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Hart calendar of events 2018

'Getting The Crop In' seminar

Wednesday, March 14

Hart AGM

Tuesday, April 10

Winter Walk

Tuesday, July 17

Hart Field Day

Tuesday, September 18

Spring Twilight Walk

Tuesday, October 16

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Trial harvest at Hart, 2017

Front cover photo by Sandy Kimber: 'Controlled Traffic', featuring participants from our 2017 'Been Farming Long' workshop series.

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SARDI, New Variety Agronomy Pt Lincoln:
Andrew Ware

Hart Field-Site Group
Sarah Noack & Dylan Bruce

Hart management

Our values

Independence, relevance, integrity, credibility, professionalism, value for money, generosity.

We have a clear purpose

To deliver value to growers and make agriculture better (in productivity, sustainability & community).

We are committed to delivering on our vision

To be SA's premier cropping field site, providing independent information and skills to the agricultural community.

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The 2017 season at Hart

Early seeded crops were sown into good soil moisture, with 62.2 mm recorded for April (Figure 1). The site's soil moisture probe indicated the 'bucket' was 60 - 70% full (total PAWC 206 mm) in early May.

Time of sowing research trials required irrigation to achieve early sowing (mid-March) and establishment at Hart. Rainfall was patchy and lower than expected early in the growing season, with well below rainfall in May, June and June (combined 93 mm less than the long-term average).

Much needed rainfall (44 mm) occurred in early August however, September and October rainfall was below average, recording 36 mm in total (Figure 1). There were few frost and heat events at Hart in 2017. However, they still caused significant damage to crops at susceptible growth stages. To see the maximum and minimum daily temperatures to Hart, refer to page 20 of this manual (Figure 1). Care should be taken when interpreting variety and time of sowing trials due to differences in varietal maturities and therefore possible frost / heat incidence this season.

Overall the 2017 growing season rainfall at Hart was 191 mm compared to the long-term average of 300 mm (Table 1). Without stored soil moisture pre-seeding the yields harvested would not have been achievable. In general yields across the Mid-North were variable this season with majority producing average or slightly above average yields. Majority of Hart's trials were harvested in late November, prior to the 40 mm which fell in early December.

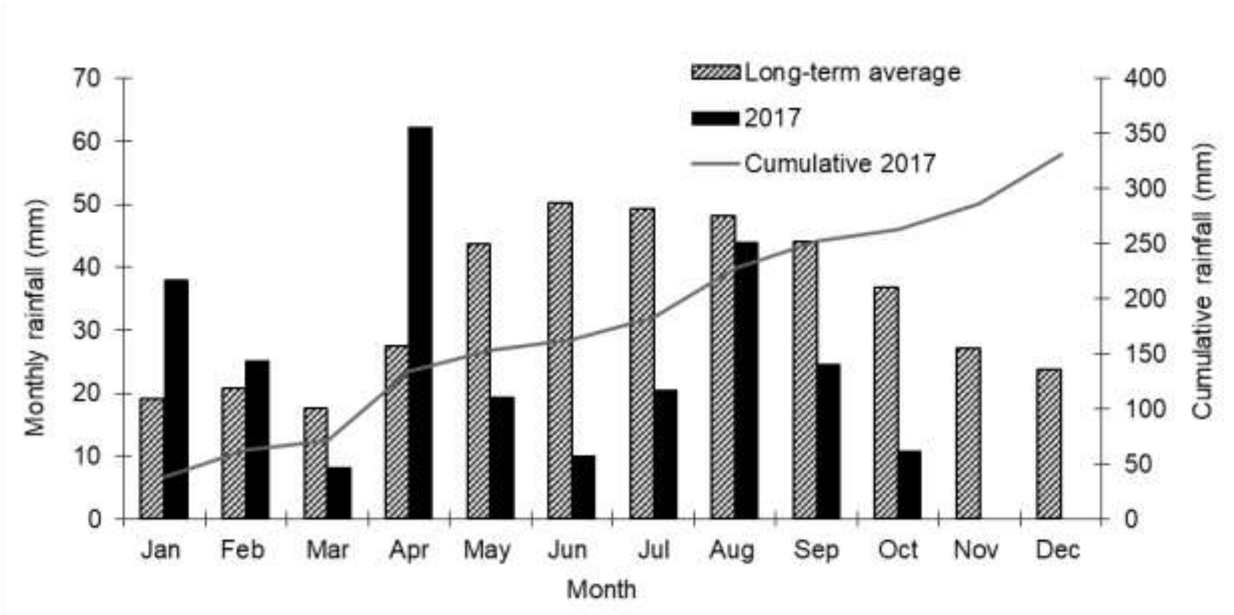

Figure 1. Hart rainfall graph for 2017 and long-term (100 year) average. The grey line indicates cumulative rainfall for 2017.

Table 1. Hart rainfall chart 2017

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1					3.2				0.4			9.8
2								2.6	1			19.6
3							2.2	2.8	3.4		0.8	1.8
4		1.8					6.2	1.4	5.6			
5		7					0.2	1.2	6.8			
6		16.4				0.4	0.2	8.6	0.2			
7			1				0.6	1.6	0.6	0.2		11
8							0.2					
9	12.8			1.4								
10												
11										4.2		
12			6.6									1
13	10.2		0.4						3.8			
14							0.8	0.6				
15								17			2.6	
16						1.2	2.8				0.2	
17					1.2		1	0.2				
18						0.2	0.6	0.2	1.6			0.2
19	11			0.4	4.2				0.4			0.2
20	1			47.6				5.2				
21				0.4				1.8				
22					1.2						4.2	
23	1.6			0.2	0.8			0.2			7.4	
24	1.4			9.6						0.4	1	
25						0.4	2.6					
26				2.6		0	0.2					
27					0.2	0.6	0.4	0.6				
28					2.8	6.8			0.8			0.2
29					1.6	0.2				0.8		0.2
30			0.2		4.2	0.2				5.2	7.6	
31							2.4					
Montly total	**38.0**	**25.2**	**8.2**	**62.2**	**19.4**	**10.0**	**20.4**	**44.0**	**24.6**	**10.8**	**23.8**	**44.0**
GSR rainfall				62.2	81.6	91.6	112.0	156.0	180.6	191.4		
Total rainfall	38.0	63.2	71.4	133.6	153.0	163.0	183.4	227.4	252.0	262.8	286.6	330.6

Hart trial site – soil analysis

General soil physical and chemical properties for the Hart field site. Sampled on 10th May, 2017.

	Sampling depth (cm)			
	0 - 10	10 - 30	30 - 60	Total profile
Texture				sandy loam - loam
Gravel %	5	5	5	
Phosphorus Colwell mg/Kg	25	39	4	
Potassium Colwell mg/Kg	397	155	117	
Available soil nitrogen kg/ha	15	25	17	57
Sulphur mg/Kg	5.1	4.5	6.2	
Organic Carbon %	1.2	0.8	0.4	
Conductivity dS/m	0.1	0.1	0.1	
pH Level ($CaCl_2$) pH	7.8	7.9	8.4	

Interpretation of statistical data

The results of replicated trials are presented as the average (mean) for each of the replicates within a treatment.

Authors generally use ANOVA, in which the means of more than one treatment are compared to each other. 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 (not significant) 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 two treatments are different, and so in some cases a non-significant result may still be useful.

Interpretation of replicated results: an example

Here we use an example of a replicated wheat variety trial containing yield and grain quality data (Table 1). Statistically significant differences were found between varieties for both grain yield and protein. The LSD for grain yield of 0.40 means there must be more than 0.40 t/ha difference between yields before that varieties performance is significantly different to another. In this example Trojan is significantly different to all other varieties as it is the only variety followed by a superscript (a). Scout, Mace and Cosmick are not significantly different from each other and are all followed by a superscript (b) as they all yielded within 0.4 t/ha of each other.

Similarly, for grain protein a varieties performance was significant from another if there was more than 0.9% difference in protein. In the example, Arrow contained a higher protein level compared to all other varieties which were not different to one another.

Where there are no significant differences between treatments, NS (not significant) will be displayed as seen in the screenings column (Table 1).

Table 1. Wheat variety grain yield, protein and screenings from a hypothetical example to illustrate interpretation of LSD.

Variety	Grain yield (t/ha)	Protein (%)	Screenings (%)
Arrow	3.50^{c}	10.3^{a}	0.2
Cosmick	3.98^{b}	8.4^{b}	1.0
Mace	3.75^{bc}	9.1^{b}	0.5
Scout	4.05^{b}	8.9^{b}	0.9
Trojan	4.77^{a}	8.4^{b}	0.4
LSD (P≤0.05)	0.40	0.9	NS

Disclaimer

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

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Comparison of wheat varieties

Dylan Bruce, Hart Field-Site Group

Key Findings

- There were a number of high yielding (3.82 – 4.24 t/ha) AH varieties at Hart in 2017 including, Beckom, Scepter, Arrow, Cobra, Mace and Scout.
- Trojan and Cutlass were the highest yielding APW varieties at 4.32 and 4.00 t/ha, respectively.
- Test weight and screening levels across the trial were good, averaging 80.2 kg/hL and 0.8%.

Why do the trial?

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

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + Impact @ 100 kg/ha
Seeding date	8th May 2017		UAN (42:0) @ 60 L/ha on 3rd July
			UAN (42:0) @ 60 L/ha on 2nd August

This trial was a randomised complete block design with three replicates and 20 varieties. Fungicides and herbicides were applied as necessary to keep the crop canopy free of disease and weeds. All plots were assessed for grain yield, protein, test weight, and screenings with a 2.0 mm screen.

Results and discussion

Wheat grain yields at Hart ranged from 3.29 t/ha for Corack up to 4.32 t/ha for Trojan (Table 1), with an average site yield of 3.83 t/ha. Varieties which yielded above 4.0 t/ha included Trojan, Beckom, Scepter, RAC2388, Scout and Cutlass. The long-term variety yield results show that Trojan (112%), Scepter (109%) and Cutlass (109%) continue to perform well over a number of seasons at Hart.

Wheat grain protein levels ranged from 9.7% (RAC2388 and RAC2517) to 11.7% (Kord CL Plus). The only AH varieties to meet the minimum protein requirement for Hard 2 classification were Hatchet and Kord CL Plus. Varieties to achieve 10.5% and above (minimum requirement for APW1 classification) were Beckom, Emu Rock, Grenade CL Plus, Estoc, DS Pascal and Corack.

Grain test weights across the trial averaged 80.2 kg/hL, with all varieties exceeding 76 kg/hL, the minimum requirement for maximum grade. Screening levels at the site averaged 0.8 % and all varieties fell below the maximum level of 5% for Hard and APW classification.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of wheat varieties at Hart in 2017. Mean grain yield (% of trial average) of Hart wheat variety trials (2010-2017) and number of trials.

Quality	Variety	**Grain yield** t/ha	% of site average	**Protein** %	% of site average	**Test Weight** kg/hL	% of site average	**Screenings** %	% of site average	**Mean yield 2010-2017**	No. of trials
AH	Arrow	3.94	103	10.0	96	80.8	101	0.4	48	101	3
	Beckom	4.29	112	10.6	102	80.4	100	0.7	91	-	
	Cobra	3.82	100	10.4	100	78.5	98	0.6	84	103	6
	Cosmick	3.73	97	10.1	97	79.8	100	2.5	334	102	4
	DS Darwin	3.61	94	9.9	94	80.4	100	0.5	71	-	
	Emu Rock	3.75	98	10.9	104	80.8	101	0.7	88	105	7
	Grenade CL Plus	3.63	95	10.5	101	79.9	100	0.4	55	96	6
	Hatchet CL Plus	3.31	86	11.8	113	79.7	99	0.3	39	82	5
	Havoc (LPB13-1995)	3.73	97	10.2	98	80.5	100	0.5	65	-	
	Kord CL Plus	3.70	97	11.7	112	79.9	100	1.0	131	95	7
	Mace	3.91	102	10.4	100	80.2	100	0.4	51	106	8
	Scepter	4.24	111	9.8	93	81.0	101	0.7	90	109	3
	Scout	4.11	107	10.0	96	82.2	102	0.4	58	106	8
	H1 receival standard			*>13.0*		*>76.0*		*<5.0*			
APW	Corack	3.29	86	11.0	105	80.8	101	0.2	31	103	7
	Cutlass	4.00	104	9.9	95	80.0	100	0.6	79	109	3
	DS Pascal	3.44	90	11.1	106	76.5	95	2.8	369	-	
	Estoc	3.68	96	11.2	107	81.8	102	0.7	98	100	8
	Trojan	4.32	113	10.0	96	80.4	100	0.5	68	112	5
	APW1 receival standard			*>10.5*		*>76.0*		*<5.0*			
Unclassified	RAC2388	4.13	108	9.7	92	79.8	100	0.6	77	-	
	RAC2517	3.95	103	9.7	93	80.7	101	0.5	67	-	
	Site Average	3.83	100	10.5	100	80.2	100	0.8	100		
	LSD (P≤0.05)	0.52		0.79		0.84		0.37			

- *Insufficient data (included in Hart wheat variety trials for less than three seasons)*

Comparison of barley varieties

Dylan Bruce, Hart Field-Site Group

Key Findings

- Oxford, Fleet, Hindmarsh and Keel were the highest yielding feed barley varieties at Hart averaging 4.57 t/ha.
- Navigator, GrangeR and LaTrobe were the highest yielding malt barley varieties averaging 4.68 t/ha.
- RGT Planet (undergoing malt accreditation) was the highest yielding barley variety at Hart, at 5.85 t/ha.

Why do the trial?

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

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + Impact @ 100 kg/ha
Seeding date	8th of May 2017		UAN (42:0) @ 60 L/ha on 3rd July

This trial was a randomised complete block design with three replicates and 18 varieties. Fungicides and herbicides were applied as necessary to keep the crop canopy free of disease and weeds. All plots were assessed for grain yield, protein, test weight, and screenings with a 2.2 mm screen and retention with a 2.5 mm screen.

Results and discussion

The highest yielding barley variety at Hart in 2017 was RGT Planet (pending malt accreditation) which yielded 5.85 t/ha, over 1.0 t/ha more than the next highest variety. The highest yielding malt variety was Navigator with 4.82 t/ha, followed by GrangeR and LaTrobe with 4.72 t/ha and 4.52 t/ha, respectively. Compass (pending malt accreditation) also yielded in this range at 4.60 t/ha. The lowest yielding malt variety was Schooner at 2.12 t/ha due to head loss from strong winds at the beginning of November (data not shown).

Oxford, Fleet, Hindmarsh and Keel were the highest yielding feed barley varieties yielding between 4.28 and 4.72 t/ha. The remaining varieties trialed were Fathom and Rosalind yielding slight lower on average at 4.04 t/ha. Long-term barley yield results show Fathom (110%), Fleet (108%) and Keel (107%) continue to perform well across a number of seasons at Hart.

Grain protein levels for all malt varieties averaged 7.5%, lower than the required 9.0% minimum for malting classification. Test weights for all malt varieties were above the minimum 65 kg/hL for maximum grade, while all feed varieties met the minimum 62.5 kg/hL for F1 barley classification.

Screening levels across the trial were low, averaging 1.2%. Retention levels across the trial were high, averaging of 91.4%, with all malt varieties exceeding the minimum 70% retention requirement for malt 1 classification.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL), screenings and retention (%) of barley varieties at Hart in 2017. Mean grain yield (% of trial average) of Hart barley variety trials (2010-2017) and number of trials.

Quality	Variety	**Grain yield** t/ha	% of site average	**Protein** %	% of site average	**Test Weight** kg/hL	% of site average	**Screenings** %	% of site average	**Retention** %	% of site average	**Mean yield 2010-2017**	No. of trials
Feed	Fathom	4.09	94	8.4	109	69.0	98	1.2	99	92.5	101	110	7
	Fleet	4.53	104	8.1	107	65.9	94	1.4	115	84.8	93	108	8
	Hindmarsh	4.28	98	8.3	108	72.7	104	1.7	144	90.5	99	106	8
	Keel	4.46	102	8.0	105	70.4	100	1.0	80	95.8	105	107	8
	Oxford	4.72	108	6.8	88	70.8	101	1.6	134	79.6	87	100	8
	Rosalind	3.99	91	8.2	107	71.0	101	0.9	78	92.3	101	-	
	F1 receival standard			*NA*		*>62.5*		*<15*		*NA*			
Malting	Charger	4.21	97	8.1	105	68.9	98	2.0	169	87.4	96	104	5
	Commander	4.44	102	8.1	105	68.6	98	2.1	177	88.6	97	104	8
	GrangeR	4.72	108	7.3	96	71.3	102	0.7	58	95.0	104	97	7
	La Trobe	4.51	104	7.5	98	73.3	104	1.2	97	91.7	100	105	6
	Navigator	4.82	111	7.2	94	68.4	97	0.7	55	94.5	103	106	8
	Schooner	2.12	49	7.9	103	71.9	102	0.9	79	94.5	103	86	8
	Scope	3.89	89	7.1	93	72.1	103	0.7	56	93.0	102	97	8
	Westminster	4.44	102	7.3	95	71.3	102	0.6	53	94.4	103	88	6
	Malt 1 receival standard			*9-12%*		*>65.0*		*<7.0*		*>70.0*			
Unclassified	Explorer (EB1401)	4.49	103	7.5	98	67.4	96	1.1	89	93.2	102	-	
Pending malt accreditation	Compass	4.60	106	8.1	105	70.9	101	0.7	56	96.6	106	106	6
	RGT Planet	5.85	134	6.3	82	69.5	99	1.1	94	89.1	97	-	
	Spartacus CL (IGB1334T)	4.29	98	7.2	94	73.4	105	0.7	61	94.6	103	-	
	Site Average	4.36	100	7.6	100	70.2	100	1.2	100	91.4	100		
	LSD (P≤0.05)	0.57		1.37		1.09		0.60		5.00			

- *Insufficient data (included in Hart barley variety trials for less than three seasons)*

Comparison of durum varieties

Dylan Bruce, Hart Field-Site Group

Key findings

- The average grain yield for all durum varieties was 4.24 t/ha, with six out of eight varieties trialed high yielding at Hart in 2017.
- Grain protein and screening levels were low, while test weight values were high.

Why do the trial?

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

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + Impact @ 100 kg/ha
Seeding date	9th of May 2017		UAN (42:0) @ 60 L/ha on 3rd July
			UAN (42:0) @ 60 L/ha on 2nd August

This trial was a randomised complete block design with three replicates and eight varieties. Fungicides and herbicides were applied as necessary to keep the crop canopy free of disease and weeds.

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

Results and discussion

Durum grain yields ranged from 3.92 t/ha (Caparoi) to 4.44 t/ha (AGTD043), with a site average yield of 4.24 t/ha (Table 1). Six out of eight varieties trialed were high yielding including, Tamaroi, Saintly, DBA-Aurora, Tjilkuri, Yawa and AGTD043. Grain protein levels ranged from 9.6% to 11.0%, with Hyperno, DBA-Aurora and Caparoi meeting the 10% requirement for DR3 durum classification.

All varieties were well above the minimum test weight value of 76 kg/hL, averaging 80.1 kg/hL. Screening levels across all varieties were below 5%, ranging from 0.56% (Caparoi) to 3.41% (Yawa).

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) for durum varieties at Hart, 2017. Average grain yield (% of trial average) of Hart durum variety trials (2012-2017) and number of trials.

Variety	Grain yield t/ha	% of site average	Protein %	% of site average	Test Weight kg/hL	% of site average	Screenings %	% of site average	Mean yield %	No. of trials
Caparoi	3.92	92	11.0	109	81.7	102	0.6	41	93	6
Tamaroi	4.35	103	9.6	95	81.2	101	0.9	67	103	6
Saintly	4.23	100	10.0	99	80.0	100	0.6	46	101	6
Hyperno	4.06	96	10.0	99	79.5	99	1.7	122	97	6
DBA-Aurora	4.26	100	10.4	103	79.9	100	1.2	87	101	4
Tjilkuri	4.23	100	9.9	98	79.2	99	1.2	86	101	6
Yawa	4.41	104	9.8	97	79.1	99	3.4	252	105	6
AGTD043	4.44	105	9.9	98	80.6	101	0.8	58	-	
DR1 receival standard			*>13*		*>76*		*<5*			
Site Average	**4.24**	**100**	**10.1**	**100**	**80.1**	**100**	**1.4**	**100**		
LSD (P≤0.05)	0.26		0.73		0.66		0.60			

\- *Insufficient data (included in Hart durum variety trials for less than three seasons)*

Early sown winter wheats – Hart

Dylan Bruce[1], Sarah Noack[1], Kenton Porker[2], James Hunt[3]
Hart Field-Site Group[1], SARDI[2], La Trobe University[3]

Key Findings

- The highest yielding spring varieties trialed were Cutlass and Trojan sown on the 3rd of May at 4.5 t/ha and 4.3 t/ha, respectively.
- The highest yielding winter varieties trialed were V09150-01 and Kittyhawk sown on the 18th of April at 4.2 t/ha, which was not significantly different to the top yielding spring lines.
- LPB14-0392 sown on the 18th of April topped the trial at Hart yielding 4.7 t/ha. This variety is neither a spring or winter plant type, but described as facultative (shorter but distinct vernalisation requirement which flowers earlier compared to true winter types).

Why do the trial?

In SA the time at which wheat flowers is very important in determining overall yield. Crops that flower too early have increased risk of frost damage, while crops which flower too late have increased risk of high temperatures and water stress which can restrict grain formation and grain-filling. As the size of farming enterprises are increasing, getting a wheat crop established so that it flowers during the optimal flowering period for peak yield can be difficult. However, an opportunity exists in South Australia to take advantage of stored moisture over the summer and rain events in March and April to start sowing crops earlier than what is currently practiced.

Over the last few decades wheat breeding efforts have focused on mid-fast maturing varieties that need to be sown in the first half of May to flower during the optimal period (late September for Hart) for grain yield. Sowing earlier than what is currently practiced requires winter varieties that are slower to mature, and recent studies with near isogenic lines have indicated that a 15% yield gain could be achieved through well adapted winter varieties. This would equate to a 0.6 t/ha increase in yield in an average 4 t/ha season at Hart, however, currently available winter varieties (e.g. Wedgetail and Rosella) bred for NSW are not suited to SA conditions.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 2% Zn @ 75 kg/ha
Seeding date	ToS 1 – 14th March		UAN (42:0) @ 60 L/ha on 3rd July
	ToS 2 – 31st March		UAN (42:0) @ 60 L/ha on 2nd Aug
	ToS 3 – 18th April		
	ToS 4 – 3rd May		

The trial was a split block design with four replicates of nine varieties (Table 1) at four times of sowing (ToS). Fungicides and herbicides were applied as necessary to keep the crop canopy free of disease (i.e. stripe rust) and weeds. All plots were assessed for grain yield, protein, test weight and screenings with a 2.0 mm screen.

Table 1. Different categories of wheat varieties based on their development habits (and speed) selected for the trial at Hart.

Spring	Facultative	Winter
Cutlass (slow) Scepter (fast) Trojan (fast-medium)	LPB14-0392 (intermediate winter – fast spring)	ADV08.0008 (slow) ADV11.9419 (slow) Kittyhawk (medium) Longsword (fast) V09150-01 (medium)

Results and discussion

After receiving above average rainfall over the summer months of 2016/2017 (50 mm above long-term average) opening rains for the 2017 growing season were minimal during the March ToS, with only 8 mm falling for the month. A significant rainfall event did not arrive until the 20th of April where 48 mm fell at the site. To ensure plant emergence would occur, the first three ToS (14th March, 31st March and 18th April) were irrigated with the equivalent of 10 mm of rainfall post-sowing. The last ToS did not require irrigation for emergence.

Emergence & Establishment

Plant establishment differed between ToS with increased plant densities at later ToS (Table 2). This was probably due to higher soil temperatures and faster evaporation during the earlier ToS. The only treatment to reach the targeted plant density was ToS 4 with 164 plants/m², when adequate soil water was available and evaporation was not as severe due to cooler air temperatures. Plant density also differed between varieties with the slower maturing winter types such as ADV08.0008 and ADV11.9419, and the facultative type LPB14-0392 emerging poorly at the first two ToS.

Table 2. Average plant densities across all four ToS at Hart (target 150 plants/m^2).

Time of Sowing	Average plants/m²	Average air temperature (°C) two weeks post sowing
1	110	24.6
2	127	16.8
3	141	16.7
4	164	13.2
LSD (P≤0.05)	**9.1**	

Grain Yield

The highest yielding treatment was LPB14-0392 (facultative wheat type) sown on 18th April at 4.7 t/ha (Table 3). V09150-01 and Kittyhawk performed well for the winter varieties sown on 18th April yielding 4.2 t/ha. Cutlass and Trojan sown on 3rd May performed best for the spring varieties yielding 4.5 t/ha and 4.3 t/ha, respectively.

Generally, the higher yielding varieties flowered just before the optimal flowering period at Hart (21 September to 2 October) (Figure 1). This isn't surprising due to the warmer and drier conditions during the growing season when compared to 2016, favouring varieties that are able to fill grain quickly before becoming too water stressed.

As expected, planting spring varieties during March and April increased sterility (up to 38%, data not shown) due to flowering too early during the colder months of June and July, negatively affecting yield. Interestingly, the winter variety Longsword flowered around the optimal flowering period when sown on 18th April and 3rd May but showed increased levels of sterility (35% when sown on 18th April) even though no frost events were recorded around that time (Figure 1). Early sown Kittyhawk also yielded poorly even though flowering around the optimal flowering period due to increased levels of disease present, causing plants to become stunted and yellow.

Grain Quality

Protein content differed between variety and ToS across the trial (Table 3). The highest protein treatment was Longsword sown 31st March with 15.2%. Longsword and LPB14-0392 sown on the 14th March also had protein content above the 13% receival standard for H1 classification. However, treatments with higher protein content were also generally lower yielding due to the 'dilution effect', where the available nitrogen in the higher yielding varieties is distributed amongst a greater number of grains or within larger grains, therefore diluting the protein concentration in each grain.

Test weight also differed between variety and ToS. None of the varieties from ToS 1 reached the required 76 kg/hL test weight for maximum grade, while the number of varieties to reach 76 kg/hL increased with later ToS. Overall Kittyhawk had the highest average test weight with 75.3 kg/hL, followed by Cutlass and Longsword with 73.8 kg/hL and 73.7 kg/hL, respectively.

Screening levels for all treatments were well below the maximum level of 5% for maximum grade.

Table 3. Grain yield and quality for all wheat varieties at different times of sowing at Hart in 2017 (LSD P≤0.05 is for the interaction between variety and time of sowing). Treatments shaded grey are not significantly different from the highest yielding treatment.

	Yield (t/ha)				**Protein %**			
	14th March	**31st March**	**18th April**	**3rd May**	**14th March**	**31st March**	**18th April**	**3rd May**
ADV08.0008	3.1	3.6	4.0	3.4	11.6	11.2	11.8	11.1
ADV11.9419	3.2	3.6	3.5	3.2	9.7	9.9	10.4	9.7
Cutlass	2.1	2.7	3.3	4.5	12.6	12.7	11.4	9.1
Kittyhawk	2.2	3.9	4.2	3.6	11.9	10.7	10.6	10.1
LPB14-0392	1.8	3.9	4.7	3.9	14.6	11.0	10.3	10.3
Longsword	2.0	2.4	3.0	3.5	14.6	15.2	13.6	11.6
Scepter	1.4	2.1	2.6	4.1	11.8	11.9	12.4	9.5
Trojan	1.3	1.9	3.1	4.3	12.3	12.6	12.8	9.4
V09150-01	2.8	3.9	4.2	4.1	12.0	10.9	11.1	9.6
LSD (P≤0.05)	**0.4**				**1.1**			
	Test weight (kg/hL)				**Screenings %**			
	14th March	**31st March**	**18th April**	**3rd May**	**14th March**	**31st March**	**18th April**	**3rd May**
ADV08.0008	71.2	72.7	73.1	70.6	0.5	0.6	0.7	0.9
ADV11.9419	68.8	70.7	71.1	70.0	1.7	1.5	1.4	1.5
Cutlass	68.3	74.5	76.3	76.2	0.5	0.1	0.1	0.1
Kittyhawk	74.8	76.1	76.1	74.2	0.5	0.4	0.6	1.1
LPB14-0392	68.5	75.5	75.9	72.9	0.7	0.5	0.7	1.3
Longsword	71.2	73.6	74.7	75.2	0.3	0.1	0.1	0.2
Scepter	69.8	70.8	73.7	76.7	1.8	0.3	0.2	0.3
Trojan	65.7	69.0	75.2	76.3	0.3	0.2	0.1	0.2
V09150-01	70.0	72.3	72.7	70.4	0.3	0.2	0.2	0.4
LSD (P≤0.05)	**1.9**				**0.4**			

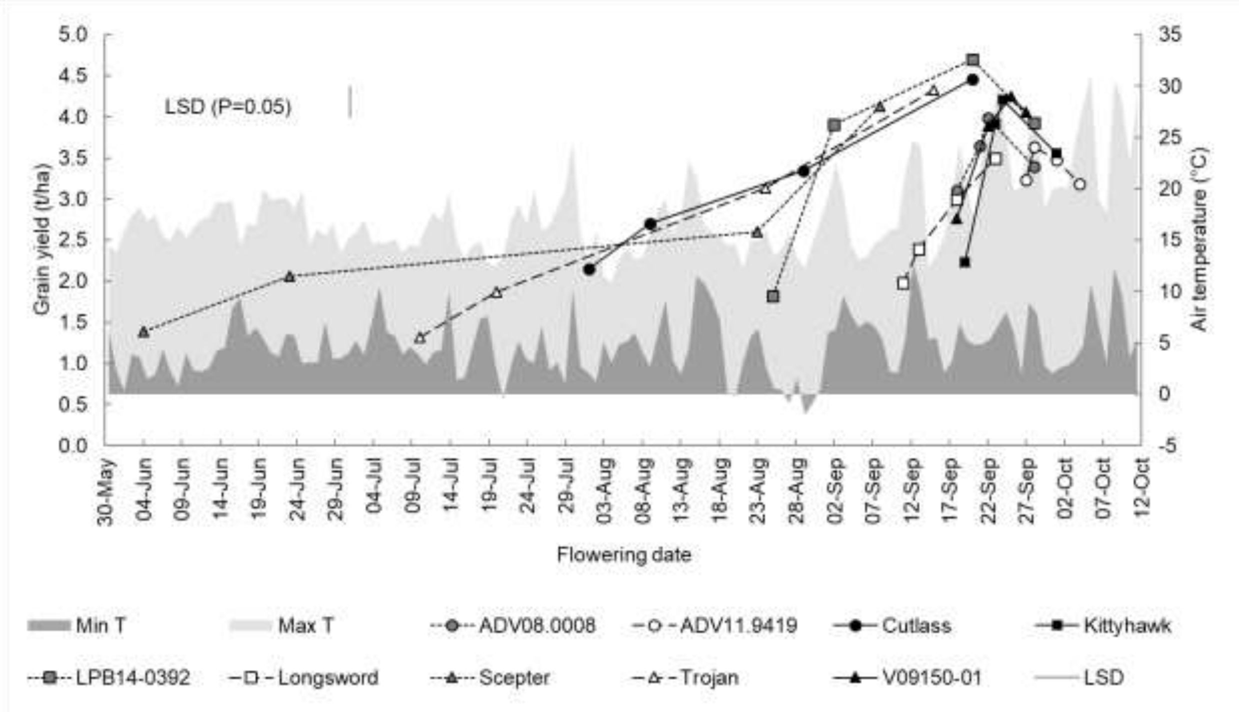

Figure 1. Average yield and flowering date for all varieties and times of sowing with maximum and minimum temperatures at Hart in 2017.

Summary / implications

In 2017, 331 mm of rain fell at the site compared to the long-term average of 406 mm. The lack of opening rainfall made it difficult for early sown (pre-Anzac Day) crops to emerge in this trial, but once established they were able to access good subsoil moisture from summer rainfall.

The use of different ToS and varieties with differing maturities resulted in a wide range of flowering dates, yields and overall crop performance were observed in this trial. The spring varieties' yields peaked when sown 3rd May, compared to the winter varieties which generally yielded highest when sown 18th April. Due to their vernalisation requirements, the winter varieties appear to have greater stability with their time of flowering and also yield regardless of being sown two or more weeks apart. This is a positive result from the first year of trials indicating newer winter varieties may be suitable to an early sowing program where they will flower during the optimal flowering period for peak yield. With the development of winter varieties such as V09150-01 and Longsword there is the potential to include these varieties in a sowing program to take advantage of early season rainfall events, in order to increase whole farm yield and avoid yield penalties from sowing spring varieties too early or too late.

The relative poor performance of Longsword was due to increased sterility at this site in 2017, despite flowering in the optimum window. This result requires further investigation and suggests in some scenarios Longsword may be more prone to higher levels of sterility.

Acknowledgements

The authors thank GRDC for project funding 'Development of crop management packages for early sown, slow developing wheats in the Southern region' (ULA9175069). We also thank the Clare, SARDI team for their assistance with trial management.

Early sown winter wheats – Booleroo

Dylan Bruce[1], Sarah Noack[1], Kenton Porker[2], James Hunt[3]
Hart Field-Site Group[1], SARDI[2], La Trobe University[3]

Key Findings

- The highest yielding spring wheat was Scepter sown on the 4th of May and 16th of March at 1.98 t/ha and 1.82 t/ha, respectively.
- The winter wheat varieties yielded between 0.82 – 1.33 t/ha, with no variety consistently outperforming another.
- 2017 conditions at Booleroo were unfavourable for winter wheats, further data across seasons and locations will be continued in 2018 and 2019.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 2% Zn @ 75 kg/ha
Seeding date	ToS 1 – 16th March		UAN (42:0) @ 60 L/ha on 13th July
	ToS 2 – 3rd April		
	ToS 3 – 19th April		
	ToS 4 – 4th May		

The trial was a split block design with four replicates of nine varieties (Table 1) at four times of sowing (ToS). Fungicides and herbicides were applied as necessary to keep the crop canopy free of disease (i.e. stripe rust and net blotch) and weeds. All plots were assessed for grain yield, protein, test weight and screenings with a 2.0 mm screen.

Table 1. Different categories of wheat varieties based on their development habits (and speed) selected for the trial at Booleroo.

Spring	Facultative	Winter
Cutlass (slow) Trojan (fast-medium) Scepter (fast)	LPB14-0392 (intermediate winter – fast spring)	ADV08.0008 (slow) ADV11.9419 (slow) Kittyhawk (medium) Longsword (fast) V09150-01 (medium)

Results and discussion

After receiving above average rainfall over the summer months of 2016/2017 (86 mm above long-term average) opening rains for the 2017 growing season were minimal during the March ToS, with only 2.6 mm falling for the month. A significant rainfall event did not arrive until the 20th of April where 32 mm fell at the Booleroo site. To ensure plant emergence would occur, the first two ToS (16th March and 3rd April) were irrigated with the equivalent of 10 mm of rainfall post-sowing. The last two ToS did not require irrigation for emergence.

Emergence & Establishment

Plant establishment differed between ToS with the lowest average plant density recorded at ToS 1 (16th March) with 33 plant/m², while the highest average plant density was recorded at ToS 3 (19th April) with 149 plant/m² (Table 2). The reduced emergence and establishment during the earlier ToS was due to the combination of a lack of initial soil moisture and higher soil temperatures in the first 10 cm of top soil, therefore leading to faster evaporation and soil crusting. For the latter two ToS however, conditions were more suitable for germination with adequate seed bed moisture and cooler soil temperatures, allowing plant densities to reach the targeted 150 plants/m². The slower maturing winter types ADV08.0008 and ADV11.9419, and the facultative type LBP14-0392 on average emerged poorly when compared to the other varieties.

Table 2. Average plant densities across all four ToS at Booleroo (target 150 plants/m²).

Time of Sowing	Average plants/m²	Average air temperature (°C) two weeks post sowing
1	33	23.0
2	81	17.2
3	154	15.4
4	149	12.6
LSD (P≤0.05)	**23.5**	

Grain Yield

Overall grain yields at Booleroo ranged from 0.82 t/ha to 1.98 t/ha (Table 3). The yield and flowering date results for the spring varieties in ToS 1 at Booleroo were inconsistent, flowering later and yielding higher compared to ToS 2 (Figure 1 and 2). This was a result of the variable and staggered germination in ToS 1, causing the development of plants in individual plots to be inconsistent and initiate flowering at different times.

The highest yielding treatment at Booleroo was Scepter sown on 4th May at 1.98 t/ha (Table 3). Both Cutlass and Trojan were also high yielding at the early May sowing. The winter varieties yielded between 0.82 t/ha and 1.33 t/ha, with no one variety consistently outperforming another. In general, the yield of the winter varieties was consistent across all ToS. The exception was Longsword at ToS 3 where the yield dropped due to a high level of sterility (57%), as also observed at Hart (see ‘Early sown winter wheats – Hart’, page 17 of this manual).

Overall the selected spring varieties and facultative variety outperformed the winter varieties, even when sown well before their optimal sowing window. These results have been caused by the combination of drought, frost, heat and disease (crown rot) stress observed at Booleroo in a season which favoured varieties that develop quickly.

Environmental conditions at Booleroo made it difficult for any varieties to flower during periods of low frost or heat/drought risk as the optimal flowering window is narrow. This is primarily due to a lack of in-season rainfall and temperatures dipping below 0°C on ten occasions and exceeding 30°C on two occasions between August and September. Due to the nature of the season yields and grain quality were generally low. This can be attributed to high levels of sterility.

Grain Quality

Grain protein content was generally high across the trial and differed between variety and ToS (Table 3). The majority of variety and ToS treatments contained protein levels well above 13% (minimum required for maximum grade). The highest protein contents were observed in Kittyhawk (ToS 4) at 18.0%, closely followed by V09150-01 (ToS 4), Longsword (ToS 4) and Kittyhawk (ToS 3). This is likely due to the extreme drought and heat experienced during grain-fill with later sowing, where accumulated nitrogen has been distributed amongst fewer grains or within smaller grains, increasing the protein concentrations in each grain.

Test weights differed between variety and ToS across the trial (Table 3). In general test weight increased with ToS from 74.5 kg/hL at ToS 1 up to 76.9 kg/hL at ToS 4. Overall the spring varieties outperformed the winter varieties in test weight. Trojan had the highest average test weight with 78.1 kg/hL, followed by Scepter and Cutlass with 76.5 kg/hL and 76.4 kg/hL, respectively.

Overall there were few treatments to exceed the 5% screening level at Booleroo (Table 3). The lowest performing ToS was ToS 1 with screenings levels at 3.9%, however this improved with later ToS. Overall the spring varieties had lower screenings on average when compared to the winter varieties with Trojan, Cutlass and Scepter recording average screenings of 1.9%, 2.2% and 2.3%, respectively.

Table 3. Grain yield and quality for all wheat varieties at different times of sowing at Booleroo in 2017 (LSD P≤0.05 is for the interaction between variety and time of sowing). Treatments shaded grey are not significantly different from the highest yielding treatment.

	Yield (t/ha)				**Protein %**			
	16th March	**3rd April**	**19th April**	**4th May**	**16th March**	**3rd April**	**19th April**	**4th May**
ADV08.0008	0.83	1.03	1.14	1.09	15.7	14.6	14.7	16.0
ADV11.9419	1.15	1.21	1.21	1.33	15.1	13.9	13.9	15.7
Cutlass	1.32	1.03	0.99	1.61	13.5	13.1	13.9	14.1
Kittyhawk	1.13	1.10	0.97	0.99	14.6	13.8	16.5	18.0
LPB14-0392	1.22	1.31	1.17	1.28	14.5	14.9	15.3	16.2
Longsword	1.11	0.91	0.82	1.22	16.2	16.2	16.1	16.6
Scepter	1.82	1.70	1.56	1.98	11.9	12.0	12.9	12.8
Trojan	1.53	1.59	1.42	1.57	12.6	13.2	13.4	14.1
V09150-01	1.10	1.12	1.11	1.30	15.3	15.1	15.2	16.7
LSD (P≤0.05)	**0.29**				**1.25**			
	Test weight (kg/hL)				**Screenings %**			
	16th March	**3rd April**	**19th April**	**4th May**	**16th March**	**3rd April**	**19th April**	**4th May**
ADV08.0008	72.0	73.4	76.4	76.5	5.2	6.0	4.7	4.2
ADV11.9419	73.4	74.5	75.6	76.0	7.6	7.3	4.3	4.9
Cutlass	76.0	76.2	75.6	77.7	2.3	1.2	2.5	2.8
Kittyhawk	75.3	75.8	76.4	77.5	4.6	4.8	5.1	2.1
LPB14-0392	74.0	74.2	75.2	77.5	7.0	5.2	5.6	3.2
Longsword	72.8	73.2	69.8	74.1	2.0	2.0	4.3	2.6
Scepter	76.8	76.3	74.4	78.5	2.3	1.5	2.5	3.0
Trojan	78.1	76.2	78.0	80.1	1.6	2.1	2.0	1.7
V09150-01	71.9	74.5	74.5	74.4	2.0	3.3	2.2	3.3
LSD (P≤0.05)	**2.83**				**2.44**			

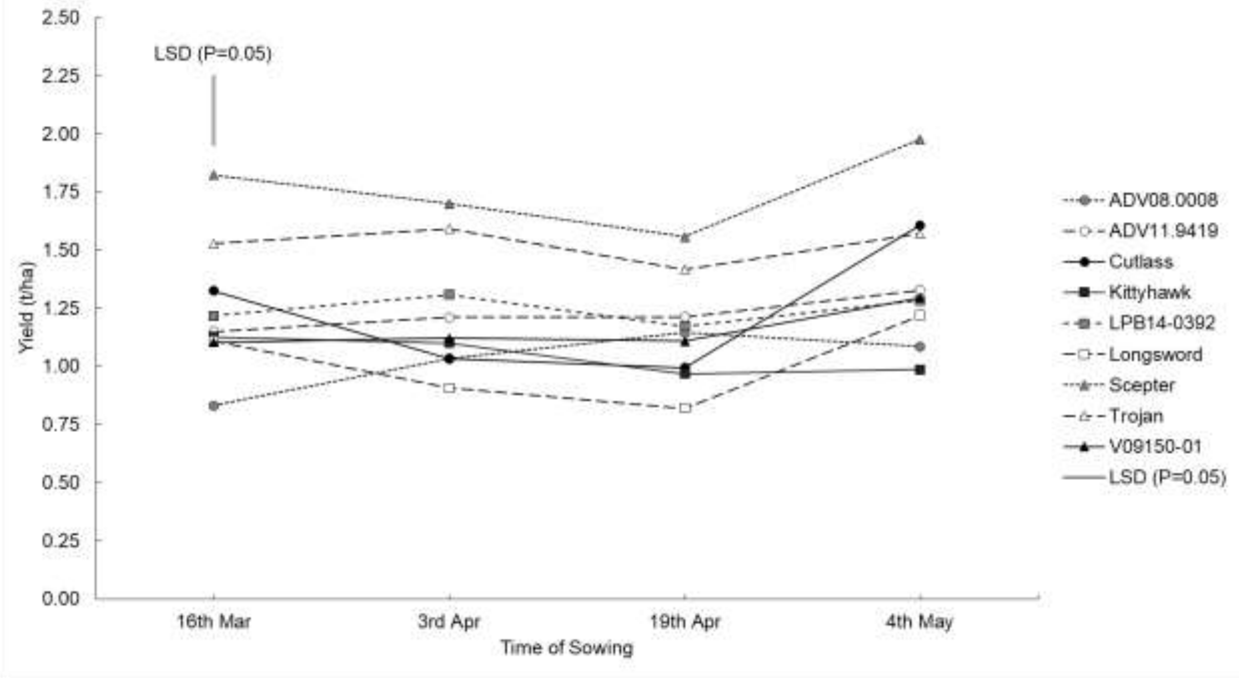

Figure 1. Average yield for all varieties and times of sowing at Booleroo in 2017.

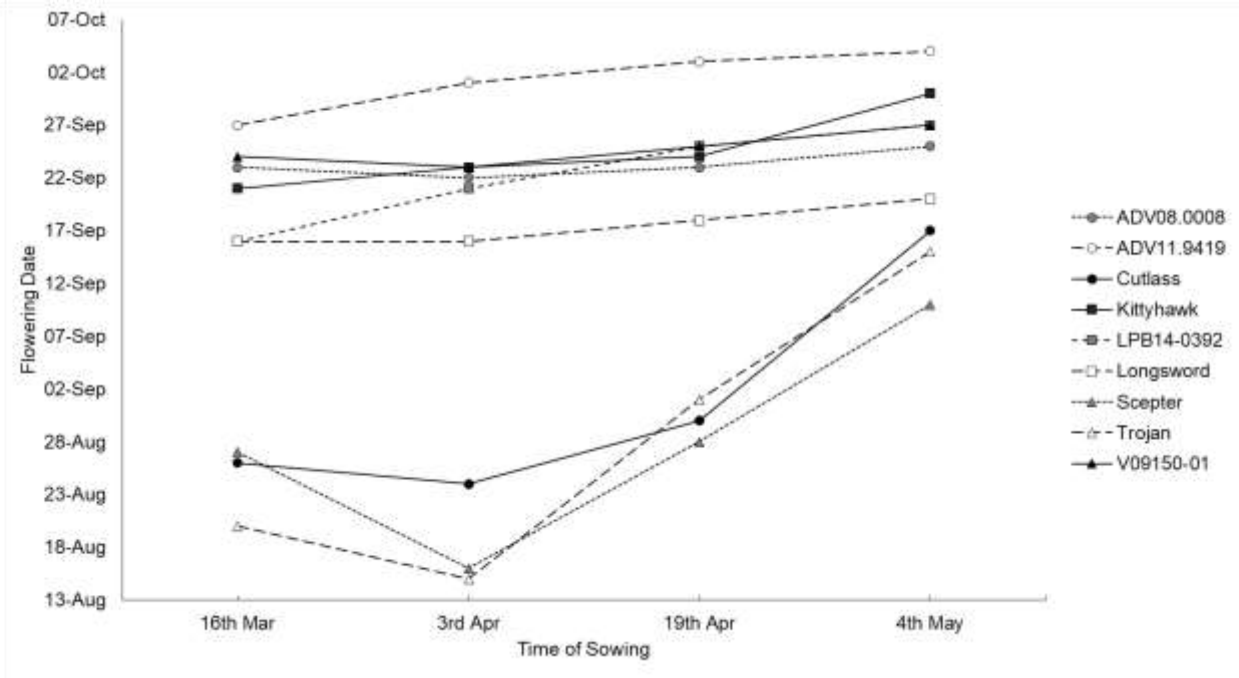

Figure 2. Average flowering dates for all varieties and times of sowing at Booleroo in 2017.

Summary / implications

Overall the 2017 season at Booleroo was a challenging one with only 165 mm falling during the growing season compared to the long-term average of 274 mm. Achieving good emergence and establishment was difficult due to dry top soil and lack of opening rainfall, until a significant rainfall event arrived in late April.

The use of different ToS and short and long season varieties resulted in a wide range of flowering dates, yields and overall crop performance. Due to low rainfall, hot and frosty conditions, quicker developing spring varieties such as Scepter, Trojan and Cutlass were favoured at Booleroo compared to the longer season winter wheats. The winter wheats however, had greater stability in flowering time and yield even though they were consistently lower than the spring varieties. It would be interesting to see how these varieties would perform in this environment under more favourable conditions, but further investigation and consecutive years of data collection and analysis is required.

Acknowledgements

The authors thank GRDC for project funding 'Development of crop management packages for early sown, slow developing wheats in the Southern region' (ULA9175069). We also thank the SARDI Clare team for their assistance with trial management.


Sowing the wheat ToS trial at Booleroo on May 4, 2017

Comparing coleoptile length in wheat varieties

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Hart Field-Site Group[1], SARDI[2]

Key Findings

- Varieties with the longest coleoptiles on average were Cutlass and Yitpi with 81 mm and 80 mm, respectively.
- Varieties with the shortest coleoptiles on average were Cobra and Wedgetail with 61 mm and 62 mm, respectively.
- Increasing soil temperature had a negative impact on coleoptile length with an average length of 67 mm recorded at 21°C, compared to 72 mm at 16°C.

Why do the trial?

The coleoptile is the protective sheath of tissue surrounding the stem of seedlings. The length of the coleoptile is an important characteristic when considering the seeding depth of cereals, especially during drier conditions when sowing deeper to reach soil moisture. If a variety is planted deeper than the potential length of the coleoptile, this can cause poor plant establishment as the shoot will emerge underground where it may never reach the soil surface.

The length of the coleoptile is influenced by a number of factors including variety, seed size, seed dressing, soil moisture and temperature. Genes found in many commercial semi-dwarf wheat varieties have also been associated with shorter coleoptile length, while taller varieties will have longer coleoptiles. However, the genetic variation for coleoptile length within Australian semi-dwarf wheat varieties is still considerable.

The aim of this experiment was to measure the coleoptile lengths of 12 wheat varieties under different soil temperatures according to average soil temperature data in late March and early May at Hart.

How was it done?

The experiment was a split-split plot design with three replicates of 12 varieties germinated in two soil types at two temperatures (Table 1).

Firstly, the base of individual seedling pots were filled with either Hart soil or Mallee sand and lightly compacted. Five seeds of each variety (in the size range of 25 - 28 mg) were placed on top of the compacted soil at the base of the pots. The pots were then filled loosely with the appropriate soil and firmly compacted so a one centimetre gap remained at the top of each pot. The soil was wetted to a field capacity and allowed to drain, the pots then placed on a tray, covered and placed inside an opaque plastic bag. The trays were then placed in growth rooms with temperatures set at 16°C and 21°C. After approximately 14 days the trays were removed from the growth rooms and the length of individual seedling coleoptiles was recorded.

Table 1. Wheat varieties, soil types and temperatures chosen for the coleoptile experiment.

Wheat Varieties	Soil Types	Temperatures
ADV08.0008	Hart Soil	21°C
ADV11.9419	Mallee Sand	16°C
Cobra		
Cutlass		
Kittyhawk		
Longsword		
LPB14-0392		
Scepter		
Trojan		
V09150-01		
Wedgetail		
Yitpi		

Results and discussion

Coleoptile length differed between varieties in this experiment ranging from 61 mm to 81 mm (Figure 1). The varieties with the longest coleoptile on average were Cutlass at 81 mm followed by Yitpi at 80 mm. At the other end of the scale Cobra, Wedgetail, LPB14-0392 and ADV08.0008 produced the shortest coleoptiles averaging 62 mm. There was no correlation between a varieties developmental type (spring, facultative or winter) and coleoptile length with the developmental types producing a range of coleoptile lengths.

The results show there were small variations in coleoptile length among the varieties trialed. If choosing to sow early with a winter variety (e.g. pre-Anzac day) and deeper into soil moisture the results show Longsword and Kittyhawk produced the longest coleoptile lengths.

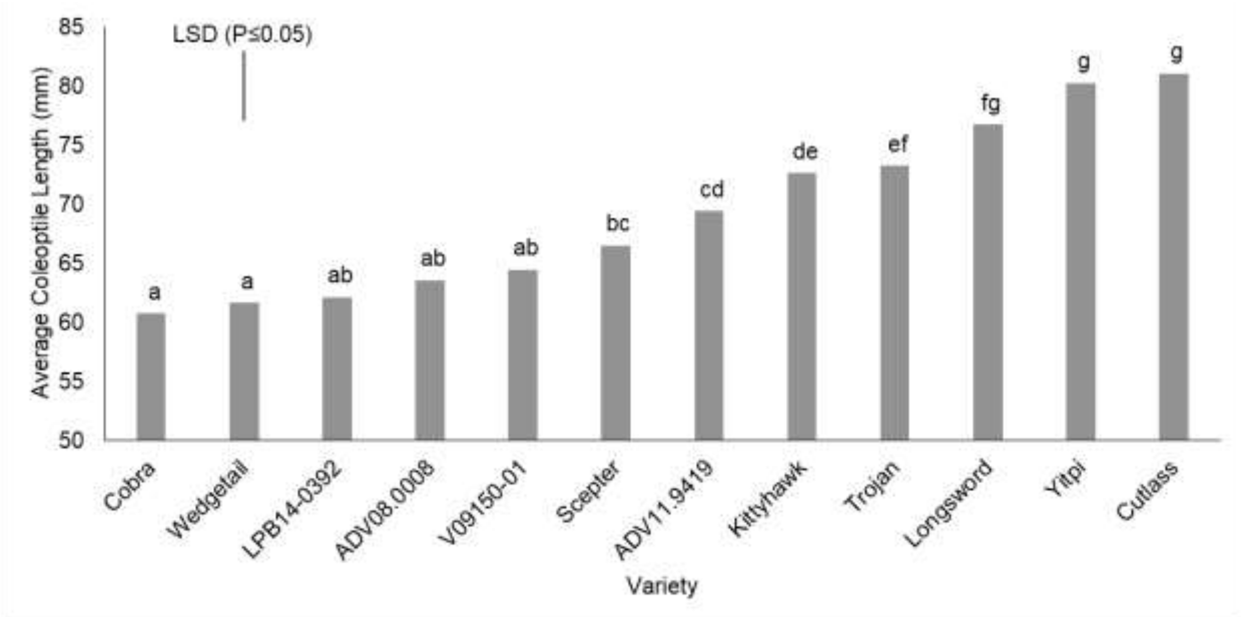

Figure 1. Average coleoptile length of varieties grown in two soil types and at two temperatures.

Coleoptile length also differed between temperatures used in this experiment (Figure 2). The results show a maximum average coleoptile length of 72 mm was recorded at 16°C, compared to a shorter coleoptile of 67 mm at 21°C. This is consistent with previous research of Australian commercial wheat varieties which has indicated coleoptiles can reach their optimal length at soil temperatures around 15°C, but shorten linearly when approaching temperatures around 35°C (Radford, 1987).

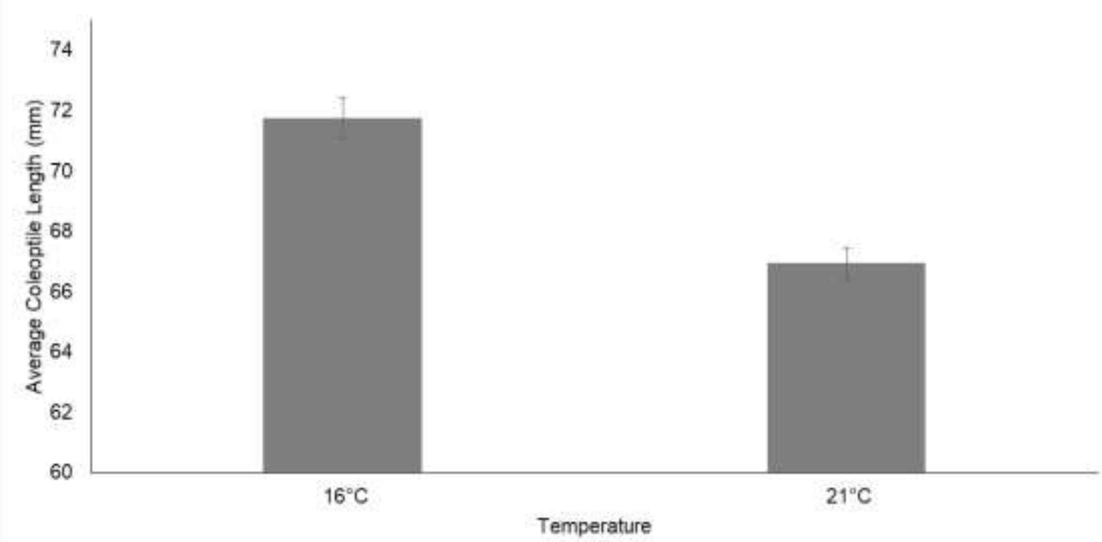

Figure 2. Average coleoptile length of wheat varieties grown at two temperatures based on soil temperatures in late-March (21°C) and early-May (16°C) at Hart.

Summary / implications

The varietal differences in coleoptile length were significant with Cutlass and Yitpi recording the longest coleoptiles at 81 mm and 80 mm, respectively. An increase in soil temperature had a negative effect on coleoptile length and soil types (clay loam v sand) did not affect coleoptile length.

Wheat varieties that have longer coleoptiles can be sown deeper to access stored moisture from summer rainfall events. These varieties would be better suited to capturing yield benefits associated with early sowing opportunities compared with shorter coleoptile varieties, especially when sowing into warmer soils. Special attention also needs to be given to incorporated herbicides and seed treatments. However, a greater evaluation of commercially available and developing wheat varieties under a variety of treatments and growing conditions needs to be taken to determine their suitability to early sowing conditions in Southern Australia.

References

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What effect does time of sowing and nitrogen have on wheat yield?

Mariano Cossani and Victor Sadras, SARDI

Key findings

- Sowing date combined with appropriate variety selection and adequate nitrogen supply was key to increasing grain yields.
- Nitrogen fertiliser decision needs to consider the maximum attainable yield and be adjusted for the seasonal conditions and initial available soil nitrogen.

Why do the trial?

Breeding for improved wheat yield over the past six decades has resulted in varieties that take up and use more Nitrogen (N). This means the N management of new varieties needs to continuously be assessed and adjusted.

In addition, there is increasing interest in adjusting sowing time to stretch the window for completing sowing operations on farm. To improve yield and maintain protein content under earlier sowing times, it is important to consider which varieties are most suited, and if your N management needs to be adjusted.

How was it done?

Plot size	1.75 m x 6 m
Seeding date	13 May 2017, 26 May 2017, 9 June 2017, 23 June 2017
Fertiliser	Urea; @ 0 kg/N ha; @ 50 kg N/ha; @ 100 kg N/ha; @ 150 kg N/ha
	Application time: 50% at 2-4 leaf & 50% at GS31

Field trials were carried out during 2017 in two locations (Turretfield and Hart) in the Mid-North of South Australia. Trials consisted of a combination of four sowing times, six wheat varieties, and four N rates at each location. The earliest sowing time was on the 12-13th of May 2017 and the following sowings were at fortnightly intervals. The latest sowing was on the 23rd of June.

Varieties were chosen based on those commonly grown, N requirement and phenology (Table 1). Nitrogen treatments consisted of unfertilised control, and three fertiliser rates (50, 100 and 150 kg N/ha) applied as urea. In all cases, N application was split in 50% at 2-4 leaf and 50% just before stem elongation (GS31).

Table 1. Wheat varieties trialed at Hart and Turretfield in 2017.

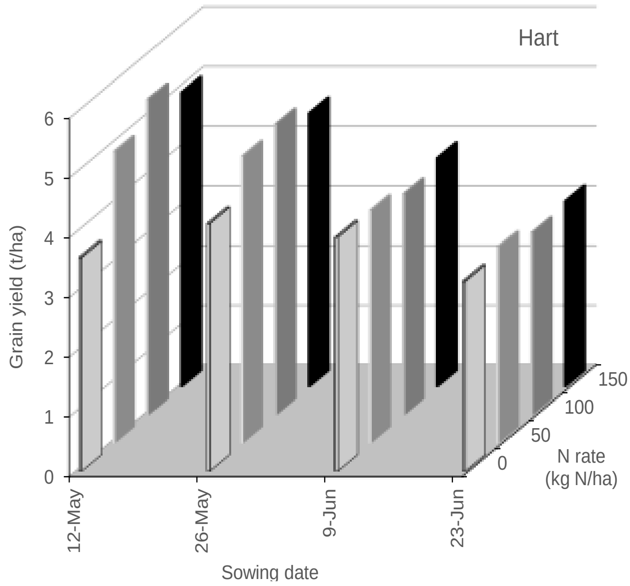
Variety	Maturity type
Axe (AGT)	early flowering and very early maturity variety suited to southern Australia
Cobra (LongReach)	high yielding early-mid maturity variety suited to high yielding areas of Southern Australia
Mace (AGT)	early to mid-season maturity and has been the leading wheat variety in both WA and SA in recent seasons
Scout (LongReach)	mid maturity variety, derived from Yitpi
Spitfire (LongReach)	is an early mid maturing variety with high grain size and consistently high grain protein
Trojan (LongReach)	mid-late maturing variety

Results and discussion

Grain yield was affected by sowing time, location, N rates and variety. Yields at Hart were in general 1.0 t/ha higher compared to Turretfield. However, differences between locations were reduced from 1.2 t/ha in early-mid May sowing time to less than 0.5 t/ha in the mid-late June (Figure 1).

At both sites Mace was the highest yielding variety (4.3 t/ha in first sowing time) but was not different from Cobra, Trojan or Scout (Figure 2). Spitfire was the lowest yielding variety at both the first (3.8 t/ha) and last sowing time (2.7 t/ha). Mace remained the highest yielding variety across all times of sowing. The early maturing variety Axe, did not show any advantages when sown in mid-May compared to late June. Sowing in mid-May produced a significant positive effect on grain yield only when N availability (soil + fertiliser) was above 150 kg N/ha.

Nitrogen fertilisation had a significant effect on grain yield with differential response between location, sowing time, and varieties. At Hart, N fertilisation increased the grain yield in the first and second sowings (before June) but did not improve yield when sowing in early or late June. At Turretfield, where initial soil N was exceptionally high (279 kg N/ha), N fertilisation reduced the grain yield in the first sowing time, with no effect in the later sowings (Figure 1). While in most cases yield decreased as seeding date was delayed into June, sowing time did not affect yield when fertilising at the maximum rate at Turretfield.



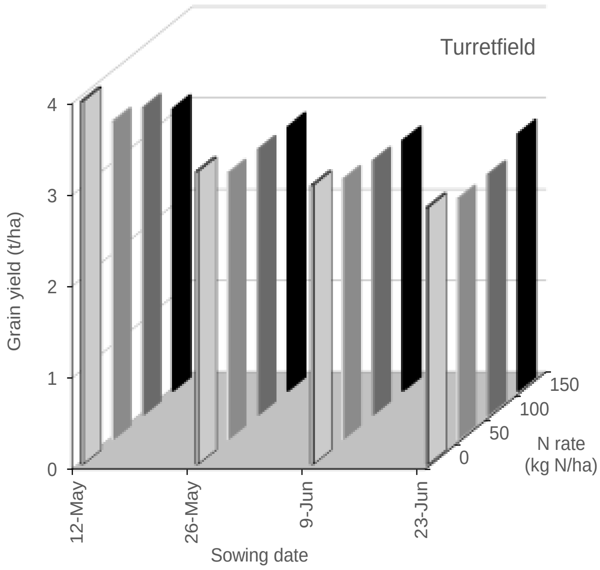


Figure 1. Grain yield across sowing date and N rate for both trial sites. Initial soil N was 111 kg N/ha at Hart and 279 kg N/ha at Turretfield. Least significance difference between bars were 0.21 t/ha for sowing time and 0.1 t/ha for N rate.

The varieties displayed different response to N depending on sowing time and location. The early maturing (Axe) and the mid-long maturing variety (Trojan) did respond positively to N supply. However, the mid maturity varieties (Mace, Cobra and Spitfire) did not respond to N fertilisation. Scout did not respond to N up to 150 kg N/ha and had a yield reduction at this rate (Figure 2). Differences between the varieties were also observed with sowing time, except in the late May sowing. For all varieties, yield declined with delayed sowing. The average rate of yield decline was 25.5 kg/ha of grain per day delay in sowing. Axe had lower yield than other varieties in the first sowing time (Figure 3).

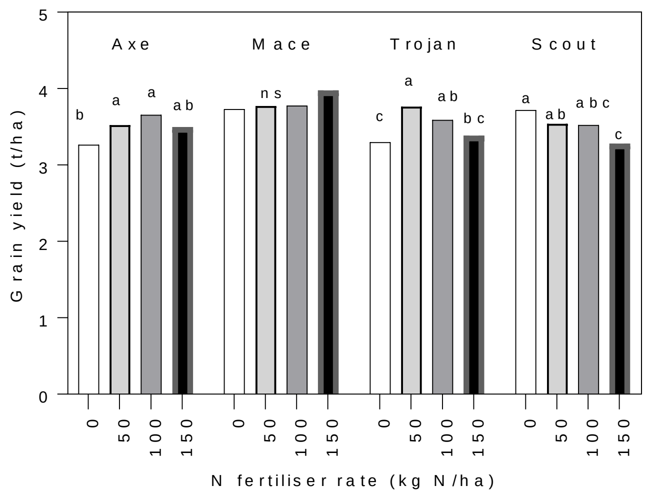


Figure 2. Average response of wheat varieties to N rates at both sites.

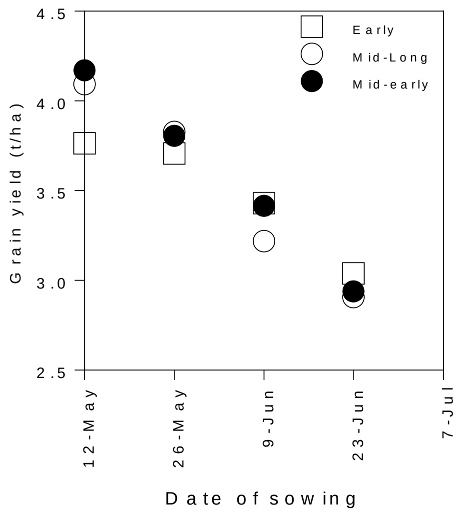


Figure 3. Average response of early, mid-early and mid-long varieties to sowing date.

Summary / implications

Sowing on time in early-mid May produced the highest grain yields at Hart in 2017. However, when considering this sowing time, variety and N supply become important. The benefits of sowing early can be obtained when using mid-maturity varieties and when providing the crop with enough N to maximise its productivity. The N response in terms of grain yield differ between very early, mid early, and mid-long varieties.

Acknowledgements

Funding for the establishment, maintenance, and analysis of field trials has been provided by the GRDC-SARDI bilateral (DAS00166). Special thanks are given to the Hart Field-Site Group, J. Fernandez-Lopez, G. Sepulveda and B. Sleep for their support and collaboration with the field and lab activities. We also acknowledge the help of Longreach and Australian Grain Technologies for their provision of the germplasm.


Wheat ToS trial at Hart on June 22, 2017

Wheat grain yield response to elevated temperature and nitrogen

Mariano Cossani and Victor Sadras, SARDI

Key findings

- Elevated temperature reduced yield by 0.3 – 0.4 t/ha per degree (°C) higher during pre- and post-flowering.
- The effect of temperature was offset by grain number per m^2.
- Higher N rates may partially mitigate the effect of elevated temperature.

Why do the trial?

Efficient management practices together with crop breeding are required to improve grain yields. Growers often take considerable risk with making N fertiliser decisions given the variability in uptake and response from season to season. Increasingly growers are utilising early sowing opportunities to take advantage of early season breaks and the ability to spread their seeding window. Shifting seeding date also modifies the thermal regime the crop experiences at critical stages.

Both sowing time and variety selection modify crop growth and N requirements. The interaction between N availability and temperature is largely unknown. The objective of this trial was to study the effect of elevated temperature, sowing time, variety, and N rate on wheat yield.

How was it done?

Plot size	1.75 m x 6.0 m	**Fertiliser**	Urea
Seeding dates	26 May, 9 June &		@ 0 kg N/ha, 2-4 leaf & GS31
	23 June 2017		@ 100 kg N/ha, 2-4 leaf & GS31

The field trial at Hart combined three sowing times, two wheat varieties, two temperature regimes during critical stages (heated and control) and two N rates. Sowing times spanned from late May to late June. Varieties were Mace (AGT) and Spitfire (LongReach). Temperature regimes consisted of unheated controls (actual field temperature), and plots heated with open-top passive heating cubes (1.5 m wide, 1.5 m length and 1.5 height) (Photo 1). The timing of heating was from booting (GS40) to 10 days after flowering (in first and second sowing time) and from 10 days after flowering till maturity (third sowing time). N treatments consisted of unfertilised control, and 100 kg N/ha applied as urea split between early tillering and just before stem elongation.

Photo 1. Open-top passive heating system before flowering (left) and during grain filling (right).

Results and discussion

Temperature regimes

The temperature in the heated treatments closely followed the temperature of untreated controls, providing a realistic system for comparison (Figure 1). On average, the heating system increased the average temperature by 1.4 °C for the first and second sowing times, and 1.7 °C during the late stages of the third sowing time. The increase in average temperature was due to consistently higher maximum temperatures with little change in minimum temperatures.

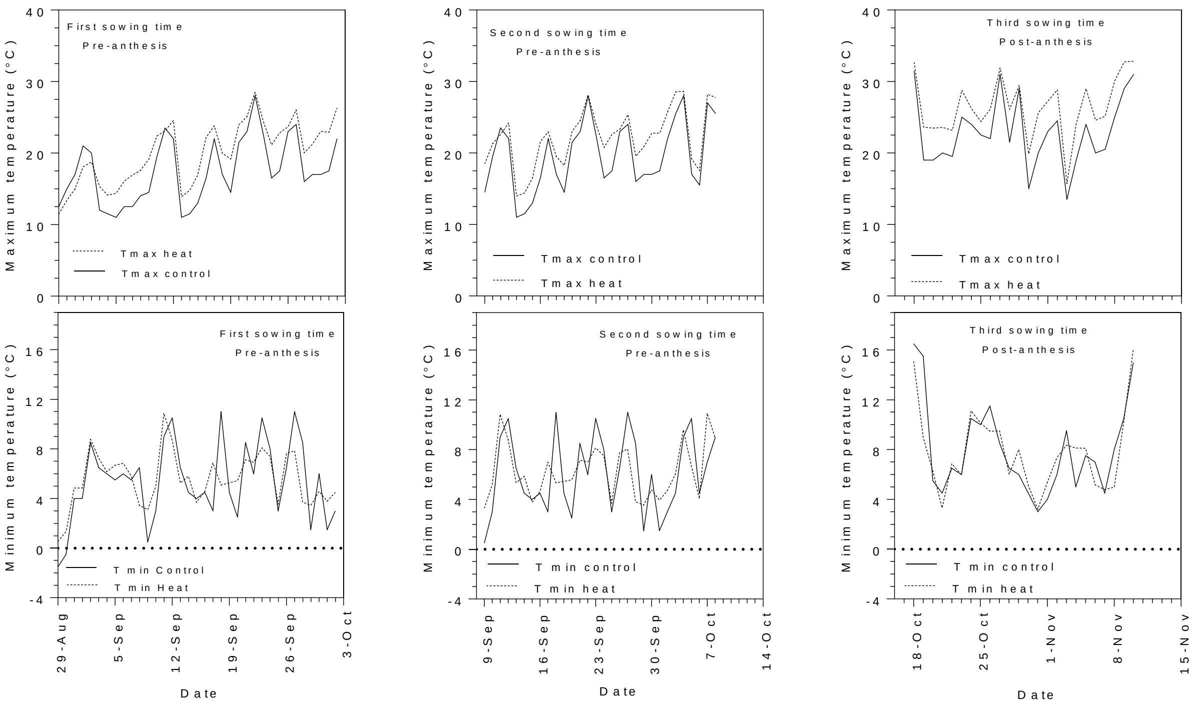


Figure 1. Minimum (T min) and maximum (T max) temperatures during the heating period for the three sowing times.

Temperature effects before flowering

Grain yield was affected by temperature, sowing time and N. The varieties Mace and Spitfire did not differ in grain yield in this trial. The effect of N fertiliser depended on the sowing time with a significant increase in yield (1.4 t/ha) in the first sowing and no effect on the second time. Delaying sowing reduced grain yield of fertilised crops but not for the unfertilised controls. Increasing the temperatures before flowering reduced grain yield in unfertilised crops but not in fertilised crops (Figure 2). The reasons for this response are unknown and will be the subject of further research.

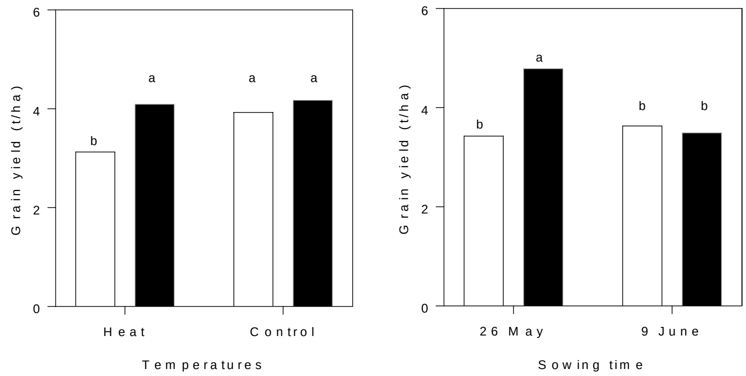


Figure 2. The effect of temperature (left panel) and sowing time (right panel) on grain yield for unfertilised (white bars) and fertilised crops (black bars). Different letters indicate significant differences (P ≤ 0.05) between bars.

Increasing temperatures during the pre-flowering period and the addition of N affected both grain number and thousand grain weight in both sowing times. Elevated temperature reduced grain set by 15%. Applying 100 kg N/ha increased grain set by 50% in the first sowing and 24% in the second sowing time. Delaying sowing decreased the grain number but only in fertilised crops (Figure 3).

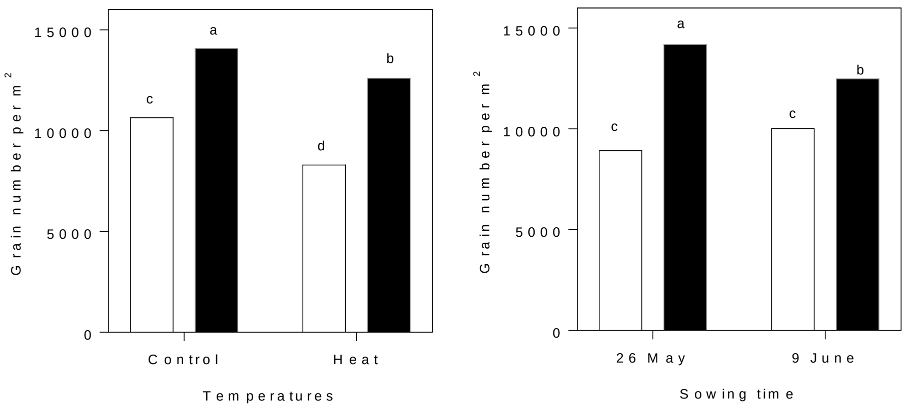


Figure 3. Main effect of temperature before flowering (left panel) and sowing time (right panel) on grain number per m2 for unfertilised (white bars) and fertilised crops (black bars). Different letters indicate significant differences (P ≤ 0.05) between bars.

The significant effects of the temperature, sowing time and N on grain number were transferred to thousand grain weight. Delayed sowing by 15 days reduced grain weight by 19% under high N conditions but not in unfertilised crops (Figure 4), however, the effect was only significant under high N conditions. The heating treatments during pre-flowering did not reduce the thousand grain weight, and even there was a slight increase under fertilised conditions.

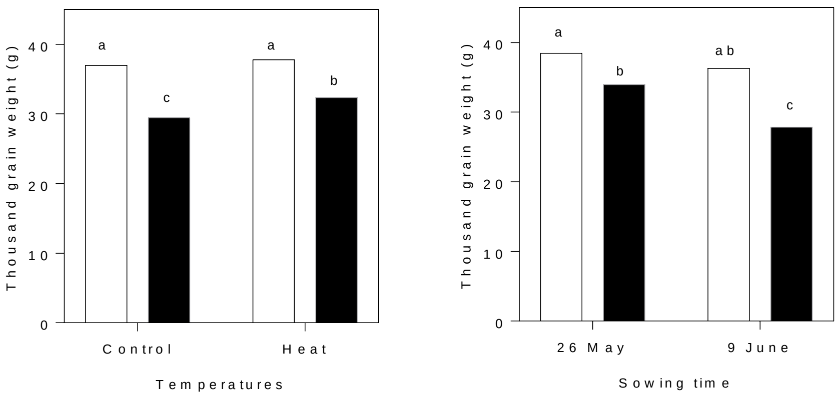


Figure 4. Main effect of temperature before flowering (left panel) and sowing time (right panel) on thousand grain weight for unfertilised (white bars) and fertilised conditions (black bars). Different letters indicate significant differences (P≤0.05) between bars.

Temperature effects after flowering

For crops sown on 23 June, Mace (3.46 t/ha) out-yielded Spitfire (2.78 t/ha). Increasing average temperature by 1.7 °C, reduced the yield of Mace by 15% but did not affect Spitfire (Figure 5). The reasons for the difference in response between cultivars are unknown, but this indicates that certain combinations of varieties and nitrogen rate could improve yield under elevated temperature. Nitrogen fertilisation did not affect grain yield.

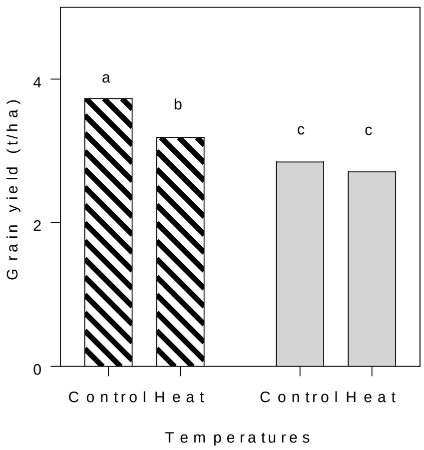


Figure 5. Main effect of temperature during post-flowering for grain yield for Mace (diagonal lines bars) and Spitfire (grey bars). Different letters indicate significant differences between bars.

Grain number was significantly affected by variety, temperature, and N. Mace produced approximately 2150 grains more per square metre than Spitfire. Increasing temperatures produce a significant decrease of 11% on grain number with higher effect under fertilised conditions. Nitrogen fertilisation increased grain number and reduced thousand grain weight.

Summary / implications

In this preliminary study, we showed how N, temperature and sowing time can affect wheat yield and quality. Small temperature increases during critical period for yield determination can seriously impair the yield and quality of wheat. High temperatures during pre-flowering, either manipulated experimentally with heating cubes or with delayed sowing, reduced grain number and yield. This reinforces the importance of early sowing providing frost risks are managed. Nitrogen fertilisation could play an important role in mitigating the impact of higher temperatures on grain number and grain yield. Varieties also differed in yield response to temperature in late-sown crops.

Acknowledgements

Funding for the establishment, maintenance, and analysis of field trials has been provided by the GRDC-SARDI bilateral (DAS00166) and Yitpi Foundation. Special thanks are given to the Hart Field-Site Group, J. Fernandez-Lopez, G. Sepulveda and B. Sleep for their support and collaboration with the field and lab activities. We also acknowledge the help of Longreach and Australian Grain Technologies for their provision of the germplasm.


Open-top passive heating cubes at Hart in 2017

Legume and oilseed herbicide tolerance

Key findings

- In the post emergent treatments a range of herbicides produced very good control of all oilseed and legume crops included.

Why do the trial?

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

How was it done?

Plot size	2.0 m x 3.0 m	**Fertiliser**	MAP (10:22) + 2% Zn @ 75 kg/ha
Seeding date	26th May 2017		

Thirteen strips of canola, pasture, vetch, chickpea, faba bean, field pea and lentils were sown. Fifty herbicide treatments were applied across all 13 crops at different timings.

The timings were:

Post seeding pre-emergent (PSPE)	1st June
Early post emergent (3-4 node)	5th July
Post emergent (5-6 node)	27th July
Late post emergent (8 node)	8th August

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

Crop damage ratings were:

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

Results

Many of the herbicides used here 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. In 2017 a number of the herbicide treatments produced different crop tolerance or control ratings than expected. Care should be taken when interpreting these results as herbicide effects can vary between seasons and depend on soil and weather conditions at time of application.

Majority of the post sowing pre-emergent (PSPE) herbicide applications had no effect on crop growth compared to the nil (Table 1). This would not usually be expected and can be attributed to the dry surface soil conditions during the months of June and July following application.

At the 3 – 4 node application simazine was the safest herbicide option. This is in contrast to previous season (2015 and 2016) where it caused damage (rating 3) on the chickpea and Jumbo 2 lentils. At this timing, metribuzin was more damaging to both lentil varieties, vetch and Genesis090 chickpea. For a number of seasons, Broadstrike has produced severe effects in both vetch varieties (RM4 and Timok) and pasture species. This was consistent in 2017 however, Zulu II clover was the only pasture variety where noticeable damage occurred.

Ecopar is now registered in pastures, vetch, field pea and faba bean however, its use in other crops remains off label. Refer to the crop safety on label for specific variety information. In the Hart trial at the 3rd node application Ecopar resulted in slight damage (1 - 2 rating) to most of the legumes, but moderate damage (3 – 4 rating) to the lentils.

In the post emergent 5 - 6 node treatments a range of herbicides produced very good control of all the oilseed and legume crops. These included Eclipse, carfentrazone, Vortex, Paradigm, Precept, Velocity, Flight, Triathlon and Jaguar. Ecopar was safer on field peas in 2016 and 2017. It should also be noted that crop establishment in the pasture section (Wilpena Sulla, Zulu II and Sultan SU) was patchy and poor early vigour contributed to a number of herbicides causing significant damage scores compared to those usually observed.

For some of the newer product entries;

- Pixxaro with Arylex active (16.25 g/L Arylex + 250 g/L fluroxypyr) is a post-emergent herbicide for use in all winter cereals from 3 leaf to flag leaf for the control of a range of broadleaf weeds. Pixxaro resulted in good control of the legume crops in both 2016 and 2017.
- Rexade is a post emergent grass plus broadleaf herbicide for use in wheat. It contains the group B herbicide pyroxsulam plus the new Group I herbicide Arylex (halauxifen-methyl). It can be tank mixed with a range of broadleaf herbicides, typically MCPA LVE. In 2017 Rexade gave very good control of the legume and canola crops.
- Talinor (37.5 g/L bicyclopyrone and 175 g/L bromoxynil) is a new fast acting cereal broadleaf herbicide that offers broad spectrum post-emergent weed control in wheat and barley (excluding durum). This product has been in the Hart herbicide matrix for two seasons and provided excellent control of all the legume and oilseed crop types.

In the 8 - 9 node treatments Gunyah peas were a standout by tolerating MCPA sodium and amine, and a low rate of 2,4-D ester. A low rate of 2,4-D ester was slightly more damaging on Genesis090 chickpeas than normally expected. In the knockdown treatments both vetch lines were the most difficult to control, with the woolly pod vetch (RM4) being the hardest. There was little variation in knockdown and spike treatments for the remaining crops in 2017, with all providing good levels of control.

Table 1. Crop damage ratings for legume and oilseed herbicide tolerance trial at Hart 2017.

Seeding date: 26th May 2017
Fertiliser: MAP (10:22) @ 75 kg/ha

N ➡

				Pasture	Clover	Medic	Lentil	Lentil	Vetch	Vetch	C/pea	Pea	Bean	Canola	Canola	Canola
				Wilpena Sulla	Zulu II	Sultan SU	Hurricane	Jumbo 2	Timok	RM 4	Genesis090	Gunyah	Nura	Pioneer 44Y90	HyolaS559TT	AV Garnet
Number	**Timing**	**Treatment**	**Rate kg/ha**	10	8	10	55	45	45	45	120	100	140	4	4	4
1	**Post seeding pre-emergent** 1st June 2017	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1
2		Diuron (900 g/kg)	550 g	4	4	1	1	1	1	1	1	1	1	3	3	3
3		Diuron (900 g/kg)	825 g	6	6	5	1	1	1	1	1	1	1	3	5	5
4		Simazine (900 g/kg)	550 g	4	6	2	1	1	1	1	1	2	1	2	1	3
5		Simazine (900 g/kg)	825 g	5	6	2	1	1	1	1	1	2	1	2	1	4
6		Diuron (900 g/kg) + Simazine (900 g/kg)	410 g + 410 g	5	6	2	1	1	1	1	1	1	1	2	3	4
7		Metribuzin (750 g/kg)	180g	4	5	2	1	1	1	1	1	1	1	2	2	3
8		Metribuzin (750 g/kg)	280g	4	5	2	2	1	1	2	1	1	1	5	3	3
9		Terbyne (750 g/kg)	1000 g	6	6	6	1	1	1	1	1	1	1	5	2	6
10		Spinnaker	100g	4	6	2	1	3	1	1	3	1	2	2	6	6
11		Spinnaker + Simazine	45 g + 830 g	5	6	3	1	2	1	1	1	1	1	2	5	6
12		Balance	100 g	6	6	6	4	4	1	1	1	2	3	6	6	6
13		Balance + Simazine	100 g + 830 g	6	6	6	5	5	2	1	1	3	6	6	6	6
14		Terrain (500 g/kg)	180 g	5	5	4	3	3	2	1	1	2	2	4	4	4
15	**3-4 Node** 5th July 2017	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1
16		Simazine (900 g/kg)	850 g	2	2	1	1	1	1	1	1	1	1	1	1	1
17		Metribuzin (750 g/kg)	280 g	2	6	4	3	3	4	3	5	1	3	6	1	6
18		Broadstrike + Wetter 1000	25 g + 0.2%	1	5	2	2	1	5	6	1	1	3	1	6	6
19		Brodal Options	150 mL	6	5	2	2	1	1	1	5	1	3	4	4	4
20		Brodal Options + MCPA Amine 750	150 mL + 100 mL	6	3	4	3	3	5	5	5	2	5	6	6	5
21		Spinnaker + Wetter 1000	70 g + 0.2%	2	2	2	2	4	3	1	4	1	1	2	6	6
22		Raptor + Wetter 1000	45 g + 0.2%	1	3	1	1	4	2	2	4	1	3	2	6	6
23		Ecopar + Wetter 1000	800 mL + 0.2%	3	3	1	4	3	1	1	2	2	2	2	3	2
24	**5-6 Node** 27th July 2017	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1
25		Ally + Wetter 1000	7 g + 0.1%	6	6	6	5	6	4	5	6	5	6	2	4	5
26		Eclipse SC + Wetter 1000	50 mL + 0.1%	5	6	5	4	5	6	5	6	5	6	1	4	5
27		Atrazine + Hasten	825 g + 1%	6	6	6	6	5	4	5	6	5	4	5	2	5
28		Lontrel 600	150 mL	4	3	3	4	4	4	4	5	4	5	1	1	2
29		Ecopar + MCPA Amine 750	400 mL + 330 mL	4	2	2	4	4	4	4	5	3	4	4	4	4
30		Jaguar	1000 mL	5	4	4	5	5	6	5	6	4	4	5	5	5
31		Carfentrazone + MCPA Amine 750	100 mL + 330 mL	6	6	5	6	6	5	4	6	5	6	6	6	5
32		Velocity + Uptake	670 mL + 0.5%	6	5	6	5	5	5	5	6	5	5	6	6	6
33		Talinor + Hasten	1000 mL + 1 %	6	6	6	5	5	6	6	6	5	5	6	6	6
34		Paradigm + Uptake	25 g + 0.5%	6	6	5	5	5	5	5	5	5	5	6	6	6
35		Vortex + Uptake	820 mL + 0.5%	6	6	5	5	5	5	5	5	5	5	5	5	5
36		**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1
37		Flight EC	720 mL	6	4	4	4	4	5	5	6	4	5	6	6	6
38		Triathlon	1000 mL	6	4	5	5	4	5	5	6	4	5	6	6	6
39		Banvel M	1000 mL	4	5	4	4	4	5	4	4	4	4	4	5	5
40		Intervix + Hasten	600 mL + 0.5%	5	6	1	1	5	4	4	4	3	4	1	5	5
41		Starane	600 mL	2	6	4	4	4	5	5	6	4	4	4	4	4
42		Pixxaro + Uptake	300 mL + 0.5%	5	6	4	5	5	6	5	6	5	5	3	3	3
43		Rexade + Wetter 1000	100 g + 0.25%	4	6	5	5	4	5	6	5	5	5	1	5	5
44		Atlantis OD + Hasten	330 mL + 0.5%	5	6	5	4	4	4	5	5	5	5	1	5	5
45	**Late post emergent 8 - 9 node** 8th August 2017	MCPA Amine (750 g/L)	350 mL	6	6	2	4	4	4	4	2	2	5	6	6	6
46		Buttress	1500 mL	3	3	2	2	2	2	2	2	2	4	5	5	5
47		NUL 3342	2000 mL	3	3	1	5	4	5	4	4	4	4	6	6	6
48		Amicide Advance 700	1200 mL	6	6	6	6	6	6	6	6	5	6	6	6	6
49		2,4-D Ester (680 g/L)	70 mL	5	5	2	1	1	1	1	3	1	1	4	4	4
50		**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1
51		Sprayseed	2000 mL	5	6	5	5	5	5	4	6	6	4	6	6	6
52		Gramoxone	1500 mL	5	6	6	5	5	5	4	6	6	4	6	6	6
53		Alliance	2000 mL	6	6	5	6	6	4	4	6	6	6	6	6	6
54		Glyphosate 450 + LI700	1000 mL + 0.25%	6	6	6	6	6	4	4	5	6	6	6	6	6
55		Glyphosate + Goal + LI700	1000 mL + 75 mL + 0.25%	6	6	6	6	6	4	3	5	6	6	6	6	6
56		Glyphosphate + B-Power + Hasten	1000 mL + 160 mL + 0.5%	6	6	6	6	6	4	4	6	6	6	6	6	6
57		Glyphosate + Hammer400 + LI700	1000 mL + 30 mL + 0.25%	5	6	6	6	6	3	3	5	6	5	6	6	6
58		Glyphosate + Sharpen + Hasten	1000 mL + 17 g + 1%	6	6	6	6	6	4	4	6	6	6	6	6	6
59		Glyphosate + Terrain + Hasten	1000 mL + 30 g + 1%	6	6	6	6	6	4	4	6	6	6	6	6	6
60		Glyphosate + Amicide Advance 700 + LI700	1000 mL + 500 mL + 0.25%	6	6	6	6	6	4	4	6	6	6	6	6	6
61		Glypohsate + Dicamba + BS1000	1000 mL + 240 mL + 0.25%	5	6	6	6	6	4	4	6	6	6	6	5	6

Managing clethodim resistant ryegrass in canola with crop competition and pre-emergent herbicides

Sam Kleemann, Gurjeet Gill, Chris Preston – University of Adelaide
Sarah Noack – Hart Field-Site Group

Key findings

- Two seasons of trials have demonstrated there are differences in crop vigour / biomass production within open pollinated varieties ATR Stingray (less competitive) and ATR Bonito (more competitive) relative to a competitive hybrid variety Hyola559TT.
- In 2017, at Hart and Roseworthy both OP and hybrid varieties provided similar crop competition for ryegrass control.
- A combination of effective pre-emergent herbicides with competitive canola varieties combines two tactics to reduce ryegrass seed set.

Why do the trial?

Clethodim (Select®) has been a major herbicide used for the control of annual ryegrass in canola and pulse crops. However, resistance to clethodim in ryegrass has been increasing in the southern region, which makes it more difficult for the growers to control this weed. Some growers have responded by using increased rates of Clethodim, but weed control achieved can still be disappointing. As canola is more sensitive to clethodim than pulse crops, increasing clethodim dose can cause crop damage. Even though there are currently two different types of herbicide tolerant canola available in SA (TT, triazine tolerance; CLF, imidazolinone tolerance), each of these types has weaknesses for weed management and all have relied on clethodim to manage annual ryegrass.

Crop competition has long been known to be a useful tool in weed management. Practices such as decreasing row spacing, increasing seed rates, and growing more competitive varieties have all been demonstrated to reduce weed numbers. With an increasing number of canola varieties introduced to the market each season there is limited understanding of their ability to compete with weeds.

Here we report results from field trials undertaken at Hart and Roseworthy to demonstrate that crop competition afforded by a hybrid canola in combination with pre-emergent herbicides can reduce ryegrass seed set.

Materials and Methods

Field trials were established at Hart and Roseworthy in 2017 to investigate the effect of crop competition and different pre-emergent herbicides and their mixtures on annual ryegrass control in canola. The trials were established in a split-plot design to compare a triazine (TT) open-pollinated (OP) variety (ATR Bonito) with a TT-Hybrid (Hyola559TT) under eight pre-emergent herbicide strategies (Table 1).

Table 1. Pre-emergent herbicide strategies used in canola competition trial at Hart & Roseworthy in 2017.

Herbicide treatment	Herbicides applied
1	Nil
2	Propyzamide (1.0 L/ha) pre
3	Butisan® (1.5 L/ha) pre
4	Altiplano® (3 kg/ha) pre
5	Atrazine (1.1 L/ha) pre + atrazine (1.1 L/ha) post
6	Propyzamide® (1 L/ha) pre + atrazine (1.1 kg/ha) post
7	Butisan® (1.5 L/ha) pre + atrazine (1.1 kg/ha) post
8	Altiplano® (3 kg/ha) pre + atrazine (1.1 kg/ha) post

Seeding rate was adjusted according to seed viability and size to obtain a target density of 35 plants/m^2, with ATR Bonito (equivalent to 2.3 kg seed/ha) and Hyola559TT (equivalent to 2.9 kg seed/ha) sown on the 3rd of May at Hart. Because of the adverse sowing conditions at Roseworthy higher seed rates for ATR Bonito (2.8 kg seed/ha) and Hyola559TT (3.4 kg seed/ha) were sown on the 12th of May. The replicated trials were sown using a standard knife-point press wheel system on 22.5 cm (9") row spacing. Fertiliser rates were applied as per district practice, with glyphosate applied for pre-sowing weed control. Pre-emergent herbicides were applied with a 2 m pressurised handboom within a few hours of sowing. Atrazine was applied post-emergent (treatments 5, 6, 7 & 8) to ryegrass at the 1-3 leaf growth stage.

Assessments included ryegrass control (reduction in plant and seed set), crop establishment, and grain yield. Data was transformed by a square root if required to stabilise variances. Data from the competition trials was analysed by 2-way ANOVA with variety and herbicide treatment as factors. Where the result of the ANOVA was significant, means were separated by Fisher's protected LSD test ($P \leq 0.05$).

Results

There was no effect of herbicide treatment on canola establishment at Roseworthy (~50 plants/m^2). However higher establishment was observed for ATR Bonito (28 plants/m) compared to Hyola559TT (24 plants m^{-2}) at Hart, respectively (data not presented). Higher crop establishment at Roseworthy relative to Hart resulted from the higher seed rate used at Roseworthy to compensate for the adverse sowing conditions.

At Hart there were differences between herbicide treatments, variety and their interaction on ryegrass control early in the season (Table 2). Only herbicide treatment was significant at Roseworthy (Table 3). Despite the low ryegrass infestation at Hart (<90 plants/ m^2), nearly 2-fold more ryegrass was present in plots sown to ATR Bonito compared to Hyola559TT, whereas equal densities (83 plants/m^2) were observed between varieties at Roseworthy. At both sites herbicides propyzamide, Butisan® and Altiplano® provided similar effective control (>74%) irrespective of variety. In comparison weed control in ATR Bonito with atrazine was <50%. Atrazine requires adequate soil moisture for activation, and rainfall deficits in May and June at both field sites may have compromised the herbicides activity.

*Table 2. Influence of canola variety and herbicide strategy on ryegrass density 6 weeks after sowing at Hart in 2017. *Post atrazine not yet applied.*

Herbicide treatment	T1	T2	T3	T4	*T5	*T6	*T7	*T8	Average
	Ryegrass density (plants m^2)								
Variety									
ATR Bonito	88	12	20	11	38	25	14	17	28
Hyola559TT	40	11	11	17	15	15	17	15	18
Average	64	12	16	14	26	20	16	16	
Interaction	<0.01								
Herbicide treatment	<0.001								
Variety	<0.01								

*Table 3. Influence of canola variety and herbicide strategy on ryegrass density 6 weeks after sowing at Roseworthy in 2017. *Post atrazine not yet applied.*

Herbicide treatment	T1	T2	T3	T4	*T5	*T6	*T7	*T8	Average
	Ryegrass density (plants/m^2)								
Variety									
ATR Bonito	210	40	51	38	128	43	71	82	83
Hyola559TT	227	58	63	57	93	44	72	45	83
Average	219	49	57	47	111	44	72	64	
Interaction	NS								
Herbicide treatment	<0.001								
Variety	NS								

At Roseworthy herbicide treatments propyzamide and propyzamide + POST atrazine were the most effective options providing >82% control relative to the nil 12 WAS (405 plants/m^2; Table 4). Propyzamide is known for its moderate persistence and the benefit of its extended residual control was obvious during this season on the larger ryegrass population at Roseworthy.

Table 4. Influence of canola variety and herbicide strategy on ryegrass density 12 weeks after sowing at Roseworthy in 2017.

Herbicide treatment	T1	T2	T3	T4	T5	T6	T7	T8	Average
	Ryegrass density (plants/m^2)								
Variety									
ATR Bonito	420	70	166	96	96	53	121	45	134
Hyola559TT	390	72	103	91	191	56	89	57	131
Average	405	71	135	94	144	54	105	51	
Interaction	NS								
Herbicide treatment	<0.001								
Variety	NS								

At both Hart and Roseworthy herbicide treatment, but not variety, impacted the number of ryegrass heads present at the end of the season (Table 5 and 6). However, herbicide responses were somewhat different between sites, with atrazine + POST atrazine providing the greatest reduction in seed production at Hart (95%), whereas propyzamide + POST atrazine (82% reduction) and Altiplano® + POST atrazine (83% reduction) were the most effective treatments at Roseworthy. Differences in weed pressure were obvious between sites, and the more robust herbicide treatments (i.e. propyzamide or Altiplano® + POST atrazine) prevailed at Roseworthy were ryegrass was present in large numbers. In contrast atrazine + POST atrazine was only effective on the smaller weed population at Hart, where rainfall conditions improved later in the season.

Table 5. Influence of canola variety and herbicide strategy on ryegrass head density at Hart in 2017. Values in average column with different letters are significantly different (P = 0.05).

Herbicide treatment	T1	T2	T3	T4	T5	T6	T7	T8	Average
	Ryegrass seed heads (heads/m^2)								
Variety									
ATR Bonito	92	14	13	17	5	15	12	4	22
Hyola559TT	78	11	8	17	3	15	10	8	19
Average	85a	13bc	11bc	17b	4d	15b	11bc	6cd	
Interaction	NS								
Herbicide treatment	<0.001								
Variety	NS								

There was no effect of variety on ryegrass seed production at either Hart or Roseworthy. This is in stark contrast to previous studies where seed set was often reduced by as much as 40-50% with the more competitive hybrid versus OP variety. For example, at Roseworthy in 2016 (Kleemann et al 2016), Hyola559TT reduced seed set by 50% compared to ATR Stingray (OP). In these studies ATR Bonito, whilst an OP variety, appeared to show more comparable early vigour and growth to hybrid Hyola559TT. This was evident from the similar NDVI values (measure of green vegetative growth) recorded from crop emergence through to flowering for both varieties (Figure 1 and 2).

Table 6. Influence of canola variety and herbicide strategy on ryegrass head density at Roseworthy in 2017. Values in average column with different letters are significantly different (P = 0.05).

Herbicide treatment	T1	T2	T3	T4	T5	T6	T7	T8	Average
	Ryegrass seed heads (heads/m^2)								
Variety									
ATR Bonito	591	194	238	278	171	90	184	77	228
Hyola559TT	442	178	162	195	245	97	146	100	196
Average	516a	186b	200b	236b	208b	93c	165bc	88c	
Interaction	NS								
Herbicide treatment	<0.001								
Variety	NS								

Previous research (Lemerle et al. 2014) reported that hybrids were generally more competitive than OP varieties but concluded that there is considerable variation in the competitiveness between varieties in their ability to suppress weed growth.

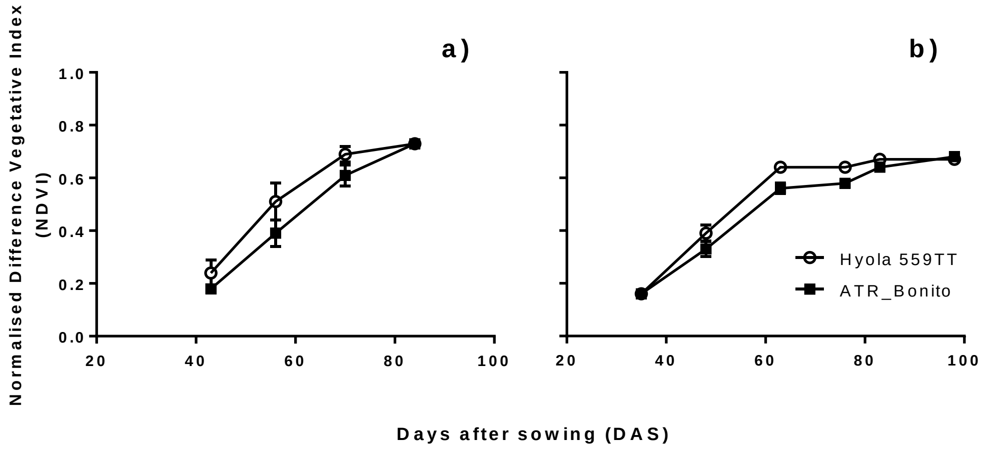


Figure 1. NDVI (Normalised difference vegetative index) of canola varieties, ATR Bonito (■) and Hyola559TT (O) measured during pre-flowering crop development at Hart (a) and Roseworthy (b). To avoid confounding effect of ryegrass on NDVI values only data from herbicide treatment 2, where ryegrass control was greatest, are presented.

Figure 2. Nil treated Bonito TT (left) and Hyola 559TT (right) taken at Hart on 1st July 2017.

Table 7. Influence of canola variety and herbicide strategy on canola yield at Hart in 2017. Values in average column with different letters are significantly different (P = 0.05).

Herbicide treatment	T1	T2	T3	T4	T5	T6	T7	T8	Average
	Canola yield (t/ha)								
Variety									
ATR Bonito	1.55	1.65	1.55	1.63	1.70	1.47	1.82	1.70	1.63a
Hyola559TT	1.41	1.42	1.36	1.36	1.51	1.35	1.50	1.38	1.41b
Average	1.48	1.53	1.43	1.49	1.60	1.41	1.66	1.54	
Interaction	NS								
Herbicide treatment	NS								
Variety	<0.001								

At Hart there was an effect of variety, but not herbicide or its interaction with variety on canola yield (Table 7). This is not entirely surprising given the weed interference at this site would likely have been negligible given the small population present, and that ryegrass on a per plant basis is far less competitive than many of the other grass weeds (i.e. brome and wild oats). Consequently, the small but significant yield difference between varieties (1.63 t/ha vs 1.41 t/ha) is more likely a reflection of the shorter growing season at Hart which would have favoured ATR Bonito which is an earlier flowering type than Hyola559TT. In comparison the impact of weed interference on grain yield was significant at Roseworthy, and there was a significant effect of herbicide (P<0.001) on canola yield (Table 8). Not surprisingly yields were significantly higher for all herbicide treatments relative to nil treatments because of the larger ryegrass population. In response to improved weed control grain yields were highest for both varieties treated with propyzamide + POST atrazine (1.47 t/ha) and Altiplano® + POST atrazine (1.46 t/ha).

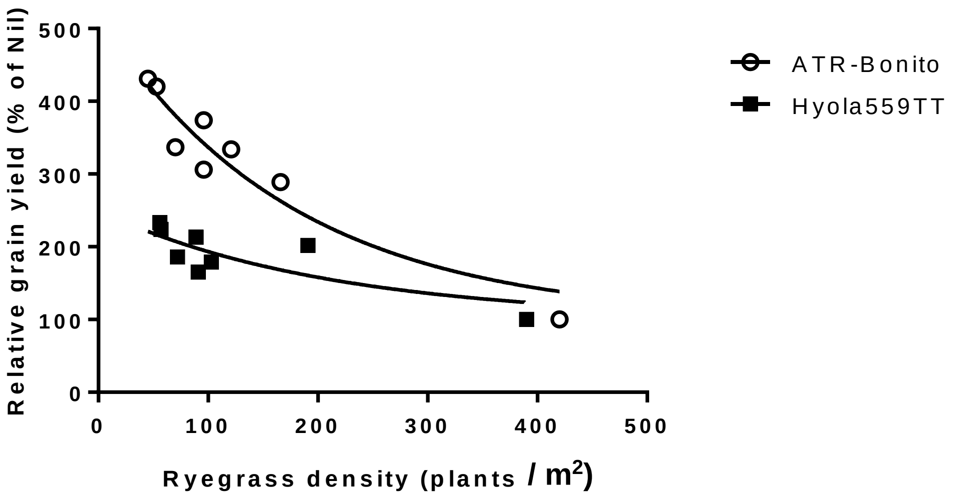


Figure 3. Relationship between average ryegrass density after application of herbicide treatments and relative grain yield of canola varieties ATR Bonito and Hyola559TT at Roseworthy.

Table 8. Influence of canola variety and herbicide strategy on canola yield at Roseworthy in 2017. Values in average column with different letters are significantly different (P ≤ 0.05).

Herbicide treatment	T1	T2	T3	T4	T5	T6	T7	T8	Average
	Canola yield (t/ha)								
Variety									
ATR Bonito	0.35	1.18	1.01	1.07	1.31	1.47	1.17	1.51	1.13
Hyola559TT	0.63	1.17	1.13	1.04	1.27	1.47	1.34	1.41	1.18
Average	0.49a	1.17bcd	1.07bc	1.05b	1.29d	1.47e	1.25cd	1.46e	
Interaction	NS								
Herbicide treatment	<0.001								
Variety	NS								

Furthermore, when the data from Roseworthy was shown as a percentage (relative yield) of the nil an exponential decay relationship between ryegrass density and grain yield was revealed (Figure 3). The yield of ATR Bonito declined more sharply at low to moderate densities of ryegrass compared to Hyola559TT and appeared to reach maximum yield loss at densities above 300 plants/m^2, where interspecific competition of ryegrass would have been high. These results appear consistent with previous studies which also showed that hybrid varieties could better maintain grain yield in the presence of weeds and appear therefore more tolerant of weed competition than the less competitive OP conventional varieties.

Conclusions

At Hart the low ryegrass population resulted in smaller differences between canola varieties and the combined impact of herbicides. Whereas the same trial at Roseworthy, with much larger ryegrass infestation, differences in competitive ability between varieties and their interaction with herbicides were more apparent.

In both studies ATR Bonito was shown to be far more competitive and comparable to the hybrid variety Hyola559TT. Previous studies using the OP variety ATR Stingray showed it is a weaker OP competitor compared to Hyola559TT. In support of previous research, the hybrid appeared to better maintain grain yield in the presence of weeds and was therefore more tolerant of weed competition than ATR Bonito. In addition to other traits, care should be taken when selecting canola varieties for their competitive ability.

Acknowledgements

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Hart Field Day 2017

Lentil and chickpea fungicide evaluation for ascochyta blight

Sarah Noack, Hart Field-Site Group

Key findings

- Growers and advisers should be vigilant in applying protective fungicide sprays in chickpea and lentil crops for ascochyta blight.
- Many current and minor use permit fungicides trialed at Hart in 2017 provided good preventative control (less than 10% of plants infected) for ascochyta blight including; chlorothalonil, Aviator Xpro®, Cabrio® and Captan®.

Why do the trial?

Ascochyta blight can be a serious but manageable disease in lentils and chickpeas. For lentils, most current varieties are unlikely to have significant yield losses due to ascochyta blight. However, the disease can infect lentil pods and seed, causing a discolouration that will reduce the marketability and value of affected grain. In chickpeas however, the disease can cause major yield loss if not managed.

A virulence change in ascochyta blight in chickpeas was observed in southern Australia in 2015 and 2016. This change resulted in all current chickpea varieties being rated as susceptible or moderately susceptible. In response a number of new fungicides and emergency use permits have become available for growers to use. *See Pulse Australia for further details on minor use permits* *http://www.pulseaus.com.au/growing-pulses/crop-protection-products*. Many of these products have limited information for the management of ascochyta blight in lentils and chickpeas. This study evaluated the effectiveness of current and new fungicides in reducing ascochyta blight infection and maintaining grain yield and quality in lentils and chickpeas.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	MAP (10:22) @ 75 kg/ha at seeding
Seeding date	9th May 2017		

The trials were randomised complete block design. Trial (1) looked at fungicide options in Monarch chickpeas and trial (2) in Flash lentils. These varieties were selected due to their susceptible (S or MS) rating for ascochyta blight to ensure infection occurred. Post seeding lentil stubble infected with ascochyta blight was spread uniformly across the trial area to increase the incidence of infection. The stubble was collected from lentil paddock on the Yorke Peninsula with a low level of ascochyta blight infection in 2016.

All seed was treated with P-Pickle T (PPT), except the untreated control. Fungicide treatments were applied at the following growth stages / dates:

Lentil (two sprays)	• Mid-vegetative 2nd August • Podding 4th October • Control = fortnightly sprays of chlorothalonil
Chickpea (three sprays)	• Mid-vegetative 2nd August • Early flowering 31st August • Podding 4th October • Control = fortnightly sprays of chlorothalonil

A number of fungicide products with varying active ingredients and groups were trialed (Table 1). The trial was also sprayed with 500 mL/ha carbendazim to prevent botrytis grey mould infection confounding the results. Carbendazim has minimal control of ascochyta blight.

Table 1. Fungicides trialed at Hart in 2017.

Product name example	Active ingredient	Fungicide group
CC Barrack ®	Chlorothalonil	Group M
Aviator XPro®	Prothioconazole and bixafen	Group 3
Amistar Xtra®	Azoxystrobin	Group 11
Cabrio® 400	Pyraclostrobin	Group 11
Captan® 900	Phthalimide	Group M4
Tilt®, Throttle®	Propiconazole	Group 3
PPT + Veritas®	Tebuconazole and azoxystrobin	Group 3 and 11
Prosaro®	Prothioconazole and tebuconazole	Group 3
Various e.g. Dithane®	Mancozeb	Group M3

All plots were assessed for ascochyta blight infection (reported as % plant infection in the entire plot) on the 22nd September. At harvest all plots were assessed for grain yield and lentil plots were scored for seed staining.

Results and discussion

Ascochyta blight in chickpeas

An outbreak of ascochyta blight was observed in the chickpea trial at Hart from late July (Table 2). The highest level of infection was observed in the untreated plots with 36.7% of all plants infected (Table 2). Not surprisingly, this high infection resulted in a lower grain yield of 1.3 t/ha compared to trial average 1.8 t/ha. The disease scores were strongly correlated with relative yield loss observed in the trial.

All fungicide treatments decreased the level of infection compared to the untreated control. The fungicide treatments which provided the greatest prevention (< 10% of plants infected) were fortnightly sprays of chlorothalonil, or three sprays of Aviator XPro® or Cabrio®. These three treatments along with Amistar Xtra® and Veritas® gave similar yields at 1.8 – 2.0 t/ha.

Taking into account the seed treatment and fungicide costs plus the resulting plant infection and grain yield, the treatments which provided best net return were Veritas® (treatment cost $59/ha) closely followed by Aviator Xpro® ($99/ha) and Cabrio® ($161/ha).

The low season rainfall in 2017 most likely limited the spread of ascochyta blight. Efficacy of the individual fungicides may differ in a wetter, longer season since rainfall spreads this disease.

Table 2. Chickpea ascochyta blight (AB) infection (measured as % of plot infected) and grain yield (t/ha) from fungicide treatments trialed at Hart, 2017. Cost of fungicide application based on seed treatment + three fungicide applications in season.

Fungicide treatment	AB infection %	Grain yield t/ha	Cost of fungicide $/ha	Net return** $/ha
Untreated control	36.7[a]	1.31[d]	0	523
PPT + *Fortnightly chlorothalonil @ 2.0 L/ha	2.3[f]	2.03[a]	255	772
PPT + Aviator XPro® @ 600 mL/ha	6.7[def]	1.94[ab]	102	863
PPT + Amistar Xtra® @ 600 mL/ha	15.0[cd]	1.80[abc]	66	803
PPT + Cabrio® 400 mL/ha	5.0[ef]	1.97[ab]	164	823
PPT + Captan® 900 @ 1.1 kg/ha	16.7[bc]	1.76[bc]	46	794
PPT + Propiconazole 500 mL/ha	25.0[b]	1.55[cd]	21	675
PPT + Veritas® @ 750 mL/ha	13.3[cde]	1.81[abc]	59	818
LSD fungicide (P≤0.05)	8.5	0.26		

*Fortnightly sprays = nine applications from late June to early September.
**Net return based on production costs of $392/ha + fungicide application and returns on grain of $700/t.

Ascochyta blight in lentils

Similar to the chickpea trial above, a significant outbreak of ascochyta blight was observed in lentils at Hart (Table 3). Plant infection ranged from 1.7% for the fortnightly sprays of chlorothalonil to 38.3% in the untreated control. In addition to the fortnightly chlorothalonil, fungicide treatments Captan® and Aviator XPro® resulted in low levels of infection (<10%).

Despite high levels of disease there was no effect of fungicide application on lentil grain yield, averaging 2.1 t/ha. The lack of yield loss in lentils is not uncommon however, seed quality can be downgraded from the infection causing seed staining. In 2017 there were low levels of seed staining in all treatments, including the untreated control, due to few rainfall events during podding (Table 3).

Despite lack of seed downgrading it is well known that ascochyta blight infection can lead to yield loss, reduce marketability of resultant stained and distorted seeds. The fungicide treatments which provided good control (<10% plants infected) and were cost effective were Captan® ($29/ha) and Aviator XPro® ($66/ha). For the remaining fungicide treatments there was small variation between plots and majority reduced infection to less than 20%.

As stated above, efficacy of the individual fungicides may differ in a wetter, longer season since rainfall spreads this disease.

Table 3. Lentil ascochyta blight infection (measured as % of plot infected) and grain yield (t/ha) from fungicide treatments trialed at Hart, 2017. Cost of application based on seed treatment + two fungicide applications in season.

Fungicide treatment	AB Infection %	Grain yield t/ha	Seed staining*	Cost of fungicide $/ha	Net return** $/ha
Untreated control	38.3^{a}	2.0	0.7	0	923
PPT + ***Fortnightly chlorothalonil @ 2.0 L/ha	1.7^{f}	2.0	0.0	255	661
PPT + Chlorothalonil @ 1.0 L/ha	17.7^{c}	1.9	0.7	31	863
PPT + Mancozeb 750 @ 2.0 kg /ha	25.0^{b}	2.1	0.3	39	923
PPT + Amistar Xtra @ 600 mL/ha	10.0^{de}	2.2	0.4	45	1015
PPT + Prosaro @ 600 mL/ha	16.7^{c}	2.1	0.1	91	917
PPT + Captan 900 @ 1.1 kg/ha	5.7^{ef}	2.0	0.6	32	878
PPT + Veritas @ 750 mL/ha	13.3^{cd}	2.4	0.3	41	1109
PPT + Aviator XPro @ 600 mL/ha	6.0^{ef}	2.2	0.2	69	1005
PPT + Veritas @ 750 mL/ha + Mancozeb @ 1 kg/ha	11.7^{cde}	2.2	0.2	59	963
LSD ($P \leq 0.05$)	6.4	NS	NS		

*Seed staining was assess using a categorical scale of 0-5; 0 = no staining and 5 = ≥ 25% seed coverage.
**Net return based on production costs of $275/ha + fungicide application and returns on grain of $600/t.
***Fortnightly sprays = nine applications from late June to early September.

Summary

Good disease management is critical to maximise the yield and quality of lentils and chickpeas. Applying the appropriate preventative fungicide early and prior to canopy closure can minimise disease pressure and reduce losses. The current study has shown there are a number of fungicide options (current and minor use permits) which provided good preventative control of ascochyta blight including; chlorothalonil, Aviator Xpro®, Cabrio® and Captan®, although this research needs to be repeated across different seasons.

While the current study focused on fungicide applications it is important to keep in mind there are a number of management options that can be used to reduce your risk of ascochyta blight infection including: crop rotation and paddock selection, regular crop monitoring, strict hygiene on and off farm and variety selection.

Acknowledgements

The Hart Field-Site Group would like to thank researchers Jenny Davidson and Rohan Kimber for their assistance with fungicide treatment selection and trial methodology.

New fungicides offer improved ascochyta blight control and yield benefit in field pea

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[1]SARDI Clare, [2]SARDI Waite, [3]formerly SARDI Clare

Key findings

- Early disease control is important for reducing initial AB infection levels in field pea crops with a yield potential above 1.5 t/ha.
- A late fungicide spray is important to control AB in spring when rainfall is conducive to disease spread and pod and seed infection.
- Early sowing into a high disease risk window with new fungicide actives evaluated in this project, were demonstrated to have improved yield benefits over later sowing in the 2017 season.

Why do the trial?

Fungicides play a key role in managing ascochyta blight (AB) in field pea (commonly referred to as blackspot), as there is no varietal resistance to disease. Recently, new fungicide actives have emerged in the market, offering superior disease control in field crops. However, they have not been tested for AB control in field pea. As part of continuing research, experimental field studies have been undertaken to evaluate the efficacy of new actives in disease control and yield benefits in low (Minnipa, upper Eyre Peninsula) and medium (Hart, Mid-North) rainfall zones in South Australia. The trials undertaken by SARDI are part of Southern Pulse Agronomy project (SPA) funded by the GRDC (DAV00150). The performance of two new actives constituting a) Bixafen (75g/L) in combination with Prothioconazole (150 g/L) trading as Aviator Xpro®, and b) Azoxystrobin (200g/L) in combination with Cyproconazole (80 g/L) trading as Amistar Xtra® were compared to, mancozeb (2 kg/ha), seed treatment P Pickle T®, fortnightly chlorothalonil treatment (complete disease control) and an untreated (nil) treatment.

How was it done?

Experimental field trials were conducted from 2015 to 2017. In 2015, trials compared new actives against the industry standard practice of a seed dressing plus two mancozeb sprays at 9 weeks after sowing (WAS) and early flowering. In 2016, trials included an earlier spray at 4 – 6 node, when disease was first sighted. In 2017, two times of sowing were included at Hart to produce high and low disease risk with fungicide treatments as per 2016. Minnipa was not sown in 2017, due to the late break to the season and extended dry conditions.

A number of fungicide treatments were tested over the three years however, only selected treatments have been presented in this report (Table 1). In 2015 and 2016, the trials were designed as Randomised Complete Block Design (RCBD), replicated three times at each site. In the sowing date experiment, treatments were arranged in a split plot design, with sowing date as whole plots and fungicide treatment applied to the split plots. PBA Coogee was used in 2015 and 2016 and PBA Oura in 2017, with sowing conducted at 55 plants/m^2.

To accelerate AB infection field pea stubble infested with AB was uniformly spread adjacent to seedlings at 1 to 2 nodes growth stage, in 2015 and 2016. In the sowing date trial (2017) the infested stubble was randomly spread in the trial prior to sowing and the forecasting model 'blackspot manager' was used to predict high and low disease risk sowing windows. Early sowing (April 27) was conducted in a high spore release window and delayed sowing (May 31) into a low risk window.

Disease severity was assessed as the percentage of plants covered by AB symptoms (purplish-black necrotic lesions on leaves) x frequency of infected plants per plot, at vegetative and flowering growth stages. Plots were machine harvested and grain yields recorded for each treatment at physiological maturity.

Results and discussion

Seasonal conditions

Low summer rainfall followed by high rainfall during the month of April led to a late release of AB spores in 2015, with all trials sown into medium or high risk disease situations. The subsequent wet winter favoured plant growth and disease progression, and AB infection was apparent at all sites.

In 2016, the growing season rainfall (GSR) was above long-term average at Minnipa and Hart. Total GSR of 356 mm and 268 mm was recorded at Hart and Minnipa respectively. The two trials were sown in late autumn into relatively dry seed bed conditions. This was followed by wet conditions in winter and a relatively cool spring that resulted in prolonged maturation of the crop, particularly at Hart.

The 2017 season started with a late break in most parts of the SA. Growing season rainfall (191 mm) and annual (330 mm) rainfall was well below the long-term annual average (400 mm) for Hart. Early AB disease infection and progression was low due to an extended dry period during the growing season and non-conducive environmental conditions. However, a high rainfall event occurred in late winter (August, 44 mm)/early spring (September, 24 mm) and may have favoured disease spread in the latter growing stages. Severe frost events occurred in the last week of August, which coincided with the critical development period of pod filling in the early sown crops.

Effect of fungicide treatments on disease severity

Disease onset occurred earlier in the low rainfall zone compared to the medium rainfall zone indicating the drivers of AB were different across the two environments, in both 2015 and 2016 (Table 1). Subsequently, results showed AB response to fungicide treatment changed depending on environmental conditions.

Mancozeb applications reduced AB severity compared to the nil at Hart in 2015 and 2016, while there was no reduction in 2017. In contrast, AB severity was not reduced by this treatment at Minnipa where severity was initially higher. This may be due to the establishment of the disease prior to the first foliar applications 9 weeks after sowing.

Amistar Xtra® reduced disease infection levels at Hart in 2015, but not 2016 nor in either year at Minnipa. In 2017 at Hart, disease severity in Amistar Xtra® was lower than the nil treatment and similar to mancozeb and the two Aviator Xpro® treatments.

Aviator Xpro® sprayed at 6-8 WAS plus early flowering reduced disease severity over the nil at Hart and Minnipa in 2015, and Minnipa in 2016. The strategy of including an early spray of Aviator Xpro® at 4 WAS followed by a second application at 9 WAS and mancozeb at early flowering resulted in lower disease severity at both Hart and Minnipa, compared to the treatments other than fortnightly sprays of chlorothalonil, in 2016.

There was no fungicide interaction with sowing date in 2017, indicating the fungicide effect similar across sowing dates. The application of two Aviator Xpro® treatments showed similar disease control to the Amistar Xtra® treatment, compared to mancozeb and nil treatments.

Table 1. Ascochyta blight disease severity (% plot severity) assessed at between 9 and 13 node growth stage in field pea (PBA Coogee) under different fungicide treatments at Hart (Mid-North, SA) and Minnipa (upper Eyre Peninsula, SA), 2015 to 2017.

Year	Fungicide Treatment	Application Timing	Disease severity (%) Hart	Minnipa
2015	Nil		24	37
	P Pickle T®	Seed treatment	28	27
	Mancozeb	8 WAS + Early flowering	12	30
	Amistar Xtra®	8 WAS + Early flowering	6	30
	Aviator Xpro®	8 WAS + Early flowering	4	23
	Chlorothalonil	Fortnightly	9	18
		Lsd ($P \leq 0.05$) Fungicide x site	**8**	
2016	Nil		32	51
	P Pickle T®	Seed treatment	36	46
	Mancozeb	6 WAS + Early flowering	24	47
	Amistar Xtra®	6 WAS + Early flowering	33	49
	Aviator Xpro®	6 WAS + Early flowering	24	46
	Aviator Xpro® +	4 WAS, 9 WAS + mancozeb at early flowering	17	42
	Chlorothalonil	Fortnightly	14	25
		Lsd ($P \leq 0.05$) Fungicide x site	**7.8**	
2017	Nil		55	
	Mancozeb	Early disease + Early flowering	48	
	Amistar Xtra®	Early disease + Early flowering	42	
	Aviator Xpro®	Early disease + Early flowering	39	
	Aviator Xpro® +	Early disease + Early flowering + mancozeb	37	
	Chlorothalonil	Fortnightly	2	
		Lsd ($P \leq 0.05$) Fungicide	**8.1**	

NOTE: WAS = weeks after sowing. NB: # All treatments were treated with Apron® (350 g/L Matalaxyl-M) seed dressing to control downy mildew. Notably, in 2017, no trial was conducted at Minnipa due to the late break of the season. As some of the fungicide treatments in this research contain unregistered fungicides, application rates have been withheld. The research was carried out for experimental purposes only and the results within this document do not constitute a recommendation for that particular use by the author or author's organisation.

Effect of fungicide treatments on grain yield

The average site grain yield was 1.6 t/ha in 2015 for both Hart and Minnipa, while in 2016 Hart had higher yields (1.74 t/ha) than at Minnipa (1.30 t/ha) (Table 2). In 2017, the first time of sowing (27 April) yielded 3.1 t/ha with the second time of sowing (31st May) 2.3 t/ha (Table 3). Fungicide strategies in field pea are generally economic for yields above 1.5 t/ha.

Grain yields showed a similar fungicide treatment response across the two sites in 2015. In 2016, a fungicide treatment by site interaction was found for grain yield. Across all trials the highest yields were associated with Aviator Xpro®, Amistar Xtra® and fortnightly sprays of chlorothalonil, while mancozeb sprays did not significantly increase yield over nil treatments in any of the trials (Table 2).

In 2017, the three spray application strategy of Aviator Xpro® at early disease sighting, early flowering and a late spray of mancozeb at mid-flowering produced yields similar to fortnightly chlorothalonil (Table 2). In contrast, this response was not found in 2016, where fortnightly chlorothalonil had higher yields than the three spray strategy. This may be due to the number of chlorothalonil sprays being applied in seasons with more favourable and wetter finishing conditions. Although 2017 was generally drier, a substantial amount of rain fell in late winter/early spring and the late spray of mancozeb in the

Aviator Xpro® treatment was beneficial in controlling the spread of AB, resulting in yield increases in early sown crops, similar to the fortnightly chlorothalonil treatment. Grain yields increased by up to 20% from the use of new actives over the current industry standard in the early sown plots at Hart, in 2017 (Table 3). In the later sowing there was no yield response to fungicides. This result shows that significant yield penalties can occur if field pea crops are sown later or in high disease risk situations, such as early sowing, where fungicides are not applied.

Table 2. Average grain yields (t/ha) of field pea (PBA Coogee) sown with different fungicide treatments at Hart (Mid-North, SA) and Minnipa (Eyre Peninsula, SA) in 2015 and 2016.

Year	Fungicide Treatment	Application Timing	Grain yield (t/ha) Hart & Minnipa	
2015	Nil		1.55	
	P Pickle T®	Seed treatment	1.47	
	Mancozeb	8 WAS and Early flowering	1.47	
	Amistar Xtra®	8 WAS and Early flowering	1.77	
	Aviator Xpro®	8 WAS and Early flowering	1.79	
	Chlorothalonil	Fortnightly	1.73	
			Lsd ($P \leq 0.05$) $_{\text{Fungicide}}$ = 0.16	
			Hart	**Minnipa**
2016	Nil		1.49	0.95
	P Pickle T®	Seed treatment	1.33	1.05
	Mancozeb	6 WAS + Early flowering	1.54	1.19
	Amistar Xtra®	6 WAS + Early flowering	1.84	1.32
	Aviator Xpro®	6 WAS + Early flowering	1.93	1.4
	Aviator Xpro® + Mancozeb	4 WAS, 9 WAS + Early flowering	1.65	1.58
	Chlorothalonil	Fortnightly	2.67	1.67
			Lsd ($P \leq 0.05$) $_{\text{Fungicide X Site}}$ = 0.34	

Table 3. Average grain yields (t/ha) of field pea (PBA Oura) at different sowing dates under varying AB disease risk levels and different fungicide treatments at Hart (Mid-North, SA), in 2017.

	Grain yield (t/ha)		**Grain weights (g/100 seed)**	
Fungicide Treatment	**27-Apr**	**31-May**	**27-Apr**	**31-May**
Chlorothalonil	3.53^{a}	2.29^{a}	22.99^{a}	22.11^{a}
Aviator Xpro® & Mancozeb	3.42^{a}	2.19^{a}	22.15^{b}	22.51^{a}
Aviator Xpro®	3.22^{b}	2.33^{a}	22.00^{b}	22.46^{a}
Amistar Xtra®	3.04^{b}	2.37^{a}	21.21^{c}	22.57^{a}
Mancozeb	2.76^{c}	2.31^{a}	20.87^{cd}	22.57^{a}
Nil	2.66^{c}	2.28^{a}	20.65^{d}	22.35^{a}
Lsd (*P*≤0.05) Fungicide x Sowing	**0.19**	**0.19**	**0.47**	**0.47**

NB: Seed dressing of P Pickle T® was used at sowing in all treatments except nil treatment

Frost damage impacted the grain quality of early sown crops, whereby more seeds had a shrivelled and discoloured appearance on the seed coat (Figure 1). This shows the importance of paddock selection when early sowing in order to avoid frost event during critical growth and development periods. Growers may need to adjust the sowing window of early sown crops depending on history of frost events on farm.

TOS 1 (April, 27) – Seed coat damage (shrivelled) and discolouration	TOS 2 (May, 31) – Seed coat damage (shrivelled) and discolouration

Figure 1. Frost damage expressed as shrivelled and discoloured seed coat in field pea (PBA Oura) sown at different sowing dates under varying AB disease risk levels and different fungicide treatments at Hart (Mid-North, SA) in 2017.

Implications for growers

Early disease control with new fungicide actives is important for reducing initial AB infection levels. In addition, a late fungicide spray is important to control AB in spring when rainfall is conducive to disease spread and pod and seed infection.

In environments with yield potentials above 1.5 t/ha, new fungicides showed improved disease control and a yield benefit of 15-20% over the current industry standard. Early sowing into a high disease risk window with these improved new fungicide actives was demonstrated to have improved yield benefits over later sowing in the 2017 season. However, the results need to be interpreted with caution as disease pressure was low and progression was reduced by below average rainfall in 2017. The susceptibility of early sown field pea to frost events will also require consideration.

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Subsoil amelioration – three years on

Stuart Sherriff and Sam Trengove, Trengove Consulting

Key findings

- The highest yielding treatments at five of the seven sites were the standard paddock practice where no additional nutrition or deep ripping has been applied.
- Placing the amendment in the subsoil did not provide any benefit over placing the amendment on the surface.
- There was little difference in response to applying chicken litter at 20 t/ha or matched rates of synthetic fertiliser.

Why do the trial?

Subsoil constraints are known to have a large impact on grain yields in the Mid-North of SA. Trials in other regions including south western Vic have reported large yield responses (up to 60% yield increase in the 1st year) from treatments of deep ripping and deep placement of high rates (up to 20 t/ha) of chicken litter. The grain yield response is thought to be coming from increasing the plant available water holding capacity of these soils, by improving the structure of the subsoil. Although the cost associated with implementing these treatments is high, with these reported yield gains it is possible to pay for the treatments in the first season.

How was it done?

Seven randomised complete block design trials with three replicates of the same eight treatments were established in March 2015. The trials were located in three different geographic areas including two near Clare at Hill River, two at Hart and three at Bute. At each location the trials were located on different soil types which are described below.

Plot size:	2.5 m x 12.0 m
Seeding date 2017:	**Hill River:** 7th May **Hart:** 7th May **Bute:** 11th May
Seed & fertiliser 2017:	**Hill River:** 110 kg/ha Samira beans, 80 kg/ha DAP kg/ha IBS
	Hart: 90 kg/ha Scepter wheat, 80 kg/ha DAP IBS, 75 kg/ha post emergent urea
	Bute: 60 kg/ha Jumbo 2 lentil, 77 kg/ha MAP IBS

Sites and soil types

Hart east	Calcareous gradational clay loam High pH and moderate to high ESP below 30 cm
Hart west	Calcareous loam High pH, Boron and ESP below 30 cm
Bute northwest	Calcareous transitional cracking clay High pH, Boron and ESP below 30 cm
Bute mid	Calcareous loam High pH, Boron and ESP below 60 cm
Bute southwest	Grey cracking clay with high exchangeable sodium at depth High pH, Boron and ESP below 30 cm
Hill River east	Black cracking clay
Hill River west	Loam over red clay Moderate ESP below 60cm and moderate Boron below 90 cm

The initial treatments (Table 1) were established prior to sowing in 2015. Ripping and subsoil treatments were applied with a purpose built trial machine loaned from Victoria DPI. The machine is capable of ripping to a depth of 60 cm and applying large volumes of product to a depth of 40 cm. Chicken litter was sourced from three separate chicken sheds for ease of freight, the average nutrient content is shown in table 2. After the treatments were implemented the plots at all sites were levelled using an offset disc. Since 2015 only seed and district practise rates of fertiliser have been applied to the plots.

At Hart, in all three years, the trials were sown using narrow points and press wheels on 250 mm spacing. The exception was in 2015 when the Hart west trial was sown with a John Deere 1980 disc. At Bute the three sites were sown using a plot seeder on 225 mm spacing with knifepoints and press wheels in 2015 and in 2016 and 2017 they were sown using a concord seeder on 300 mm spacing with 150 mm sweep points and press wheels. At Hill River the sites were sown using parallelogram knifepoint and press wheel seeder on 250 mm spacing in all three years.

Commercial rates of seeding fertiliser, post emergent urea and pesticides were applied by the growers in their standard paddock operations over the top of all trial treatments to provide adequate nutrition and crop protection for the control treatments.

The rate of chicken litter (20 t/ha) used in these trials was based on work in south western Victoria where large yield responses have been observed. To assess if the results are coming directly from the nutrition in the chicken litter a synthetic fertiliser treatment was applied to replicate the level of nutrition that is found in 20 t/ha of chicken litter at the time. This treatment is made up of 800 kg/ha mono ammonium phosphate (MAP), 704 kg/ha muriate of potash (MoP), 420 kg/ha sulphate of ammonia (SoA) and 1026 kg/ha urea.

Table 1. Treatment list for the seven subsoil manuring sites established pre-seeding 2015.

Treatment	Nutrition	Ripping	Placement
1	Nil	No	Nil
2	Nil	Yes	Nil
3	20 t/ha chicken litter	No	Surface
4	20 t/ha chicken litter	Yes	Surface
5	20 t/ha chicken litter	Yes	Subsoil
6	3 t/ha combo*	No	Surface
7	3 t/ha combo*	Yes	Surface
8	3 t/ha combo*	Yes	Subsoil

* 3 t/ha combo includes MAP, MOP, OA, Urea

Table 2. Average nutrient concentration from the three sources used in the Bute, Hill River and Hart subsoil manuring trials 2015.

Nutrient		Nutrient concentration dry weight	Moisture content	Nutrient concentration fresh weight	Kg nutrient per tonne fresh weight
N	Nitrogen	3.8 %	8%	3.50 %	35.0
P	Phosphorus	1.72 %		1.58 %	15.8
K	Potassium	2.31 %		2.13 %	21.3
S	Sulfur	0.55 %		0.51 %	5.1
Zn	Zinc	0.46 g/kg	8%	0.42 g/kg	0.4
Mn	Manganese	0.51 g/kg		0.47 g/kg	0.5
Cu	Copper	0.13 g/kg		0.12 g/kg	0.1

Measurements in 2017 include grain yield and quality at the Hart sites and grain yield at the Bute and Hill River sites. All results were analysed using ANOVA in the statistical package R.

Results and discussion

Hill River sites

The average bean grain yields for the Hill River sites were 2.89 and 2.11 t/ha for the west and east sites, respectively. The application of chicken litter on the surface in 2015 increased grain yield in 2017 at the east site by 0.64 t/ha but there was no difference at the west site in the absence of ripping (Table 3).

Where the amendments (chicken litter or matched fertiliser) were applied to the surface and the treatments were ripped, chicken litter was higher yielding compared to the matched synthetic fertiliser. However, when the plots were not ripped or if the amendment was placed in the subsoil there was no difference at either site between amendment types.

Deep ripping did not affect grain yield at the east site, however at the west site a negative response in grain yield was generally observed. The addition of the chicken litter at the west site to the ripped plots was able to overcome this negative affect.

Table 3. Faba bean grain yield for Hill River subsoil manuring trials 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	Grain yield (t/ha)	
				Hill River East	Hill River West
1	0	No	None	1.84	3.04
2	0	No	Deep rip	1.96	2.75
3	20	No	None	2.48	3.21
4	20	No	Deep rip	2.48	3.13
5	20	No	Deep rip & place	1.89	2.87
6	0	3t/ha combo	None	2.31	2.97
7	0	3t/ha combo	Deep rip	2.03	2.40
8	0	3t/ha combo	Deep rip & place	1.86	2.76
LSD (0.05)				*0.27*	*0.31*

Hart sites

Average wheat grain yields at the west and east sites were 5.00 t/ha and 3.18 t/ha respectively. Frost events in late August explain some of the difference in grain yield between the sites with the lower yielding site (East) situated lower in the landscape. This may also have contributed to the lack of response to amendments and placement within the east trial.

The application of either chicken litter or synthetic fertiliser generally increased grain yields and protein by 0.19 t/ha and 0.9% when applied to the surface at the west site (Table 4a). At the east site the additional nutrition did not affect grain yields but protein was increased by an average of 2.5 percentage points (Table 4b). Screening levels across two Hart trials were low, with all treatments falling below the 5% level. This is in contrast to previous season where high screening levels have been observed in treatments with additional nutrients.

Deep ripping at Hart did not improve grain yield compared to the nil (district practice) treatment. However, in both trials there was an increase in grain protein with ripping, on average 0.4% in the west trial and 0.7% in the east trial.

The placement of the amendment, either on the surface or in the subsoil did not change the response to grain yield or quality. There was no significant difference in test weight within a site, with the west and east sites averaging 74.5 kg/hL and 73.8 kg/hL respectively.

Table 4a. Wheat grain yield and quality for Hart west subsoil manuring trial in 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	Grain yield (t/ha)	Protein (%)	Screenings (%)
1	0	No	None	4.84	12.0	0.8
2	0	No	Deep rip	4.80	12.5	0.8
3	20	No	None	5.21	13.5	0.8
4	20	No	Deep rip	5.08	13.7	0.7
5	20	No	Deep rip & place	4.86	13.0	0.9
6	0	3t/ha combo	None	5.16	12.7	0.8
7	0	3t/ha combo	Deep rip	4.97	13.0	0.9
8	0	3t/ha combo	Deep rip & place	5.09	12.6	0.8
LSD (0.05)				*0.19*	*0.9*	*ns*

Table 4b. Wheat grain yield and quality for Hart east subsoil manuring trial in 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	Grain yield (t/ha)	Protein (%)	Screenings (%)
1	0	No	None	3.18	13.0	0.8
2	0	No	Deep rip	3.10	13.4	1.0
3	20	No	None	3.29	15.8	1.3
4	20	No	Deep rip	3.06	16.2	1.3
5	20	No	Deep rip & place	3.03	15.3	1.0
6	0	3t/ha combo	None	3.51	14.7	1.2
7	0	3t/ha combo	Deep rip	3.07	15.9	1.6
8	0	3t/ha combo	Deep rip & place	3.19	15.9	1.2
LSD (0.05)				*ns*	*0.4*	*0.4*

Bute Sites

Treatments with no additional nutrition added in 2015 were the highest yielding at all sites at Bute in 2017, but particularly at the mid and south east sites (Table 5).

The inclusion of ripping in the treatment did not increase grain yield at two of the three sites, however at the south east site yield increased by 0.17 t/ha and was the single highest yielding treatment in the absence of increased nutrition at this site.

Placement of chicken litter in the subsoil produced marginal improvements in grain yield over surface placement at all three sites, however is was not significant at the mid site and both treatments were less than the control at all sites. The deep placement of the synthetic fertiliser was not significantly different to surface placement.

Table 5. Lentil grain yield for the Bute subsoil manuring trial in 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	2017 Lentil Grain yield (t/ha)		
				Mid	North west	South east
1	0	No	None	2.61	1.92	1.61
2	0	No	Deep rip	2.44	1.86	1.78
3	20	No	None	2.07	1.58	1.15
4	20	No	Deep rip	1.94	1.59	1.01
5	20	No	Deep rip & place	2.11	1.83	1.26
6	0	3t/ha combo	None	2.23	1.87	1.20
7	0	3t/ha combo	Deep rip	2.26	1.77	1.36
8	0	3t/ha combo	Deep rip & place	2.31	1.73	1.33
LSD (0.05)				*0.36*	*0.14*	*0.14*

Summary / implications

There have been large yield responses reported from subsoil manuring in high rainfall environments, particularly south western Victoria. However, in recent seasons with lower rainfall these yield responses have declined. The results from the first season of the Hart and Bute trials (2015) were negative with the high nutrition treatments and deep ripping producing lower grain yields than the nil. With better crop establishment, wetter and cooler spring conditions and high yield potential in 2016 there were positive yield responses to high nutrition (chicken litter or fertiliser) at three of five cereal sites, however no benefit was observed for deep ripping or deep placement of amendment (results not presented, see 2016 Hart Trial Results book).

In 2017, the results were not dissimilar to those observed in previous seasons, with the highest or equal highest yields coming from the nil (district practice) in four of the seven sites. However, the higher yielding wheat and pulse sites did benefit from some additional nutrition (applied in 2015) at Hart and Hill River.

Interestingly, in the two seasons where lentils have been grown (2016 Hart and 2017 Bute), there has been a negative response to surface applied chicken litter at all five sites. At three of the five lentil sites the negative chicken litter effect was negated by placement in the subsoil, however this was not better than the untreated control. A negative response to matched synthetic fertiliser applied to the surface was observed at three of five sites.

As in previous years there were very few positive responses to deep ripping treatments across the seven sites in 2017. Therefore, caution should be taken when considering deep ripping on these soil types and environments. It should be noted that other trials on sandy soil types located in close proximity to the Bute sites have shown large yield gains can be made in some areas with the implementation of deep ripping. The results presented in this report however, shows it is important to know your soil types and the areas where deep ripping could reduce grain yields.

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Establishing deep ripping treatments

Managing your fertiliser dollar in wheat, barley and canola

Sarah Noack, Hart Field-Site Group

Key Findings

- In wheat an application rate of 20 kg N/ha in-season was sufficient to achieve the highest yield at Hart in 2017. However, it was the 80 kg/ha treatment which maximised yield and protein to achieve the best return on nitrogen fertiliser invested.
- For barley an application of 40 kg N/ha was adequate to produce the highest yield and quality within the trial.

Why do the trial?

The two main grower questions with nitrogen management are how much nitrogen needs to be applied and when should it be applied. While there are a variety of approaches to nitrogen management, the basis of most is a nitrogen budget. However, in reality nitrogen management decisions are often 'reactive' to the season and based on previous season's experiences and attitude to risk.

The key components to nitrogen budgeting are target yield and protein, as crop yield potential is the major driver of nitrogen requirement. This trial is designed to look at simple nitrogen management strategies in wheat, barley and canola across multiple seasons. The specific aims were to:

- Assess simple nitrogen management strategies to determine the best return on investment from fertiliser nitrogen applications.
- Determine within a crop rotation (wheat, barley and canola) where was your fertiliser dollar best spent over a number of seasons.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) @ 60 kg /ha at seeding (equivalent to 10 kg N/ha) In-season nitrogen rates Table 1.
Seeding date	3rd May 2017		

Each trial was a randomised complete block design. Trials were blocked separately by crop type (Mace wheat, Spartacus CL barley and 44Y90 canola). Prior to sowing the trial area was assessed for available soil nitrogen (0-10, 10-30, 30-60 cm) and gravimetric water content. All plots were assessed for grain yield and quality (protein or oil content %, test weight kg/hL, screenings % and retention %).

Table 1. Nitrogen rates applied to the wheat, barley and canola nutrition trials at Hart in 2017.

Wheat	Barley	Canola
1. Nil	1. Nil	1. Nil
2. 80 kg N/ha @ seeding	2. 80 kg N/ha @ seeding	2. 100 kg N/ha @ seeding
3. 20 kg N/ha @ GS31	3. 20 kg N/ha @ GS31	3. 50 kg N/ha @ seeding + 50 kg N/ha @ late cabbage
4. 40 kg N/ha @ GS31	4. 40 kg N/ha @ GS31	4. 50 kg N/ha @ seeding + 50 kg N/ha @ late cabbage + 100 kg N/ha @ bolting
5. 80 kg N/ha @ GS31		5. 200 kg N/ha @ bolting
6. 100 kg N/ha @ GS31		
7. 200 kg N/ha @ GS31		

Results and discussion

Soil available nitrogen pre-seeding

Starting available soil nitrogen was 57 kg N/ha. This low figure is not unexpected given the previous crop rotation of oaten hay (2016), canola (2015) and barley (2014).

Barley

The nitrogen rates trialed in Spartacus CL barley showed 40 kg N/ha was sufficient to achieve the highest yield and protein (Table 2). While Spartacus CL is currently pending malt accreditation if approved, in this trial it would have meet malt classification (9-12%) for the 40 kg N/ha rate at 9.7%. All other nitrogen rates of 80 kg N/ha at seeding, GS31 or GS65 did not improve yield or protein. In comparison to the nil treatment, the application of 40 kg N/ha was 0.4 t/ha higher yielding and also shifted the receival grade from feed to malt.

Test weight was unaffected by nitrogen application and all treatments fell above 65 kg/hL (minimum required for maximum grade). Grain retention did vary among nitrogen treatments, however was of little consequence as all values were above 70% for malt classification.

Table 2. Spartacus CL grain yield and quality for nitrogen treatment trialed at Hart, 2017. Treatments shaded grey are not significantly different from the highest yielding / quality treatment.

Treatment	Yield t/ha	Protein %	Screenings %	Test weight kg/hL	Retention %
Nil	3.59^{b}	8.8^{b}	1.71^{c}	72.05	88.0^{a}
80 kg N/ha @ seeding	4.07^{a}	10.1^{a}	2.40^{bc}	71.84	83.3^{b}
40 kg N/ha @ GS31	3.95^{a}	9.7^{a}	3.13^{ab}	71.85	79.9^{cd}
80 kg N/ha @ GS31	4.00^{a}	10.1^{a}	3.76^{a}	71.53	77.8^{d}
80 kg N/ha @ GS65	3.91^{a}	10.3^{a}	2.93^{ab}	71.63	81.6^{bc}
LSD (P≤0.05)	0.27	0.72	0.91	ns	2.26

Wheat

In 2017, an application of 20 kg N/ha was sufficient to achieve the highest yield at Hart. If the nitrogen rate had been increased to 40, 80 or 100 kg/ha there was no yield benefit and a negative impact was observed at 200 kg N/ha rate. There was also no difference in grain yield if nitrogen was applied upfront at seeding or in-season (GS31).

As expected with increasing nitrogen application rate, grain protein also increased. Unfortunately, even the 200 kg/ha rate was unable to achieve 13% required for H1. This can be attributed to the season. The in-season N rates were applied in late July and while sufficient rainfall was received to wash the nitrogen into the soil, the surface soil remained relatively dry (reduced plant root access to the nitrogen) due to below average rainfall in August, September and October.

Three treatments produced grain protein levels which met the receival grade H2 (>11.5%) which were the 80, 100 and 200 kg N/ha rates applied at GS31. An additional 60 kg N/ha (130 kg urea/ha) to achieve the higher grade would have cost approximately $60/ha and provided a better return given the lower protein in the 20 or 40 kg N/ha would have only achieved ASW. The results show that applying 80 kg/ha upfront was not able to maintain protein in comparison to the equivalent rate at GS31. The optimum nitrogen rate for wheat in this trial was 80 kg N/ha at GS31 to achieve maximum yield and quality in 2017.

Grain screenings and test weight were excellent across the trial with all treatments falling below 5% screenings and test weights above 76 kg/hL.

Breaking down the nitrogen budget

There are many variations and figures for developing your nitrogen budget. Here we show one example:

Assume 40 kg N/ha* required per tonne of grain to achieve protein level of 11% in wheat. We require 160 kg N/ha to achieve a 4.0 t/ha crop at Hart in 2017.

Starting soil N (0 - 60 cm)	=	57 kg N/ha
**Mineralisable N	=	35 kg N/ha
Starting fertiliser	=	10 kg N/ha
Fertiliser required	**=**	**60 kg N/ha**

**Assumes 50 % nitrogen fertiliser use efficiency*
***Mineralisable N = 0.15 × OC% × GSR (for in Hart 2017 = 0.15 × 1.3% × 191 mm)*

Table 3. Mace wheat grain yield and quality for nitrogen treatment trialed at Hart, 2017. Treatments shaded grey are not significantly different from the highest yielding / quality treatment.

Nitrogen rate	Yield t/ha	Protein %	Screenings %	Test weight kg/hL
Nil	3.55^{c}	8.8^{e}	0.66	81.0^{a}
80 kg N/ha @ seeding	4.13^{a}	9.9^{d}	0.84	80.8^{ab}
20 kg N/ha @ GS31	4.02^{a}	9.9^{d}	0.71	80.8^{ab}
40 kg N/ha @ GS31	3.99^{a}	10.8^{c}	0.64	80.6^{bc}
80 kg N/ha @ GS31	3.88^{ab}	11.7^{b}	0.61	80.3^{cd}
100 kg N/ha @ GS31	3.88^{ab}	11.8^{b}	0.71	80.0^{d}
200 kg N/ha @ GS31	3.64^{bc}	12.5^{a}	0.65	80.2^{d}
LSD (P≤0.05)	0.33	0.69	ns	0.39

Canola

The addition of 100 kg N/ha was sufficient to achieve the highest yield in the trial at 1.4 t/ha. This was on average 0.3 – 0.4 t/ha higher compared to the nil applied and did not differ to where 200 kg N/ha was spread. The oil content data shows the 100 kg N/ha treatments maintained oil at > 42% similar to the nil. However, the 200 kg N/ha rate applied at bolting or a triple split across seeding, late cabbage and bolting contained the lowest oil contents on average 39.9%. For the 2017 season 100 kg N/ha spread post seeding or split was the best treatment in terms of yield and oil content.

Table 4. 44Y90 canola grain yield and quality for nitrogen treatment trialed at Hart, 2017. Treatments shaded grey are not significantly different from the highest yielding / quality treatment.

Nitrogen rate (kg N/ha)	Yield t/ha	Oil content %
Nil	1.07[c]	44.3[a]
50 kg N/ha seeding + 50 kg N/ha late cabbage	1.31[b]	42.8[ab]
100 kg N/ha seeding	1.40[ab]	43.9[a]
50 kg N/ha seeding + 50 kg N/ha late cabbage + 100 kg N/ha bolting	1.31[b]	41.1[bc]
200 kg N/ha @ bolting	1.52[a]	38.5[c]
LSD (P≤0.05)	0.2	2.7

Summary / implications

Developing your own nitrogen fertiliser budgets is the best way to determine nitrogen rate at seeding and in-season. Some key points to remember:

- Taking account of available soil nitrogen reserves prior to the main applications of nitrogen fertiliser in wheat is a key measure to improve nitrogen fertiliser management, N efficiency and avoiding losses to the atmosphere.
- Whilst nitrogen needs to supplied to growing wheat crops throughout the growing season, it is important to recognise that 20-30% of a wheat crop's needs are required prior to stem elongation.
- Targeting the majority of nitrogen to the wheat crop just prior to early stem elongation is the best way of matching N supply to crop demand.
- Predictive models such as Yield Prophet® can more accurately determine yield potential and therefore the N fertiliser requirement.
- Seasonal climate forecasts are also more accurate later in the season i.e. July- August for determining yield potential and therefore calculating the correct amount of nitrogen fertiliser to apply.

Can soil organic carbon be increased in a continuous cropping system in the low to medium rainfall zone?

Harm van Rees and Anne Jackman, Cropfacts Pty Ltd
Sarah Noack, Hart Field-Site Group
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Key Findings

- Eight trial sites were established across South Eastern Australia to investigate whether soil organic carbon levels can be increased in no-till farming systems, inclusive of adding nutrients to aid the biological breakdown of stubble into soil organic matter.
- After three or five years of treatment, no increase in soil organic carbon could be confirmed across four trial sites. However, it is well known that no-till and stubble retention protects the soil from wind and water erosion and over a longer time-frame soil organic carbon levels may increase. But, based on these results it is likely that any potential increase in soil organic carbon will be small.

Why do the trial?

Soil organic matter has physical, chemical and biological functions in soil. Increasing soil organic matter levels may improve the capacity of these functions in the soil, thereby improving the soil's resilience to degradation and possibly improving the soils productivity. Increasing soil organic matter also sequesters atmospheric CO_2 which acts as a sink for greenhouse gas emissions.

Increasing soil organic matter on broad-acre farms in the Australian wheat-sheep zone has been very difficult to achieve with long term trials showing little or no increase in soil organic carbon regardless of management practices imposed. Recent research undertaken by CSIRO at a medium to high rainfall site in NSW, showed that increasing soil organic carbon was possible if residues are pulverised and incorporated with a rotary cultivator together with an application of sufficient fertiliser nutrients (N, P and S) to enhance soil biological activity to break down the crop residues into soil organic matter (Kirkby et al. 2016). This innovation was adapted to broadacre cropping methods in the current study and tested over a three and five-year cropping rotation at eight sites across the southern grain belt. The sites were located at Minnipa, Hart, Birchip and Temora for five years, and Winchelsea, Cressy Tasmania, Condobolin and Ouyen.

Soil organic matter consists of three fractions – Particulate (POC), Humus (HOC) and Resistant Organic Carbon (ROC). The three fractions have different physical, chemical and biological functions in soils. The proportions of the three fractions as components of the soil organic matter were measured and are reported in these results.

Particulate organic carbon (POC)	**Humus organic carbon (HOC)**
Reducing soil crusting and improving infiltration, Improving soil friability, Lowering soil bulk density, Increasing plant available water (note – POC has a small effect on the drained upper limit of the soil because clay-loam soils in relatively dry environments are rarely at drained upper limit), Storage and cycling of nutrients, Food source for soil micro-organisms	Improving soil friability Storage and cycling of nutrients Soil pH buffer (reducing acidification) Improving the Cation Exchange Capacity (CEC) Food source for soil micro-organisms Mineralisation of ammonium and nitrate (plant available N) **Resistant organic carbon (ROC)** Binding detrimental ions (such as aluminium), Some effect on the cation exchange capacity

It is clear that if soil organic carbon levels can be increased, the benefits for improving the soil physical, chemical and biological condition would be significant.

How was it done?

Eight sites were established in South Eastern Australia to test whether soil organic carbon levels can be increased by retaining stubble and applying additional nutrients (N, P and S) to enhance soil biological activity to breakdown the stubble into soil organic matter. Four of these sites were maintained for three years, the other four sites for five years (including the Hart site).

The trial compared stubble retention versus stubble removal, with the application of additional fertiliser nutrients to aid the breakdown of stubbles into soil organic matter over a cropping rotation. Each season the stubble load of the previous crop was determined, and additional nutrients were applied to match the given stubble load as a treatment to enhance the breakdown of stubble into soil organic matter.

Soil microbes use stubble as a food source and convert stubble into humus. Stubble is carbon rich relative to the other essential nutrients required by microbes and additional nutrients are required by the soil microbes to convert stubble into humus. The amount of NPS required by the microbial population to break down stubble into humus is worked out from:

- 1 tonne of carbon as humus contains 80 kg N, 20 kg P and 14 kg S
- 1 tonne of wheat stubble contains 450 kg carbon, of which 70% is lost to the atmosphere (hence 135 kg carbon is retained for every tonne of stubble)
- For the soil microbes to convert this amount of stubble carbon into humus requires 10.8 kg N, 2.7 kg P and 1.9 kg S
- 1 tonne of wheat stubble already contains 5 kg N, 0.5 kg P and 1 kg S
- Hence for every tonne of wheat stubble an additional 5.8 kg N, 2.2 kg P and 0.9 kg S is required to enable the soil microbes to break down stubble into humus.

The trial was established at Hart in 2012. Treatments were replicated 4 times and consisted of:

- Stubble: (i) retained and left standing;
  (ii) cultivated and incorporated prior to sowing;
  (iii) removed prior to sowing.
- Nutrients: (i) normal application of NPS to optimise production;
  (ii) additional nutrients applied at sowing to enhance microbial activity to breakdown stubble into soil organic matter. (Note – the Yield Prophet model was used to optimise N requirements in-crop)

Note: at Hart an additional treatment was included – double the stubble load plus additional nutrients.

The trial ran for five cropping seasons (2012 to 2016). At the end of the trial, in March 2017, all treatment plots were soil sampled to 30 cm depth with three replicate cores taken in each plot. Each core was divided into 0-10 and 10-30 cm sections. Each sample was air dried and analysed for bulk density, total soil organic carbon (Leco) and the fractions of soil organic matter – Particulate (POC), Humus (HOC) and Resistant (ROC) using MIR.

Note: soil organic carbon values measured with the Leco technique are generally 20% higher than the more traditionally used analysis for soil organic carbon with the Walkley Black technique.

Treatment crop yields were recorded.

What happened?

Trial rotation and crop yield

Over the five-year trial there were no differences in yield between treatments (Table 1). This result implies that the additional nutrients applied as a treatment were not used by the crop for yield but were available to the soil microbes for potential stubble breakdown into humus.

Table 1. Crop rotation and yield over five years of treatments (2012 to 2016) at Hart.

Stubble treatment	**Nutrition treatment**	**Grain yield (t/ha)**				
		2012	**2013**	**2014**	**2015**	**2016**
GSR (April to October rainfall mm)		168	303	280	228	356
Crop type / variety		Wheat Gladius	Barley Fathom	Wheat Wallup	Canola 44Y89	Wheat EmuRock
Stubble removed	Normal practice	1.8	6.0	4.0	0.7	4.2
Stubble removed	“ plus NPS	2.1	5.9	4.0	0.7	4.2
Stubble standing	Normal practice	1.7	5.8	3.9	0.7	4.0
Stubble standing	“ plus NPS	1.8	6.0	4.3	0.7	4.9
Stubble incorporated	Normal practice	1.9	5.9	4.0	0.7	4.0
Stubble incorporated	“ plus NPS	1.8	5.9	4.1	0.7	4.6
	LSD (0.05)	***ns***	***ns***	***ns***	***ns***	***ns***

At the other three sites with a five year rotation (Minnipa, Birchip and Temora) there were no differences in crop yield between treatments in any season.

Change in soil organic carbon after five years of treatments

The average soil organic carbon content of the topsoil (0-10 cm) at Hart was 1.7% and 1.0% in the subsoil (10-30 cm). After five years of trial work there was no difference in total soil organic carbon (t/ha, 0-30 cm) at Hart (Table 2) nor at the other three trial sites. On average the Hart site contained 51.3 t soil C/ ha in the top 30 cm. This value is at the higher end of previous soil organic carbon stocks reported for the Mid-North 20.3 – 63. 2 t/ha across a range of sites (MacDonald et al. 2012).

Table 2. Soil organic carbon stock (t/ha, 0-30cm) after five years of treatments (2012 to 2016) at four trial sites.

Stubble treatment	Nutrition treatment	Soil C (Leco) 0-30cm (t/ha)			
		EPARF	Hart	BCG	FarmLink
Stubble removed	Normal practice	38.1	50.5	31.8	42.9
Stubble removed	" plus NPS	38.3	53.0	29.8	44.0
Stubble standing	Normal practice	37.0	49.7	32.0	42.5
Stubble standing	" plus NPS	35.7	49.7	31.9	44.5
Stubble incorporated	Normal practice	37.9	51.9	30.9	39.8
Stubble incorporated	" plus NPS	39.0	53.0	31.4	41.5
Double stubble	Plus NPS		52.6*		
	LSD (P=0.05)	***ns***	***ns***	***ns***	***ns***

* Annual application of double the stubble load plus additional NPS at Hart only.

At the Hart site an extra treatment was included – each year the stubble load was doubled and the required additional nutrients were applied. This treatment did not result in higher soil organic carbon levels (Table 2) after five years of experimentation.

Soil organic carbon fractions

At Hart and the other three trial sites the treatments did not result in changes in the soil organic matter fractions. After five years of treatment applications the soil organic carbon fraction proportions were: 13.6% POC, 56.8% HOC and 29.6% ROC of total soil organic carbon content.

What does this mean?

In the South Eastern Australian low to medium rainfall zone it is difficult to increase soil organic carbon levels using current cropping techniques, even if additional nutrients are applied to enhance soil microbial activity for the breakdown of stubble into soil organic matter. Previous research undertaken in southern NSW where significant increases in soil organic carbon were measured (Kirkby et al. 2016), included pulverising the residues with a flail mulcher followed by incorporation with a rotary cultivator. This treatment was not applied in our trials because we regarded it unlikely that farmers could be persuaded to pulverise stubbles and cultivate the soil, increasing the risk of soil erosion in low to medium rainfall environments, to see a potential increase in soil organic carbon.

At all eight sites (either managed for three of five years) the result was the same – an increase in soil organic carbon could not be demonstrated with the treatments outlined in this paper.

The take home message in relation to soil organic carbon is that it is unlikely to increase with current cropping practices. But it is well known that no-till and stubble retention protects the soil from wind and water erosion and over a longer time-frame soil organic carbon levels may increase. However, based on these results it is likely that any potential increases in soil organic carbon will be small.

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Long term comparison of seeding systems

Dylan Bruce and Sarah Noack, Hart Field-Site Group

Key findings

- Seeding system had a significant effect on wheat grain yield with the disc treatment averaging 4.1 t/ha compared to the no-till and strategic systems which averaged 3.5 and 3.4 t/ha, respectively.
- The higher nitrogen treatments increased grain protein levels and screenings, while decreasing test weight across all seeding systems.

Why do the trial?

To compare the performance of three seeding systems and two nitrogen (N) strategies. This is a rotation trial (Figure 1) to assess the longer term effects of seeding systems and higher fertiliser input systems on soil fertility, crop growth, and grain yield and quality.

How was it done?

Plot size	35 m x 13 m	**Fertiliser**	DAP (18:20) @ 100 kg/ha
Seeding date	27th May 2017 (no-till and strategic), 1st of June 2017 (disc)	**Medium nutrition**	Urea (46:0) @ 75 kg/ha on 28th July
		High nutrition	Urea (46:0) @ 75 kg/ha on 28th July UAN (42:0) @ 70 L/ha on 12th Sept
Variety	Scepter wheat @ 100 kg/ha		

The trial was a randomised complete block design with three replicates, containing three tillage/seeding treatments and two N treatments. In addition to this in 2016 all disc treatments were harvested at 31 cm using a draper front (in place of a stripper front) due to lodging, while both the no-till and strategic treatments were harvested lower at 16 cm stubble height.

The disc, strategic and no-till treatments were sown using local growers Tom Robinson, Michael Jaeschke and Matt Dare's seeding equipment, respectively.

Figure 1. Crop history of the long-term cropping systems trial at Hart.

2000	2001	2002	2003	2004	2005	2006	2007	2008
Sloop	ATR-Hyden	Janz	Yitpi	Sloop	Kaspa	Kalka	Janz	Janz
Barley	Canola TT	Wheat	Wheat	Barley	Peas	Durum	Wheat	Wheat

2009	2010	2011	2012	2013	2014	2015	2016	2017
Flagship	Clearfield	Correll	Gunyah	Cobra	Commander	44Y89 CL	Scepter	Scepter
Barley	Canola	Wheat	Peas	Wheat	Barley	Canola	Wheat	Wheat

Seeding treatments:

- Disc – sown into standing stubble in one pass with a John Deere 1980 single disc at 152 mm (6”) row spacing, closer wheels and press wheels.
- Strategic – worked up pre-seeding, sown with 100 mm (4”) wide points at 200 mm (8”) row spacing with finger harrows.
- No-till – sown into standing stubble in one pass with a Flexicoil 5000 drill, 16 mm knife points with 254 mm (9”) row spacing and press wheels.

Nutrition Treatments:

- Medium – starter fertiliser plus one in-season N application.
- High – starter fertiliser plus two in-season N applications as Urea or UAN.

All plots were assessed for soil available N (0-20, 20-40, 40-60 and 60-80 cm depths) on the 10th of May. Nitrogen mineralisation potential was estimated using a 21-day laboratory incubation method (Gupta et al. 1994) where 75 g soil was wet up to 18% moisture and incubated at 25°C.

Plant establishment and tiller number was assessed by counting 4 x 1 m sections of row across each plot on the 22nd of June at GS13 (three leaf) and 28th of July at GS30 (start stem elongation), respectively. Plots were scanned using a Greenseeker® to measure crop canopy greenness at GS31 (first node) on 14th of August. All plots were assessed for grain yield, protein, test weight and screenings at harvest (6th December).

Results and discussion

Soil available N to a depth of 80 cm was measured in autumn and ranged between 64 kg N/ha (disc, medium) to 112 kg N/ha (strategic, high) (Figure 2). The high nutrition treatment had accumulated 70 kg N/ha more available N compared to the medium treatment with an average difference of 23 kg N/ha. Seeding system also had a significant effect on available N with the strategic system recording an average 23 kg N/ha more available N than the no-till and disc seeding treatments.

On average all treatments mineralised 19 kg N/ha in the lab incubation. There were no differences in soil mineralisable N among seeders and N rates. This is surprising, given the higher amount of N available in some treatments (Figure 2) to assist with stubble (carbon) decomposition. This outcome has been consistent across two seasons and indicates a value of 20 kg N/ha could be used to assist with N fertiliser calculations in-season at Hart.

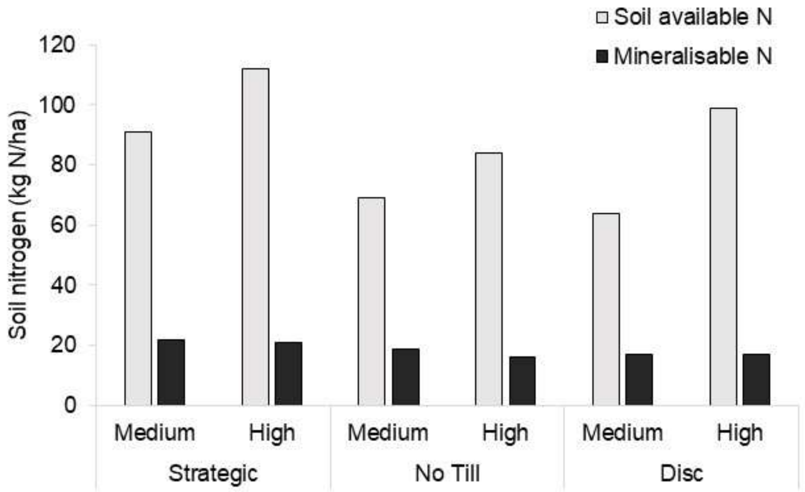

Figure 2. Soil available nitrogen pre-seeding (seeder LSD = 15 and nutrition LSD = 12 at P≤0.05) and mineralisable nitrogen potential (not sig).

Plant establishment and tiller counts indicate there was uniform plant establishment across the seeding systems (Table 2). The NDVI results also show there was little variation among the seeding systems and N rates.

Table 2. Plant establishment and tiller count (number/m²), and NDVI for seeding and nutrition treatments in 2017. There was no significant interaction between seeding system × nutrition treatment or either factor on their own.

Seeding System	**Nutrition Treatment**	**Plant count**	**Tiller count**	**NDVI**
		number/m²		
Strategic	Medium	148	392	0.47
	High	163	388	0.49
No Till	Medium	161	462	0.51
	High	143	337	0.47
Disc	Medium	148	398	0.56
	High	154	421	0.52

Seeding system had an effect on yield with the disc system averaging 4.1 t/ha, compared to the no-till and strategic systems which on average yielded 3.5 t/ha and 3.4 t/ha, respectively (Table 3). This could be linked to the disc treatments increased stubble load reducing the effects of evaporation throughout the growing season when rain events were limited.

The nutrition treatment effect on yield was not significant. This could be attributed to the lack of growing season rainfall for the crop to utilise the higher N application.

Grain protein was significantly higher for the high nutrition treatment. This is due to the additional N applied in season and the extra 70 kg N/ha of soil available N under this treatment pre-seeding. For the other quality parameters seeding system and nutrition treatments both had an effect. For grain test weight the no-till treatment averaged 75.6 kg/hL, compared to 74.6 kg/hL and 73.6 kg/hL for the strategic and disc treatments, respectively. The higher nutrition treatment also decreased the test weights in each seeding system, this is correlated to the increase in the percentage of screenings found in these treatments.

Table 3. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) for nutrition and seeding treatments in 2017.

Seeding System	**Nutrition Treatment**	**Yield** t/ha	**Protein** %	**Test Weight** kg/hL	**Screenings** %
Strategic	Medium	3.54	7.0	75.4	1.9
	High	3.28	12.2	73.8	3.9
No Till	Medium	3.53	6.7	76.6	1.1
	High	3.47	10.6	74.6	3.3
Disc	Medium	4.07	6.4	74.6	1.3
	High	4.13	9.5	72.7	4.5
	LSD (P≤0.05)				
	Seeder	0.2	0.5	1.0	ns
	Nutrition	ns	0.4	0.8	0.8
	Seeder × Nutrition	ns	0.7	ns	ns

Acknowledgements

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Sowing the long term seeding systems trial in 2015

Improving pre-emergent herbicide spray coverage in stubble retention systems

How does stubble effect spray coverage?

Stubble interferes with spray coverage as a physical barrier and can tie up some herbicides. This problem has been intensified with advanced cropping systems now retaining more stubble at greater heights due to improved harvesters, seeders and inter-row sowing. In some paddocks we may still be maintaining good spray coverage in the inter stubble rows however, at the base of stubble weed escapes are becoming more frequent. A reduction in herbicide coverage leads to a decrease in the efficacy of the herbicide applied, resulting in poor weed control.

Will the herbicide wash off the stubble?

It depends on the product (a quick recap in Table 1). The behaviour of pre-emergent herbicides in soil is driven by three key factors;

1. **solubility of the herbicide** influences how far the herbicide will move in the soil profile in response to rainfall events.
2. the **rate of breakdown of the herbicide in soil**. That is, how long it takes for herbicide to be degraded chemically or more commonly by soil microbes.
3. how **tightly the herbicide is bound to stubble and soil components** (e.g. soil organic matter, clay).

Recent laboratory research has focused on the amount and frequency of rainfall required to wash common pre-emergent herbicides from cereal stubble (Khalil 2017). The herbicide selected in this study ranged in solubility and binding including, Sakura® (low solubility and medium binding), prosulfocarb (low solubility and high binding) and trifluralin (very low solubility and very high binding). They found a 5 mm rainfall event was sufficient to wash a large percentage of Sakura® (from 4 t/ha stubble load) on to soil, providing good control (>95%) of ryegrass. The authors reported Sakura® was easily washed off stubble, prosulfocarb less so and trifluralin less again. Interestingly, rainfall events above 5 mm (e.g. 10 and 20 mm) was of little additional benefit to herbicide wash off and subsequent ryegrass control.

Another key finding from this work was wet stubble binds herbicides tighter**.** When herbicides were sprayed onto wet stubble, they were bound more tightly than herbicides sprayed onto dry stubble. The exception was Sakura®, which once again was readily washed off wet or dry stubble with rainfall.

Table 1. Water solubility, binding characteristics to soil organic matter and degradation half-life for common pre-emergent herbicides.

Herbicide	Trade name	Water solubility mg/L	Solubility rating	Binding mg/L	Binding rating	Degradation half-life days
Trifluralin	Triflur X®	0.22	Very low	15,800	Very high	181
Pyroxasulfone	Sakura®	3.9	Low	223	Medium	22
Triallate	Avadex® Xtra	4.1	Low	3000	High	82
Prosulfocarb	Boxer Gold®	13	Low	2000	High	12
S-metolachlor		480	High	200	Medium	15
Propyzamide	Edge®, Kerb®, Rustler®	15	Low	840	High	120
Diuron	Diuron	36	Medium	813	High	75.5
Chlorsulfuron	Glean®	12,500	Very high	40	Low	160

Three ways to improve your spray coverage

Number 1 – measure it so you can improve it

An easy way to assess spray coverage in your paddock can be done using water sensitive paper (WSP). This paper can be placed on the soil surface, beneath stubble or attached within standing stubble (Figure 1). In this project the cost of a single packet of WSP (50 cards) ranged from $50-$60 from a local reseller.

Water sensitive paper has a special coating which produces a stain when spray droplet lands on the paper (see below) for a given target. Using the free SnapCard app (Android and IOS), spray coverage as % of the card area stained can be easily measured in the field. In addition to this you can also access droplet size using the examples provided below (Figure 1).

TIPS for placing water sensitive paper in the field:

- Measure coverage in both the inter-stubble row and at the base of the stubble (often where coverage declines and weed escapes occur).
- Place cards on top and below trash.
- Find some different stubble heights within the paddock to compare coverage.
- When using the SnapCard app make sure you are facing direct sunlight (i.e. don't shade the WSP).

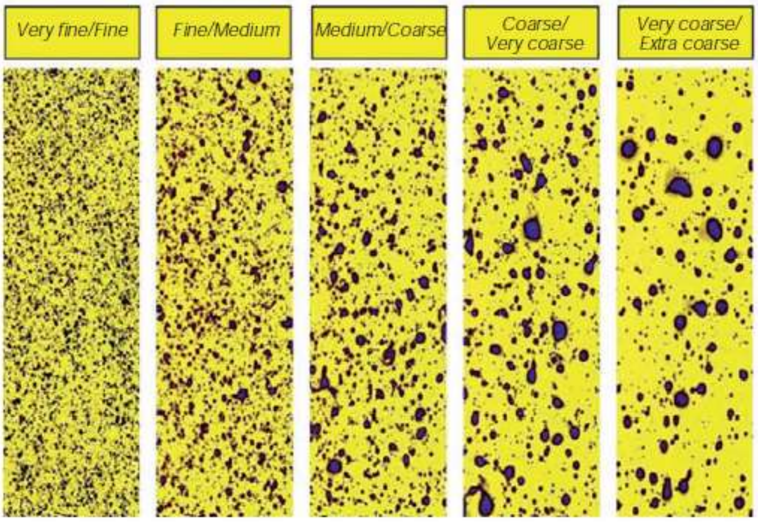

Figure 1.
(above) Water sensitive paper illustrating various spray qualities at the same application volume. Source: Tom Wolf
(left) Water sensitive paper placed within standing stubble. Spray droplets have dyed the card blue.

Rules of thumb for spray coverage using water sensitive paper:

- Fully translocated herbicides >6 - 8%
- Contact herbicides >10 - 12%
- Fungicides >15%
- Pre-emergent herbicides >15-20% (as a guide depends on the product, soil moisture and rainfall) *Source: Bill Gordon*

Number 2 - managing your stubble at harvest

As you may expect, the more stubble on the ground, the more likely it is that herbicides will be bound to it. Lower levels of stubble in combination with leaching rain result in the best scenario to achieve herbicide efficacy for all herbicides. Unfortunately, there is no one rule for target stubble height or stubble cover as herbicide efficacy depends on stubble load, summer rainfall to aid decomposition and rainfall following herbicide application.

In case studies completed as part of this project we assisted farmers to assess their paddock/spray coverage. In an example below the farmer had an average wheat stubble load of 6.8 t/ha and of that biomass 40% (2.7 t/ha) was standing stubble and the remaining 60% (4.1 t/ha) was flat on the soil surface (Figure 2). At harvest time the crop had lodged and knowing the stubble load was going to be high, the farmer harvested at 21 cm to make seeding operations easier. However, this resulted in a higher proportion of chaff/trash material returned to soil surface.

Water sensitive paper was strategically placed within the stubble to measure the spray coverage in the inter-row with and without any trash cover and at the base of stubble. The application was made with water only at 80 L/ha to achieve a medium/coarse droplet size. Interestingly there was a 7% reduction in spray coverage in the inter stubble row compared to the stubble base. Furthermore, the amount of stubble hitting the soil surface was <3% where trash was present. In this scenario for a pre-emergent herbicide application the farmer was left with two management options:

1. Selecting a pre-emergent herbicide with high solubility and low stubble binding capacity. In addition to timing the spray application and seeding operations to ensure the herbicide is washed from the stubble onto soil.
2. Burn the stubble prior to seeding to remove some of the physical barrier and potential for herbicide tie up. Removing stubble also gives greater flexibility in pre-emergent herbicide selection.

Figure 2. Proportion of 6.8 t/ha stubble load standing versus laying on the soil surface.

Cards placed inter-row NO trash **17.6%**

Cards placed at the stubble base **11.4%**

Cards placed inter-row underneath chaff / trash on soil surface **2.6%**

What about stubble burning and pre-emergent herbicide tie up?

If stubble loads are too high, a last resort of burning windrows or the whole paddock may be an option. Similar to stubble however, ash is a physical barrier between the soil and herbicide. There is limited research in this area to understand if the herbicide also binds to the ash. Despite this, the benefit of burning is less material in the field for herbicides to be intercepted by or possibly bind with. Aiming for warmer burns prior to sowing and if possible waiting for a rain following the burn, before spraying will help minimise the impact of ash on pre-emergent herbicides (Haskins 2012).

Number 3 – adjusting water volume

One of the simplest changes to improve spray coverage in high stubble loads is increasing water rate (Figure 3). Field research conducted in this project showed, on average for stubble heights <30 cm (baled, short and medium) spray coverage was increased from 13%, 20% to 33% for 50 L/ha, 100 L/ha and 150 L/ha, respectively. The second year of results showed a very similar trend with spray coverage increasing from 12%, 20% to 28% for the same three spray volumes. Generally, volumes above 150 L/ha do not provide further improvements in efficacy.

The stripper front harvested stubble was the only treatment to significantly reduce spray coverage. The area covered was reduced by 5 - 16% for the 50 L/ha, 100 L/ha and 150 L/ha treatments. This reduction was not significant in the second season ranging 5 – 9% across the three volumes. This difference in seasons can be attributed to overall stubble load and stubble strength (i.e. how much was knocked over versus upright). Furthermore, in high stubble loads cutting shorter creates a larger volume of chaff returned to the soil surface which will reduce spray coverage on the soil further to that reported below (Figure 4).

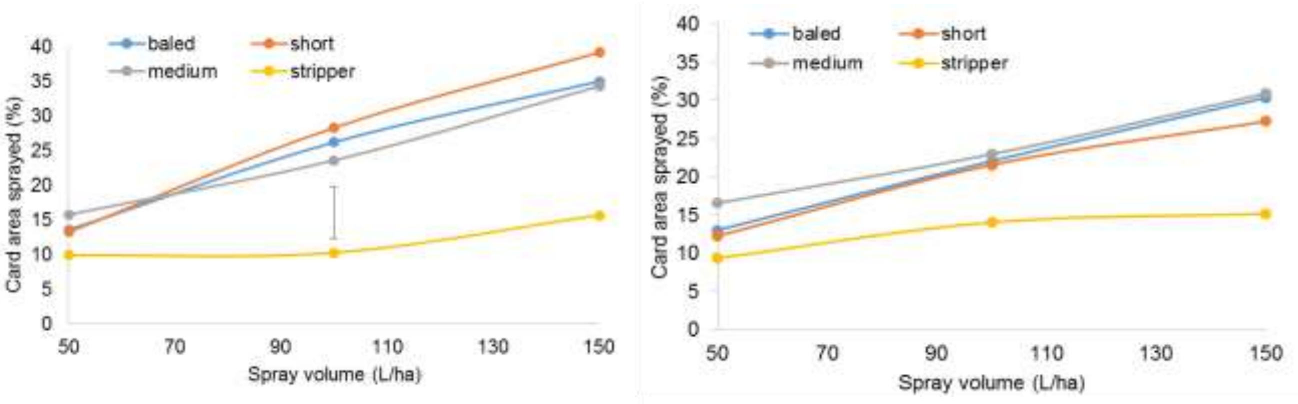

Figure 3. Area (%) of card sprayed in different stubble and spray volume combinations for medium sized droplet in 2015 (left) and 2016 (right). These are the average values for spray cards placed at the stubble base and inter-row. Signification interaction (P≤0.05) for stubble and volume for both droplet sizes is indicated by the error bars.

Figure 4. Baled (left) and stripper front harvested (right) stubble treatments.

An interaction between droplet size and spray volume was not observed (data not shown). The range of droplet sizes tested were not sufficient to see differences. That is, selecting a coarse or medium droplet size did not increase the % area of spray card in any of the stubble treatments or carrier volumes tested. However, other research has shown large droplets in addition to high water rates are required in high stubble loads to ensure the herbicide reaches the soil.

Are there other ways to manipulate my spray setup and improve coverage?

While water volume and droplet size were the focus of this study there are further measures that can be taken by the spray operator to increase herbicide penetration in stubble. In a recent paper by Gordon (2017) some of the strategies highlighted were:

- **Reducing spraying travel speeds** can generally improve the penetration into stubble and improve the evenness of the application.
- **Narrower nozzle spacings** can also be of benefit, provided the spray quality and boom height are suitable.
- Alternately, many operators have plumbed machines with **nozzle spacings to match the crop row width**. Where nozzles are positioned in the centre of the inter-row gap between standing stubble lines, the nozzle height may be lowered to obtain an overlap close to the base of the stubble. This may improve soil contact and reduce interception by the stubble, provided spraying speeds and wind speeds do not excessive.

Other resources:

- Khalil, Y (2017) Effect of crop residue and rainfall on the availability of pre-emergent herbicides in the soil. GRDC Update paper Perth
- AHRI Insight – Herbicide and stubble
- Haskins, B (2012) Using pre-emergent herbicides in conservation farming systems
- GRDC Pre-emergent herbicides manual & GRDC Spray Application Manual
- Gordon, B (2017) Spray Applications tips and tactics GRDC Update Paper

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Disclaimer

Yield Prophet® performance in 2017

Sarah Noack, Hart Field-Site Group

Key findings

- Yield prophet under predicted the final grain yield of Mace (3.9 t/ha) at Hart in 2017.
- Lack of rainfall during the season meant the difference between 20% and 80% of years was only 0.5 t/ha towards the end of the season.

Why do the trial?

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

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

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

How was it done?

Seeding date	1st May 2017	**Fertiliser**	40 kg N/ha 1st May 20 kg N/ha 20th July
Variety	Scepter wheat @ 180 plants per square metre		

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

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

Results

At the first simulation, 1st June 2017 Yield Prophet® predicted that Mace wheat sown on the 1st May would yield 4.8 t/ha in 50% of years (Figure 1). After well below average rainfall in June and July, it is not surprising that this yield prediction reduced to 4.3 t/ha from mid-June until late August.

The Yield Prophet® simulation on the 10th of October for grain yield, decreased by a further 1.0 t/ha. This was driven by below average rainfall for September and October (45 mm below the long-term average). The 20% of year's prediction was slightly higher at 3.5 t/ha. The actual grain yield for Mace sown in early May was 3.9 t/ha in the Hart wheat variety trial. The Yield Prophet® predicted wheat grain yield at Hart was down in comparison to previous seasons.

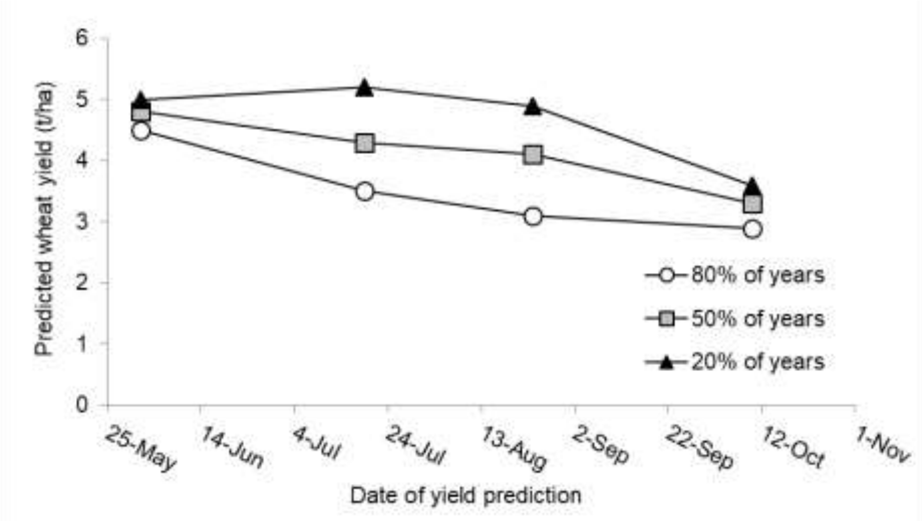

Figure 1. Yield Prophet® predictions from 1st June to the 10th October for Mace wheat sown on the 1st May, 2017. 80%, 50% and 20% represent the chance of reaching the corresponding yield at the date of the simulation.

Plant available water (PAW) (0-90 cm) when the first simulation was run at the beginning of June was 169 mm (Figure 2). This was significantly more stored moisture compared to the same time in 2015 (19 mm) and 2016 (33 mm). Plant available water decreased rapidly during June and July due to below average rainfall. Rainfall in August kept the PAW level consistent. From early September the bucket water level decreased to almost empty at the start of October. The soil moisture probe at Hart also indicated that the soil bucket was almost empty, with wheat roots extracting to depths of 80 cm at the beginning of October. The next major rainfall fell in early December. This event 'topped the bucket up' and there was approximately 40% stored soil moisture at the end of January 2018.

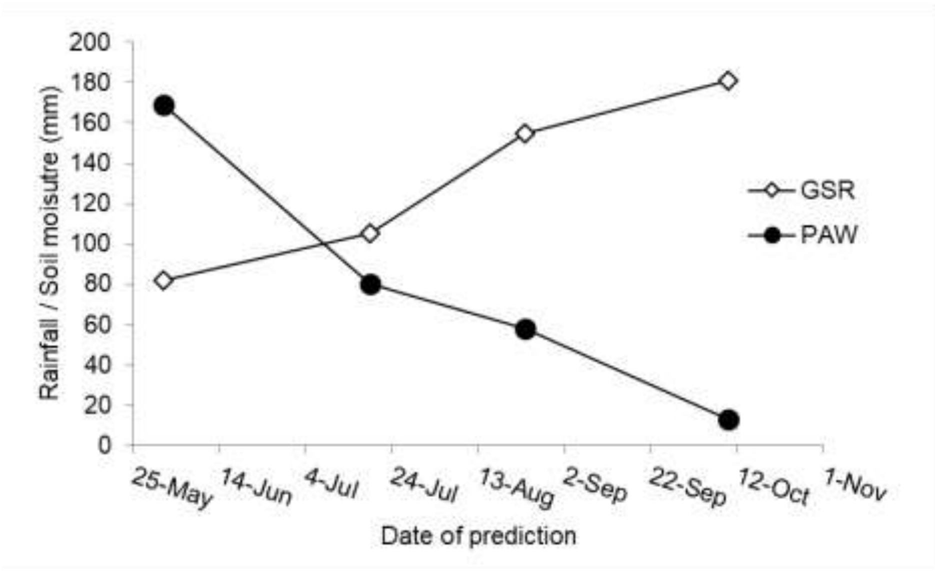

Figure 2. Predicted plant available water (PAW) and recorded cumilative growing season rainfall from 1st of June to 10th of October at Hart in 2017.

Around the site 2017

At the official opening of The Regional Hub, Clare.


Spray workshop with Bill Gordon April 2017


'Been Farming Long' workshop series; Insect ID


Getting The Crop In seminar, March 2017 Farmer Panel Q&A with growers Randall Wilksch, Linden Price and Rob Purvis


Progress! New field lab facility under construction thanks to funding through the GRDC Infrastructure Grant program


Research trip to the Riverine Plains – can you tell we don't see too many pivots in the Clare Valley…

Winter Walk 2017

Spring Twilight Walk 2017

Notes

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Quality Fertilisers

Premium
Cropping Range

DAP ZinCote 1%

1% Zinc evenly applied to every granule

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

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