	**Fertiliser**	100 kg/ha DAP (18:20)
Seeding date	28th May 2011		

The crops included:
2 strips of canola were sown. AV Garnet (not tolerant) & Clearfield 44C79 (tolerant).
2 strips of barley were sown. Buloke (not tolerant) & Scope (tolerant).
3 strips of wheat were sown. Gladius (not tolerant), Justica CL plus & Clearfield JNZ (tolerant).
2 strips of lentils were sown. Nipper (not tolerant) & PBA Herald HT (tolerant).

The treatments for all the crops included:
2 residual herbicide treatments were applied prior to sowing

The treatments for the wheat, barley and canola included:
6 group B post emergent (3-4 node) herbicide treatments applied on the 14th July and 2 different group I herbicide treatments

The treatments in the lentils included:
1 PSPE treatment was applied post sowing prior to emergence
1 post emergent (3-4 node) herbicide treatment applied on the 14th July

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

Crop damage ratings were:

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

Results

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

There was no crop damage to any of the tolerant crop lines of wheat, barley and lentils in any herbicide treatment. The only damage in the tolerant line of canola, 44C79 was from group I (hormone) chemistry.

There was no visual difference in the new wheat variety Justica CL Plus (twin gene) compared to the older Clearfield JNZ (single gene).

The 700 ml/ha rate of Intervix resulted in death of the non tolerant varieties Buloke, Gladius and AV Garnet. Tolerant varieties Scope, Justica CL Plus, Clearfield JNZ and 44C79 were not affected.

Midas applied at 900 ml/ha also severely affected non tolerant varieties Buloke and Gladius. Tolerant varieties Scope, Justica CL Plus and Clearfield JNZ were not affected.

Residual Logran (7g) had a moderate effect on Nipper lentils and AV Garnet canola. There was also no effect of residual Intervix in any variety, which is not normal and needs to be viewed with caution.

PBA Herald HT (formally CIPAL 702) the new lentil variety released for improved tolerance to Broadstrike and group B herbicide residues was not affected by any of the group B residual or Spinnaker herbicide treatments. This result should be treated with caution however and label recommendations should be followed. Other research conducted by SARDI has demonstrated that certain group B herbicides and their residues can cause significant damage symptoms to PBA Herald HT.

Nipper (non tolerant) lentils incurred a moderate level of damage to both PSPE and post timing applications of Spinnaker and the residual 7g Logran treatment. Intervix was not applied to either lentil variety. 10g/ha of Logran did not have any effect on Nipper lentils, which is very unusual, and in the herbicide tolerance trial alongside produced a severe effect on the Flash lentils.

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Group B tolerant crops

		Lentil		Barley		Wheat			Canola	
		Not Tol	Tol	Not Tol	Tol	Not Tol	Tol	Tol	Not Tol	Tol
Timing	Herbicide	Nipper	PBA Herald HT	Buloke	Scope	Gladius	Justica CL plus	Clearfield JNZ	AV Garnet	Clearfield 44C79
	Nil	1	1	1	1	1	1	1	1	1
Residual	7g logran	3	1	1	1	1	1	1	3	1
3-4 leaf or node	10g logran	1	1	1	1	1	1	1	4	1
Residual	180mL Intervix	1	1	1	1	1	1	1	1	1
3-4 leaf or node	700mL Intervix	Untreated		5	1	5	1	1	5	1
nil		1	1	1	1	1	1	1	1	1
3-4 leaf or node	Spinnaker PSPE 100g	3	1	2	1	3	1	1	4	1
3-4 leaf or node	Spinnaker post 100g	3	1	2	1	3	1	1	4	1
3-4 leaf or node	Midas 900ml	na	na	4	1	4	1	1	4	4
3-4 leaf or node	Logran 10g	na	na	1	1	1	1	1	4	1
3-4 leaf or node	Banvel M 1.0L	na	na	1	1	1	1	1	4	4
3-4 leaf or node	2,4-D 1.0L	na	na	1	1	1	1	1	4	4

Wild oats in disc seeding treatment

Select resistant ryegrass

Harrington seed destructor

Droplet size demonstration at Hart

SpraySeed – medium droplet

Glyphosate – medium droplet

SpraySeed – coarse droplet

Glyphosate – coarse droplet

SpraySeed - extra course droplet

Glyphosate - extra course droplet

The control of barley using medium, coarse or extra coarse spray droplets with 1.5L/ha glyphosate or SpraySeed, at the Hart field site. Treatments were applied on September 26th 2011 and these photos were taken three weeks later. Results show larger droplets performed as well as traditional medium droplets.

Control of net form net blotch in barley – fungicide trials 2011

Rohan Kimber & Hugh Wallwork – SARDI

Key findings

- Control of net form net blotch using effective fungicides resulted in yield increases of up to 1.0 t/ha compared to nil treatments.
- Two strategic fungicide applications during early-mid growth stages (before end of August) – suppressed disease development and provided control comparable to four applications made every 2-4 weeks from early August.
- Tilt ®, Amistar Xtra ®, Opera ® and Prosaro ® were effective for control of net form of net blotch.

Why do the trials?

To evaluate fungicide efficacy against net form net blotch (NFNB) of barley and investigate application strategies for efficient control of the disease.

How was it done?

Two field trials were conducted during 2011, one at Port Vincent and one at Arthurton on the Yorke Peninsula. Four fungicide products were evaluated; Tilt ® (500 ml/ha), Amistar Xtra ® (200 ml/ha), Opera ® (500 ml/ha) and Prosaro ® (150 ml/ha) and five application strategies based on timings of Aug 9 (T1) at GS32, Aug 21 (T2), Sept 1 (T3) and the final application (T4) made on Sept 14 (Port Vincent) or Sept 29 (Arthurton). Treatments were a single application at T1, two fungicide applications at T1&T2, T2&T3 or T3&T4 and a 'complete' treatment (four fungicide applications at T1-T4). A control treatment; nil (no fungicide) was also included. The Port Vincent trial was conducted as 'in-field plots' within an established crop, whereas the Arthurton trial was sown and managed as trial plots; both were conducted with cv Maritime. Disease was assessed on Sept 16 at both sites, recording % Leaf Area Diseased (LAD) on the mid-canopy foliage, and later on October 12 at the Arthurton site. This assessment was not conducted at Port Vincent due to dry conditions. Yield data was collected for both trials.

Results

Net form net blotch established at both sites. On Sept 16, moderate levels (>40% LAD) were observed in uncontrolled plots at Arthurton compared to higher levels (>60% LAD) at Port Vincent. Tilt ®, Amistar Xtra ®, Opera ® and Prosaro ® all exhibited significantly less disease than the nil control plots at both sites. Analysis showed fungicide treatments with a single application (T1) or two strategic applications later in the season (T3&T4) exhibited the highest disease levels at both sites (>10% LAD at Arthurton and >30% LAD at Port Vincent) compared to other treatments. Strategies consisting of two early applications (T1&T2) or two applications during mid-growth stages (T2&T3) showed the lowest levels of disease, and these were comparable to the 'complete' treatments using four fungicide applications (T1-4).

Final disease assessments and yield data for all treatments at both sites are presented in Table 1. Yields up to 3.6 t/ha were recorded at Port Vincent. The lowest yields were in untreated plots and treatments using a single application of fungicide, which were significantly lower than all other fungicide treatments evaluated.

Yields up to 4.4 t/ha were recorded at Arthurton but only treatments using Tilt ® applied at T2&T3 and the complete treatment using Opera ® were significantly higher than the nil treatment.

Summary

Severe net form net blotch can develop on susceptible cultivars of barley when exposed to high inoculum loads (eg. infested residues) and when conditions and frequent rain events favour disease spread. Tilt ®, Amistar Xtra ®, Opera ® and Prosaro ® were effective fungicides for control of the disease in two field trials evaluated in 2011, under moderate to high disease pressure. Control of the disease was most effective when strategic applications were made at the onset of disease and during the mid-stages of crop development. However, later applications may be required in seasons when warm and wet conditions persist in spring. Late season applications of fungicide risk yield loss in crops by allowing early infections to spread and promote high inoculum levels in the crop.

Table 1: Fungicide treatments evaluated control of net form net blotch on barley (cv Maritime) at two trial sites during 2011. Disease (%LAD) was assessed on mid-canopy foliage after final treatment applications and grain yield (t/ha) at harvest.

Entry	Treatment[a]	Port Vincent Trial		Arthurton Trial	
		NFNB Sept 16 (%LAD mid-canopy)	Yield (t/ha)	NFNB Oct 12 (%LAD mid-canopy)	Yield (t/ha)
1	Opera T1	38.8	2.54	15.0	3.79
2	Amistar Xtra T1	32.5	2.82	23.3	3.98
3	Prosaro T1	31.3	2.64	25.0	3.63
4	Tilt T1	35.0	2.81	21.7	4.16
5	Opera T1&T2	23.8	2.87	11.7	3.79
6	Amistar Xtra T1&T2	18.8	3.00	11.7	4.08
7	Prosaro T1&T2	18.8	3.06	13.3	3.72
8	Tilt T1&T2	23.8	3.10	5.0	4.07
9	Opera T2&T3	22.5	3.25	8.3	4.00
10	Amistar Xtra T2&T3	26.3	3.39	8.3	4.12
11	Prosaro T2&T3	30.0	3.22	10.0	4.13
12	Tilt T2&T3	21.3	3.26	8.3	4.40
13	Opera T3&T4	35.0	3.33	15.0	3.98
14	Amistar Xtra T3&T4	40.0	3.43	11.7	3.70
15	Prosaro T3&T4	37.5	3.19	18.3	4.09
16	Tilt T3&T4	36.3	3.37	10.0	3.94
17	Opera T1-T4	11.3	3.63	4.0	4.39
18	Amistar Xtra T1-T4	15.0	3.60	8.3	4.08
19	Prosaro T1-T4	13.8	3.25	8.3	3.91
20	Tilt T1-T4	13.8	3.42	5.0	4.16
21	Untreated	63.8	2.59	28.3	3.66
-	**LSD (0.05)**	**9.5**	**0.38**	**12.3**	**0.65**

Acknowledgements

Peracto SA, and their co-operators, for a professional service conducting and managing field trials. The Grains Research Development Corporation provided financial support for this study. The Hart Field-Site Group Inc. and Stuart Sherriff of SARDI (Clare) for the management of a field site located at Hart (data not presented as disease failed to establish).

Survey of field pea crops and blackspot in Hart region 2007 to 2009

Jenny Davidson (SARDI), Moin Salam (DAFWA) and Peter Hooper (Hart Field-Site Group)

Key findings

- From 2007 to 2009 field pea crops in the Hart district were sown in an even spread from early May through to June.
- The majority of crops were within 500 m of field pea stubble from the previous year.
- Blackspot was most severe in early sown crops adjacent to field pea stubble.
- There was a significant relationship between predictions of disease risk made by Blackspot Manager and the disease severity observed in these crops.

Why do the surveys?

To identify management decisions that impact on blackspot in field peas and to validate disease risk predictions from Blackspot Manager.

How was it done?

Each year from 2007 to 2009, all field pea crops within a 10-km radius of Hart were identified and mapped. Approximate sowing dates were calculated in winter from the mean number of nodes on 20 plants selected randomly in the crops. This information was used to group crops into sowing categories similar to the sowing dates in the field trials described above; Early (late April to early May), Medium (Mid – late May) and Late (early June onward). Crops representative of each sowing group were selected for assessment of severity of ascochyta blight in late September or October. Selection within each sowing group was based on proximity to infested field pea stubble, such that crops on or adjacent to, within 500 m of, or more than 500 m from infested stubble were represented. Twenty plants were selected in a W transect across the field, one every 50 paces. Plants were assessed for the growth stage (vegetative, flowering, early pods, mature pods), total number of nodes, and number of nodes girdled by ascochyta blight. The effect of sowing period on disease severity was analysed using crops as replicates. The association between observed disease severity and the percentage of ascospores present at crop emergence calculated by Blackspot Manager was also analysed.

Results

In 2007, 2008 and 2009 there were 52, 45 and 41, respectively, commercial field pea crops mapped in a 10-km radius of Hart. Sowing dates were evenly spread in all three seasons; 32.6% were in the Early sown category, 35.6% were in the Medium sown category and 32.7% were sown Late. The majority of the crops were in close vicinity to infested field pea stubble from the previous season; 49.4% were either adjacent to or planted into field pea stubble, 29.9% were no more than 500 m from field pea stubble, and only 20.6% of crops were more than 500 m from field pea stubble. All crops were affected by blackspot at varying severity and disease was assessed in 18, 15 and 22 crops in 2007-09, respectively.

In each consecutive year of the study disease severity significantly increased with earlier sowing ($P \leq 0.01$) (Table 1). The severity of blackspot ranged from 0.4 to 14.8 (average 5.4) girdled nodes in 2007, and from 1.8 to 12.7 girdled nodes (average 5.9) in 2008. In 2009 the minimum disease severity was 8.3 and the maximum was 20.2 girdled nodes (average 13.2). In 2008 proximity to infested stubble significantly ($P<0.01$) increased blackspot severity at each sowing period. Disease was least severe in crops sown in the mid or late period which were not adjacent to infested stubble (Table 1b). In 2009 disease was least severe in crops sown in the late period not adjacent to infested field pea stubble (Table 1c).

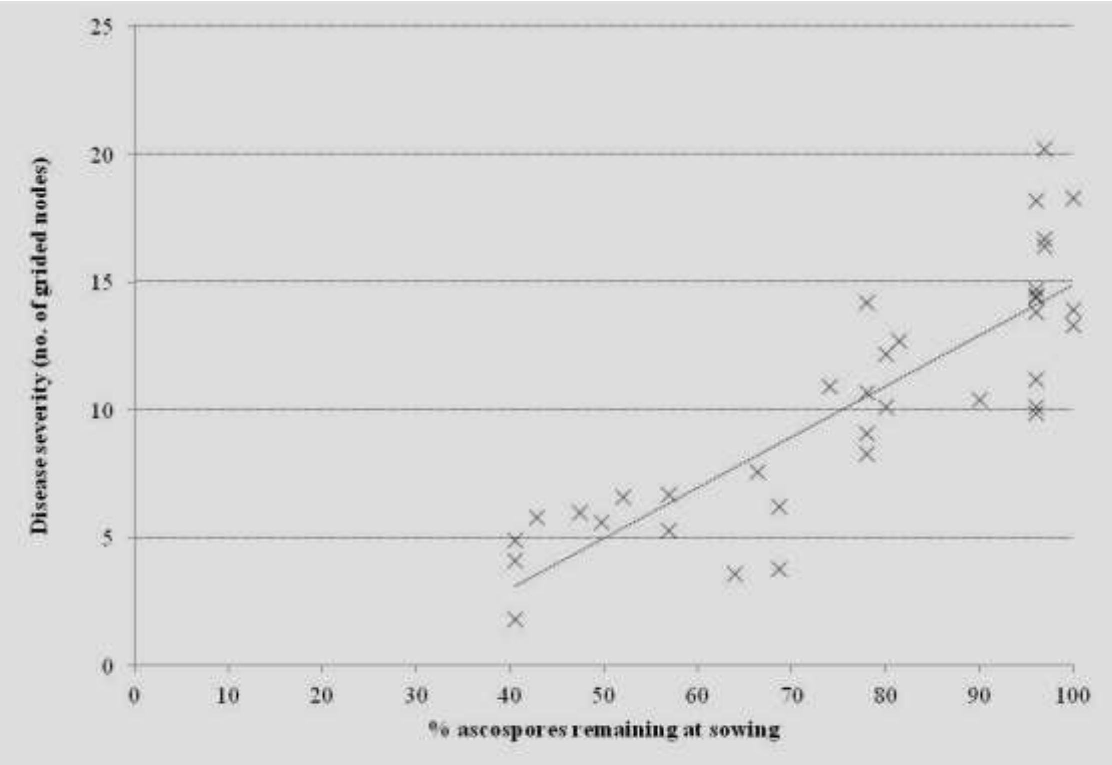
Table 1 Mean severity of blackspot (number of girdled nodes) in field pea crops a 10-km radius of Hart, South Australia from 2007 to 2009.

	Sowing period		
	Early (Early May)	**Mid (Mid-late May)**	**Late (early June onward)**
(a) 2007	12.4a[a] (3)[b]	4.9b (4)	3.7b (11)
(b) 2008			
Adjacent to or on field pea stubble	8.6a (3)	6.4b (3)	5.7bc (2)
Not adjacent to field pea stubble	4.7de (2)	5.2cd (3)	4.0e (2)
Maximum Least Significant Difference = 1.00; Average Least Significant Difference = 0.93; Minimum Least Significant Difference = 0.82.			
(c) 2009			
Adjacent or on field pea stubble	17.3a (3)	12.2c (4)	11.3c (3)
Not adjacent to field pea stubble	14.0b (4)	14.7b (5)	9.4d (3)
Maximum Least Significant Difference = 1.08; Average Least Significant Difference = 1.02; Minimum Least Significant Difference = 0.93.			

[a]Numbers followed by the same letter are not significantly different at P <0.001.
[b]Number of crops per category is in parentheses.

There was a significant linear relationship ($r^2 = 0.72$, $P < 0.001$) between observed disease severity in the survey of crops near Hart and percentage of ascospores present at crop emergence predicted by Blackspot Manager. When 40% of ascospores were present at crop emergence the average observed disease severity was 3 girdled nodes (Fig. 1). Other researchers have estimated that minimal yield loss occurs below 5 girdled nodes.

Figure 1 The linear relationship between the % of ascospores remaining at crop emergence (calculated by Blackspot Manager) and the observed disease severity assessed in the survey of commercial field pea crops in Hart district (10 km radius) in 2008 and 2009.



Summary

The survey of commercial field pea crops in the Hart district validated the effect of time of sowing and distance from infested pea stubble on disease severity. Many growers appear to have ignored basic agronomic disease management strategies of distance from stubble and or delayed sowing. This may be due to constraints in field selection on the property and the yield risk associated with short dry seasons when sowing is delayed. In these circumstances Blackspot Manager allows growers to identify the disease risk linked to their agronomic decisions. Research to identify reasons for the failure of industry to implement current recommendations for field selection and distance from infested stubble is warranted to improve the adoption of integrated disease management strategies aimed at minimising exposure to inoculum.

If crops were sown according to recommendations of Blackspot Manager (i.e. when less than 40% of spores were remaining on stubble) then blackspot severity was less than 3 girdled nodes, a level that does not limit yield.

Acknowledgements

The South Australian Grains Industry Trust and the Grains Research Development Corporation provided financial support for this study. Larn McMurray and Stuart Sherrif of SARDI, Clare, assisted with the surveys of commercial field pea crops in the Hart district.

Crown rot varietal screening

Margaret Evans and Hugh Wallwork - SARDI GRDC funded project – DAS00099

Key findings

- Durum breeders' lines Td17/1 and WID902 showed promise of improved resistance/tolerance to crown rot.
- Hyperno and AGT Katana performed best of the recently released durum wheat and bread wheat cultivars, respectively.
- Gladius expressed significant crown rot symptoms (but not whiteheads) and may contribute to rapid build up of crown rot inoculum.

Why do the trials?

To evaluate durum breeding lines and commercial cultivars of bread wheat and durum wheat for resistance and tolerance to crown rot (Fusarium pseudograminearum).

How were they done?

Data presented in this report were compiled from a number of sites and seasons. For assessment of crown rot symptoms – Hart 2007-2011, Cambrai 2008-2010, Mallala 2007-2008, Roseworthy 2010 and Wunkar 2011. For whitehead expression data were only used from sites with medium to high disease pressure – Hart 2007-2008, Cambrai 2008 and Mallala 2007.

Trials were laid out using randomised block designs and had at least 4 replicates (except Wunkar, which had 3 replicates).

Only information relating to commercial cultivars of bread wheat and durum wheat and advanced breeders' durum lines is presented in this report. Seed of SARDI durum families (Td and 979- prefixes) and University of Adelaide durum lines (WID prefix) was provided by Hugh Wallwork and Jason Able, respectively. Checks were 2-49 (moderate resistance), Kukri and Sunco (moderately susceptible), Frame and Janz (susceptible) and Tamaroi and Kalka (very susceptible).

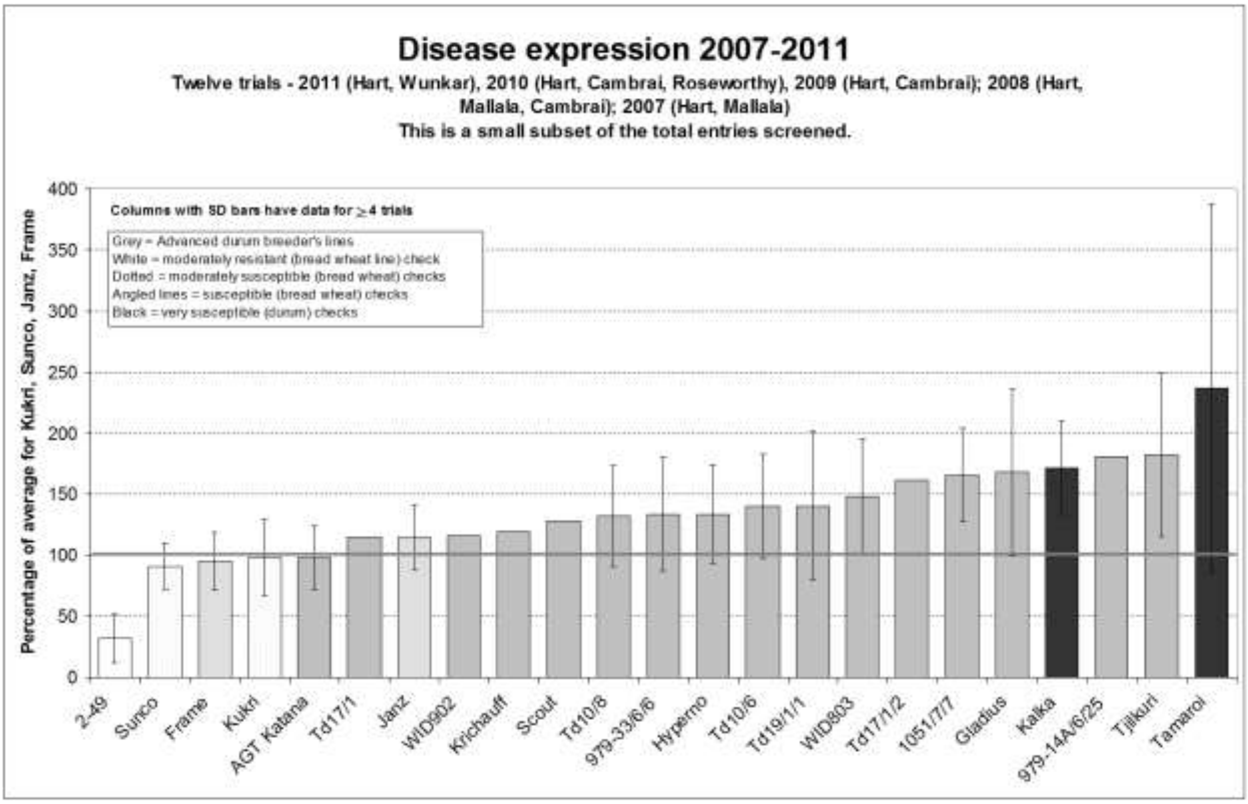
Seed was inoculated with a crown rot spore suspension prior to seeding, except at Cambrai where there was a naturalised inoculum source. To assess yield loss, a second, uninoculated plot was included for selected entries. Plant samples were collected at early grainfill, when whiteheads and total heads were counted and main stems were assessed for severity of crown rot symptoms.

Crown rot severity on main stems was scored visually on the following scale:

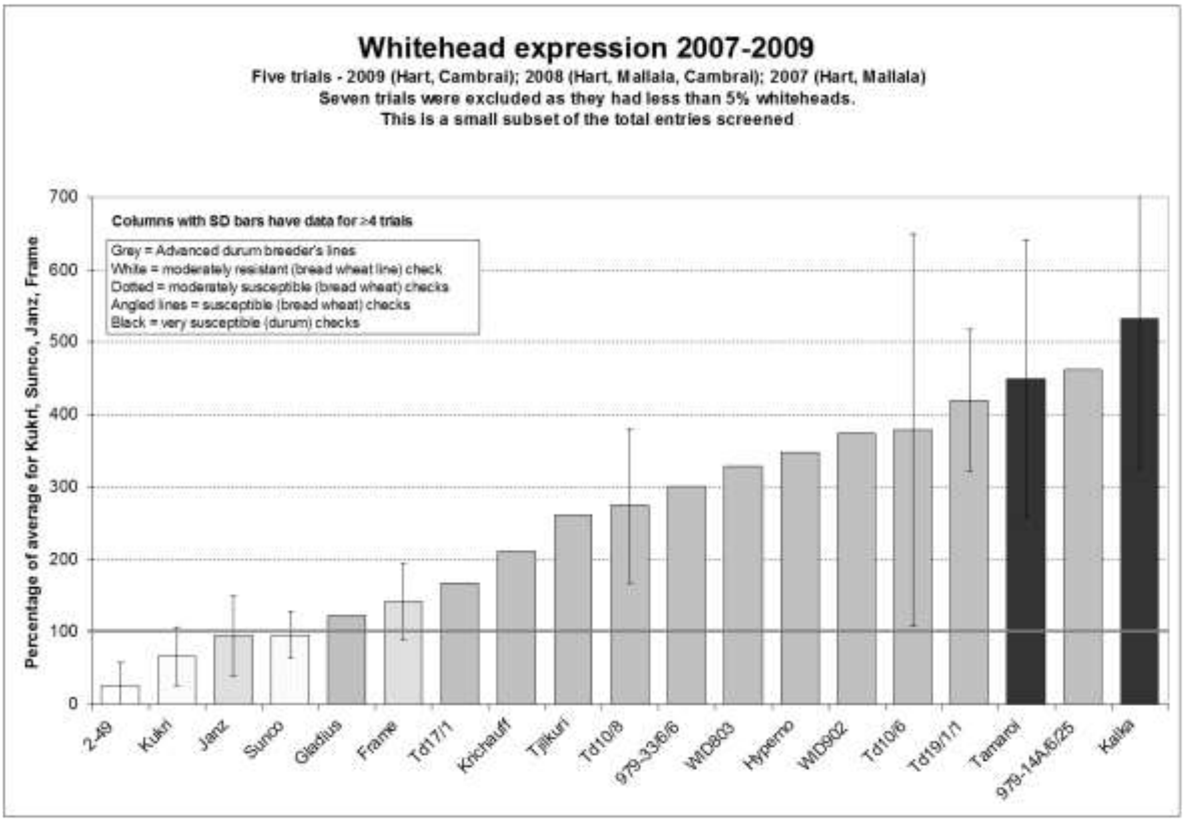
0 = 0%	No yield loss
1 = 1-10%	Possibility of minor yield loss
2 = 10-25%	Possibility of some yield loss
3 = 25-50%	Probably some yield loss
4 = 50-75%	Significant yield loss likely
5 > 75%	High yield loss likely

Results

Entries were not always present in every trial, making direct comparisons difficult. For this reason, results for disease and whitehead expression are presented as a percentage of averaged results from Kukri, Sunco, Janz and Frame. Where there are no error bars, the entry has only been present in a few trials. This means the result is less reliable and may be an artefact of exposure to only low or only high disease pressure when compared with the other entries.



Bread wheat entries generally had less disease than did the durum wheat entries, although Gladius had unexpectedly high levels of stem browning. Bread wheat entries (including Gladius) had lower whitehead expression than did the durum wheat entries.



Tamaroi had the most and Hyperno the least disease expression of the commercial durum wheat cultivars. The best breeders' lines were Td17/1 and WID902, which both had disease expression in the same range as that for commercial bread wheat cultivars. All durum wheat entries had high levels of whiteheads when compared with bread wheat entries, although whiteheads are not as reliable an indicator of resistance/tolerance to crown rot.

Discussion

Improving field resistance and/or tolerance to crown rot in durum wheat is proving difficult as there is considerable variability in responses of entries between seasons. Some of this variability in performance, particularly in terms of whiteheads, may be accounted for by the lack of agronomic adaptation exhibited by many of the durum lines. The large data set presented in this report has helped to demonstrate that some of the current breeders' lines are showing promise, particularly Td17/1 and WID902.

AGT Katana performed best of the recently released bread wheat cultivars and Hyperno performed best of the recently released durum wheat cultivars. Gladius did not have large numbers of whiteheads, but its disease expression was in the same range as that of durum wheat cultivars. Gladius may contribute to rapid build-up of crown rot inoculum.

Improving water use efficiency

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

Key findings

- The highest recorded water use efficiency (WUE) was observed at Spalding where 26.6 kg of wheat was produced per hectare for every mm of growing season rainfall.
- Growing season rainfall was below average meaning that stored summer soil moisture was very valuable in 2011.
- The WUE at Hart has been 14 kg/mm/ha or 70% calculated since 2001.

Why do the trial?

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

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

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

How was it done?

Plot size 8m x 10m

Seeding date
Hart: 30th May 2011
Condowie: 21st May
Spalding: 19th May
Saddleworth: 16th June

Fertiliser

Hart	DAP@50 kg/ha+2% Zn
Condowie	DAP@40 kg/ha+2% Zn
Spalding	32:10 (DAP/Urea) @ 150 kg/ha
Saddleworth	DAP@ 90 kg/ha + 2% Zn

Post emergent nitrogen

Hart:	UAN @ 70 L/ha 29th July 2011
Saddleworth	Urea @ 100 kg/ha 2nd August 2011

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

The 4 crops include Gladius wheat, Fleet barley and Kaspa peas grown in rotation to ensure weed free plots are available for wheat in each successive season.
All trials were sown with 50mm chisel points and press wheels on 225mm (9”) row spacing.

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

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

WUE was calculated for the cereal crops at each site using the French & Schultz formula. Given the wet summer of 2010 and 2011 the growing season rainfall was calculated as:

- 1/3 rainfall above 20mm for December to February
- ½ rainfall above 20mm for March
- the total rainfall between April and October

The values used are based on previous measurements of summer fallow use efficiency.

Wheat Yield potential = (GSR-110mm)*20 kg/mm/ha

Barley Yield potential = (GSR-90mm)*15 kg/mm/ha

Results

Growing season rainfall (GSR calculated from April to October) in 2011 was well below average (Table 1) with Condowie having the highest GSR decile (4.5). Given the wet finish to 2010 and frequent summer rains an allowance of stored summer rainfall was added to the traditional GSR (Table 1) (referenced as GSR+S). Using this method the GSR+S ranged between 262mm (Condowie and Hart) to 335mm (Saddleworth). Condowie was the only site to have more GSR+S compared to its long term GSR average.

Using this method 40 to 50mm of stored summer moisture was included in the GSR total. Measurements of moisture prior to sowing indicate that another 20mm was actually present and may explain why the Spalding site has a very high water use efficiency (WUE)(Table 3). The crop was able to access more water than what the GSR+S formula has allowed for. This might be due to the cool conditions in 2011 reducing the evaporation of moisture or larger rainfall events increasing the efficiency of water storage. This stored moisture was very important in 2011 and it could be realistically expected to have contributed 0.5 to 1.0 t/ha in extra grain yield.

Table 1. Soil type and growing season rainfall (GSR) as the average, April to October and its decile and the GSR including an allowance for stored summer rainfall (GSR+S) for the four WUE sites in 2011.

Site	Soil type	Average GSR	2011 Apr - Oct GSR (mm)	2011 GSR decile	2011 GSR with summer rain
Condowie	sandy loam	252	232	4.5	262
Hart	sandy, clay loam	305	219	2.0	262
Spalding	red brown earth	322	234	2.5	292
Saddleworth	black cracking clay	374	296	2.0	335

The wheat WUE ranged from 12.6 kg/mm/ha at Hart to 26.6 kg/mm/ha at Spalding (Table 3) producing grain yields of 2.74 t/ha and 4.84 t/ha respectively. This ranking of sites was also the same in 2010.

Wheat grain yields ranged from 1.91 t/ha (Condowie) to 5.38 t/ha (Saddleworth) and barley grain yields ranged from 1.77 t/ha (Condowie) to 5.02 t/ha (Spalding) (Table 2). Protein levels were good for wheat and barley and screenings were all below 2.5% at all WUE sites in 2011.

Table 2. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%<2.0 mm for wheat and %<2.2mm for barley) at the four WUE sites in 2011.

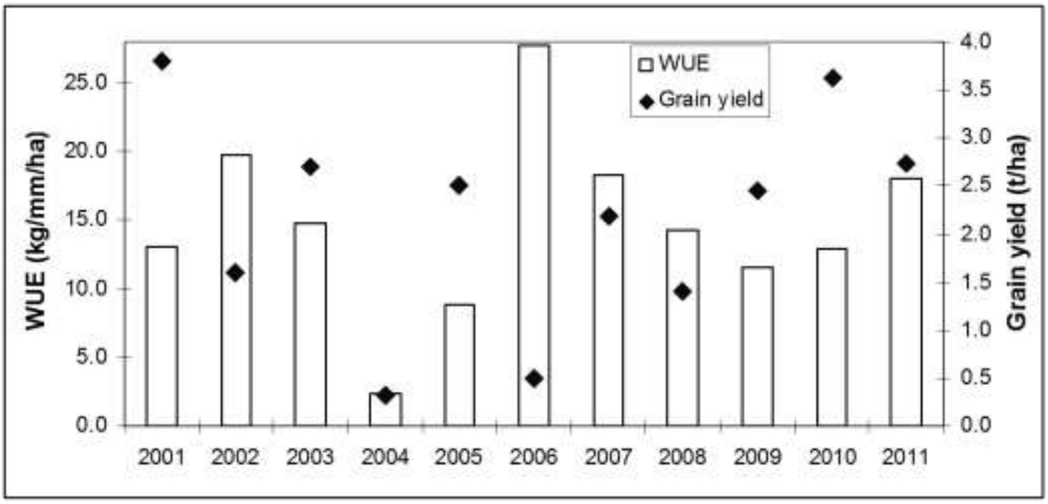
Site	Crop	Grain Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
Condowie	Wheat	1.91	12.6	73.2	2.1
	Barley	1.77	12.0	63.5	1.9
Hart	Wheat	2.74	12.5	70.4	1.7
	Barley	3.48	11.7	64.3	1.3
Spalding	Wheat	4.84	12.9	78.3	1.1
	Barley	5.02	12.0	66.2	0.9
Saddleworth	Wheat	5.38	11.0	80.8	0.9
	Barley	4.71	12.3	67.0	1.7

Table 3. Soil type, average and total rainfall and wheat and barley water use efficiency (WUE) for the four WUE sites in 2011.

Site	Soil type	Average total rainfall	2011 total rainfall	Wheat	Barley
		(mm)		WUE (kg/ha/mm)	
Condowie	sandy loam	349	415	18.0	20.2
Hart	sandy, clay loam	400	387	12.6	10.3
Spalding	red brown earth	434	419	26.6	24.9
Saddleworth	black cracking clay	497	450	23.9	19.2

The calculated WUE at Hart over the past 11 years has ranged between 2.4 kg/mm/ha (2004) to 27.8 kg/mm/ha (2006). The efficiency of crop water use depends on many factors and so it is expected that this figure will vary from year to year. Over the reported period the Hart field site has averaged about 14 kg/mm/ha or 70% WUE. This knowledge of expected efficiency can be particularly important when using seasonal rainfall to calculate likely yield expectations.

Figure 1. Wheat grain yield and water use efficiency using April to October growing season rainfall and 20 kg/mm/ha potential grain yield between 2001 and 2011 at the Hart field site.



Acknowledgements

The Hart Field-Site Group wish to thank Brian Kirchner and Simon Goldsmith, Andrew and Rowan Cootes, Michael and David Miller, David Hentschke and Matt Ashby for the use of their paddocks and cooperation with this trial work.

Improving water use efficiency – reducing soil evaporation

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

Key findings

- The addition of a straw layer acted to reduce evaporation and significantly increased grain yields and water use efficiency in 2010 and 2011 at 3 field sites.
- Soil evaporation also decreased with increasing light interception from larger crop canopies.

Why do the trial?

Throughout southern Australia many trials have recently focussed on improving the retention of summer rainfall and have clearly shown that effective and early summer weed control increases stored soil moisture. Soil cover i.e stubble, throughout the summer period was shown to provide limited additional benefit.

This trial aimed to use a thick layer of cereal straw maintained within the growing season to focus on reducing the amount of moisture lost to soil evaporation. The trials were conducted on the previously established sites used in the previous improving water use efficiency article.

How was it done?

Plot size	8m x 10m			
Seeding date	Hart 30th May 2011 Condowie 21st May Spalding 19th May Saddleworth 16th June	**Fertiliser**	Hart Condowie Spalding Saddleworth	DAP@50 kg/ha+2% Zn DAP@40 kg/ha+2% Zn 32:10 (DAP/Urea) @ 150 kg/ha DAP@90 kg/ha+2% Zn
			Post emergent nitrogen	
			Hart	UAN @ 70 L/ha 29th July 2011
			Saddleworth	Urea @ 100 kg/ha 2nd August 2011

Each trial was a randomised complete block design with 3 replicates using Gladius wheat at Hart, Condowie and Saddleworth and Pugsley wheat at Spalding.

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

6 tonnes/ha of oaten straw was spread evenly over the plots immediately after sowing. This straw layer provided about 95% soil cover.

50 kg N/ha was spread on the 23rd July. Dry matter cuts were taken at flowering.
Measurements of gravimetric soil water content and light interception were taken to calculate soil evaporation through the growing season.

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

Results

In 2010, the addition of straw increased wheat grain yields by 5, 7 and 14% at Spalding, Saddleworth and Condowie respectively. In 2011 these values were 8, 19, 26 and 11% at Spalding, Saddleworth, Condowie and Hart respectively. Condowie produced the largest increase in grain yield from 1.91 t/ha to 2.40 t/ha, while Spalding had the lowest increase (Figure 1). The ranking of these sites was consistent between 2010 and 2011. The addition of extra nitrogen increased grain yield significantly at Condowie and Hart.

Figure 1. The influence of straw or straw and extra nitrogen on wheat grain yields at Hart, Condowie, Saddleworth and Spalding in 2011. (LSD's (0.05) for grain yield were 0.16, 0.32, 0.93 and 0.43 for Condowie, Hart, Saddleworth and Spalding, respectively).

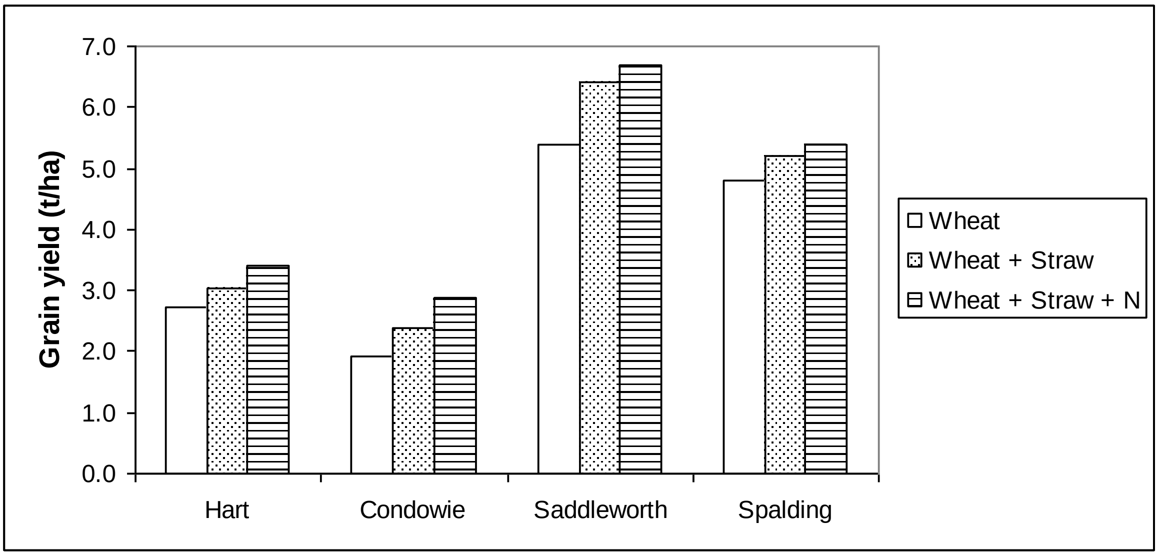
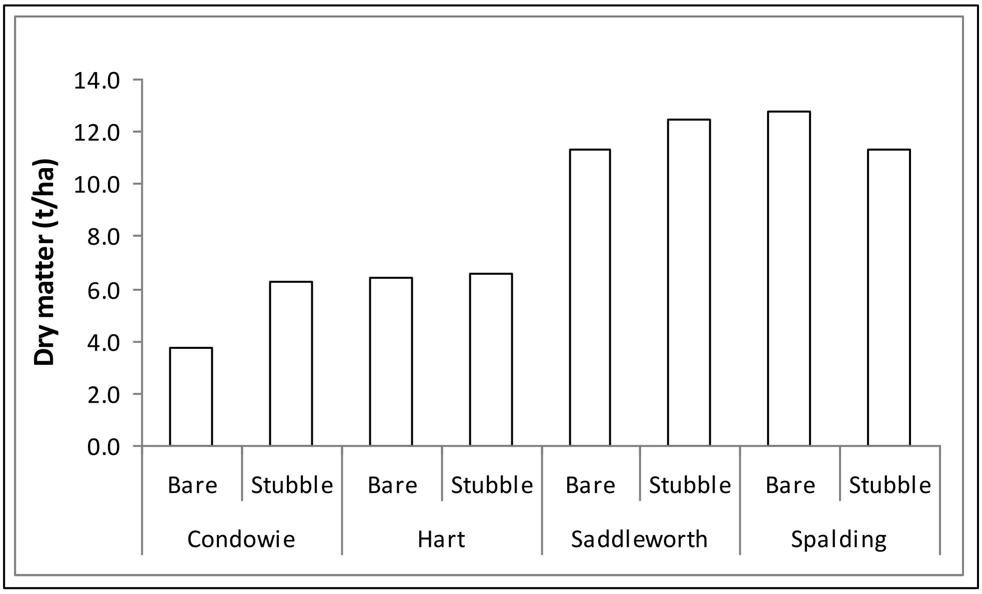


Table 1. Wheat grain quality measurements for straw and nitrogen treatments applied at Condowie, Hart, Saddleworth and Spalding in 2011.

Site	Treatment	Grain yield (t/ha)	Protein (%)	Test wt (kg/hL)	Screenings (%)	WUE
Condowie	Wheat	1.91	12.6	73.2	2.1	12.6
	Wheat + Straw	2.40	12.6	74.0	2.1	15.8
	Wheat + Straw + N	2.87	13.2	72.7	2.4	18.9
LSD (0.05)		0.16	0.5	2.3	ns	na
Hart	Wheat	2.74	12.5	70.4	1.7	18.0
	Wheat + Straw	3.05	12.7	71.0	2.0	20.1
	Wheat + Straw + N	3.41	13.5	70.9	2.5	22.4
LSD (0.05)		0.32	0.6	1.9	0.4	na
Saddleworth	Wheat	5.38	11.0	80.8	0.9	26.6
	Wheat + Straw	6.35	11.5	76.9	1.3	35.2
	Wheat + Straw + N	6.69	12.1	75.8	1.6	36.8
LSD (0.05)		0.93	1.0	1.9	0.6	na
Spalding	Wheat	4.84	12.9	78.3	1.1	23.9
	Wheat + Straw	5.20	12.0	77.8	1.1	23.1
	Wheat + Straw + N	5.43	13.2	77.8	2.0	24.0
LSD (0.05)		0.43	ns	1.3	ns	na

Generally the application of extra nitrogen had a smaller effect on grain yield compared to the addition of straw, but it significantly increased grain protein at Condowie and Hart by an average of 0.7% (Table 1).

Figure 2. The biomass production (kg/ha) at anthesis at each site for wheat with and without 6t/ha straw in 2011.



The addition of straw immediately after seeding reduced the plant emergence of these treatments by about 20%. However, apart from Spalding the other sites produced greater biomass where straw had been added (Figure 2). This increase was greatest at Condowie and Saddleworth, which is also similar to the greatest increases in grain yield.

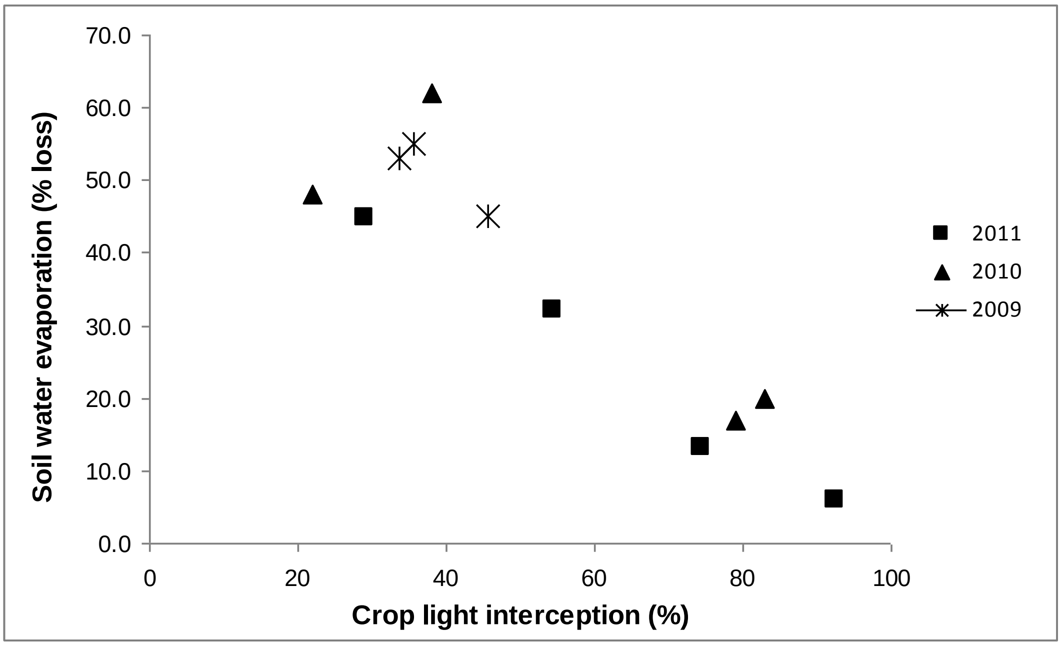


Figure 3. The percentage of total crop available water evaporated from the soil and the amount of light intercepted by the crop canopy during stem elongation at three sites in 2009 and 2010, and four sites in 2011.

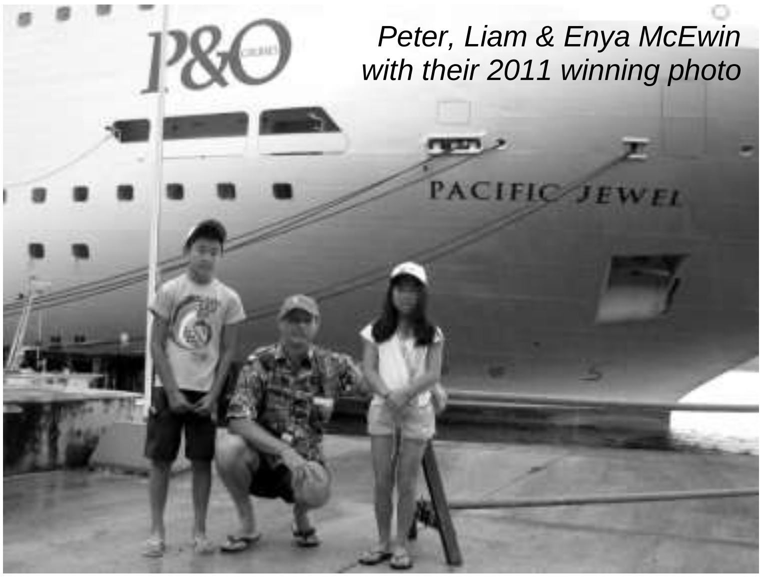
Logically, reducing the amount of sunlight hitting a soil surface, for instance by adding a layer of straw, will decrease the amount of moisture lost from soil evaporation. Figure 3 shows how the developing crop canopy at each of the sites was also able to reduce soil evaporation. As more light was intercepted by the crop canopies the proportion of water lost through soil evaporation decreased, thus leaving more water available for crop transpiration or growth.

Generating this sort of soil cover would be unrealistic in most paddocks and so future research will look at the benefits of standing stubble.

Acknowledgements
The Hart Field-Site Group wish to thank Brian Kirchner and Simon Goldsmith, Andrew and Rowan Cootes, Michael and David Miller, David Hentschke and Matt Ashby for the use of their paddocks and cooperation with this trial work.

WHERE HAS YOUR HART HAT BEEN??

Send us a happy snap of you wearing your Hart hat somewhere far away, interesting, funny or unusual to win a Hart Gold Membership!



Peter, Liam & Enya McEwin with their 2011 winning photo

Hart board member Damien Sommerville in Ireland

Hart trials manager Peter Hooper at the Taj Mahal

Managing crop growth and water use

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

Key findings

- Wheat dry matter production and total crop nitrogen was significantly lower in wider row spacing treatments.
- For the all the crops grain yield was significantly lower in the wider row spacing treatments.
- Treatments imposed to manipulate crop growth were unable to save more soil moisture for grain fill.

Why do the trial?

Throughout southern Australia many trials have recently focussed on improving the retention of summer rainfall and have clearly shown that effective and early summer weed control can increase the retention of stored soil moisture. Previous research conducted at the Hart field site in 2009 and 2010 showed that soil cover i.e stubble, provided limited additional benefit.

The research also showed that additional stored moisture was more likely to be used early in the season to increase crop growth, rather than contributing towards grain fill.

The above average rainfall and cool summer conditions of 2010 and 2011 built up a significant amount of stored soil moisture (40 to 60mm in many areas). This trial aimed to manage the crop canopy and conserve the stored soil moisture so that it might be saved for grain-fill, rather than being used to create early crop growth.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	All treatments received 10 kg/ha phosphorus
Seeding date	20th May 2011	**Varieties**	Gladius wheat @ 100 kg/ha Hyperno durum @ 100 kg/ha Buloke barley @ 100 kg/ha

The trial was a randomised block design with 9 treatments and 3 replicates (Table 1). The seeding equipment used was a knife-point press wheel system on 22.5cm (9") row spacings. The wider row treatments were 45cm (18") row spacings and for the straw treatments 6 t/ha was spread evenly over the plots immediately after sowing. This straw layer provided about 95% soil cover.

Table 1. Treatments and nitrogen fertiliser rates and timings for managing crop growth and water use at Hart in 2011.

Treatment	**Nitrogen fertiliser (kg N/ha) timing**			
	Sowing	**2nd August (GS31)**	**5th September (GS39)**	**Total**
Conventional crop	32	42	0	74
Reduced seed rate (50 kg/ha)	32	42	0	74
Slashed at GS30	32	42	0	74
Wide row (450mm)	9	42	23	74
Wide row (450mm) + 6 t/ha straw	9	42	23	74
Growth regulant at GS30	32	42	0	74
Delayed nitrogen	9	42	23	74
6 t/ha straw	32	42	0	74
High rate delayed nitrogen	9	42	74	125

42 kg N/ha was applied to all treatments at 1st node (GS31) and at full flag leaf emergence (GS39) nitrogen was added to the wider row spacing and delayed nitrogen treatments.

1 L/ha of chlormequat plant growth regulator was applied at the beginning of stem elongation (GS30) and the slashing plots were cut down to 10cm of height on the same day.

Dry matter cuts (2m of crop row) were conducted at flowering and unreplicated leaf samples were also collected. Gravimetric soil samples were collected on the 27th September, coinciding with flowering for the wheat and durum.

Plant counts and head counts were conducted during the season and all plots were assessed for grain yield, protein, wheat screenings with a 2.0 mm screen and barley screenings with a 2.2 mm screen and retention with a 2.5mm screen.

Pre-sowing plant available soil moisture was 70mm and soil nitrogen to 60cm was 82 kg N/ha

Results

Crop establishment was significantly lower for the wider row spacing treatments for all the crops, averaging 52 plants per square metre, compared to 132 for the other treatments (Table 1). The 6 t/ha layer of straw significantly reduced the barley crop emergence, down to 76 plants per square metre.

However, by early grain fill there was no difference in the number of heads per square metre in the barley (Table 1). Both the wheat and durum plots had lower head numbers in the wider row spacing and reduced seed rate treatments. While for the durum, delaying nitrogen application or slashing at stem elongation also reduced the number of heads produced.

Table 1. Crop establishment measured as plants per square metre and resultant heads per square metre for canopy management treatments at Hart in 2011.

Treatment	Plants per square metre			Heads per square metre		
	Wheat	Durum	Barley	Wheat	Durum	Barley
Conventional crop	131	151	110	295	286	572
Reduced seed rate (half 50 kg/ha)	87	99	56	296	236	578
Slashed at GS30	159	159	112	310	239	603
Wide row (450mm)	59	54	49	233	182	434
Wide row (450mm) + 6 t/ha straw	51	63	36	246	201	439
Growth regulant at GS30	130	148	104	354	298	501
Delayed nitrogen	130	156	102	302	253	453
6 t/ha straw	114	146	76	375	234	541
High rate delayed nitrogen	141	153	96	341	276	519
LSD (0.05)	21	29	23	64	71	ns

Wheat dry matter production and total crop nitrogen content was significantly lower for the wider row spacing treatments (Table 2). Plant and head numbers per square metre were also lower for these treatments. However, at flowering in the barley there was no difference in dry matter production or crop nitrogen content. There was no significant difference between the treatments in wheat or barley for total crop nitrogen concentration (not displayed).

Although the measurement of leaf boron concentration was not replicated (Table 2) it clearly shows for the wider rows and the addition of straw treatments producing lower boron concentrations, for wheat and barley. This was visually evident, resulting in greener canopies for these treatments. In the barley the wider row treatment with a layer of straw produced the lowest leaf boron concentration.

Table 2. Crop growth measured as dry matter production (t/ha), total crop nitrogen content (kg N/ha) and leaf boron concentration (ppm) at flowering for wheat and barley and canopy management treatments at Hart in 2011.

Treatment	Wheat			Barley		
	Dry matter (t/ha)	Nitrogen (kg N/ha)	Boron (ppm)	Dry matter (t/ha)	Nitrogen (kg N/ha)	Boron (ppm)
Conventional crop	7.7	91.9	32	10.4	159.4	59
Reduced seed rate (half 50 kg/ha)	7.8	109.3	27	11.1	151.3	67
Wide row (450mm)	6.0	82.9	23	10.5	141.4	61
Wide row (450mm) + 6 t/ha straw	5.7	82.0	18	10.3	164.9	38
Growth regulant at GS30	8.0	117.0	29	11.7	176.9	71
6 t/ha straw	8.8	120.1	22	8.6	147.2	63
LSD (0.05)	1.8	28.2	1 rep only	ns	ns	1 rep only

For all the crops grain yield was significantly lower in the wider row spacing treatments (3.14 t/ha) compared to the other treatments (3.49 t/ha) (Table 3). In the barley there was no significant difference between the remaining treatments, but for the wheat and durum the reduced seed rate and slashing treatments also significantly reduced grain yield. For all the crops applying a growth regulant at stem elongation, delaying nitrogen, applying 6 t/ha straw on 22.5cm row spacings or growing a conventional crop all produced statistically similar grain yields.

Grain protein in the durum and barley was significantly higher where grain yields were low, straw had been added to 22.5cm row spacings or the higher rate of nitrogen was applied. There was no significant difference between the treatments for the wheat protein. There was no significant difference between crops or treatments for screenings, retention or test weights (not displayed).

Table 3. Grain yield (t/ha) and protein (%) for wheat, durum and barley and canopy management treatments at Hart in 2011.

Treatment	Grain yield (t/ha)			Protein (%)		
	Wheat	Durum	Barley	Wheat	Durum	Barley
Conventional crop	3.66	3.18	3.87	11.0	11.3	10.3
Reduced seed rate (half 50 kg/ha)	3.32	2.94	3.66	11.7	11.9	11.0
Slashed at GS30	3.14	2.94	3.54	11.7	11.6	10.7
Wide row (450mm)	3.28	2.83	3.40	11.4	12.1	11.4
Wide row (450mm) + 6 t/ha straw	3.14	2.92	3.29	12.0	12.3	11.9
Growth regulant at GS30	3.89	3.26	3.75	11.1	11.3	11.4
Delayed nitrogen	3.64	3.35	3.77	11.4	10.6	11.0
6 t/ha straw	3.79	3.19	3.45	10.7	11.8	11.3
High rate delayed nitrogen	4.13	3.28	3.52	11.7	11.7	11.4
LSD (0.05)	0.53	0.22	0.37	ns	0.68	0.52

The wider rows and wider rows with 6 t/ha straw treatments produced significantly higher grain weight (51.5 mg) for the barley (Table 4). Grain weight was not significantly different between any of the treatments in the wheat (37.1 mg) and durum (35.8 mg).

For all the crops the number of grains produced per square metre was significantly lower in the wider row spacing and reduced seed rate treatments (Table 4). These treatments averaged 7840 grains per square metre while the other treatments averaged 8980 grains per square metre, 15% more. In the wheat slashing at stem elongation also significantly reduced grain number.

Table 4. Grain weight (mg/grain) and grains per square metre produced for all crops and treatments at Hart in 2011.

Treatment	Grain weight (mg/grain)			Grains per square metre		
	Wheat	Durum	Barley	Wheat	Durum	Barley
Conventional crop	38.0	35.1	46.1	9657	9062	8396
Reduced seed rate (half 50 kg/ha)	37.4	34.7	47.1	8847	8486	7780
Slashed at GS30	35.1	34.3	43.7	8934	8948	8119
Wide row (450mm)	36.8	35.7	48.3	8417	7928	6646
Wide row (450mm) + 6 t/ha straw	38.6	36.7	51.5	8144	7964	6355
Growth regulant at GS30	37.5	35.9	44.6	10395	9094	8405
Delayed nitrogen	37.1	36.7	46.7	9905	9152	8076
6 t/ha straw	38.5	35.8	46.1	9840	8895	7889
High rate delayed nitrogen	34.7	37.4	45.1	11069	8782	6984
LSD (0.05)	ns	ns	2.4	1304	540	592

In the barley soil moisture measurements at flowering showed only very small differences between the treatments (Table 5). The total moisture content down to 90cm ranged from 108.5 mm (reduced seed rate) to 123.9 mm (6 t/ha straw) across the treatments, a difference of only 15mm. This difference was significant in the 50-70cm and 70-90cm soil layers. The two treatments with 6 t/ha straw had significantly higher soil moisture at both depths.

In the wheat there was less than 10mm difference between the treatments for the 90cm total core, which was not significant.

Table 5. Total soil moisture for increments down to 90cm and total moisture content at anthesis in barley for canopy management treatments at Hart in 2011.

Treatment	Total soil moisture (mm)				
	0-20cm	20-50cm	50-70cm	70-90cm	Total
Conventional crop	21.2	32.8	25.4	32.6	112.0
Reduced seed rate (half 50 kg/ha)	19.1	30.0	25.2	34.2	108.5
Wide row (450mm)	20.2	34.6	29.0	32.2	116.0
Wide row (450mm) + 6 t/ha straw	20.8	32.9	28.6	35.8	118.1
6 t/ha straw	19.7	34.9	33.7	35.6	123.9
LSD (0.05)	ns	ns	2.8	3.1	

The wet 2011 summer provided an opportunity to reduce early crop growth and aim to conserve moisture for grain fill. None of the treatments used to manipulate the crop canopy positively influenced crop growth or grain yield. This was supported by little difference in soil moisture remaining at flowering.

The dry and warm period in August and September meant that crops with a lower number of grains set per square metre had a limited grain yield potential. Although the treatments with straw visually stayed greener for longer and had lower levels of boron, they were unable to produce extra grain yield. Possibly they produced too few grains per square metre, weren't encouraged to develop a deep enough root system or all the treatments were limited by the high boron subsoil.

This is particularly relevant given that the addition of a straw layer produced significant grain yield increases at other sites in 2011.

Effect of straw keeping crop greener

Allergic to bees??

Canopy management; wide v conventional

WUE – Condowie site

WUE – Saddleworth site

Yield and water use improvements of South Australian wheat varieties from 1957-2007

Funded by the GRDC Water Use Efficiency Initiative. Conducted by Chris Lawson and Victor Sadras, SARDI

Key findings

- An increase of wheat grain yields released between 1957 and 2007 was found.
- Yields have increased because of improved harvest index, more biomass at flowering, and increased grain number.
- Nitrogen is critical in allowing each variety to reach its potential through increasing growth rate between stem elongation (GS31) and flowering.
- WUE has improved over the 1957-2007 timescale through increased yields, not greater extraction of water.

Why do the trial?

In 2010 the initial 'Historical Trial' was conducted over three sites. The work showed a steady increase in yields over the variety time scale. In 2011 the trial was repeated at Hart and Roseworthy, with the addition of high and low nitrogen treatments. Both trials monitored water use with a capacitance probe installed in each plot. The purpose of this trial is to update the water use efficiency benchmark of 20 kg/ha/mm derived from French and Schultz. The benchmark should be updated to account for the advances made in wheat breading over the past 50 years.

How was it done?

Plot size 1.4m X 10m

Fertiliser

High Nitrogen:
- 90 kg DAP at sowing
- 160 kg/ha urea on 29th July
- 50 kg/ha urea on 7th September

Low Nitrogen:
- 90 kg DAP at sowing

Seeding date Hart: 30th May
Roseworthy: 7th June

13 varieties released between 1957 and 2007 were used. They were; Heron (1958), Gamenya (1960), Halberd (1969), Condor (1973), Warigal (1978), Spear (1984), Machete (1985), Janz (1989), Frame (1994), Krichauff (1997), Yitpi (1999), Wyalkatchem (2001), and Gladius (2007).

Results

In the 2010 season we found the annual rate of yield improvement was 25 kg/ha. In the 2011 trails this rate of improvement dropped to 15 kg/ha. We expect the rate to fluctuate year on year depending on the environmental yield, the 2010 season average yield for the trial was 4.2 t/ha at Hart, while in 2011 it was 3 t/ha, hence the reduced rate of improvement.

Improved harvest index is one of the reasons for the increase in yield over time (Figure 1). In varieties released after the 1980s grain number increased, this observation was consistent over both 2010 and 2011 seasons. In 2010 we found that increased yield was correlated to greater biomass at flowering, this was also the case in 2011, although there was no significant difference among the varieties.

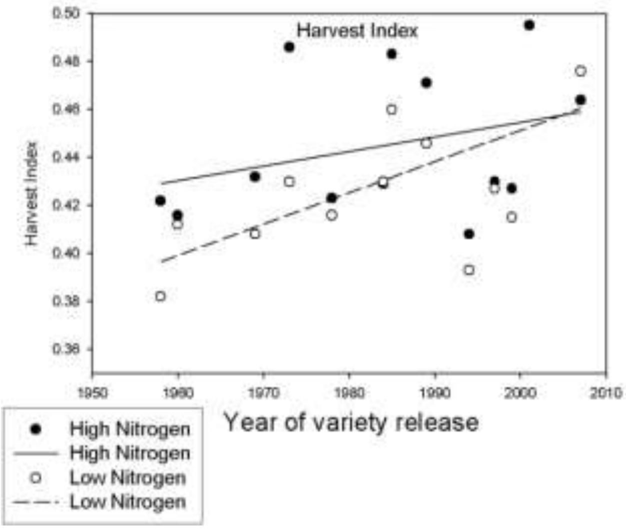


Figure 1: Harvest index for all varieties and nitrogen treatments. Linear regression shows trends for nitrogen treatments.

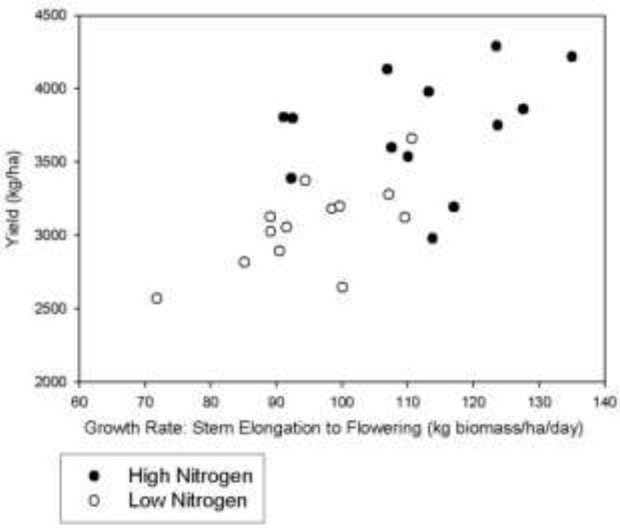


Figure 2: Relationship between grain yield and growth rate between stem elongation and anthesis for high and low nitrogen treatments.

The addition of nitrogen increased growth rate between stem elongation and flowering. This increased growth rate had a strong correlation with final yield (Figure 2). This has implications for farm management as it shows having adequate nitrogen is critical to capture yield potential.

Wheat varieties have increased yield under the same water uptake, hence water use efficiency has improved. The total water use from each variety did not differ, which was consistent in both 2010 and 2011. The major advances in breeding have come through improved plant physiology rather than improved water uptake. These advances mean a WUE benchmark closer 25 kg/ha/mm should be used.

Cropping systems

Funded by Caring for Our Country and conducted in collaboration with farmers Michael Jaeschke and Matt Dare, South Australian No Till Association, and Rocky River Ag.

Key findings

- The no-till sowing system had significantly higher grain yields at Hart in 2011.
- Higher fertiliser nutrition significantly increased protein, but not grain yield.
- The strategic treatment produced the most dry matter and shoot nitrogen.
- Mice damage significantly reduced crop emergence in the disc treatment.

Why do the trial?

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

How was it done?

Plot size	35m x 13m	**Fertiliser**	DAP @ 100 kg/ha
		High nutrition	UAN @ 70L/ha and Twin Zinc @0 .5L/ha 29th July
Seeding date	Disc: 14th June No-till: 8th June Strategic: 12th June	**Medium nutrition**	No extra fertiliser applied
		Variety	Correll wheat @ 100 kg/ha

This trial is a randomised complete block design with 3 replicates, each containing 3 tillage treatments and 2 nutrition treatments. The strategic treatment was sown using local farmer Michael Jaeschke's seeding equipment. The disc seeding treatments was sown by Andrew Bird from the South Australian No Till Association. The No-till treatment was sown by David Cliff of Rocky River Ag.

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

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Sloop Barley	Canola	Janz Wheat	Yitpi Wheat	SloopSA Barley	Kaspa Peas	Kalka Durum	JNZ Wheat	JNZ Wheat	Flagship barley	Clearfield canola

Tillage treatments:

Disc – sown into standing stubble with Serafin Baldan single discs on 400mm (16") row spacing, closer wheels and press wheels.

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

No-till – sown into standing stubble in 1 pass with Flexicoil PD 5700 drill, narrow points with 300mm (12") row spacing and press wheels.

Nutrition treatments:
Medium – No extra fertiliser applied post seeding.
High – UAN applied at 70 L/ha and Twin Zinc at 0.5 L/ha, July 29th.

Soil nitrogen (0-60cm) was measured on 20th May in all plots.

For the plant counts, 4x1m sections of row were counted across each plot.

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

All plots were assessed at awn emergence (GS49) for dry matter yield, and tissue analyses conducted to determine total crop nitrogen, zinc content, and phosphorus content.

Results

Tillage treatments significantly influenced the grain yield and quality of Correll wheat in this trial at Hart in 2011 (Table 2). The no-till treatment yielded the highest (2.51 t/ha), followed by the strategic (2.22 t/ha) and disc (1.73 t/ha). However, there may also have been a time of sowing factor involved in these results as the no-till treatment was sown 4-6 days earlier than the other treatments. Row spacings (400mm) in the disc treatment may also have had a negative impact on yield.

There was no significant difference in grain yield between the two nutrition treatments.

The no-till treatment had the lowest grain protein which may reflect an inverse relationship to grain yield. Grain protein was significantly higher (12.7%) in the higher nutrition treatments than the medium treatments (10.2%). This may be explained by higher soil nitrogen (Table 3) and greater crop nitrogen (Table 4) in the high nutrition treatments compared to the medium. Screenings were significantly higher in the disc treatments (1.9 %) compared to the other tillage treatments (1.3 %) but were within industry recieval standards. Grain weight, although significantly lower (76.3 kg/hL) in the high nutrition treatments than in the medium (78.2 kg/h L) were all within industry receival standards (Table 2.)

Table 2. Grain yield (t/ha), protein (%), screenings (%), and test weight (kg/hL) for nutrition and tillage treatments at Hart in 2011.

Nutrition	Tillage	Grain yield (t/ha)	Protein (%)	Screenings (%)	Test Weight (kg/hL)
High	Disc	1.75	12.1	2.0	76.0
	No-till	2.53	12.6	1.5	77.0
	Strategic	2.15	13.4	1.7	76.0
Medium	Disc	1.71	10.6	1.8	77.3
	No-till	2.49	8.9	1.0	79.0
	Strategic	2.30	11.2	1.1	78.4
LSD (0.05)					
Tillage		0.16	0.62	0.50	1.12
Nutrition		ns	0.51	0.41	0.92
Tillage * Nutrition		ns	0.88	ns	ns

Soil available nitrogen to 60cm was measured in autumn and ranged between 52 kg N/ha (disc, medium) and 101 kg N/ha (strategic, high) between the tillage treatments (Table 3). The strategic tillage treatment had significantly higher soil nitrogen. The high nutrition treatments had accumulated 27.8 kg N/ha more soil available nitrogen compared to the medium treatments to a depth of 60cm. These results are consistent with those measured in previous years.

Crop emergence was highly variable with the no-till seeder producing significantly higher plant numbers (210 pl/sqm). The disc treatment produced 104 plants/square metre less than the no-till treatment due to mouse damage (Table 3).

Table 3. Available soil nitrogen (kg/ha), seedling emergence (plants/sq m) and dry matter at awn emergence (t/ha) for nutrition and tillage treatments at Hart in 2011.

Nutrition	**Tillage**	**Available soil nitrogen (kg N/ha)**	**Emergence (plants per sq m)**	**Dry matter (t/ha)**
High	Disc	65	97	3.8
	No-till	62	207	4.8
	Strategic	101	179	5.4
Medium	Disc	52	114	3.4
	No-till	55	213	3.8
	Strategic	60	152	5.1
LSD (0.05)				
Tillage		ns	22	0.7
Nutrition		21.2	ns	0.5
Tillage * Nutrition		ns	ns	ns

Dry matter produced in the high nutrition treatments (4.7t/ha) was significantly higher compared with the medium nutrition treatments (4.1t/ha). Although crop emergence was lower in the strategic treatment compared with the no-till, by awn emergence the strategic treatment had grown greater biomass.

Total crop nitrogen content was significantly higher (86.5 kg/ha) in the high nutrition treatments compared with the medium nutrition treatments (58.7 kg/ha). Also, significantly higher crop nitrogen was measured in the strategic treatment (93.1 kg N/ha) compared to the no-till (66.8 kg N/ha) or disc treatment (58.0 kg N/ha) (Table 4).

Although the strategic treatment produced significantly more dry matter and accumulated more shoot nitrogen, it did not produce the highest grain yield. However, it did produce significantly higher levels of grain protein (Table 2) resulting from greater levels of soil and crop nitrogen.

The application of foliar zinc on July 29th in the high nutrition treatment produced significantly higher tissue zinc levels (26.6 ppm) compared with the medium nutrition treatments (16.9 ppm) where no zinc was added.
There were no significant differences in phosphorus tissue levels between tillage or nutrition treatments.

Table 4. Total crop nitrogen content (kg/ha) and leaf nutrient content of zinc and phosphorus at awn emergence (GS49) for tillage and nutrition treatments at Hart in 2011.

Nutrition	**Tillage**	**Total Crop nitrogen (kg N/ha)**	**Tissue test GS49**	
			Zinc (ppm)	**Phosphorus (%)**
High	Disc	66.2	24.1	0.19
	No-till	84.3	26.9	0.22
	Strategic	109.0	29.0	0.22
Medium	Disc	49.7	15.2	0.21
	No-till	49.3	19.4	0.23
	Strategic	77.2	16.2	0.22
LSD (0.05)				
Tillage		16.9	ns	ns
Nutrition		13.8	6.4	ns
Tillage * Nutrition		ns	ns	ns

Increasing the value and marketability of feed grains

This trial is funded by the GRDC and SAGIT and conducted by Productive Nutrition Pty Ltd

Key findings

- Oats demonstrated the greatest variation in ME between samples, with values ranging from 12.8 to 13.9 MJ ME/ kg DM.
- Due to the greater variation in ME for oats than other cereal grains, testing to determine nutritive values is recommended.
- Average ME at 13.6 MJ ME/ kg DM and protein at 13.2% were high for cereal grains and appeared to be consistent across varieties and between sites.

Why do the trial?

The project aims to quantify and potentially exploit the variation in nutritive value of a range of cereal grains that come on to the feed market in South Australia to increase grain trading options for grain growers.

As growing seasons across southern Australia appear to be more variable, the ability to finish livestock to a saleable weight without grain supplementation is becoming an increasing challenge. The demand for feed grains is predicted to grow, with increasing interest from livestock producers in sourcing grain based on the predicted value to livestock, rather than purely on a $/t basis. Knowing the nutritive value of grain is important to livestock producers, as it allows the most cost effective feeding strategies to be implemented.

How was it done?

Grain samples from twelve sites across South Australia, including the Hart Field Site have been sourced for analysis to identify the variation in nutritive value across species, variety, replicate, rainfall region, site and season. The species and varieties sourced from Hart for the 2010 season are listed in Table 1.

Results

The nutritive value of cereal grains in the 2010 season varied across species, varieties and locations. There were however, distinct trends in the nutritive value of each species, especially in the metabolisable energy (ME) and protein levels of each grain. The results from the Hart site are shown in Table 1.

The relatively high fibre levels compared with other cereal grains (average NDF 30.6%) means they are a safer feed grain for livestock. This along with the high ME (average of 13.36 MJ ME/ kg DM), indicates that oats have the potential to become a preferred cereal grain to feed to livestock; this largely disproves a commonly held belief that oats should be provided at a price discount and are a feed of lesser quality than other grains.

Table 1 Average nutritive value of cereal grains sampled from the Hart Field Site in 2010

		Est Metabolisable Energy (MJ ME/ kg DM)	Crude Protein (CP %)
Oat Grain			
Milling varieties	Euro	12.9	9.5
	Mitika	13.6	11.7
	Possum	13.3	9.9
	SV97181-12	13.3	9.8
	SV98146-26	12.9	9.1
	SV98185-27	13.3	10.2
Feed varieties	Echidna	13.3	8.5
	Potoroo	13.4	9.2
	Wintaroo	13.5	10.4
	Yallara	13.2	10.4
Average values		**13.3**	**9.9**
Barley Grain			
Malting varieties	Baudin	13.5	9.6
	Buloke	13.5	8.9
	Commander	13.4	9.2
	Gairdner	13.4	9.9
	Schooner	13.5	10.0
Feed varieties	Fleet	13.5	9.8
	Hindmarsh	13.5	9.8
	Keel	13.4	9.6
	Maritime	13.4	10.3
Average values		**13.5**	**9.7**
Triticale Grain			
Triticale varieties	Bogong	13.5	11.1
	Hawkeye	13.5	11.8
	Jaywick	13.5	11.8
	Rufus	13.5	11.8
	Tahara	13.5	11.6
Average values		**13.5**	**11.6**
Wheat Grain			
Hard varieties	Axe	13.6	12.8
	Correll	13.6	11.8
	Gladius	13.6	12.8
	Mace	13.6	11.9
	Yitpi	13.6	11.7
APW varieties	Espada	13.6	12.1
	Scout	13.6	11.5
	Wyalkatchem	13.6	11.7
Average values		**13.6**	**12.0**

Oats demonstrated the greatest variation in ME between samples, with values ranging from 12.8 to 13.9 MJ ME/ kg DM (Figure 1). This variation in oat ME was replicated between all sites (Figure 2), with the ME of oats from the Hart site being relatively consistent with ME values of samples from Nunjikompita, Riverton and Crystal Brook. Oat samples from Waikerie showed higher ME values than all other sites at an average of 13.53 MJ ME/ kg DM. The variation in ME was greater for oats than other cereal grains, therefore testing to determine nutritive value is recommended.

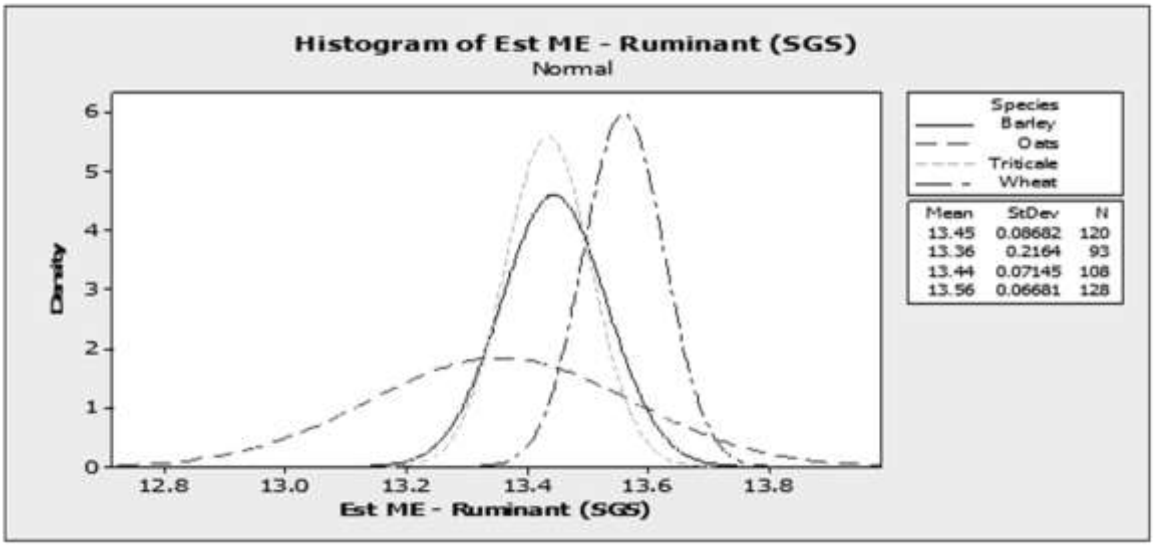


Figure 1 Variation in ME between cereal grains from 2010 season samples

75% of malt barley varieties in 2010 failed to meet market specification. Of these samples 30% were downgraded due to protein levels below 9%, with 11% downgraded for high protein (>12%).

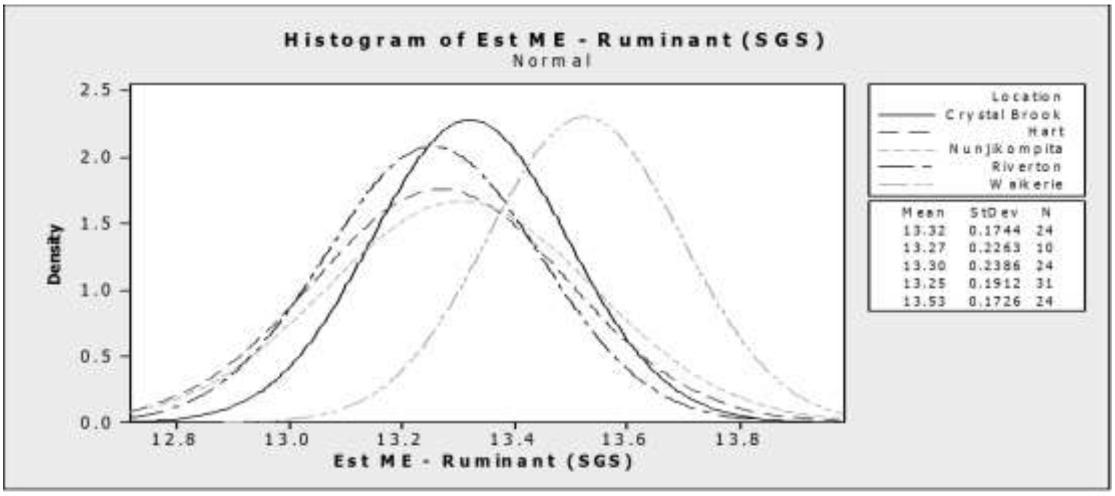


Figure 2 Variation in oat ME between sites from 2010 season samples

Although 93% of malting barley varieties at the Hart site were outside of Malt 1 specifications, only a small proportion (9%) were downgraded for low protein. Average protein values of samples from Hart were 9.6% (Figure 3). The majority of malting barley samples at Hart were downgraded due to low test weights at an average of 51.7kg/ hl, with only 6% above 65kg/ hl.

Hindmarsh barley, a feed variety which has the potential to be reclassified to Malt, has demonstrated promising nutritive values in the 2010 season. Average ME of Hindmarsh across all sites was 13.39 MJ ME/ kg DM and the grain displayed adequate levels of protein at 10.1%.

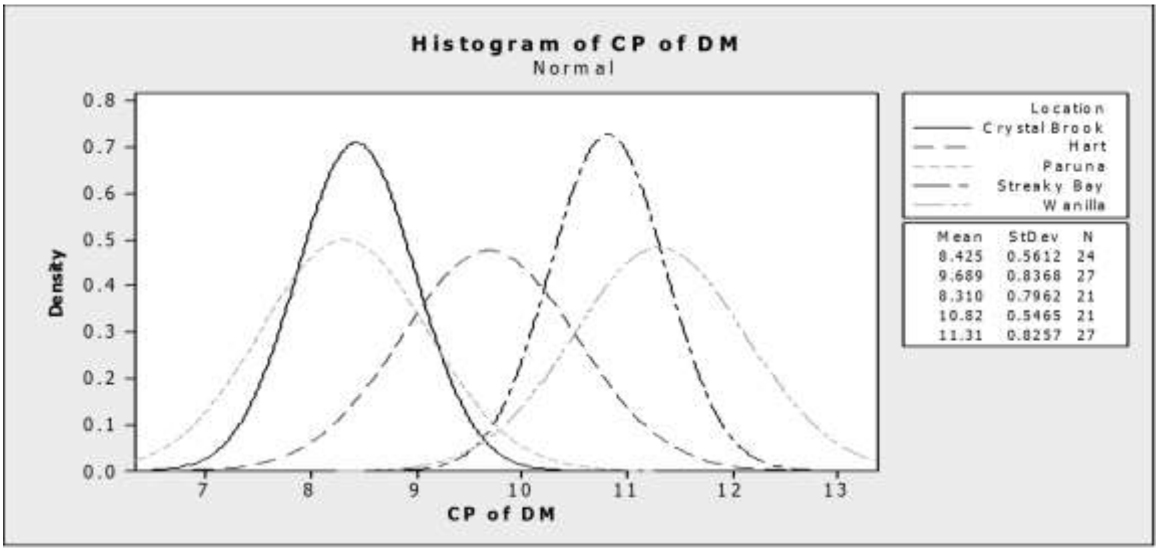


Figure 3 Variation in barley crude protein (%) between sites from 2010 season samples

While care should be taken when feeding triticale to livestock, due to its low fibre levels (average 12.5%) and therefore increased risk of acidosis, triticale analysed from the 2010 season has shown consistently high ME and protein levels. The average ME for triticale between all sites in 2010 was 13.4 MJ ME/ kg DM and average protein levels were 13.3%, with little variation shown between varieties. However the protein levels of triticale grain at the Hart site averaged 11.6%.

Similarly care needs to be taken when feeding wheat to livestock, with wheat samples analysed from the 2010 season showing low fibre values at an average of 11% NDF, significantly below oats at 30.8% NDF. Average ME at 13.6 MJ ME/ kg DM and protein at 13.2% were high for cereal grains and appeared to be consistent across varieties and between sites. Wheat samples analysed from the Hart site had the most consistent ME of all sites showing no variation at 13.6 MJ ME/ kg.

These results from the 2010 season indicate that there is potential to increase financial returns for each grain species, when it is marketed based on its nutritive value instead of via traditional marketing methods. For example, a discount of $50/ t for oats, against wheat when sold via traditional methods, may be improved when sold to livestock producers based on nutritive value. Similarly, if malting barley was downgraded due to excess protein, the price discount may be mitigated by selling on its nutritive value.

While it is encouraging that some trends appear in the 2010 results, further analysis over the next two seasons will assist in determining the strength of these trends and the influence of factors such as season, species and variety.

If trends are consistent, these may assist in the decision making process when determining which species or variety to sow for feed quality and to identify those that have the potential to maximize returns to growers under adverse seasonal conditions. A tool will be developed to provide growers with access to information on the potential dollar value of their grain when it is based on its production potential to livestock producers.

Analyses of grain samples from the 2011/2012 season are currently underway, with extension of these results planned for the 2012 Hart Field Day in September. For more information please contact Lauren Costin, Productive Nutrition on 08 88423192 or visit www.productivenutrition.com.au.

Yield Prophet® performance in 2011

Key findings

- Yield prophet accurately predicted the final grain yield of 3.0t/ha.
- Predictions made in mid-August using an average finish to the season have been 80% accurate.

Why do the trial?

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

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

The *Yield Prophet®* (YP) wheat growth model has been very accurate throughout Australia over the past 6 years in a range of soil types and seasons. At 4 sites in the Mid-North over the past 5 seasons YP has demonstrated this accuracy by providing accurate yield predictions with an average finish in mid-August (Figure 1).

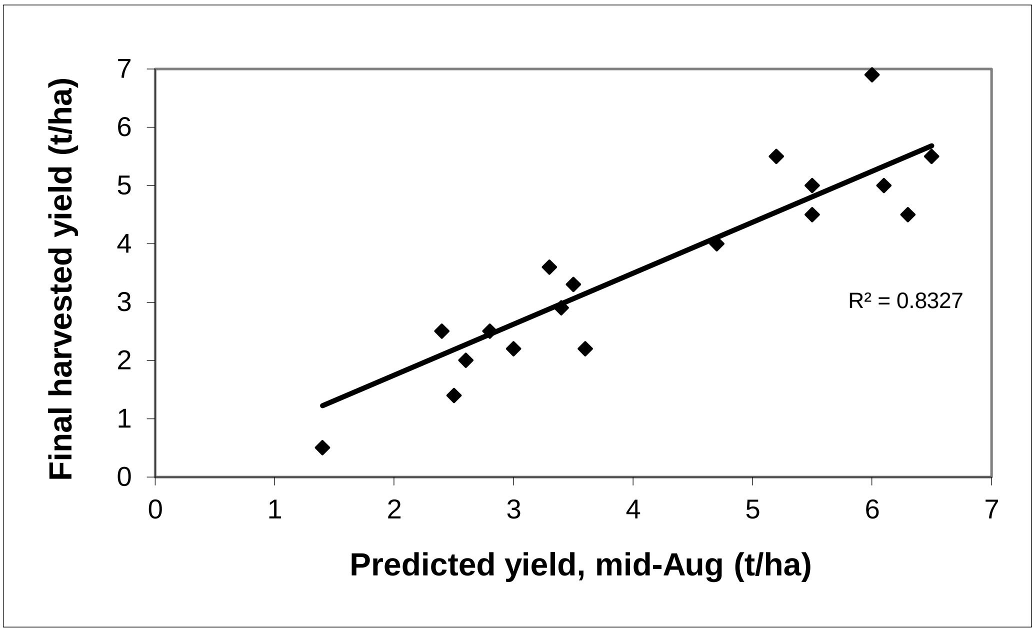


Figure 1. The relationship between predicted yield in mid-August, given an average finish to the season, against harvested grain yield. The sites and seasons include Spalding, Condowie, Tarlee (for 2009 and 2010), and Hart (2005 to 2011).

This early prediction of grain or hay 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	30th May 2010	**Fertiliser**	DAP @ 50 kg/ha UAN @ 70 L/ha 29th July
Variety	Gladius wheat @ 80 kg/ha		

Soil samples were taken for soil nitrogen and moisture on the 11th May 2011.

Table 1: Soil conditions at Hart (0-90cm), 11th May 2011.

Available soil moisture	70 mm
Initial soil N	157 kg/ha

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

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

Results

The grain yield for Gladius wheat sown on the 30th May at Hart in 2011 was 3.0 t/ha. This final grain yield matched the Yield Prophet® prediction (Figure 1).
At the first simulation, 5th July 2011, the Yield Prophet® simulation predicted that Gladius wheat sown on the 30th May would yield 4.0t/ha in 50% of years. The predicted grain yield decreased steadily throughout the growing season, due to only moderate winter rainfall rain and mild temperatures. The Yield Prophet® on the 9th October for grain yield, given an average (50%) finish to the season, was 3.2 t/ha.

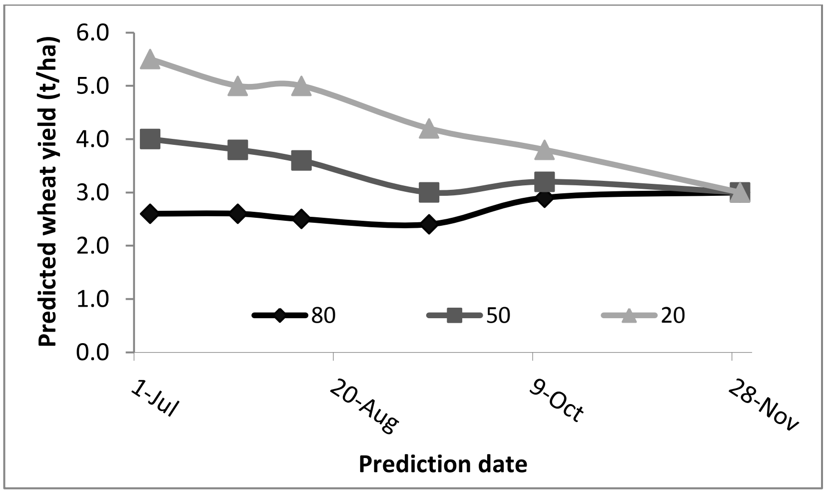


Figure 1: Yield Prophet® predictions from 1st July to the 28th November for Gladius wheat sown on the 30th May with 50 kg/ha DAP. 80%, 50% and 20% represent the chance of reaching the corresponding yield at the date of the simulation.

At time of sowing plant available water (PAW) measured 0mm (0-90cm). Figure 2 shows that at the first simulation on the 5th of July, PAW was over 60mm due to high levels of stored moisture from summer and autumn rains. PAW decreased significantly during August and continued to drop until boosted by further rains in September and October. With greater crop use and higher temperatures, it dropped to below 10mm PAW by the end of October.

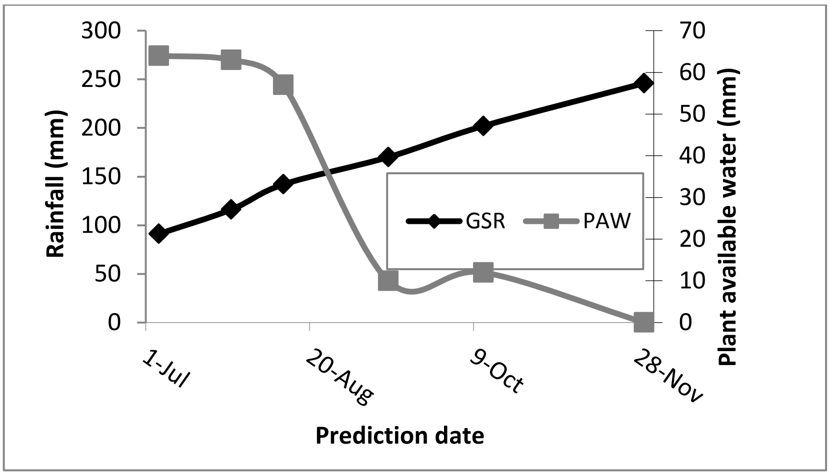


Figure 2: Predicted plant available water and recorded cumulative growing season rainfall from 5th July to the 28th November at Hart in 2011.

Getting The Crop In seminary 2011

Predicting yield variability across paddocks

Funding from Caring For Our Country

Key findings

- There was good correlation between yield predicted from historical yield maps and actual yield data.
- Wind during harvest caused over 0.5t/ha yield loss in the lower yielding areas of the paddock.

Why do the trial?

To assess the usefulness of using historical yield data to predict future yields and adjust fertiliser rates according to production zones.

How was it done?

Historical cereal yield data from seasons 2004, '05, '07, '08 and '10 were used to create production zones based on a mid-year prediction that the paddock would average 4t/ha grain yield. The data years utilised had previously produced complete and realistic yield maps.

The historical production zones were compared with the actual yield map from harvest.

Results

The paddock was harvested over several days. Harvest began on 29th November but was stopped by windy weather and completed on the 1st and 2nd of Dec. Arrows on Figure 1 (see last page of this article) indicate the areas harvested before the wind, ie. the head lands and the western side. The thinner lower yielding areas that were standing suffered more yield loss due to head loss as the plants were able to shake more. The losses in these areas were over 0.5t/ha and equated to 110 heads per square metre that were on the ground and not able to be harvested in the worst areas. The thicker higher yielding areas had already lodged and did not shake as much and the yield loss in these areas due to head loss was negligible.

The production zone map created mid-year had a good correlation with the actual yield map, although there are some discrepancies, some of which can be explained by the effect of head loss due to windy conditions (Figure 2).

This result demonstrates the usefulness of previous yield maps and the potential accuracy of this data. It is important to remember that the production zone map was created for above average season (4 t/ha) and that it may look different in other seasons.

Acknowledgement:

The Hart Field-Site Group wish to thank Robert and Glenn Wandel for the use of their barley crop and their cooperation with this trial work.

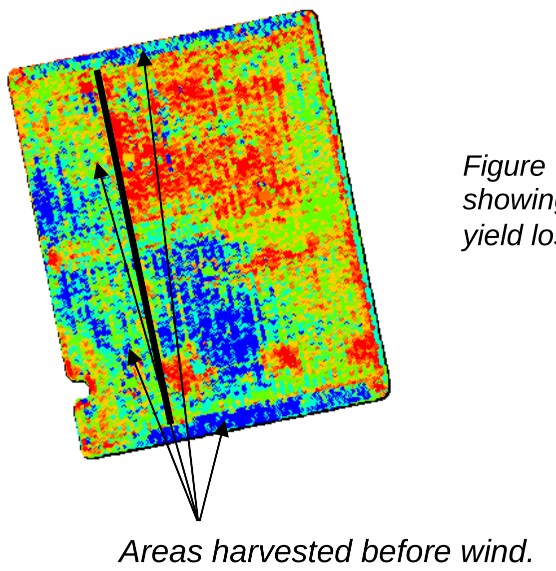


Figure 1: The 2011 yield map showing the effect of wind on yield loss due to barley head loss.

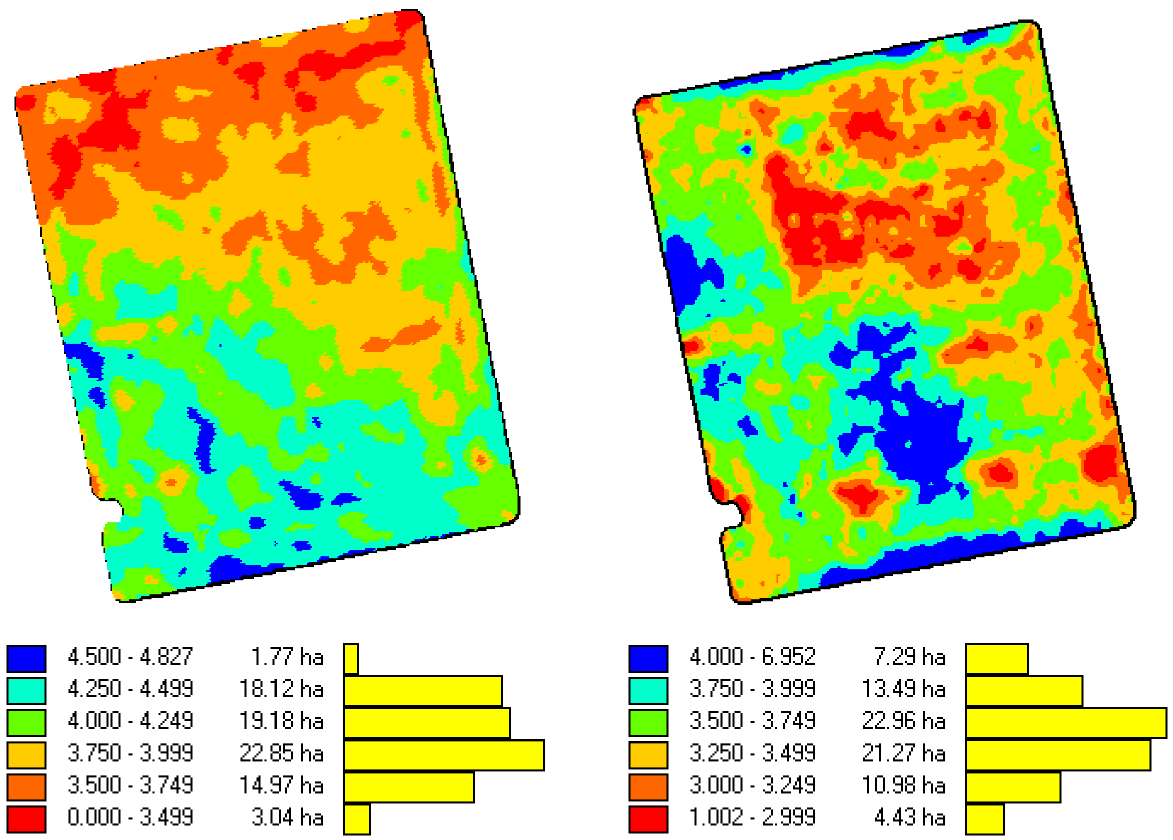


Figure 2 a) The production zone map based on historical cereal yield data from 2004, '05, '07, '08 and '10 and an average expected yield of 4 t/ha, b) the actual 2011 barley yield map, with errors due to barley head loss.

Increasing economic returns of agronomic management using precision agriculture

Michael Wells PCT, Peter Treloar, Felicity Turner.

Just south of the Hart Field Trial site Glen and Robert Wandel farm on the property Firgrave. In 2008 paddock No 5 was sown to wheat. At the end of what was a drier season a yield map (fig 1 – see last page of this article) was created from the paddock.

The paddock averaged 2.87t/ha but had yield ranging from 1.8t/ha up to 4.18t/ha. The paddock had consistent management across the yield ranges, thus creating a large variation in gross margin.

This raises questions about the variation in yield; first what is causing it? Can I fix it? Or can I manage my risk to it?

Firgrave is one of 5 locations across SA that have an area of the farm participating in a 3 year SAGIT funded project. 'Increasing economic returns of agronomic management using Precision Agriculture'. This project aims to improve the use of modern technology in identifying and managing paddock variation, with the overall outcome being improved management and gross margins for the farmers.

The initial key opportunities that will be targeted with the project on Firgrave are seeding and post nitrogen, phosphorus fertiliser, soil amelioration for sodicity and targeting ryegrass areas.

What has happened to date?

The initial stages of the project have been targeted at gathering information. This has included grain yield, elevation and soil surveys.

Mapping the Soil

Two types of soil sensors have been used to help us map the changes in soil conditions over the paddocks including Electro Magnetic (EM) and Gamma Radiometrics. The maps created show where the soil profile changes but to really understand what the crop sees when it is searching for moisture, deep cores have been collected and analysed.

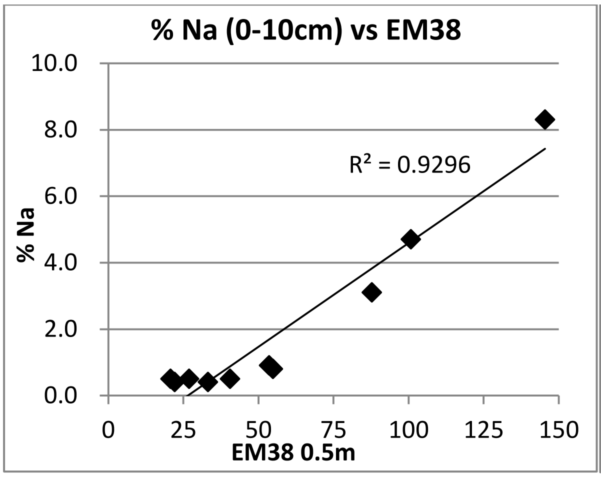
Water movement

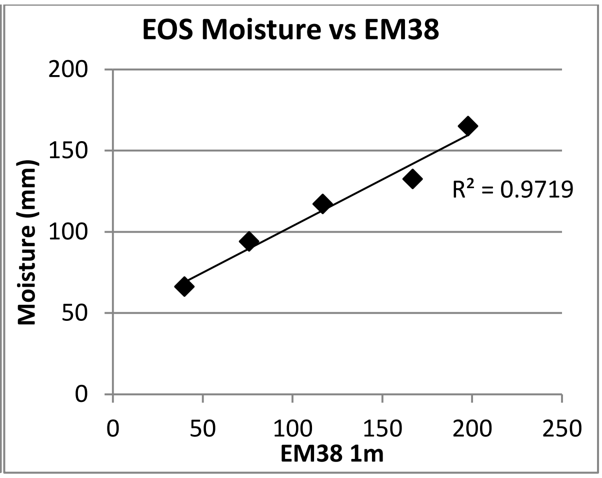
RTK GPS elevation information has also been used to map where water can potentially move across each paddock as there will be differences in how long water has to infiltrate into the profile and store there for the crop to use.

How does this relate to yield

Historical yield maps have been analysed against the soil sensor and topography maps to assess how well they are related, then the soil core information used to identify the actual cause and what potential management changes can be made. Figure 2 (see last page of this article) is an example of an outcome from comparing the maps of soil change to the wheat yield map from 2008. It is suggesting a trend that as the EM map value increase the amount of yield produced declines.

To understand why the EM is affecting yield we need to look closely at the soil test results, the two factors most strongly following the EM are salinity and sodicity. Both these factors affect a plants ability to extract moisture from the soil, as can be seen by the end of season moistures collected in November 2011.





What are the next steps?

The main agronomic issues to be assessed in 2012 are:

- Targeting of seeding and post seeding nitrogen applications in line with identified changes in soil water characteristics ie changes in the ‘bucket’
- Assessment of gypsum applications over soil zones identified as having variations in sodicity levels. A trial has already been implemented which will allow economic assessment for several years.
- Sound agronomic and economic phosphorus fertiliser management in line with changes in productive capacity of soil zones and responsiveness of soil types to phosphorus applications.

Further information

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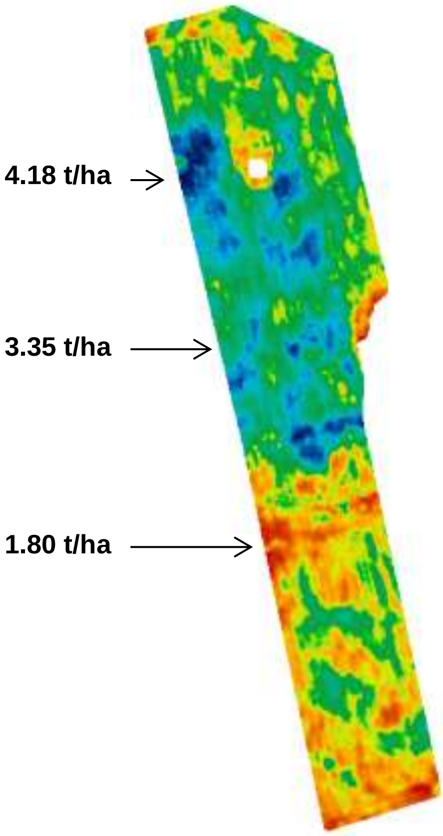


Figure 1. Wheat yield from 2008 season showing low and higher yielding areas within paddock No 5.

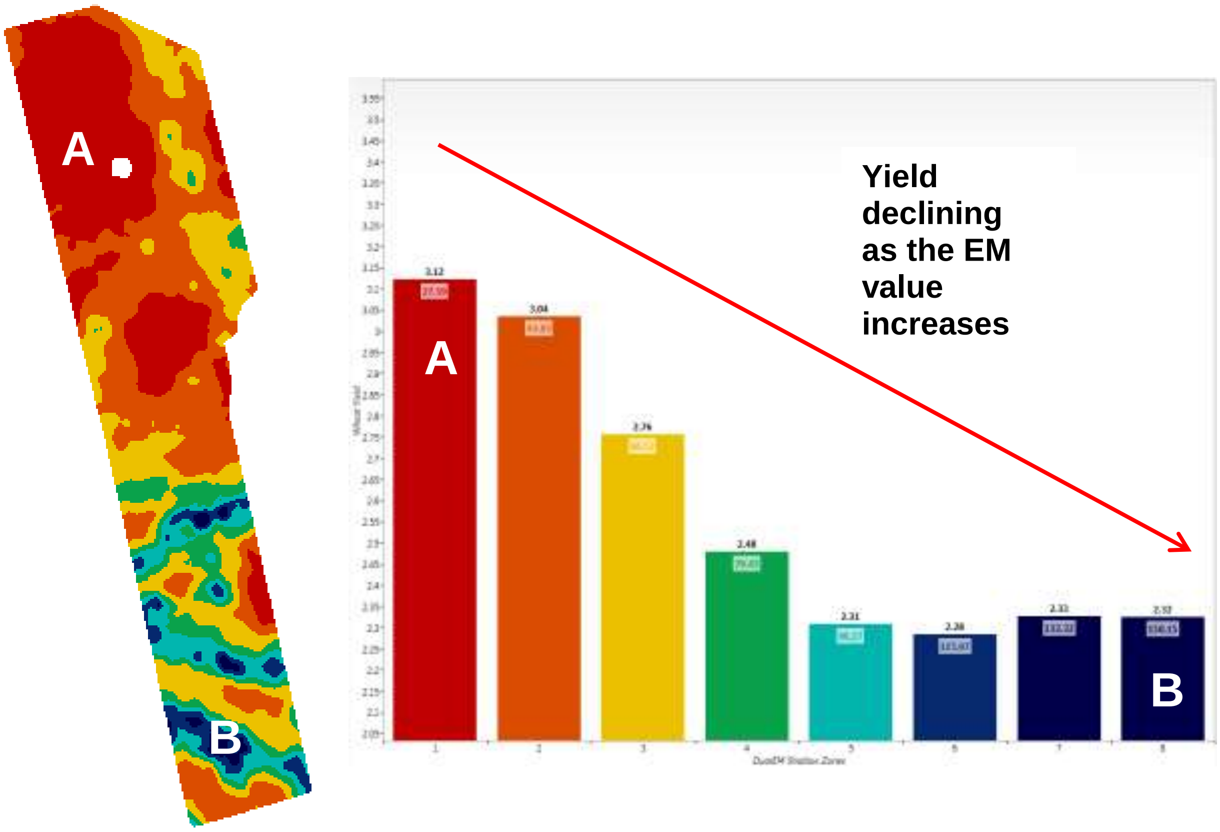


Figure 2. 'A' is a low EM area with highest wheat yield 2008, 'B' is a high EM area with lowest wheat yield.

Phosphorus rates across zones within a paddock at Kybunga

Funded by the GRDC and conducted by Sam Trengove, SPAA Precision Agriculture Australia, 2010

Key findings

- Results from this trial indicate that on large areas (85%) of the paddock P rates could be cut significantly with no loss of yield in the short term. However, this will lead to a decline in P reserves and yield losses would be expected in future years.

Why do the trial?

To compare the effects of P rates on barley yields across production zones.
To assess the effects of P rates on plant and grain P concentrations.

Up until recently the fertiliser has been applied uniformly, regardless of variability in soil type and yield potential of different paddock zones. This often results in variable levels of soil available P as variable crop yields mean that the removal of P from the paddock is also variable. So, areas of consistently lower yields tend to build up P as less is removed and areas of higher yields tend to have lower P levels as more is removed. Variable rate applications of fertiliser provide an opportunity to match the fertiliser input to crop requirement in each part of the paddock.

This trial aimed to establish what the variability in soil P is across the trial paddock and investigate what impact that has on the responsiveness of the crop to P fertiliser.

How was it done?

The trial paddock is 200ha and is located approximately 3km west of Kybunga, in the Mid North of SA, where it receives an average annual rainfall of 400mm. The soils in the paddock range from sandy dunes to heavier loamy swales, with some areas of shallow rock with grey calcareous soils.

The paddock was zoned into three zones using K-means clustering of three historical yield maps from 2006 (wheat), 2007 (barley), and 2008 (canola). These three seasons were dryer years and the resultant zone map depicts the soil types quite well according to the growers' knowledge. The paddock was soil tested with samples targeted within each zone (Figure 2a).

Historical Landsat imagery was also compiled from images captured in the growing seasons of 2004, 2005, 2006, 2007 and 2009 (Figure 2b).

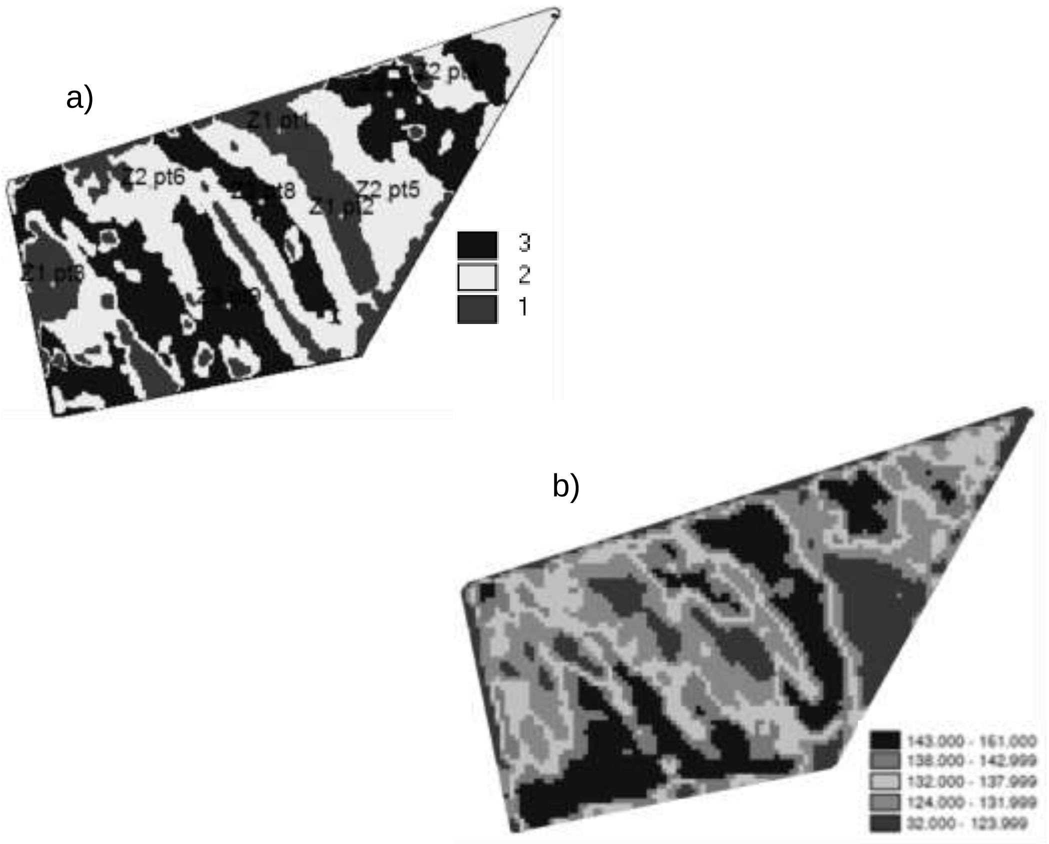


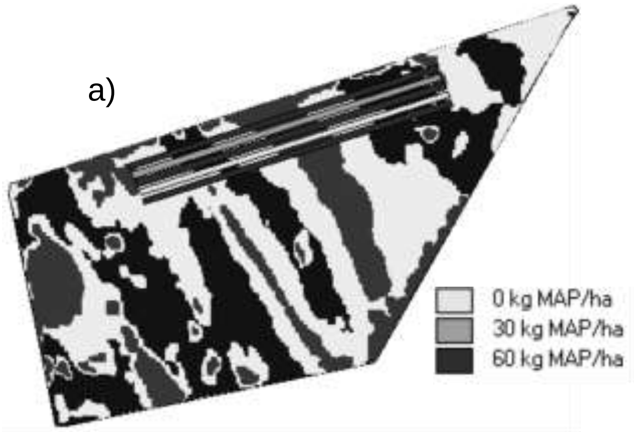
Figure 2 a) zone map generated from yield maps from 2006, 2007 and 2008 showing soil test locations, b) Landsat imagery compilation from seasons 2004, 2005, 2006, 2007 and 2009. Higher values indicate greater crop growth.

The paddock was sown with Fleet barley on June 10th 2010. The seeding equipment was a triple bin 3450 Flexicoil box and 18m Flexicoil ST820 bar. The bar is fitted with 16mm Agmaster knife points on 225mm spacing and with press wheels. Variable rate applications are controlled with a Topcon X20 system.
The three bin seeder was setup with seed, MAP and urea. Seed and urea were varied according to zone (Table 1).

Table 1: Seed and urea rates applied in each paddock zone.

Zone	Seed Rate (kg/ha)	Urea Rate (kg/ha)
Zone 1 - Loam	60	30
Zone 2 - Mid	70	50
Zone 3 - Sand	75	65

The MAP fertiliser that had been budgeted for the paddock was redistributed according to the previous year's yield in 2009 with rates ranging from 40 to 70 kg MAP/ha (Figure 3). However, five adjacent constant rate strips were applied across the zones with rates of 0, 30 and 60 kg MAP/ha for the trial.



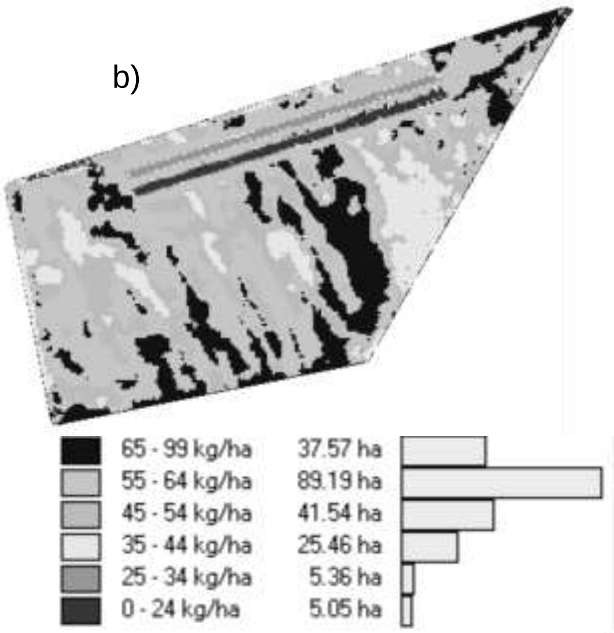


Figure 3 a) trial strip location with respect to zones, b) as applied map recorded on the Topcon X20 of the rates of MAP that were applied according to trial design and previous years yield.

The crop was assessed for leaf and grain nutrients and grain yield.

Leaf nutrient analysis of P didn't show any clear response to increasing P rates within each zone (Table 3). However, they did show significant differences between zones that follow the same trend as the DGT soil tests, where zone 2 has the lowest concentration of P in the plant and zone 3 (sand hill) has the highest. For the majority of the other nutrients including iron (Fe), manganese (Mn), boron (B), copper (Cu) and sulphur (S) the leaf nutrient analysis shows that nutrient concentration grades from highest on the flat and lowest on the sand hill. This is expected given the lower clay and organic matter content of the sand and its poorer ability to store nutrients. Despite this, none of the other nutrients were below the critical level for deficiency.

Table 2: soil P test results from zones and predicted grain yield response. The critical DGT value to attain 90% yield potential is 57 micro g/L.

Location	Colwell P (mg/kg)	PBI	Critical Colwell P	DGT (micro g/L)	DGT Grain yield predictio	Response prediction	
						Colwell P with PBI	DGT
Zone 1 - Flat	41	51	21	126	99	No	No
Zone 2 - Mid	42	98	28	47	82	No	Yes
Zone 3 - Sand Hill	34	19	14	178	100	No	No

Results

The soil test results (Table 2) showed that that zone 2 (mid) had less available phosphorus.

Table 3: Leaf nutrient analysis results from treatment strips within zones collected at the 5-6 leaf stage (Zadoks 15-16, 22-24). Elements tested are iron (Fe), manganese (Mn), boron (B), copper (Cu), zinc (Zn), calcium (Ca), magnesium (Mg), potassium (K), phosphorous (P) and sulphur (S).

Leaf Nutrient Analysis												
Location	MAP (kg/ha)	Growth Stage	Fe mg/kg	Mn mg/kg	B mg/kg	Cu mg/kg	Zn mg/kg	Ca mg/kg	Mg mg/kg	K mg/kg	P mg/kg	S mg/kg
Zone 1 - Flat	0	6 leaf	134	47	6.2	14	30	5500	1660	30000	3400	4900
Zone 1 - Flat	30		122	39	9.9	14	23	4600	1880	31000	4000	4600
Zone 1 - Flat	60		106	46	7.7	14	25	5200	1740	29000	3600	4700
Zone 2 - Mid	0	6 leaf	90	32	5.9	12	27	5100	2100	27000	2900	4100
Zone 2 - Mid	30		87	32	5.8	12	30	5500	2000	24000	2600	3900
Zone 2 - Mid	60		87	34	7.0	11	26	5600	1890	27000	3100	4100
Zone 3 - Sand Hill	0	5 leaf	74	31	4.4	7.4	24	6700	1650	39000	3700	3100
Zone 3 - Sand Hill	30		81	39	4.3	7.6	26	7300	1570	42000	3900	2900
Zone 3 - Sand Hill	60		74	32	4.2	7.6	23	6400	1570	39000	3900	3200
Zone 1 - Flat	Average of zone		121	44	8	14	26	5100	1760	30000	3667	4733
Zone 2 - Mid			88	33	6	12	28	5400	1997	26000	2867	4033
Zone 3 - Sand Hill			76	34	4	8	24	6800	1597	40000	3833	3067
Critical nutrient levels at 5 leaf stage												
Deficiency			25	20		3.0	20	2000	1200	25000	3700*	3000
Toxicity					40.0							

* Critical P concentration 3000 mg/kg at 6 leaf stage

Grain nutrient analysis showed a similar trend to the leaf nutrients and soil tests, with zone 2 having the lowest grain P levels, while zone 1 (flat) had the highest (Table 4). The rate response within zones is not strong, although in each zone the treatment of 0 MAP has the lowest grain P levels. The concentration of other nutrients does not follow the same trends as leaf nutrient with respect to zones, with manganese (Mn) showing the strongest trend with higher concentrations in the sample from zone 1 (flat) and lowest from zone 3 (sand hill).

Table 4: grain nutrient analysis results from treatment strips within zones collected at maturity. Elements tested are iron (Fe), manganese (Mn), boron (B), copper (Cu), zinc (Zn), calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P) and sulphur (S).

Grain Nutrient Analysis											
Location	MAP (kg/ha)	Fe mg/kg	Mn mg/kg	B mg/kg	Cu mg/kg	Zn mg/kg	Ca mg/kg	Mg mg/kg	K mg/kg	P mg/kg	S mg/kg
Zone 1 - Flat	0	24	17	1.6	4.1	15	470	1110	4400	3000	1030
Zone 1 - Flat	30	23	15	1.5	3.5	12	440	1130	4800	3300	1000
Zone 1 - Flat	60	24	17	1.6	3.7	13	460	1120	4700	3300	1020
Zone 2 - Mid	0	19	14	1.7	3.9	16	380	1080	4200	2300	1040
Zone 2 - Mid	30	21	13	1.5	3.4	14	420	1100	4200	2700	1040
Zone 2 - Mid	60	21	14	1.7	4.1	16	390	1110	4300	2400	1060
Zone 3 - Sand Hill	0	21	10	1.7	3.1	12	460	1140	4500	2500	960
Zone 3 - Sand Hill	30	24	13	1.6	3.7	11	440	1120	4300	2500	1030
Zone 3 - Sand Hill	60	23	12	1.3	3.0	11	460	1120	4500	2700	970
Zone 1 - Flat	Average of zone	24	16	1.6	3.7	13	457	1120	4633	3200	1017
Zone 2 - Mid		20	14	1.6	3.8	15	397	1097	4233	2467	1047
Zone 3 - Sand Hill		23	12	1.5	3.3	11	453	1127	4433	2567	987

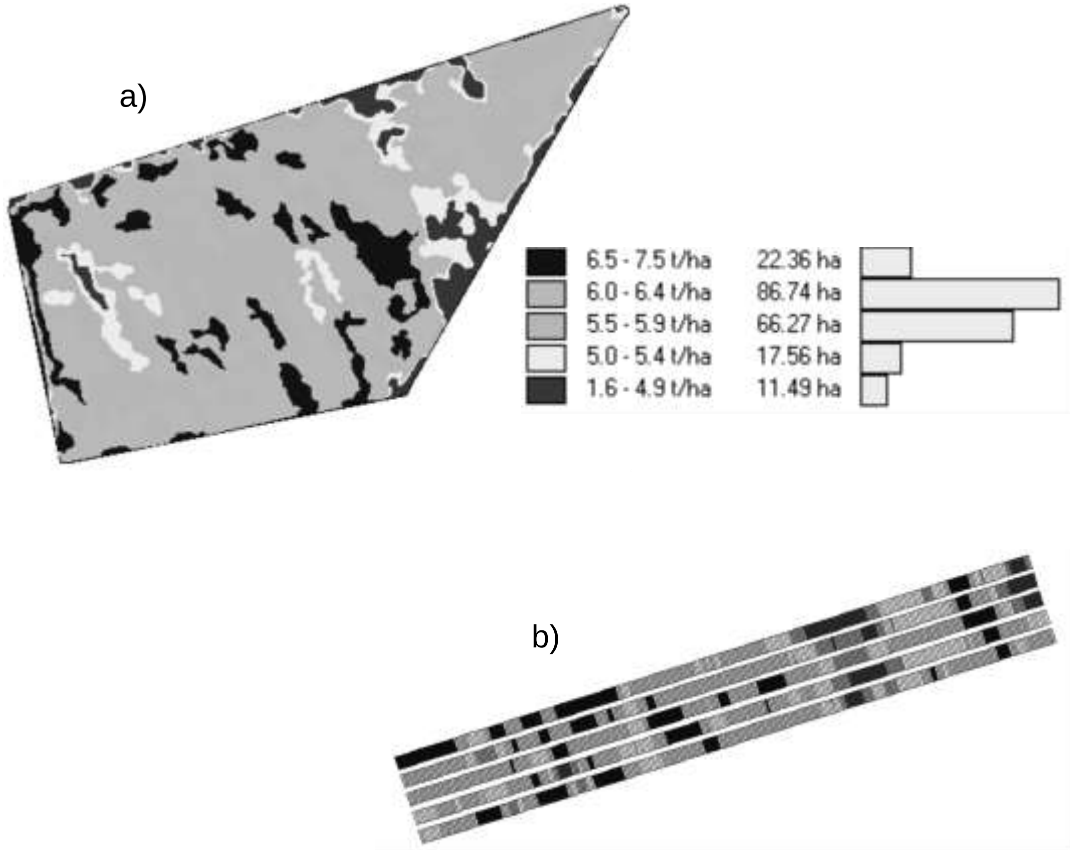


Figure 4: a) barley yield map for 2010,b) yield data for trial strips in 5m segments.

Yield differences between the trial strips were not significant.

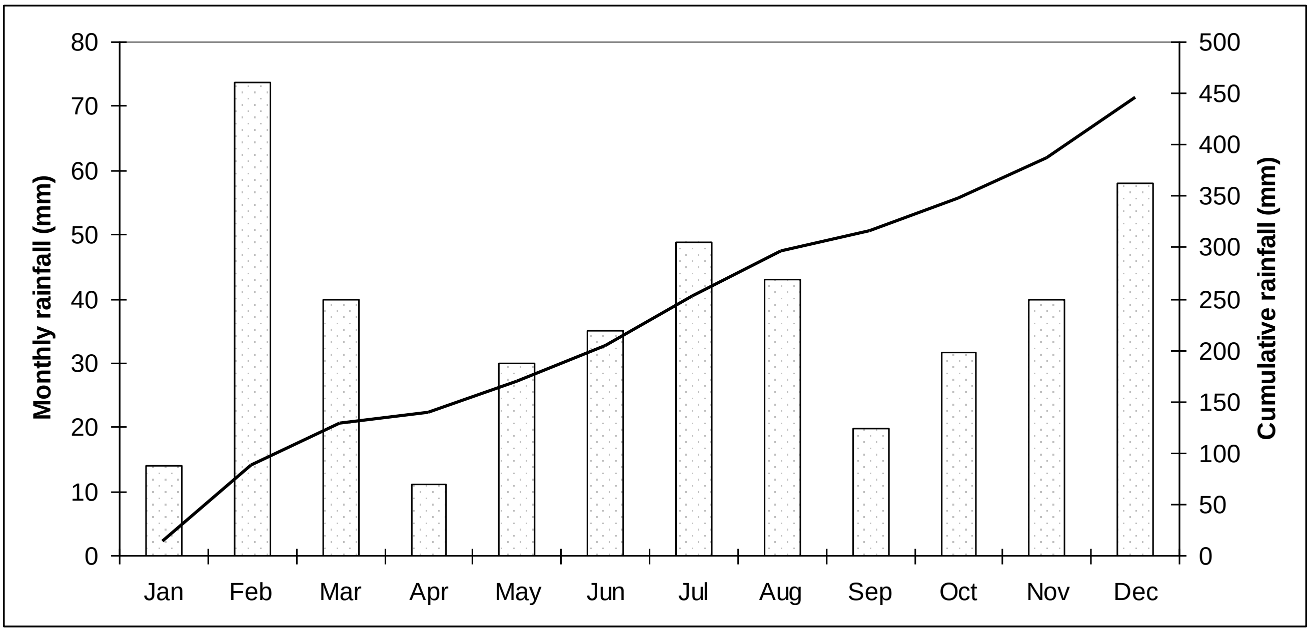
This trial shows that there are P responsive soils in this paddock, where P rates should not be cut too severely. However, the trial also indicates that on large areas (85%) of the paddock P rates could be cut significantly with no loss of yield in the short term. However, this will lead to a decline in P reserves and yield losses would be expected in future years. Soil test and leaf nutrient tests were useful in predicting the yield response and will be useful in future monitoring of zones. In this paddock, cutting rates from 60 kg MAP/ha to zero on the 170 ha that are not responsive would equate to a saving of $7,140 in 1 year with MAP at $700/t, while maintaining adequate fertiliser rates on the responsive soils. Rather than cutting rates too severely, the grower will use a maintenance program to keep P levels adequate, but target more P at the responsive areas to build them up. This scenario is relevant for the western half of the property.

Acknowledgements
Kenton and Tracey Angel hosted the trial.
Leighton Wilksch (Landmark) supplied compiled historical LandSAT data.
Sean Mason (University of Adelaide) tested soils for P availability.

Rainfall, Hart 2011

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1												
2							10.2					
3						12.0	0.8					
4							1.2	0.8	0.2			
5		25.0				3.0	0.4	5.8		7.2		
6							10.8	4.4			3.8	
7			6.0				2.4	3.0		1.0		
8							0.8	0.4		5.0		
9							5.6	0.4	0.4		22.2	20.0
10							2.6	0.8		0.8		
11		12.0	11.0	6.0			0.4	1.8	0.8			
12					5.0			0.2	0.4			
13										6.4		
14	14.0											
15												
16								1.6				
17							3.8	14.4				
18		16.8					1.2	4.0				38.0
19		20.0						4.8				
20			23.0					0.2			5.4	
21				5.0		20.0		0.2				
22					25.0			0.2				
23										6.8		
24												
25												
26												
27												
28											8.6	
29							7.6		18.0	4.4		
30							1.0					
31												
Monthly total	14.0	73.8	40.0	11.0	30.0	35.0	48.8	43.0	19.8	31.6	40.0	58.0
Running total	14.0	87.8	127.8	138.8	168.8	203.8	252.6	295.6	315.4	347.0	387.0	445.0

Average GSR (Apr-Oct)	305 mm	Average rainfall	400 mm
2011 GSR (Apr-Oct)	219 mm	2011 total rainfall	445 mm
2011 GSR (Apr-Oct)+summer	264 mm		



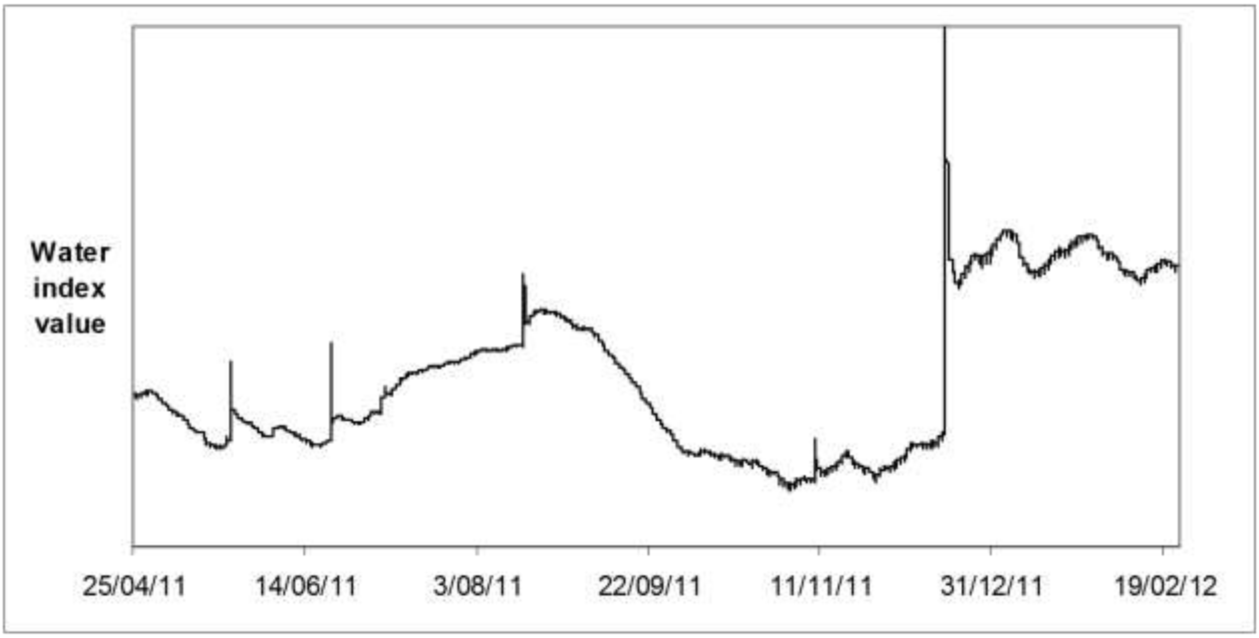
Soil test Hart trial site 2011

March 2010 – Northern quarter

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

Available soil moisture 21st May (0-90cm)	80 mm	**Soil nitrogen 21st May (0-90cm)**	95 kg N /ha

Hart soil water in 2011



The change in soil water at Hart (as a relative index, not actual mm) between April 2011 and February 2012. It is being continually measured by an Adcon Telemetry Advantage Pro moisture probe, and is positioned under the commercial crop, down to 90cm.

Notes