Trial Results 2019

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Front cover photo by Sandy Kimber; Hart Field Day 2019.

Thanks also Sandy Kimber, Sarah Noack and Gabrielle Hall for other photos used within this publication.

Research supporters

We also receive project funding support provided by the Australian Government

Collaborators

Hart Events 2020

HART FIELD DAY

September 15

Our main Field Day attracts over 600 visitors from all over the South Australia and interstate.

Every half hour a block of eight sessions are run simultaneously with highly regarded specialists speaking at each trial. A comprehensive take-home Field Day Book included in the entry fee.

This is Hart's main event of the year.

Hart AGM

April 7

6pm - Bentley's Hotel, Clare

All welcome

Please RVSP to Sandy on 0427 423 154

Getting The Crop In

March 11

8am – 12:30pm

Industry guest speakers from across the county cover a wide range of topics, all relevant to broadacre cropping.

Winter Walk

July 21

9am – 12pm

An informal guided walk around the trial site; the first opportunity to inspect the site post seeding, with guest speakers presenting their observations on current trials.

They are on hand to answer questions and will also share their knowledge on all the latest cropping systems and agronomic updates.

Spring Twilight Walk

October 20

5pm followed by BBQ

Another informal opportunity to inspect the trial site, this time just prior to harvest, again with industry researchers & representatives presenting in the field.

This event is followed by drinks and a BBQ in the shed - a great opportunity to network.

Acknowledgements

The success of our research program could not be achieved without the contribution of a large number of people and organisations.

Supporters

We thank the numerous growers and consultants who provide various contributions, from knowledge and experience through to land and equipment for conducting trials.

Peter Baker
Shawn Cadzow
Robert & Dennis Dall
Matt Dare
Mick Faulkner
Leigh Fuller
Simon Honner
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Michael Jaeschke
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Matt McCallum
Wayne Rooke
Stefan Schmitt
Stuart Sherriff
Damien & Ben Sommerville
Sam Trengove
Tom & Ashley Robinson
Robert & Glenn Wandel
Justin, Bradley & Dennis Wundke

A BIG thank you to 10 growers who also participated in our soil and plant testing project and crop establishment paddock surveys in 2019.

We would also like to thank various organisations for the provision of seed and/or products that were trialed in the 2019 research program.

ADAMA
Advanta Seeds
Australian Grain Export
Australian Grain Technologies
BASF
Bayer Crop Science
Corteva Agriscience
Crop Care
FMC
Global Grain Genetics
Heritage Seed
Imtrade
Incitec Pivot
InterGrain
Longreach Plant Breeders
Nufarm
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Pasture Genetics
Pioneer Seeds
Pulse Breeding Australia
Seednet
Seed Force
Syngenta

Partners

Blyth Revegetation Committee, Mid-North Grasslands Working Group, Wakefield Regional Council

Site Management

SARDI, Agronomy Clare:
John Nairn, Phil Rundle, Sarah Day, Dili Mao, Richie Mould, Patrick Thomas, Navneet Aggarwal, Penny Roberts, Dylan Bruce, Greg Walkley

SARDI, Agronomy Waite:
Kenton Porker

Hart Field-Site Group:
Sarah Noack & Jade Rose

Our guiding principles

OUR PURPOSE

To deliver value to growers and make agriculture better

(in productivity, sustainability & community)

OUR VISION

To be Australia's premier cropping field site, providing independent information and enhancing the skills of the agricultural industry

OUR VAULES

Independence

in order to provide unbiased results

Relevance

to issues facing farmers

Integrity

in all dealings

Credibility

through providing reliable, quality information

Professionalism

in the management of the site and presentation of trials

Value for money

low cost of information to farmers

Hart management

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or give us a call, we'd love to hear from you

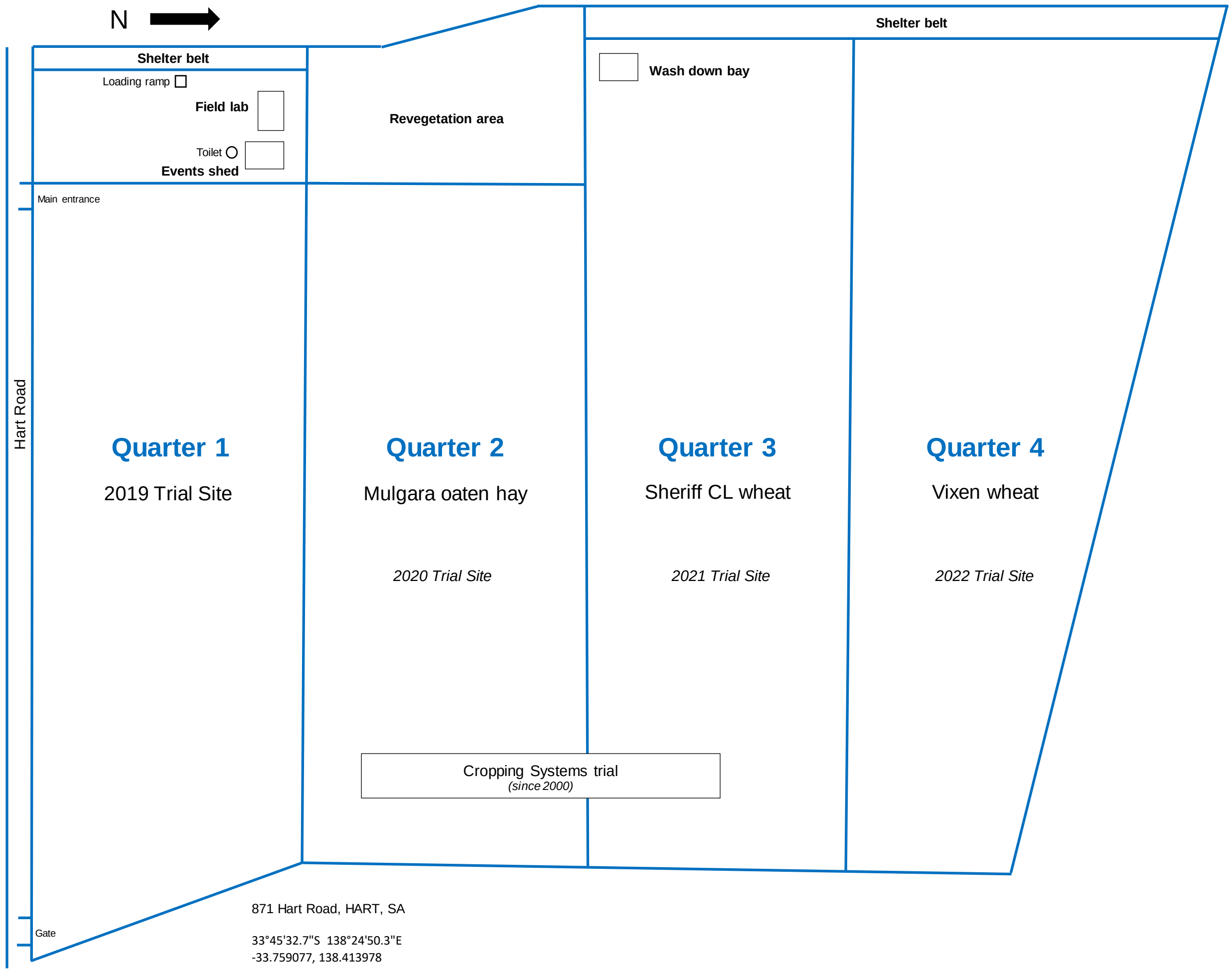
Ryan Wood, Chairman 0439 563 833

Sandy Kimber, Executive Officer 0427 423 154

The Hart site

The Hart field site (40 ha owned by the group) is managed as four quarters that are rotated each year.

In 2019, Quarter 1 hosted our trials. Quarter 2 was sown with Mulgara oats and was cut for hay to tidy the site in preparation for 2020 trials and Quarters 3 and 4 were sown with wheat as our commercial crop.



Hart Field Day 2019 - Quarter 1
Photo: Andre Sabeeney

Hart commercial crop report

Matt Dare, Hart Field-Site Group

In 2019, our commercial crop was sown with Sheriff CL and Vixen wheat in Quarters 3 & 4 on May 30. Thanks to Josh Reichstein and InterGrain for organising and donating the commercial crop seed.

On July 27, the commercial wheat crop was sprayed for broadleaf weeds with 25 g/ha Paradigm, 500 ml MCPA LVE 570 g/L + 250 ml Epoxiconazole + 0.5% Hasten Oil @ 90 L/ha. Thanks to Mick Lines, Corteva Agriscience for donating the Paradigm herbicide.

Nitrogen was applied as 50 kg/ha urea on August 6.

The wheat was harvested on November 12, averaging 1.74 t/ha and H2 quality.

Quarter 2 of the site (10 ha) was sown to Mulgara oats for hay on May 31 in preparation for the 2020 trial site. Seed was kindly donated by local growers Peter and Lyle McEwin.

Quarter 1	**8 ha 2019 trial site**
Quarter 2	**10 ha Oaten hay (2020 trial site)**
Spray: 30/5/19 1.6L/ha Glyphosate520g/L + 100ml/ha Striker +1% SOA v/v + 0.25% LI700 v/v @100L/ha	
Seeding date: 31/5/19	
Crop & Variety: Mulgara oats	
Seeding rate: 100 kg/ha	
Fertiliser: 50 kg/ha MAP	
Post Em Spray: 27/7/19 500 ml/ha MCPA LVE 570 g/L + 250 ml/ha Epoxiconazole + 0.5% v/v Hasten Oil @ 90 L/ha	
Quarter 3	**8 ha Sheriff CL wheat**
Spray: 30/5/19 1.6 L/ha Glyphosate 520g/L + 100 ml/ha Striker + 118 g/ha Sakura + 1% SOA v/v + 0.25% LI700 v/v @ 100 L/ha	
Seeding date: 30/5/19	
Crop & Variety: Sheriff CL	
Seeding rate: 100 kg/ha	
Fertiliser: 50 kg/ha MAP	
Post Em Spray: 27/7/19 25 g/ha Paradigm + 500 ml/ha MCPA LVE 570 g/L + 250 ml/ha Epoxiconazole + 0.5% v/v Hasten Oil @ 90 L/ha	
In-season nitrogen spread: 6/8/19 50 kg/ha urea	
Quarter 4	**10 ha Vixen wheat**
Spray: 30/5/19 1.6 L/ha Glyphosate 520 g/L + 100 ml/ha Striker + 118 g/ha Sakura + 1% SOA v/v +0.25% LI700 v/v @ 100 L/ha	
Seeding date: 30/5/19	
Crop & Variety: Vixen wheat	
Seeding rate: 100kg/ha	
Fertiliser: 50kg/ha MAP	
Post Em Spray: 27/7/19 25 g/ha Paradigm + 500 ml/ha MCPA LVE 570g/L + 250 ml/ha Epoxiconazole + 0.5% v/v Hasten Oil @ 90 L/ha	
In-season nitrogen spread: 6/8/19 50 kg/ha urea	

The 2019 season at Hart

The Mid-North had a dry start to seeding and Hart was no exception. With well below average summer rainfall (Figure 1) this also meant there was limited stored moisture available (Figure 2) going into the season.

Trial seeding commenced on the March 18, well before our traditional sowing window and the final trials were sown June 5. Trial plots sown prior to the beginning of May were irrigated to achieve germination and establishment.

The majority of Hart's research program was sown in mid-May. The site received less than average rainfall during April, with 8 mm. A total of 41 mm was captured throughout May which improved seed bed moisture and reduced moisture stress in early sown trials.

June was the only month where Hart received above average monthly rainfall of 56 mm (Figure 1). This was followed by well below average rainfall for July, August, September and October. By the end of October Hart's growing season rainfall was 162 mm. Annual rainfall for the year was 189 mm (Table 1) placing Hart at a decile 1 for both growing season and annual rainfall in 2019.

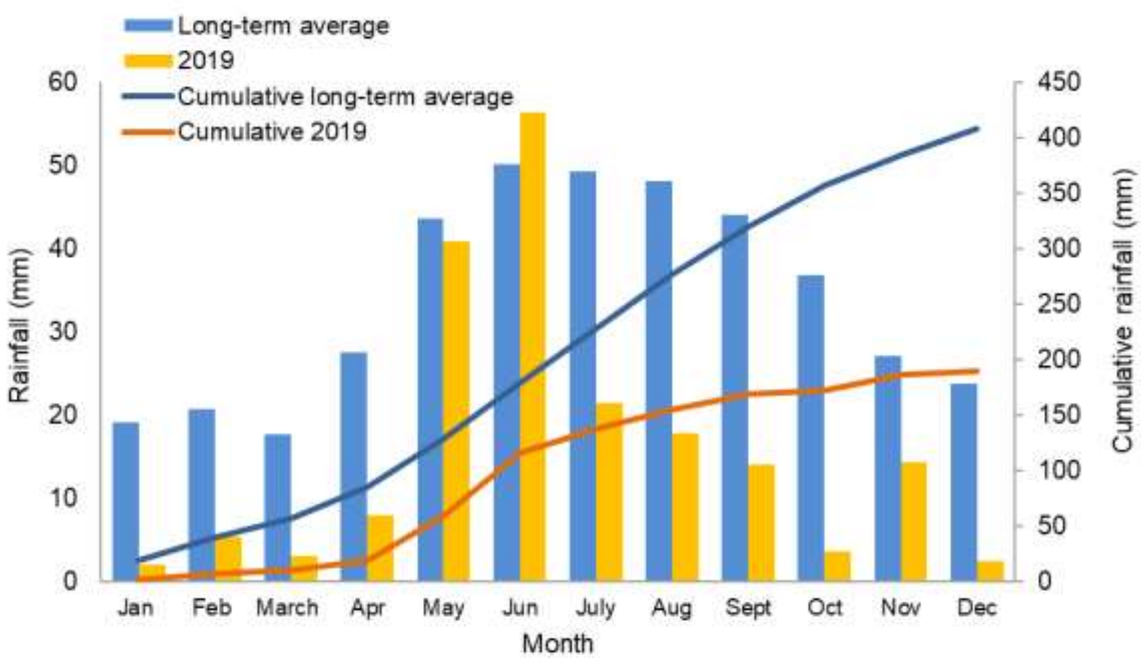


Figure 1. Hart rainfall graph for the 2019 season to date and long-term average. The cumulative rainfall is presented as lines for long term average (blue) and 2019 (orange).

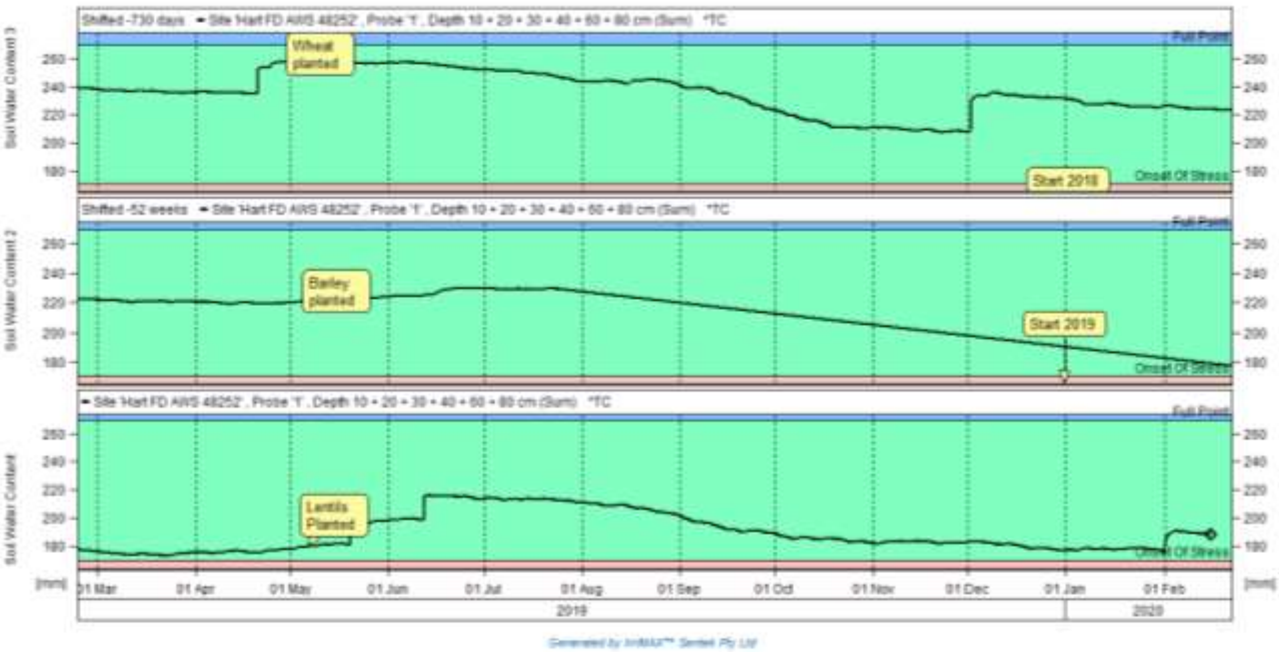


Figure 2. Hart Field-Site soil moisture probe summed comparison for 2017 (top), 2018 (middle) and 2019 (bottom). Hart data is free to view via AgByte: http://www.hartfieldsite.org.au/pages/live-weather/soil-moisture-probe.php

Table 1. Hart rainfall chart 2019 (AgByte weather station)

	January	February	March	April	May	June	July	August	September	October	November	December
1	0	0	0	0	3.2	0	0	0	0	0	3.8	2.4
2	0	0	0	0	1	1	0	0	0	0	2.6	0
3	0	0	0	0	1.4	1	0	0	0	0	2	0
4	0	0.4	0	0	0	0	0	0	0	0	0.8	0
5	0	0	2.8	0	0	0	0	0	0	0	0	0
6	0	2.2	0	0	0	0	4	0	2.6	0	0	0
7	0	0	0	0	0.6	0	1.2	3.6	0.2	1.8	0	0
8	0	0	0	0	0	0	0	5.4	0	0.8	2	0
9	0	1	0	0.8	13.4	0	0.2	3.2	0	0	0	0
10	0	0	0	0	1.8	0.4	3.0	0.4	0	0	0	0
11	0	0	0	0	0.8	0	1.8	0.2	0	0	0	0
12	0	1.8	0	0	0	41	4.2	0.2	0	0	0	0
13	0	0	0	0	0	0.2	0	0	0	0.2	0	0
14	0	0	0	0	0	0.6	1.0	0	0	0	0	0
15	0	0	0	0	0	0	1.0	0	0.6	0	0	0
16	0	0	0	0	0	0	0.4	0	0	0.2	0	0
17	0	0	0	0	0	0	0.6	0.2	0	0	0	0
18	0	0	0	0	0	1	0	3.2	0	0	0	0
19	0	0	0	0	9	0	0	0.4	0	0	0	0
20	0	0	0	0	0	0	0	0.8	9	0	0	0
21	0	0	0	2.2	0	0	0	0	0.8	0	0	0
22	0	0	0	0	0	0	0	0	0.6	0	0	0
23	0	0	0.2	0	0	0	1.0	0	0.2	0	0	0
24	0	0	0	0	0	0	1.6	0	0	0	0	0
25	0	0	0	0	4.8	0	0.2	0	0	0	0	0
26	2	0	0	0	0.4	0	0.6	0	0	0.6	0	0
27	0	0	0	0	1.2	0	0.2	0	0	0	0	0
28	0	0	0	0	0.6	0	0	0	0	0	0	0
29	0		0	0	1.6	11.0	0.2	0.2	0	0	2.8	0
30	0		0	5	0.8	0.2	0.2	0	0	0	0.4	0
31	0		0		0.2		0	0		0		0
Montly total	**2.0**	**5.4**	**3.0**	**8.0**	**40.8**	**56.4**	**21.4**	**17.8**	**14.0**	**3.6**	**14.4**	**2.4**
GSR rainfall				8.0	48.8	105.2	126.6	144.4	158.4	162.0		
Total rainfall	2.0	7.4	10.4	18.4	59.2	115.6	137.0	154.8	168.8	172.4	186.8	189.2

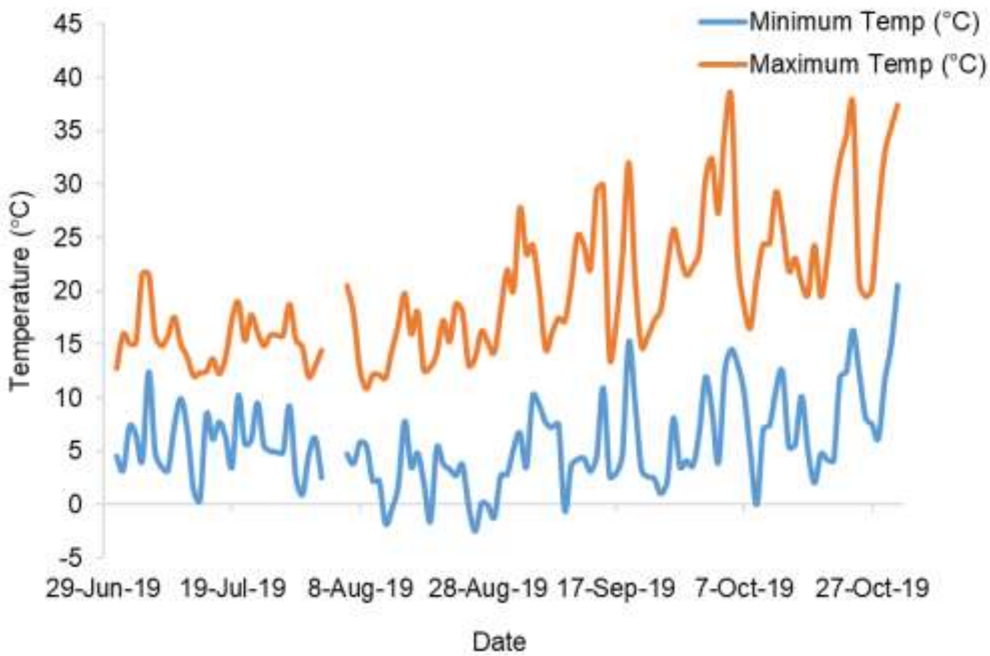


Figure 3. Hart daily maximum and minimum air temperature from July 1 to October 31, 2019. Source: AgByte weather station.

Table 2. General soil physical and chemical properties for the Hart field site. Sampled on May 24, 2019.

		Sampling depth (cm)					
Soil property	**Units**	**0-15**	**15-35**	**35-55**	**55-75**	**75-105**	**Total profile**
Texture							Loam - clay loam
Gravel	%	0	0	0	0	0	
Phosphorus Colwell	mg/kg	34	11	6	4	3	
Potassium Colwell	mg/kg	443	275	257	263	271	
Available soil nitrogen	kg/ha						26
Sulphur	mg/kg	5	3	5	17	53	
Organic carbon	%	1.6	0.9	0.5	0.4	0.2	
Conductivity	dS/m	0.13	0.12	0.20	0.26	0.54	
pH ($CaCl_2$)		7.8	7.7	7.9	8.1	8.2	

Yield Prophet® performance in 2019

Sarah Noack, Hart Field-Site Group

Key findings

- Yield Prophet® closely predicted wheat grain yield for Scepter towards the end of the season.
- Lack of rainfall during the season meant the difference between 20% and 80% of years was 0.8 t/ha in mid-September and only 0.1 t/ha in early October.

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	May 1, 2019	**Fertiliser**	30 kg N/ha May 1 20 kg N/ha July 18
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.

The 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, June 20 Yield Prophet® predicted that Scepter wheat sown on May 1 would yield 3.9 t/ha in 50% of years (Figure 1). June was the only month where Hart received above average rainfall in 2019. The Yield Prophet® prediction remined high at 3.6 t/ha going into July. After well below average rainfall in July and August (Table 1), it is not surprising this yield prediction reduced to 2.5 t/ha by late August.

The Yield Prophet® simulation in mid-September decreased further by 1.0 t/ha. This was driven by below average rainfall for September (Table 1). By mid-October, the 20%, 50% and 80% of year's prediction were closely aligned between 1.3 – 1.4 t/ha. The actual grain yield for Scepter sown in mid-May was 1.6 t/ha in the Hart wheat variety trial (trial average 1.5 t/ha). Yield Prophet® closely predicted wheat grain yields towards the end of the season as it has in previous years. Localised frost damage was observed in the district and would have contributed to lower grain yields. The effects of heat and frost stress were not modelled in the predictions presented here. Yield predictions from the last eight seasons (Figure 2) have demonstrated Yield Prophet® can accurately predict yields with an average finish.

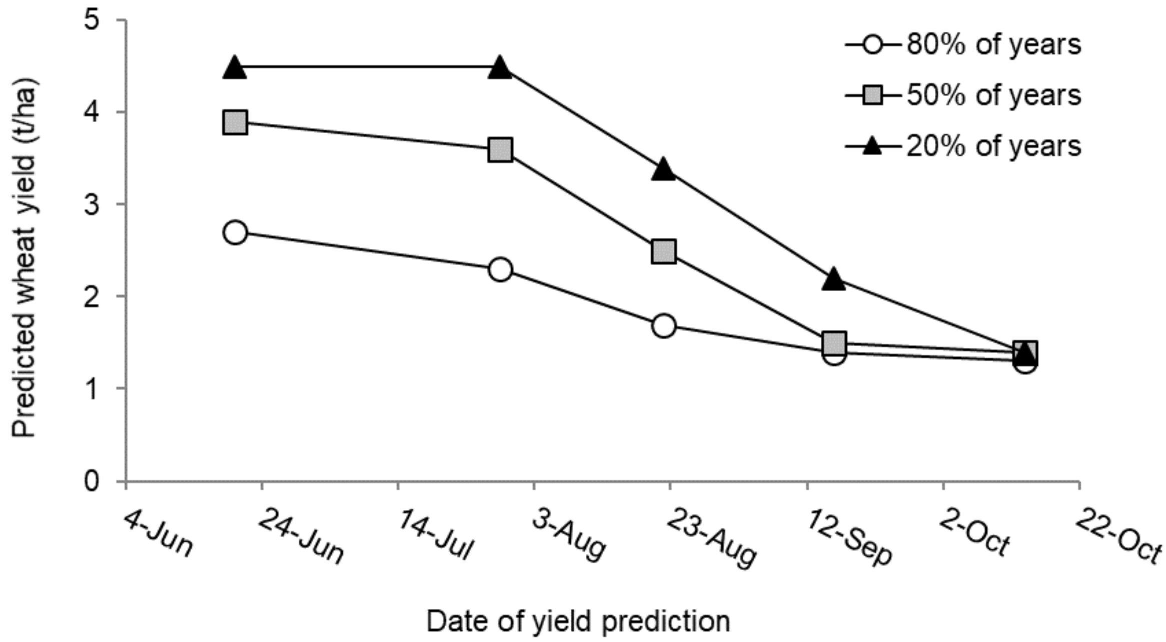


Figure 1. Yield Prophet® predictions from June 20 to October 14 for Scepter wheat sown on the May 1, 2019. The 80%, 50% and 20% represent the chance of reaching the corresponding yield at the date of the simulation.

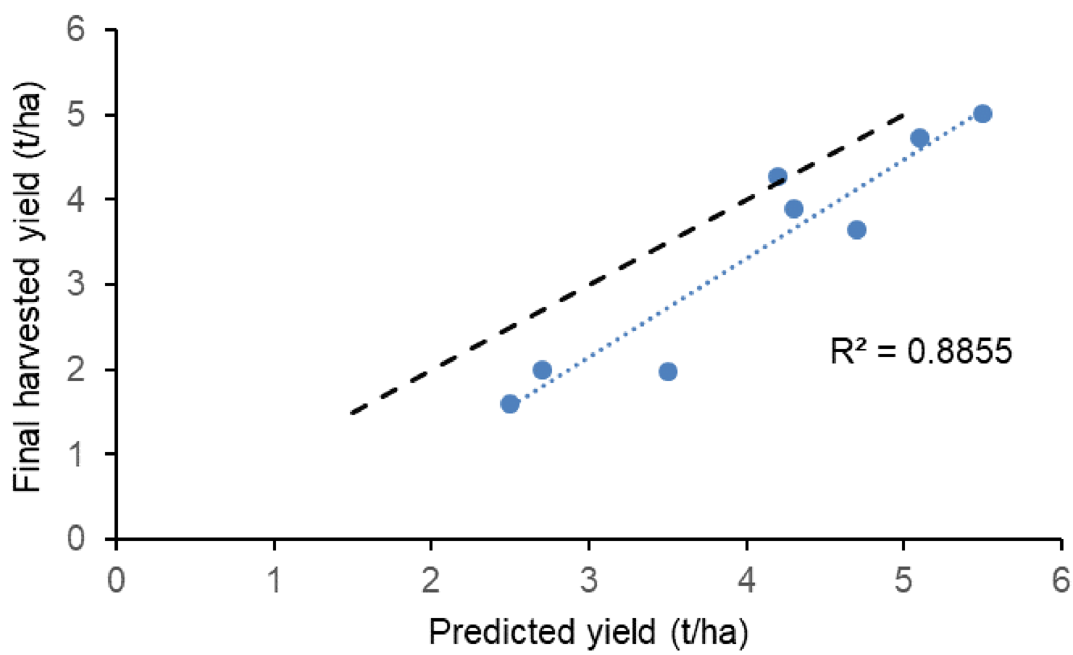


Figure 2. The relationship between predicted yield in mid-August, given an average finish to the season, against final harvested grain yield (blue line). This is a summary of Hart wheat yields from 2012 to 2019. The dashed black trendlines is the 1:1 line, through point 0.

Table 1. Long-term (100-year average) and 2019 monthly rainfall (mm) for Hart.

	Long-term average (mm)	2019 (mm)	Difference (mm)
Jan	19	2	-17
Feb	21	5	-16
Mar	18	3	-15
Apr	27	8	-19
May	44	41	-3
Jun	50	56	6
Jul	49	21	-28
Aug	48	18	-30
Sep	44	14	-30
Oct	37	4	-33
Nov	27	14	-13
Dec	24	2	-22
Total	408	189	

Plant available water (PAW) (0-90 cm) in mid-June was low, at 48 mm (Figure 3). This was the same as the stored moisture content this time in 2018. Across the entire growing season PAW never exceeded 50 mm (or 25% of the 'bucket' estimated to hold 200 mm PAW). Plant available water continued to decrease from June through to October. From early September the bucket water level decreased to almost empty at the start of October, reflecting the dry finish and signalling another early harvest.

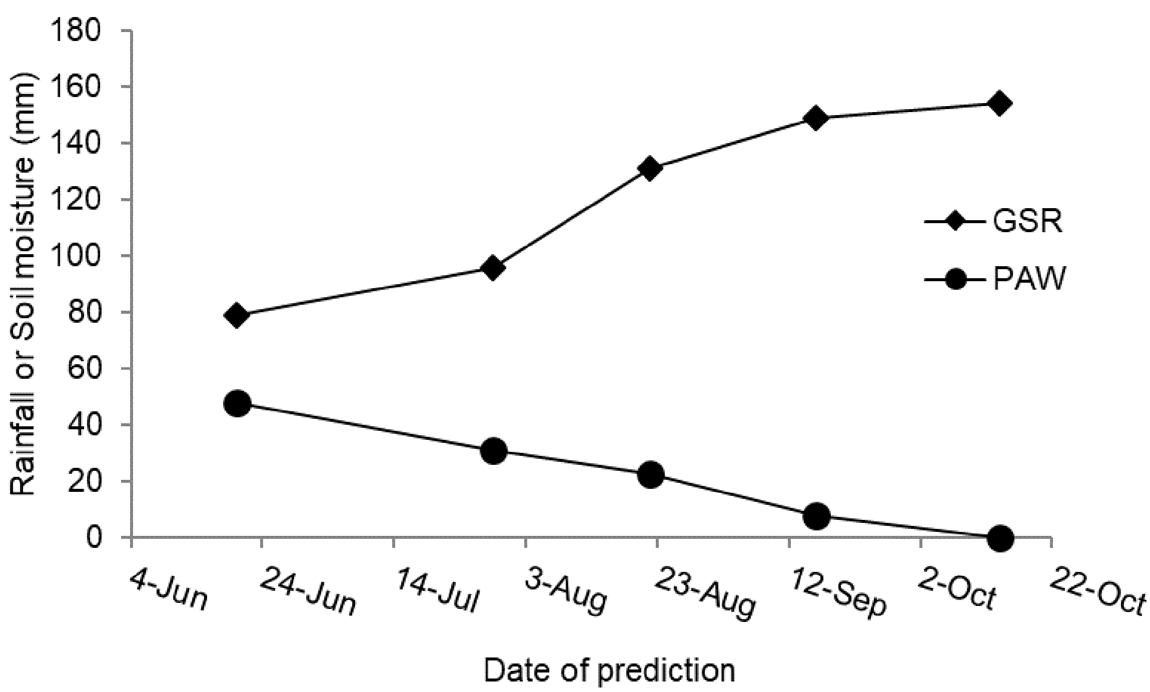


Figure 3. Predicted plant available water (PAW) and recorded cumulative growing season rainfall from June 20 to October 14 at Hart in 2019.

HART BEAT - yield predictions through the growing season for 8 Mid-North sites

HART BEAT

14th October 2019

ISSUE 50

IN THIS ISSUE

Definitions

Site information

Hart Beat site reports

- Hart
- Spalding
- Condowie
- Kybunga
- Farrell Flat
- Pinery
- Eudunda
- Tarlee

HART BEAT

Yield Prophet® simulations for 8 sites across the mid-north of SA

The Yield Prophet® simulations featured are not a crystal ball, but provide a realistic prediction of the available soil water and nitrogen status of your crop

HART EVENTS

Getting The Crop In – March 11, 2020

Winter Walk – July 21, 2020

HART FIELD DAY – September 15, 2020

Spring Twilight Walk – October 20, 2020

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The *HART BEAT* newsletter, first introduced in 2009, is an initiative of the Hart Field-Site Group.

It is aimed at providing farmers and agronomists with regular updates of current and predicted crop and soil conditions as a season progresses.

We believe it will assist in making informed choices on the need for additional nitrogen and fungicide applications.

The Yield Prophet® simulations featured are not a crystal ball but provide a realistic prediction of the available soil water and nitrogen status of your crop.

Current (and historical) editions are all available online now, for free:

www.hartfieldsite.org.au

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 variety's 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.

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

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

Comparison of wheat varieties

Sarah Noack, Hart Field-Site Group

Key Findings

- The highest AH yielding (1.56 – 1.67 t/ha) varieties were Vixen, Beckom, Scout, Scepter, Cosmick, Emu Rock, Devil and Rockstar.
- Trojan, Cutlass and Sheriff CL Plus were the highest yielding APW varieties averaging 1.48 t/ha.
- Grain test weight and screening levels across all varieties averaged 78.9 kg/hL and 7.0%.

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) + Zn 2% + Impact @ 80 kg/ha
Seeding date	May 14, 2019		Easy N (42.5:0) @ 55 L/ha on Oct 7, 2019
Location	Hart, SA		

The trial was a randomised complete block design with three replicates and 21 wheat varieties. Fungicides and herbicides were applied as necessary to keep the canopy free of disease and weeds. All plots were assessed for grain yield, protein, test weight and screenings (with a 2.2 mm screen).

Results and discussion

Wheat grain yields ranged from 1.27 – 1.67 t/ha across all varieties (Table 1). Under decile one rainfall there were still a range of varieties which performed well at Hart in 2019. In general, the season favoured shorter maturing varieties. The highest AH yielding varieties were Vixen, Beckom, Scout, Scepter, Cosmick, Emu Rock, Devil and Rockstar. A number of these varieties were also present in the top ten 2019 Mid-North National Variety Trials (NVT).

Trojan, Cutlass and Sheriff CL Plus were the highest yielding APW varieties at 1.53, 1.47 and 1.44 t/ha, respectively. Long-term yield data shows Scepter, Scout, Beckom and Trojan continue to perform well at Hart over a number of seasons (Table 2).

Wheat grain protein levels were low averaging 7.8%. The trial nitrogen budget included pre-seeding available soil nitrogen (30 kg N/ha) and fertiliser applications of 40 kg N/ha (seeding and in-season). Given the low season rainfall the nitrogen budget (70 kg N/ha) set the crop up for a 1.8 – 2.0 t/ha grain yield. However, the in-season nitrogen was applied late (early October) and would not have contributed to grain protein as the soil profile was dry and the site only received 4 mm for October.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of wheat varieties at Hart in 2019.

Quality	Variety	Grain yield t/ha	% of site average	Protein %	% of site average	Test Weight kg/hL	% of site average	Screenings %	% of site average
AH	Arrow	1.36	90	7.6	97	79.7	101	4.6	65
	Beckom	1.65	110	7.9	101	80.8	102	5.7	82
	Catapult (RAC2484)	1.46	97	7.8	100	80.6	102	4.4	63
	Cobra	1.49	99	8.0	102	79.2	100	6.6	95
	Cosmick	1.58	105	7.4	94	80.7	102	8.6	123
	Devil	1.56	104	7.8	100	78.2	99	6.7	96
	Emu Rock	1.57	104	8.0	102	77.3	98	6.7	96
	Grenade CL Plus	1.40	93	8.1	103	78.2	99	6.7	96
	Havoc	1.44	96	7.7	98	78.0	99	9.2	132
	Kord CL Plus	1.37	91	7.9	100	79.0	100	14.2	203
	Mace	1.43	95	7.7	98	77.0	98	6.7	96
	Rockstar (IGW4341)	1.56	104	7.4	94	77.7	98	6.3	90
	Scepter	1.59	106	7.7	98	79.9	101	8.4	121
	Scout	1.61	107	7.8	99	77.0	98	7.1	101
	Vixen	1.67	111	7.6	97	76.5	97	6.4	92
	H1 receival standard			>13.0		>76		<5.0	
APW	Chief CL Plus	1.27	85	8.3	105	80.8	102	8.6	123
	Cutlass	1.47	98	8.3	106	81.5	103	5.9	85
	Sheriff CL Plus	1.44	96	7.8	99	79.4	101	4.2	61
	Trojan	1.53	102	8.1	104	81.6	104	4.5	65
	APW1 receival standard			>10.5		>76.0		<5.0	
ASW	Razor CL Plus	1.64	109	7.3	94	73.0	93	9.0	128
	ASW1 receival standard			NA		>76		<5.0	
Unclassified	LPB15-2485	1.47	98	8.4	107	80.1	102	5.9	84
	Site Average	1.50	100	7.8	100	78.9	100	7.0	100
	LSD (P≤0.05)	0.13		ns		2.52		1.5	

Grain test weights averaged 78.9 kg/hL across all wheat varieties. Razor CL Plus was the only variety under the minimum requirement of 76 kg/hL at 73 kg/hL. A large proportion of the varieties trialed contained screening levels higher than 5%, the maximum for Hard and APW classification.

Table 2. Long term wheat variety performance at Hart by year (expressed as % trial average).

		% of trial average					Grain yield (t/ha)
Quality	**Variety**	**2015**	**2016**	**2017**	**2018**	**2019**	**2019**
	Arrow	105	98	103	102	90	1.36
	Beckom			112	104	110	1.65
	Catapult (RAC2484)					97	1.46
	Cobra	104	105	100	96	99	1.49
	Cosmick	105	101	97	98	105	1.58
	Devil					104	1.56
	Emu Rock	100	99	98	104	104	1.57
AH	Grenade CLPlus	102	96	95	110	93	1.40
	Hatchet CLPlus	51	88	86	106		
	Havoc			97	85	96	1.44
	Kord CLPlus	97	90	97	100	91	1.37
	Mace	100	94	102	95	95	1.43
	Rockstar (IGW4341)					104	1.56
	Scepter	110	106	111	113	106	1.59
	Scout	110	103	107	107	107	1.61
	Vixen					111	1.67
	Corack	95	96	86	86		
	Chief CL Plus				87	85	1.27
	Cutlass	104	119	104	117	98	1.47
APW	DS Pascal			90	86		
	Estoc	104	108	96	100		
	Sheriff CL Plus					96	1.44
	Trojan	113	121	113	106	102	1.53
ASW	Razor CLPlus			103	104	109	1.64
Unclass	LPB15-2485					98	1.47
	Trial mean yield t/ha	**4.27**	**3.87**	**3.83**	**2.13**	**1.50**	
	Sowing date	6th May	10th May	8th May	14th May	15th May	
	Apr-Oct rain (mm)	230	356	191	160	162	
	Annual rain (mm)	353	485	331	224	189	

Acknowledgements

The Hart Field-Site Group would like to acknowledge Australian Grain Technologies (AGT), InterGrain and Pacific Seeds for providing wheat seed to complete the trial.

Comparison of barley varieties

Sarah Noack, Hart Field-Site Group

Key Findings

- Barley grain yields ranged from 2.04 – 2.42 t/ha, with a trial average of 2.25 t/ha.
- A range of feed and malt varieties performed well in a decile one rainfall season (162 mm growing season rainfall at Hart).
- Test weight, protein and screening levels across all malt varieties were good, averaging 67.9 kg/hL, 9.7% and 2.1%, respectively.

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) + Zn 2% + Impact @ 75 kg/ha
Seeding date	May 15, 2019		Easy N (42.5:0) @ 55 L/ha on Oct 7, 2019
Location	Hart, SA		

The trial was a randomised complete block design with three replicates and 15 barley varieties. Fungicides and herbicides were applied as necessary to keep the canopy free of disease and weeds. All plots were assessed for grain yield, protein, test weight, screenings (with a 2.2 mm screen) and retention (with a 2.5 mm screen).

Results and discussion

The highest yielding malt barley varieties at Hart in 2019 were LaTrobe and Compass at 2.41 and 2.38 t/ha, respectively (Table 1). RGT Planet and Spartacus CL were also high yielding along with Maximus CL (pending malt accreditation). On average both of these Clearfield varieties had a 10% yield advantage over Scope yielding 2.04 t/ha. Long-term data comparing the last five seasons (Table 2) shows Compass and LaTrobe have been above average at Hart over a number of years.

Feed variety yields ranged from 2.24 – 2.42 t/ha (Table 1). Rosalind, Fathom and Hindmarsh were the highest yielding feed varieties at Hart this season. Long-term yield data shows Fathom, Fleet and Rosalind have consistently yielded well at Hart (Table 2).

Grain protein only varied by 1.0% across all varieties ranging from 9.3 – 10.3%. All malt varieties contained protein values between 9.0 - 12.0% to achieve Malt 1 classification.

The test weights for all malt varieties were above the minimum 65 kg/hL. Spartacus CL, GrangeR and Scope had the highest test weights this season. For feed varieties Banks, Fathom, Hindmarsh and Rosalind all meet the minimum test weight (62 kg/hL) required for Feed 1 classification.

Screening levels across the trial were low, averaging 2.8%. All varieties were below the maximum level for highest classification within the feed or malt category, respectively.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL), screenings and retention (%) of barley varieties at Hart 2019.

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
Feed	Banks	2.24	99	9.8	100	71.7	107	4.3	156	41.0	61
	Fathom	2.33	104	10.0	102	63.7	95	2.5	89	71.7	106
	Fleet	2.25	100	10.3	106	61.1	91	2.3	83	70.1	104
	Hindmarsh	2.32	103	9.7	99	68.1	102	3.2	115	64.4	96
	Keel	2.28	101	9.9	101	61.9	92	5.9	213	65.7	98
	Rosalind	2.42	107	9.4	96	67.1	100	4.4	158	64.2	95
	F1 Receival Standards			NA		>62.5		<15%		NA	
Malt	Commander	2.11	93	10.0	102	65.3	97	2.2	79	82.7	123
	Compass	2.38	106	9.3	96	67.1	100	1.7	60	88.4	131
	GrangeR	2.11	93	9.7	100	69.7	104	1.7	63	63.2	94
	LaTrobe	2.41	107	9.4	97	68.9	103	2.5	89	60.8	90
	Navigator	2.10	93	10.2	105	65.1	97	1.4	52	68.2	101
	RGT Planet	2.28	101	9.6	98	67.2	100	4.5	162	52.0	77
	Scope	2.04	91	9.7	99	69.6	104	1.1	39	56.2	83
	Spartacus CL	2.25	100	9.5	98	70.7	105	1.6	56	81.7	121
	Malt 1 Receival Standards			9-12%		>65		<7%		>70%	
Pending malt accreditation	Maximus CL (IGB1705T)	2.30	102	9.7	100	69.2	103	2.4	86	79.2	118
	Site Average	**2.25**	**100**	**9.8**	**100**	**67.1**	**100**	**2.8**	**100**	**67.3**	**100**
	LSD (P≤0.001)	0.12		0.4		1.7		0.9		6.7	

Retention levels varied among the malt varieties ranging from 52.0 – 88.4%. A large number of varieties fell below 70% required for Malt 1 including; GrangeR, LaTrobe, Navigator, RGT Planet and Scope (Table 1). In contrast Commander, Compass and Spartacus CL all had high retention levels along with Maximus CL (pending malt accreditation).

Table 2. Long term barley variety performance at Hart by year (expressed as % trial average).

		% of trial average					Grain yield (t/ha)
Quality	**Variety**	**2015**	**2016**	**2017**	**2018**	**2019**	**2019**
Feed	Banks				103	99	2.24
	Fathom	112	104	94	109	104	2.33
	Fleet	107	100	104	106	100	2.25
	Hindmarsh	108	92	98	100	103	2.32
	Keel	112	97	102	105	101	2.28
	Rosalind		104	91	102	107	2.42
Malt	Commander	100	92	102	104	93	2.11
	Compass	111	86	106	105	106	2.38
	GrangeR	93	103	108	89	93	2.11
	La Trobe	107	94	104	99	107	2.41
	Navigator	92	113	111	96	93	2.10
	RGT Planet			134	97	101	2.28
	Scope	99	94	89	89	91	2.04
	Spartacus CL	106	95	98	98	100	2.25
Pending malt accreditation	Maximus CL (IGB1705T)					102	2.30
	Mean yield (t/ha)	**4.38**	**4.62**	**4.36**	**2.86**	**2.25**	
	Sowing date	6th May	10th May	8th May	14th May	15th May	
	April - Oct (mm)	230	356	191	160	162	
	Annual rainfall (mm)	353	485	331	224	189	

Acknowledgements

The Hart Field-Site Group would like to acknowledge InterGrain, Seednet, Seed Force and Heritage Seeds for providing barley seed to complete the trial.

Comparison of durum varieties

Sarah Noack, Hart Field-Site Group

Key findings

- The average grain yield for all durum varieties at Hart was 2.63 t/ha. The highest yielding varieties were Westcourt and DBS Spes at 2.81 and 2.76 t/ha, respectively
- Grain protein levels were low (trial average 9.3%).
- Screening levels in the trial averaged 7%, with Bitalli, DBA Vittaroi and Westcourt all less than 5% for DR1 classification.
- Grain test weights were generally high across all durum varieties trialed, averaging 78 kg/hL.

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) + Zn 2% + Impact @ 75 kg/ha
Seeding date	May 15, 2019		Easy N (42.5:0) @ 55 L/ha on Oct 7, 2019
Location	Hart, SA		

The trial was a randomised complete block design with three replicates and nine durum wheat varieties. Fungicides and herbicides were applied as necessary to keep the canopy free of disease and weeds. All plots were assessed for grain yield, protein, test weight and screenings (with a 2.2 mm screen).

Results and discussion

Durum grain yields ranged from 2.50 – 2.81 t/ha across all varieties (Table 1). The highest yielding varieties were Westcourt and DBS Spes at 2.81 and 2.76 t/ha, respectively. These varieties were closely followed by DBA Aurora and WID802. Looking at the long-term data there are a number of new durum varieties that have appeared at Hart for the first time in 2018 and 2019 (Table 2). For those varieties which have been trialed at Hart over multiple seasons DBA Aurora been the most consistent yielding across a number of seasons.

Grain protein levels were low in the trial ranging from 8.7 – 10.4%. Grain test weights were generally high with all varieties except WID802 meeting the requirements for DR1 classification. Screening levels were variable across the varieties trialed. Bitalli, DBA Vittaroi and Westcourt were the only varieties to fall below 5% screening for DR1 classification. The only variety to contain screening levels higher than 10% (DR3) was WID802.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) of durum wheat varieties at Hart 2019.

Variety	Grain yield t/ha	% of site average	Protien %	% of site average	Test weight kg/hL	% of site average	Screenings %	% of site average
Bitalli (AGTD088)	2.62	99	9.1	98	79.5	101	3.9	58
DBA Aurora	2.72	103	9.1	98	77.3	99	8.4	124
DBA Vittaroi	2.53	96	9.2	99	79.5	101	3.5	51
Hyperno	2.50	95	10.4	112	79.4	101	8.7	129
Saintly	2.54	97	9.4	101	79.4	101	7.4	109
DBA Spes	2.76	105	8.9	96	77.8	99	5.9	87
Westcourt (AGTD090)	2.81	107	9.6	104	80.7	103	3.7	55
WID802	2.71	103	8.7	94	74.9	95	11.5	170
UAD1154197	2.50	95	9.0	97	77.4	99	7.8	116
DR1 receival standards			*≥13.0*		*>76*		*<5%*	
Site Average	2.63	100	9.3	100	78	100	7	100
LSD (P≤0.05)	0.07		0.8		1.2		1.4	

Table 2. Durum wheat variety performance at Hart by year (expressed as % trial average).

	% of trial average					Grain yield (t/ha)
Variety	**2015**	**2016**	**2017**	**2018**	**2019**	**2019**
Bitalli (AGTD088)					99	2.62
DBA Aurora	102	102	100	102	103	2.72
DBA Vittaroi				104	96	2.53
Hyperno	98	101	96	95	95	2.50
Saintly	97	85	100	90	97	2.54
DBA Spes				102	105	2.76
Westcourt (AGTD090)					107	2.81
WID802				101	103	2.71
UAD1154197					95	2.50
Trial mean yield t/ha	**3.07**	**4.08**	**4.24**	**2.31**	**2.63**	
Sowing date	6th May	10th May	9th May	15th May	15th May	
Apr-Oct rain (mm)	230	356	191	160	162	
Annual rain (mm)	353	485	331	224	189	

Acknowledgements

The Hart Field-Site Group would like to acknowledge Australian Grain Technologies (AGT), Seednet and The University of Adelaide for providing durum seed to complete the trial.

Management of flowering time and early sown slow developing wheats

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Key Findings

- Different winter wheat varieties are required to target different optimum flowering windows.
- The best yields from winter wheats sown early are similar to Scepter sown in its optimal window.
- If sowing early use the right winter variety for the right yield and flowering environment.
- Highest yields for winter wheats come from early – late April establishment.
- Mid - slow developing spring varieties are less suited to pre – April 20 sowing.

Background

Timely operations are key to maximising farm profit, and sowing is one of the most time-critical operations. This is because there is only a short period (approximately 10 days) in spring during which crops can flower and yields can be maximised. This period is referred to as the *optimal flowering period* and its timing and length varies with location and climate. During the optimal flowering period, combined yield loss from drought, heat, frost and insufficient radiation are minimised, and yield maximised. Increasing farm sizes (and cropped area) and declining autumn rainfall have made it more challenging for growers to get crops flowering during the optimal period.

Sowing early with appropriate varieties is one management strategy to increase the amount of cropped area that flowers during the optimal period and thus farm yield can be maximised. Sowing earlier requires varieties that are slower developing to take advantage of early establishment opportunities. They are ideally sown into a moist seed bed following breaking rain or preceding a convincing forecast of enough rain to allow germination. This should not be confused with dry sowing which typically uses fast developing varieties sown into a dry seed bed that will establish when breaking rains fall.

Winter wheats for early sowing

For sowing prior to April 20, winter varieties are required, particularly in regions of high frost risk. Winter wheats will not progress to flower until their vernalisation requirement is met (cold accumulation) whereas spring varieties will flower too early when sown early. The longer vegetative period of winter varieties also opens opportunities for grazing. Winter wheat varieties allow wheat growers in the southern region to sow much earlier than currently practiced, meaning a greater proportion of farm can be sown on time.

Management of Early Sown Wheat Experiments

The aim of this series of the GRDC Management of Early Sown Wheat experiments was to determine which of the new generation winter varieties have the best yield and adaptation in different environments and what is their optimal sowing window. Prior to the start of the project in 2017 the low – medium rainfall environments had little exposure to new winter varieties, particularly at early sowing dates (mid – March). Three different experiments were conducted in the southern region in low – medium rainfall environments during 2017, 2018 and 2019, including collaboration in NSW for additional datasets presented in this paper.

Experiment 1 - Which wheat variety performs best in which environment and when should they be sown?

- Target sowing dates: March 15, April 1, April 15 and May 1 (10 mm supplementary irrigation to ensure establishment).
- Locations: SA – Minnipa, Booleroo Centre, Loxton, Hart. Vic – Mildura, Horsham, Birchip and Yarrawonga. NSW – Condobolin, Wongarbon, Wallendbeen.
- Up to ten wheat varieties – New winter wheats differ in quality classification, development speed and disease rankings (Table 1).

Table 1. Summary of winter varieties, including Wheat Australia quality classification and disease rankings based on the 2020 SA Crop Sowing Guide.

Variety	Release Year	Company	Development	Quality	Disease Rankings#			
					Stripe Rust	Leaf Rust	Stem Rust	YLS
Kittyhawk	2016	LRPB	Mid winter	AH	RMR	MS	MRMS-S	MRMS
Longsword	2017	AGT	Fast winter	Feed	RMR	MSS	MR	MRMS
Illabo	2018	AGT	Mid-fast winter	AH/APH*	RMR	S	MS	MS
DS Bennett	2018	Dow	Mid – slow winter	ASW	RMR	S	MRMS	MRMS
ADV15.9001	?	Dow	Fast winter	?	-	-	-	-
Nighthawk	2019	LRPB	Very slow spring	?	RMR	MSS	RMR	MS
Cutlass	2015	AGT	Mid spring	APW/AH*	MS	RMR	R	MSS
Trojan	2013	LRPB	Mid-fast spring	APW	MR	MRMS	MRMS	MSS
Scepter	2015	AGT	Fast spring	AH	MSS	MSS	MR	MRMS

*SNSW only

Different winter varieties are required to target different optimum flowering windows

Flowering time is a key determinant of wheat yield. Winter varieties are very stable in flowering date across a broad range of sowing dates, this has implications for variety choice as flowering time cannot be manipulated with sowing date in winter wheats like spring wheat. This means different winter varieties are required to target different optimum flowering windows. The flowering time difference between winter varieties are characterised based on their relative development speed into three broad groups fast, mid – fast, mid and slow – mid for low-medium rainfall environments (Table 1 and Figure 1).

For example, at Birchip in 2018 and 2019, each winter variety flowered within a period of 7 – 10 days across all sowing dates, whereas spring varieties were unstable and ranged in flower dates over one month apart (Figure 1). In the Birchip example, the fast – mid developing winter wheats with development speeds similar to Longsword and Illabo were best suited to flowering within the optimum period of September 10 – 20 for Birchip. In other lower yielding environments such as Loxton, Minnipa and Mildura the faster developing winter varieties ADV15.9001 and Longsword were better suited to achieve flowering times require in the first 10 days in September.

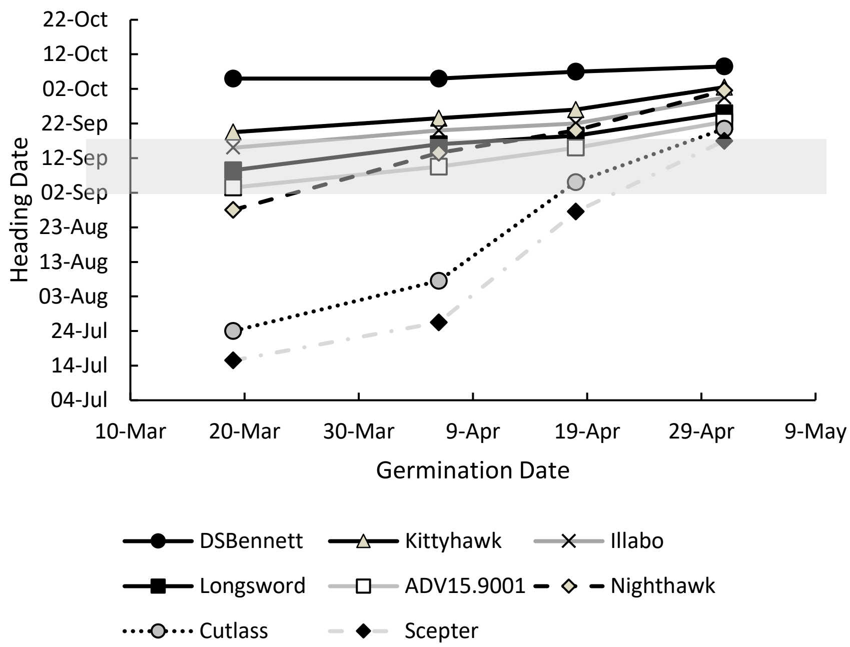

Figure 1. Average heading date responses from winter and spring varieties at Birchip in 2018 and 2019 across all sowing times, grey box indicates the optimal period for heading at Birchip.

Best yields of winter wheats sown early are similar to Scepter sown in optimal window

- Across all experiments the best performing winter wheat yielded similar to the fast developing spring variety Scepter sown at the optimal time (last few days of April or first few days of May, used as a best practice control) in 21 out of 28 sites, greater in five and less than in two environments (Figure 2).
- The best performing winter wheat yielded similar to the best performing slow developing spring variety (alternative development pattern) at 24 sites, greater at two and less than at two sites.

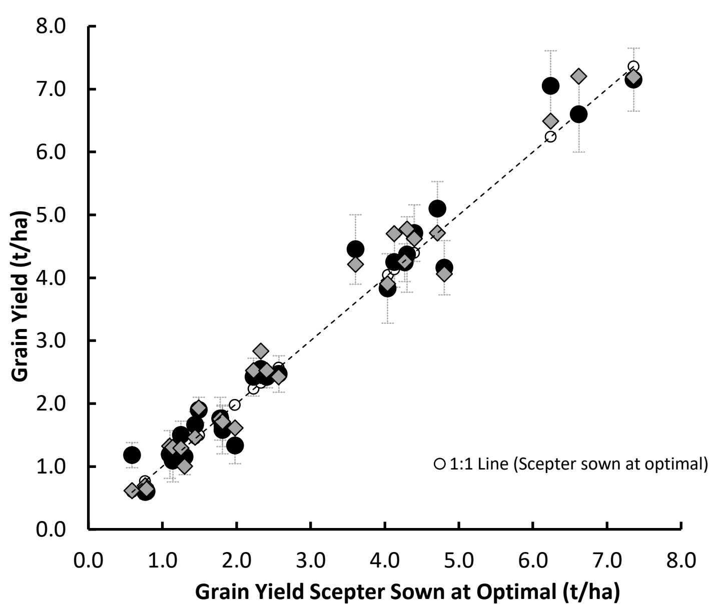

Figure 2. Grain yield performance of Scepter wheat sown at its optimal time (late April-early May) in 28 environments (2017 – 2019) compared to the performance of the best performing winter wheat. Error bars indicate LSD (P≤0.05).

Table 2. Summary of grain yield performance of the best performing winter and alternate spring variety in comparison to Scepter sown at the optimum time (late April-early May). Different letters within a site indicate significant differences in grain yield.

Site	Year	Grain yield of Scepter sown ~1 May (t/ha)		Highest yielding winter variety				Highest yielding slower spring variety			
				Grain Yield (t/ha)		Variety#	Germ Date	Grain Yield (t/ha)		Variety#	Germ Date
Yarrawonga*	2018	0.6	b	1.2	a	DS Bennett	16-Apr	0.6	b	Cutlass	16-Apr
Booleroo	2018	0.8	a	0.6	a	Longsword	4-Apr	0.7	a	Trojan	2-May
Booleroo	2019	0.8	a	0.6	a	ADV15.9001	05-Apr	0.6	a	Cutlass	01-May
Loxton	2018	1.1	a	1.2	a	Longsword	19-Mar	1.3	a	Cutlass	3-May
Loxton*	2019	1.1	a	1.1	a	ADV15.9001	15-Mar	1.3	a	Cutlass	01-May
Minnipa	2018	1.3	a	1.5	a	Longsword	3-May	1.3	a	Trojan	3-May
Mildura	2019	1.3	a	1.2	a	ADV15.9001	29-Apr	1.0	a	IGW6566	15-Apr
Mildura*	2018	1.4	b	1.7	a	DS Bennett	1-May	1.5	ab	Nighthawk	1-May
Mildura	2017	1.5	b	1.9	a	Longsword	13-Apr	1.9	a	Cutlass	28-Apr
Minnipa	2019	1.8	a	1.8	a	ADV15.9001	05-Apr	1.7	a	Cutlass	05-Apr
Horsham*	2018	1.8	a	1.6	a	DS Bennett	6-Apr	1.7	a	Trojan	2-May
Hart	2019	1.8	a	1.6	a	Illabo	05-Apr	1.7	a	Nighthawk	18-Apr
Booleroo	2017	2.0	a	1.3	b	DS Bennett	4-May	1.6	b	Cutlass	4-May
Minnipa	2017	2.2	a	2.4	a	Longsword	18-Apr	2.5	a	Cutlass	5-May
Loxton	2017	2.3	a	2.6	ab	Longsword	3-Apr	2.8	b	Nighthawk	3-Apr
Hart	2018	2.4	a	2.4	a	Illabo	17-Apr	2.5	a	Nighthawk	17-Apr
Condobolin	2018	2.6	a	2.5	a	DS Bennett	19-Apr	2.4	a	Trojan	7-May
Yarrawonga	2019	3.6	b	4.5	a	ADV15.9001	15-Mar	4.2	a	Nighthawk	05-Apr
Birchip	2018	4.0	a	3.8	a	Longsword	30-Apr	3.9	a	Trojan	30-Apr
Hart	2017	4.1	a	4.3	a	Illabo	18-Apr	4.7	b	Nighthawk	18-Apr
Yarrawonga	2017	4.3	a	4.2	a	DS Bennett	3-Apr	4.3	a	Cutlass	26-Apr
Wongarbon	2017	4.3	a	4.4	a	DS Bennett	28-Apr	4.8	a	Trojan	13-Apr
Tarlee	2018	4.4	a	4.7	a	Illabo	17-Apr	4.6	a	Nighthawk	17-Apr
Birchip	2019	4.7	a	5.1	a	DS Bennett	01-May	4.7	a	Nighthawk	01-May
Horsham	2019	4.8	a	4.2	b	Longsword	05-Apr	4.1	b	Nighthawk	05-Apr
Wallendbeen	2017	6.2	b	7.1	a	DS Bennett	28-Mar	6.5	b	Cutlass	1-May
Birchip	2017	6.6	b	6.6	b	DS Bennett	15-Apr	7.2	a	Trojan	15-Apr
Horsham	2017	7.4	a	7.2	a	DS Bennett	16-Mar	7.2	a	Trojan	28-Apr

*stem and/or reproductive frost substantially affected yield
#varieties Trojan and ADV15.9001 were not included at all sites

The best performing winter variety depends on yield environment and development speed

The best performing winter wheat varieties depended on yield environment, development speed and the severity and timing of frost (Table 2). The rules generally held that winter varieties well-adjusted to a region yielded similar to Scepter sown in its optimal window. These results demonstrate different winter wheats are required for different environments and there is genetic by yield environment interaction.

- In environments less than 2.5 t/ha the faster developing winter wheat Longsword and ADV15.9001 were generally favoured (Figure 3).
- In environments greater than 2.5 t/ha the mid – slow developing varieties were favoured; Illabo in the Mid-North of SA, and DS Bennett at the Vic and NSW sites (Figure 4).

The poor relative performance of Longsword in higher yielding environments was explained by a combination of flowering too early and having inherently greater floret sterility than other varieties irrespective of flowering date.

Sites defined by severe September frost and October rain included Yarrawonga, Mildura, and Horsham in 2018. In this scenario the slow developing variety DS Bennett was the highest yielding winter wheat and had the least amount of frost induced sterility. The late rains also favoured this variety in 2018 and mitigated some of the typical yield loss from terminal drought (i.e. Birchip 2019). Nonetheless the ability to yield well outside the optimal flowering period maybe a useful strategy for highly frost prone environments where growers want to sow early.

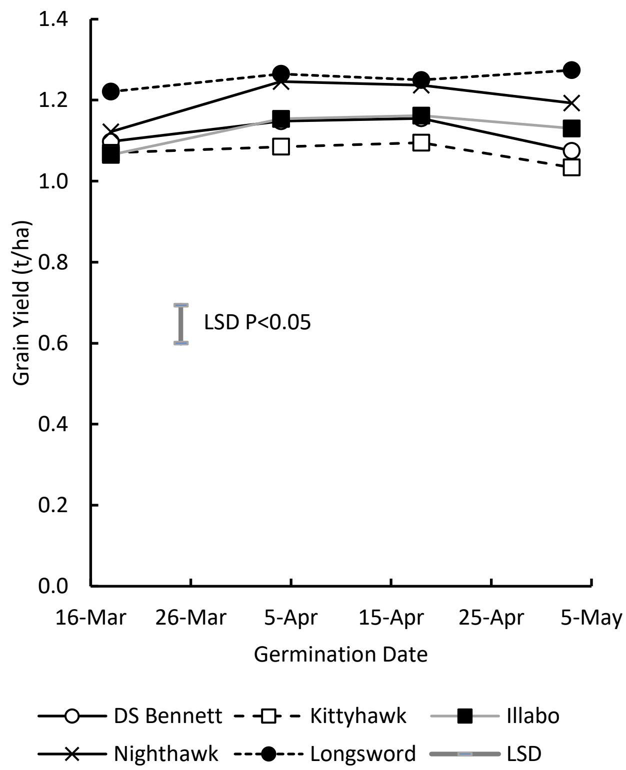

Figure 3. Average yield performance of winter wheat in yield environments less than 2.5 t/ha (n=16 sites in SA/Vic).

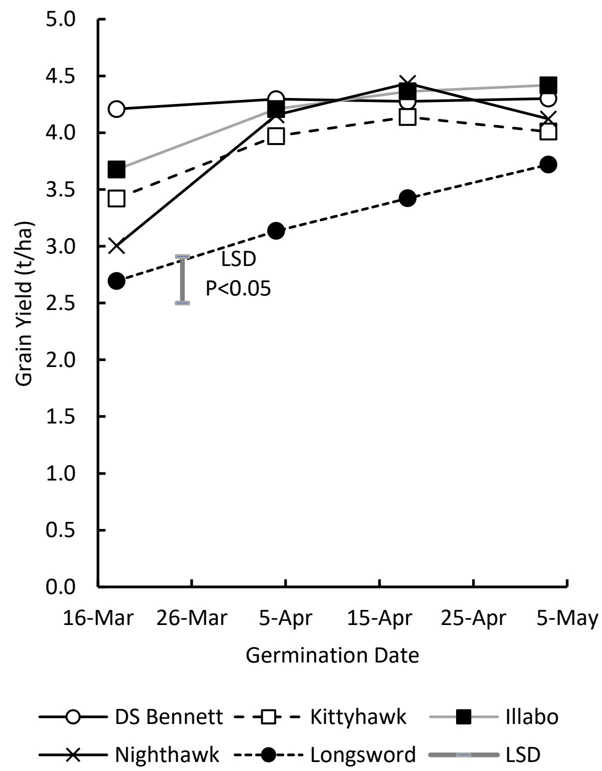

Figure 4. Average yield performance of winter wheat in yield environments greater than 2.5 t/ha (5 sites in SA/Vic).

Highest yields for winter wheats come from early – late April establishment

- Across all environments the highest yields for winter wheats generally came from early – late April establishment. The results also suggested yields may decline from sowing dates earlier than April and these dates may be too early to maximise winter wheat performance (Table 2, Figure 3 and Figure 4). The variety DS Bennett maintained yield better than all other varieties from March establishment.
- Mid – slower developing springs (i.e. Cutlass) performed best from sowing dates after April 20 and yielded less than the best performing winter varieties when sown prior to April 20. This reiterates slow developing spring varieties are not suited to pre – April 20 sowing in low – medium frost prone environments.
- The very slow developing spring Nighthawk yielded similar to the best performing winter variety in both yield environments from mid-April establishment dates.

More details on the experiment one can be found here:
http://agronomyaustraliaproceedings.org/images/sampledata/2019/2019ASA_Hunt_James_173.pdf

Conclusion

Growers in the low-medium rainfall zones of the southern region now have winter wheat varieties that can be established over the entire month of April and are capable of achieving similar yields to Scepter sown at the optimum time. However, grain quality of the best performing varieties leaves something to be desired (Longsword=feed, DS Bennett=ASW). Sowing some wheat area early allows a greater proportion of farm area to be sown on time. Growers will need to select winter wheats suited to their flowering environment (fast winter in low rainfall, mid and mid-slow winter in medium rainfall) and maximum yields are likely to come from early – mid April planting dates.

Acknowledgements

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GRDC project Management of Early Sown Wheat 9175069.

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Improving the outcomes of oaten hay in the rotation

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Key findings

- Oats can achieve similar or higher biomass than wheat (Scepter ⚘) and barley (Compass ⚘).
- Growers have access to oat varieties with similar development speeds to Compass ⚘ barley and Scepter ⚘ wheat and are likely to flower within a similar frost risk window.
- Early May sowing of oats in 2019 achieved higher total biomass and hay yield than oats sown late May/early June in three different environments.

Background

The National Hay Agronomy (NHA) trial is a new four-year project supported by AgriFutures, focusing on improving the quality of export hay in Australia. The project is being led by Georgie Troup from the Department of Primary Industries and Regional Development (DPIRD), Western Australia and includes collaborators from SARDI and Hart Field-Site Group in SA, Agriculture Victoria and Birchip Cropping Group in Victoria and Department of Primary Industries NSW.

The core agronomy component of the NHA focusses on developing updated guidelines for export oaten hay that optimise variety selection, seeding date and in-crop nutrition requirements for South Australia, Western Australia, Victoria and New South Wales. Trials commenced in 2019 and will continue for the next two seasons at Hart in the Mid-North of SA, Muresk in WA, Kalkee in Victoria, and Yanco in NSW. In these trials, we are investigating the influence and interaction between oaten hay variety, sowing date and nitrogen to provide best practice guidelines for growers to maximise both yield and hay quality.

The 2019 season was defined by spring drought, and increased frost damage in cereal crops. These seasonal conditions coupled with a strong domestic demand for fodder, highlighted the benefit of oaten hay as a risk management strategy. Additional investment from SAGIT benchmarked oaten hay varieties with the productivity of barley and bread wheat in frost prone landscapes.

Oaten Hay Varieties

Durack

Durack is a very early maturing, moderately tall, dual purpose variety. It has good lodging resistance but is susceptible to very susceptible to stem rust in SA and Victoria and has variable resistance (resistant to susceptible) to leaf rust; depending on pathotype. It has excellent grain quality with high protein levels and good hay yield. Care needs to be taken to cut at the correct growth stage to achieve highest hay quality.

Brusher

Brusher is a tall, early to mid-maturity hay variety with good hay quality and yields, commercialised by AEXCO. It has improved stem and leaf rust resistance than Wintaroo and suits low rainfall areas.

Carrolup

Carrolup is a mid-maturity, moderately tall, dual purpose variety (milling grain and hay) mainly grown in WA, with lower grain yield than milling varieties Bannister and Williams. It has similar maturity to Yallara.

Forester

Forester is a very late maturing variety, adapted to high rainfall and irrigated cropping regions. It has excellent early vigour, a good foliar disease resistance package, and good hay colour but does not resist hot dry winds as well as earlier varieties. Seed is available from AGF seed.

Koorabup

Koorabup (tested as line 05096-32) was released in 2019 and commercialised by AEXCO is a mid-tall hay variety developed for the WA market. It has improved septoria resistance compared to other current hay varieties, and good rust and bacterial blight resistance.

Mulgara

Mulgara is a tall, mid-maturity hay variety commercialised by AEXCO. It is resistant to stem nematode and has improved resistance to stem rust and bacterial blight than Wintaroo. Hay quality is similar to Wintaroo but with excellent hay colour and resist brown leaf at hay cutting.

Williams

Williams is a tall, dual purpose (milling grain and hay) variety commercialised by Heritage Seeds, released in WA but also suited to eastern Australia. It has the best septoria resistance of the milling varieties and high grain yields. Hay quality is similar to Wintaroo but yield is slightly lower than other hay varieties, and care should be taken with seeding density as its main issue is stem thickness.

Wintaroo

Wintaroo is a tall, mid-maturity hay variety with good hay yield and quality, which resists brown leaf tipping. It is susceptible to stem rust, and moderately susceptible to leaf rust. It is more prone to lodging than other hay varieties.

Yallara

Yallara is a mid-maturity, medium-tall, dual purpose (milling grain and hay) variety commercialised by Seednet. It has good hay quality and thin stems suitable for the export market. It is moderately resistant to stem rust, and resistant to leaf rust.

Kingbale

Kingbale is a tall, mid-maturity hay variety with improved tolerance to soil residues of imidazolinone herbicides. Preliminary data shows that Kingbale has a similar disease and agronomic profile to Wintaroo. The original breeding work was undertaken by Grains Innovation Australia (GIA) and is being commercialised by Intergrain, with commercial seed available in 2021 subject to 2019 field testing results, and an APVMA herbicide registration.

Methods

NHA agronomy trial

Aim: Update guidelines that optimise variety selection, seeding date and in-crop nutrition requirements for export oaten hay in South Australia

Location: Hart (as well as Kalkee-Vic, Yanco-NSW and Muresk-WA)

Varieties: Nine oat varieties (listed above, excluding Kingbale)

Management treatments:

- Two times of sowing (TOS), early May and late May / early June.
- Three nitrogen (N) rates (30 kg N/ha, 60 kg N/ha or 90 kg N/ha) for all varieties. Yallara, Mulgara and Wintaroo also had an additional three N treatments of 10 kg N/ha, 120 kg N/ha and 150 kg N/ha to ensure we were in the right ballpark for N management.
- Nitrogen treatments were split with two thirds applied at seeding, and on third applied six weeks after seeding when the plants were tillering. This split was according to current best practice for hay to achieve good early vigour, plant establishment and thin stems.
- The Hart target seeding rate was 320 plants/m^2 which equates to an average sowing rate of 165 kg/ha (ranged from 139 – 195 kg/ha).

Expansion sowing date trials

Aim: Improve productivity of oats for both grain and domestic hay in frost prone landscapes

Location: Lameroo in the Mallee (LRZ) and Tarlee in the Mid-North (HRZ)

Management treatments:

- At both sites, Carrolup was replaced with Kingbale.
- One barley (Compass) and one wheat (Scepter) variety were included for comparison.
- At all sites in SA (Lameroo, Hart and Tarlee), varieties were sown at two times, either early May (May 6, May 3 and May 1 respectively) or late May / early June (May 28, June 5 and May 31 respectively).
- At Lameroo, single N rate was used, calculated on starting soil N and expected hay yields, which equated to 45 kg N/ha at Lameroo and 80 kg N/ha at Tarlee. The targeted seeding rate at Lameroo was 240 plants/m^2 and 320 plants/m^2 for Tarlee.

Growth stage of varieties were monitored from heading, and hay cuts were taken for each plot (four rows x one metre) when the variety reached watery ripe (GS 71). Hay was cut at 15 cm height above the ground, before being dried for two days at 60°C, and hay yield determined. Hay cuts were then ground to <1mm, and hay quality determined by NIR.

Results and discussion

2019 Season

In 2019, Hart received 162 mm of growing season rainfall (GSR) from May to October, and 188 mm annual rainfall, resulting in a decile one year, and low hay yields for the season. Responses to applied N were significant but small and given this is the first year of trials, it is too early to draw conclusions based on these results. The increase in N from 30 to 60 kg N/ha increased biomass yields when sown in early May (3.0 to 3.6 t/ha), however there was no increased biomass as a result of increasing applied N above 30 kg N/ha when the crop was sown in early June. This result is not surprising as both the availability of applied N, and the plants ability to uptake applied N would have been low in 2019, due to the reduced in-season rainfall, and shortened growing season.

The 2019 season at Lameroo and Tarlee was also much drier than average, with Lameroo recording a decile three year for GSR and decile one year for annual rainfall with 196 mm GSR (218 mm annual rainfall), and Tarlee recording a decile one year with 215 mm GSR (255 mm annual rainfall).

Oat development differences

Due to the dry conditions experienced at Hart, many varieties flowered in the boot which made flowering date observations difficult. This is a problem in some varieties and is likely to influence hay quality. Cut dates were similar at Hart and Lameroo. In general, cut dates were seven to 14 days after flowering depending on the variety. Table 1 shows the dates and number of days until mid-flowering at both Lameroo and Tarlee and can be used to estimate hay cut timing.

The spread in flowering date between oat varieties with the exception of Forester was three weeks when sown early May or two weeks when sown late May. Durack was the earliest flowering oat variety, flowering and cut for hay at a similar time to Compass barley. On average Durack flowered one week before all other varieties. A number of the early-mid maturing oat varieties (Mulgara, Brusher, Williams) flowered and were cut for hay at a similar date to Scepter wheat. Forester is a very slow developing variety and did not flower under all environments. In lower rainfall areas, both the early May and late May sown Forester were cut on the same day at flowering after observing a halt in biomass growth over the previous two weeks. Forester is unlikely to be a suitable variety for the low-medium rainfall environment of SA.

Table 1. Date of mid-flowering (GS 65) and in brackets days from sowing to flowering for both sites and sowing dates.

	Lameroo		**Tarlee**	
Sowing date	*May 6*	*May 28*	*May 1*	*May 31*
Compass	Aug 28 (114)	Sep 20 (112)	Sep 1 (123)	Sep 20 (112)
Scepter	Sep 14 (131)	Sep 28 (123)	Sep 14 (136)	Sep 28 (123)
Durack	Sep 1 (118)	Sep 15 (110)	Sep 1 (123)	Sep 20 (112)
Williams	Sep 8 (125)	Sep 27 (122)	Sep 11 (133)	Sep 28 (120)
Mulgara	Sep 10 (127)	Sep 25 (120)	Sep 11 (133)	Sep 28 (120)
Brusher	Sep 11 (128)	Sep 25 (120)	Sep 9 (131)	Sep 27 (119)
Yallara	Sep 12 (129)	Sep 23 (118)	Sep 8 (130)	Sep 29 (121)
Wintaroo	Sep 12 (129)	Sep 30 (125)	Sep 20 (142)	Oct 3 (125)
Kingbale	Sep 18 (135)	Sep 30 (125)	Sep 21 (143)	Oct 3 (125)
Koorabup	Sep 19 (136)	Sep 29 (124)	Sep 20 (142)	Sep 30 (122)
Forester	Oct 22 (169)	N/A*	Oct 10 (162)	Oct 25 (147)

**Forester flowered inconsistently in some parts of the plot but a decision to cut was made for the same time as the May 6 TOS. Both Lameroo plots were cut on October 22.*

Hay biomass yields

At all three sites, hay biomass was maximised from early May sowing (Table 2). At Lameroo, Compass sown either early or late May, produced similar hay yield to the best performing early May sown oats. At Tarlee, neither Compass or Scepter could match the hay yield of the best performing oats. Although there was little variation in cutting date between most of the varieties, earlier maturing varieties (Durack, Brusher, Mulgara, Yallara), particularly at Lameroo were high yielding. At Tarlee, Mulgara and Kingbale sown in early May were the highest yielding varieties. Kingbale is a new imi-tolerant variety and yielded similar to Wintaroo at each site from early May sowing.

Table 2. Hay biomass yields (t/ha) for all SA sites. Within a site, varieties that have different letters indicate significant differences in hay yield (p≤0.05).

	Hart		Lameroo		Tarlee	
Sowing date	*May 3*	*June 5*	*May 6*	*May 28*	*May 1*	*May 31*
Compass	-	-	6.3 bcde	6.2 bcde	10.5 bcd	10.7 bc
Scepter	-	-	5.4 efgh	5.2 fgh	11.0 bc	9.4 defgh
Koorabup	3.6 b	2.4 ef	6.0 cdef	5.1 fgh	10.0 cde	8.7 fghi
Brusher	3.8 ab	2.4 ef	7.2 ab	5.4 efgh	9.9 cdef	8.5 ghi
Durack	3.7 b	2.4 e	7.3 a	5.9 defg	9.1 efg	7.9 i
Forester	1.9 g	1.1 h	5.2 fgh	4.5 h	10.2 bcde	8.2 hi
Mulgara	3.9 a	2.6 d	6.7 abcd	5.8 defg	12.3 a	10.0 cde
Williams	3.3 c	2.0 fg	6.2 cde	4.6 h	10.1 cde	8.6 ghi
Wintaroo	3.9 a	2.5 de	6.7 abcd	5.4 efgh	10.4 bcd	9.5 defg
Yallara	3.8 ab	2.6 d	7.0 abc	5.9 defg	11.0 bc	9.9 cdef
Carrolup	3.3 c	2.6 d	-	-	-	-
Kingbale	-	-	6.0 cdef	5.0 gh	11.4 ab	9.1 efgh
LSD (P≤0.05)	*0.4 (0.2 within same TOS)*		*0.9 (0.9 within same TOS)*		*1.2 (1.0 within same TOS)*	

Conclusion

This first season of trials have provided baseline data on the performance of oaten hay varieties under tough seasonal conditions. There are a number of oat varieties that will flower in a similar window to both Compass and Scepter. Most oat varieties are fast to mid-fast development speed and will flower from early May sowing within a two to three-week period in September.

At all three sites oaten hay yields were maximised from earlier sowing and were similar to those achieved with wheat and barley. There were limited differences between varieties, with the exception of Forester which was too slow in its phenology to be suitable for export oaten hay in this environment. Hay samples are still being analysed to assess the effect of sowing time and nitrogen on hay quality.

Useful resources

https://grdc.com.au/2020-south-australian-crop-sowing-guide

https://www.agric.wa.gov.au/oats/2019-oat-variety-sowing-guide-updated

http://aexco.com.au/producing-quality-oat-hay/

Acknowledgements

The National Hay Agronomy trial is a new four year project funded by AgriFutures (formerly known as RIRDC). Results from trials at Lameroo and Tarlee are also part of a three year project funded by the South Australian Grains Industry Trust (SAGIT) on improving the productivity of oats. The authors would like to thank both AgriFutures and SAGIT for their continued support.

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	May 30, 2019		

Fourteen strips of canola, pasture, linseed, vetch, chickpea, faba bean, field pea and lentils were sown. Forty-nine herbicide treatments were applied across all 14 crops at different timings.

The timings were:

Incorporated by sowing (IBS)	May 30
Post seeding pre-emergent (PSPE)	June 5
Early post emergent (3-4 node)	July 9
Post emergent (5-6 node)	August 2

Treatments were visually assessed and scored for herbicide effects approximately four to six 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

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 2019 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.

A number of new pre-emergent herbicides were included in the 2019 trial including Butisan, Devrinol C, Ultro, Reflex, Luximax and Overwatch. Majority of these treatments had no effect on crop growth compared to the nil (Table 1). Similarly, a range of post sowing pre-emergent (PSPE) herbicides 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 and has been across a number of seasons. At this timing, metribuzin was slightly more damaging to Timok vetch and Genesis090 chickpea. Thistrol Gold was a new addition to this section in 2019 and is targeted as an early post-emergent application in clover. Both Thistrol Gold and Broadstrike were safe on clover. Ecopar is also registered in pastures (and 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. At the 3-4 node application timing, the 800 mL/ha Ecopar rate resulted in slight damage (2-3 rating) to most of the legumes, but moderate damage (4 rating) in the pastures and severe (5 rating) in both lentil varieties.

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, Paradigm, Velocity, Triathlon, Quadrant, Talinor and Starane. Ecopar was safer on field peas in the last four seasons. It should also be noted that crop establishment in the pasture section (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. Linseed has been a new addition to the trial and majority of the 5-6 node treatments resulted in moderate to severe (4-5 rating) this season.

For some of the newer product entries in the 5 – 6 node section:

- 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 three leaf to flag leaf for the control of a range of broadleaf weeds. Pixxaro has resulted in good control of the legume crops in this trial over the past three years.
- Quadrant (10 g/L picolinafen, 20 g/L diflufenican, 240 g/L bromoxynil and 250 g/L MCPA) controls a range of broadleaf weeds in cereals and can be applied from the 3 leaf to late tillering crop growth stage (GS13–28).
- 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 and 2018 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 three seasons and provided excellent control of all the legume and oilseed crop types.

Table 1. Crop damage ratings for legume and oilseed herbicide tolerance trial at Hart 2019.

Number	Application Timing	Treatment	Rate (ml or kg/ha)	Canola: Nuseed Quartz	Canola: Hyola®559TT	Canola: Pioneer 44Y90	Bean: PBA Bendoc	Bean: PBA Samira	Pea: Wharton	C/pea: Genesis090	Lentil: Jumbo 2	Lentil: Hallmark	Vetch: RM4	Vetch: Timok	Linseed: Croxton	Medic: Sultan SU	Clover: Zulu II
1	IBS May 30	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
2		Trifluralin	1500 ml	1	2	2	1	1	1	1	1	1	1	1	1	1	1
3		Sakura	118 g	1	1	2	3	2	1	1	1	1	2	1	1	1	1
4		Boxer Gold	2500 mL	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5		Propyzamide	560 g	1	1	1	1	1	1	1	1	1	1	1	5	2	1
6		Butisan	1800 ml	1	1	1	3	3	2	2	1	1	3	3	1	1	1
7		Devrinol C	2000 kg	1	1	1	4	3	1	1	1	1	4	3	1	1	5
8		Ultro	1700 g	2	1	2	1	1	1	1	1	1	1	1	3	1	1
9		Reflex	1000 ml	1	1	2	1	1	1	1	1	1	1	1	2	1	2
10		Luximax	500 ml	1	1	1	1	1	3	3	2	2	2	3	3	1	1
11		Overwatch (F9600)	1250 ml	2	2	2	1	1	1	1	2	1	1	1	6	1	1
12		Terrain	180g	1	3	3	2	2	1	1	3	2	2	1	3	1	4
13	PSPE June 5	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
14		Diuron (900 g/kg)	825 g	5	6	6	1	1	1	3	3	1	2	1	3	1	6
15		Simazine (900 g/kg)	825 g	6	1	6	1	1	1	3	4	4	3	1	6	6	6
16		Metribuzin (750 g/kg)	280g	6	1	6	3	3	1	1	4	4	5	5	6	1	6
17		Terbyne (750 g/kg)	1000 g	6	1	6	1	1	1	1	4	4	3	3	6	6	6
18		Balance + Simazine	99 g + 830 g	6	6	6	6	6	6	1	6	6	6	6	6	6	6
19		Palmero TX	1000 g	6	6	6	5	6	5	1	6	6	6	6	6	6	6
20	3-4 Node July 9	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
21		Simazine (900 g/kg)	850 g	2	1	2	2	2	1	1	1	2	2	2	3	1	5
22		Metribuzin (750 g/kg)	280 g	6	1	6	5	5	1	3	1	2	3	2	4	2	6
23		Broadstrike + Wetter 1000	25 g + 0.2%	6	6	2	1	5	1	3	3	3	4	4	4	2	2
24		Thistrol Gold + Banjo	2000 mL + 0.5%	6	6	6	3	4	3	2	4	4	4	4	4	1	1
25		Brodal Options	150 mL	1	1	3	3	3	1	2	2	1	4	5	2	1	1
26		Brodal Options + MCPA Amine 750	150 mL + 100 mL	3	3	3	4	4	4	3	2	2	2	2	2	2	2
27		Spinnaker + Wetter 1000	70 g + 0.2%	6	6	2	3	3	3	2	4	1	2	2	4	1	5
28		Raptor + Wetter 1000	45 g + 0.2%	6	6	2	1	3	3	4	5	1	2	2	4	4	6
29		Ecopar + Wetter 1000	800 mL + 0.2%	6	5	6	2	2	3	4	5	5	3	2	6	4	4
30	5 - 6 node August 2	NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
31		Ally + Wetter 1000	7 g + 0.1%	6	6	1	6	6	6	6	6	6	6	5	3	4	6
32		Eclipse SC + Wetter 1000	50 mL + 0.1%	5	5	1	4	6	4	4	4	4	4	6	2	4	6
33		Atrazine + Hasten	1000 g + 1%	4	1	4	4	4	2	6	3	3	3	3	3	5	6
34		Lontrel 600	150 mL	1	1	1	6	6	5	6	6	6	6	6	3	6	6
35		Ecopar + MCPA Amine 750	400 mL + 330 mL	4	4	4	4	4	1	3	4	4	4	4	4	4	5
36		Carfentrazone + MCPA Amine 750	100 mL + 330 mL	4	4	4	4	5	4	6	4	4	3	4	4	4	6
37		Velocity + Uptake	670 mL + 0.5%	6	6	6	5	5	6	5	4	4	5	4	4	6	6
38		Talinor + Hasten	750 mL + 1 %	5	6	6	6	6	6	6	6	6	6	6	4	6	6
39		Paradigm + MCPA LVE + Uptake	25 g + 500 mL + 0.5%	6	6	6	5	6	6	6	6	6	6	6	6	6	6
40		NIL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
41		Flight EC	720 mL	6	6	6	4	5	3	4	4	4	4	5	2	5	5
42		Triathlon	1000 mL	6	6	6	4	4	5	5	4	4	2	4	3	5	6
43		Quadrant	1000 mL	6	6	6	5	5	5	5	4	4	2	5	5	5	5
44		Frequency	200 mL + 1.0%	5	6	5	4	4	5	3	2	2	3	3	5	5	6
45		Intervix + Hasten	600 mL + 0.5%	6	6	1	1	4	4	6	5	1	3	4	5	3	6
46		Starane	600 mL	1	1	1	1	1	4	6	4	4	4	4	5	3	6
47		Pixxaro + Uptake	300 mL + 0.5%	1	1	1	5	5	6	6	6	6	6	6	6	6	6
48		Rexade + Wetter 1000	100 g + 0.25%	5	6	1	4	6	6	6	6	4	6	6	5	4	6
49		Atlantis OD + Hasten	330 mL + 0.5%	6	6	1	4	6	4	4	4	2	4	5	2	4	6

Integration of time of sowing, crop seed rate and herbicides for the control of annual ryegrass and brome grass

Gurjeet Gil and Ben Fleet, The University of Adelaide

Key findings

- The response of weed density to delayed sowing is influenced not just by the weather conditions, but also by the seed dormancy attributes of the weed populations.
- At Washpool in 2019, a three-week delay in sowing had no impact on in-crop ryegrass density.
- A lower weed density after delayed sowing does not always reduce weed seed set.
- In all trials, delayed sowing in June resulted in a significant yield penalty. Therefore, a decision to delay sowing to manage weeds needs to considered very carefully.
- Higher crop seed rate on the other hand, appears to consistently improve weed suppression especially in the later sown crops.
- The results of this study clearly show that delayed sowing of wheat allows for greater seed set by ryegrass and is also associated with a large yield penalty.

Background

Constantly evolving weed infestations in Australia are responsible for significant annual expenditures ($2.5 billion) and yield revenue losses ($745 million) for grain growers (Llewellyn et al. 2016). Herbicide resistance is a major concern in the southern and western grain growing regions of Australia where 36 weed species have been confirmed resistant to one or more herbicide modes of action. Annual ryegrass has maintained its number one ranking as a weed of Australian cropping systems for many years. However, brome grass has increased in importance and has climbed to be the fourth worst weed in terms of the area infested, as well as yield and revenue loss in grain crops in Australia (Llewellyn et al. 2016).

After the loss of post-emergence (POST) herbicides used in cereals due to widespread resistance, growers now largely rely on pre-emergence (PRE) herbicides for ryegrass control. PRE herbicides, such as Sakura® and Boxer Gold®, are usually not as effective for ryegrass control as the previously used POST herbicides. Furthermore, the efficacy of the PRE herbicides tends to be strongly influenced by the soil moisture conditions at sowing and in the early weed emergence period after sowing. As the autumn-winter rainfall in southern and Western Australia has become more erratic in the last few years, the performance of the PRE herbicides has also become quite variable. Therefore, many cereal crops sprayed with PRE herbicides in dry starts to the season can be quite weedy, which means greater crop yield loss and weed seed set for future infestations.

Previous research has shown the benefits of higher wheat seed rates for the suppression of ryegrass (e.g. Lemerle et al. 2004), which can be easily integrated with herbicide tactics. Delay in crop sowing can be used to manage dense weed infestations by exposing a greater proportion of the weed seedbank to pre-sowing weed control tactics. However, delayed sowing is often associated with lower crop yields, especially in the low to medium rainfall environments. Gill and Kleemann (2013) have also shown that brome grass populations from cropping fields in the Mid-North of South Australia and Victorian Mallee regions can have significantly longer dormancy than those from non-cropped habitats.

Similar patterns of selection for increased seed dormancy have also been observed in ryegrass populations from WA under high cropping intensity (Owen et al. 2015). This adaptation mechanism facilitates avoidance of pre-sowing weed control practices.

In this GRDC funded project, research is being undertaken to investigate the effects of integrating crop sowing time, seed rate and herbicide tactics on ryegrass and brome grass management. Three case studies are presented here to highlight the impact of these management tactics on weed control.

How was it done?

Replicated field trials were undertaken in South Australia in 2018 and 2019 to investigate ryegrass and brome grass management in cereals.

Table 1. Management information on weed control trials.

Detail	Washpool 2019	Minnipa 2018	Marrabel 2018
Weed species	Ryegrass	Ryegrass	Brome grass
Crop (variety)	Wheat (Scepter)	Wheat (Scepter)	Barley (Spartacus CL)
Sowing date	TOS 1: May 15, 2019 TOS 2: June 5, 2019	TOS 1: May 11, 2018 TOS 2: June 25, 2018	TOS 1: May 24, 2018 TOS 2: June 19, 2018
Crop seed rate	100, 150 or 200 seeds/m^2	100, 150 or 200 seeds/m^2	100, 150 or 200 seeds/m^2
Herbicides	1. Control (knockdown only) 2. Boxer Gold® 2.5L/ha IBS 3. Sakura® 118g/ha + Avadex® 1.6 L/ha IBS	1. Control (knockdown only) 2. Boxer Gold® 2.5L/ha IBS 3. Sakura® 118 g/ha+ Avadex® 1.6L/ha IBS	1. Control (knockdown only) 2. Treflan® 2L/ha + Avadex® 2L/ha IBS 3. Treflan® 2L/ha + Avadex® 2L/ha IBS Fb Intervix® 750mL/ha at GS14
Growing season rainfall (mm)	229	186	195

Active ingredients: Boxer Gold = prosulfocarb + s-metolachlor; Sakura = pyroxasulfone; Avadex = triallate; Treflan = trifluralin; Intervix = imazamox plus imazapyr

Results and Discussion

Case study 1: ryegrass management Washpool (Spalding) 2019

There was no evidence at this site of any reduction in ryegrass infestation in wheat by delaying sowing by three weeks between TOS 1 (77 plants/m^2) and TOS 2 (74 plants/m^2). In 2019, the trial site only received 22.6 mm rain during the three weeks between TOS 1 and 2. Dry surface soil conditions during the delay in sowing may have been responsible for the lack of response in ryegrass plant density observed at this site. Weed populations are also known to differ greatly in seed dormancy. It is quite likely that the Washpool population has a high level of seed dormancy, which reduces the rate of ryegrass germination after the season opening rainfall events.

Wheat was much more competitive against ryegrass when it was sown early (TOS 1; Figure 1a). Even in the control (knockdown only), ryegrass head number was significantly lower in TOS 1 than in TOS 2. This trend of superior crop competitive ability against ryegrass was also evident in Boxer Gold® and Sakura® + Avadex® treatments. In-crop ryegrass density was quite similar between TOS 1 and 2; moreover, it can be argued that on a per plant basis, ryegrass was much more competitive against wheat sown under cold conditions of TOS 2 than warmer conditions conducive for the early crop vigour in TOS 1.

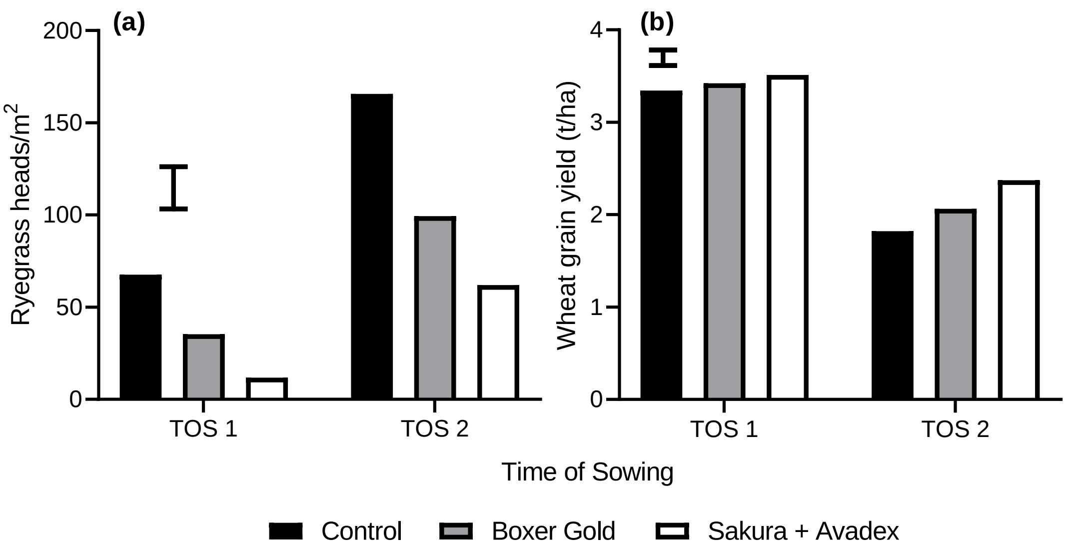

Figure 1. The effect of time of sowing and herbicide treatments on ryegrass head density (a) and wheat grain yield (b) at Washpool in 2019. The error bars represent LSD (P=0.05).

Wheat grain yield at this site was significantly influenced by the time of sowing, seed rate, herbicide treatments, and the interaction between the time of sowing and herbicides (Figure 1b). Wheat was much more tolerant to ryegrass competition when sown early (TOS 1); indeed, there was a small increase in grain yield in herbicide treated plots, but the differences were non-significant. In contrast, there was a significant increase in wheat grain yield in herbicide treatments in TOS 2. The yield gap between TOS 1 and TOS 2 in herbicide treatments ranged from 45% in the control to 40% in Boxer Gold® and 32% in Sakura® + Avadex®. The yield gap between the two sowing dates ranged from 1.14 to 1.52t /ha. The results of this study clearly show that delayed sowing of wheat allows for greater seed set by ryegrass and is also associated with a large yield penalty.

Case study 2: ryegrass management Minnipa 2018

A six week delay in sowing reduced dense establishment of ryegrass in wheat at this site (Figure 2a). This was particularly evident in the untreated control (Figure 2a), as weed density decreased from 262 plants/m^2 (TOS 1) to 139 plants/m^2 (TOS 2). The ryegrass population at Minnipa appears to have low seed dormancy, which allowed it to germinate and establish in response to many small rainfall events in June. Delayed sowing also created a synergistic interaction between the more favourable soil moisture conditions and the reduction in ryegrass density by the knockdown treatment, which collectively improved the efficacy of herbicide treatments in TOS 2 (Figure 2a).

Ryegrass seed production was significantly affected by the time of sowing, herbicide treatments and the interaction between the TOS and the herbicide treatments. PRE herbicides performed much better in TOS 2. (Figure 2b). Sakura® + Avadex® was the most effective herbicide treatment across both times of sowing; however, coupling this treatment with delayed sowing provided a 94% reduction in ryegrass seed set in TOS 2 (53 seeds/m^2). In contrast, seed production exceeded 800 seeds/m^2 for all herbicide treatments in TOS 1. This highlights the value of the knockdown treatment alone, as there was a 53% reduction in seed production with delayed sowing. Boxer Gold® efficacy also exhibited greater response to delayed sowing than Sakura® + Avadex®, with seed production ranging from 35% (TOS1) to 9% (TOS 2) of the control. Sakura® + Avadex® offered greater stability in preventing ryegrass seed production in TOS 1 (13%) and TOS 2 (2%) relative to the control.

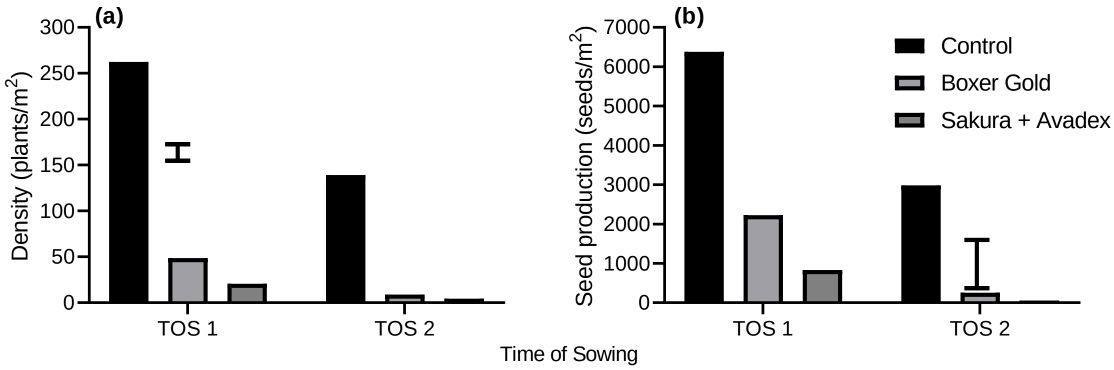

Figure 2. The effect of time of sowing wheat and herbicide treatments on in-crop ryegrass plant density (a) and its seed production (b) at Minnipa in 2018. The error bars represent LSD (P=0.05).

Wheat grain yield at Minnipa was significantly influenced by the time of sowing, seed rate, herbicide treatment, and the interaction between the time of sowing and herbicide treatments. Averaged across the seed rates and herbicide treatments, wheat produced grain yield of 1.67 t/ha in TOS 1, as compared to 1.06 t/ha in TOS 2. Even though the amount of rainfall received in May and June was well below the long-term average, a six-week delay in sowing reduced wheat yield by 36%. Wheat yield increased as seed rate increased from low (1.25 t/ha), to medium (1.41 t/ha) and high (1.44 t/ha). Even though the increase in wheat yield in response to seed rate was only 13%, it was statistically significant. There was no negative effect of crop seed rate on grain screening content, which ranged from 4% in low seed rate, to 3% in the medium and high seed rate treatments.

There were large benefits of delayed sowing on weed control by herbicides in terms of ryegrass plant density, head density and seed production. However, these benefits came at a significant cost in wheat grain yield (Figure 3). Wheat grain yield was reduced in all the herbicide treatments due to delayed sowing. Wheat benefited much more from herbicide treatments in TOS 1, where ryegrass density was much greater than in TOS 2. Therefore, it would not be advisable to delay sowing wheat to manage ryegrass unless weed seedbanks are excessively large. It would be preferable to target the optimum sowing date for wheat in the region and use the most effective herbicide options available to control ryegrass. Based on grain yields achieved and APW prices in 2018, TOS 1 treated with Boxer Gold® provided $291/ha greater gross margin than TOS 2 treated with the same herbicide. The superior levels of ryegrass control achieved by the Sakura® + Avadex® treatment with delayed sowing translated to a $9/ha advantage in gross margin over applying Boxer Gold®.

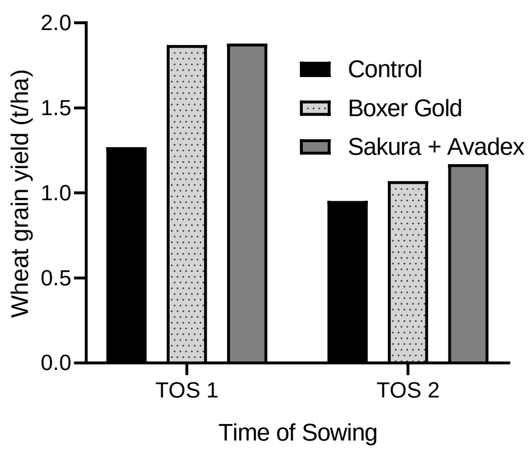

Figure 3. The effect of time of sowing wheat and herbicide treatments on wheat grain yield at Minnipa in 2018.

Case study 3: brome grass management Marrabel 2018

Brome grass plant density was significantly affected by the time of sowing and the herbicide treatments. The four week interval between TOS 1 and TOS 2 extended the opportunity for brome grass seedlings to emerge before sowing. Consequently, barley sown at TOS 2 had 48% lower brome grass infestation (108 plants/m^2) than in TOS 1 (207plants/m^2). As expected, herbicide treatments had a significant effect on brome grass plant density. When averaged across the sowing time and seed rates, the treatment of Treflan® + Avadex® was moderately effective and reduced brome grass density by only 36% (173 plants/m^2) relative to the untreated control (271 plants/m^2). In contrast, the same PRE treatment (Treflan® + Avadex®) followed by Intervix® reduced brome grass density by 90% (28 plants/m^2).

There was a significant interaction between the time of sowing and herbicide treatments. This interaction appears to be mainly associated with improved activity of Treflan® + Avadex® in TOS 2 compared to TOS 1 (Figure 4a). In TOS 2, there was 32.4 mm rainfall during the week before crop sowing, which would have created a moist seedbed and suitable conditions for the activity of trifluralin and Avadex®. In contrast, the total rainfall for the week before and week after sowing for TOS 1 was only 8.8 mm.

Brome grass seed production was significantly affected by the herbicide treatment and the interaction between sowing time and herbicide treatment. The interaction between these two management factors was almost entirely due to significantly lower brome grass seed production in the untreated control in TOS 1 than in TOS 2 (Figure 4b). This result appears to be associated with the lower head density in the control plots in TOS 1 than TOS 2. Delayed sowing reduced the competitiveness of barley with brome grass because the crop emerged under cool conditions in mid-June. Imidazolinone herbicide Intervix® was extremely effective and completely prevented brome grass seed production in this trial. The cheaper herbicide option of Treflan® + Avadex® was weak against brome grass, which was reflected by much higher seed production in TOS 1 (6258 seeds/m^2) than in TOS 2 (5667 seeds/m^2).

Time of sowing barley had a significant effect on its grain yield; TOS 1 produced 940 kg/ha greater barley grain yield than TOS 2. Barley sown in May (TOS 1) was growing in a warmer soil, whereas TOS 2 experienced lower establishment and cooler conditions during early growth. Therefore, barley showed a small response to increased seed rate in TOS 1, but there was a significant increase in yield with seed rate in TOS 2. Herbicide treatment had a large effect on crop yield (Figure 5), which was reflected in a significant increase in grain yield by the herbicide treatments compared to the untreated control. The POST application of Intervix® to the crop treated with Treflan® + Avadex® further increased barley grain yield by 872 kg/ha. Even though there were more brome plants present in all the treatments in TOS 1, barley was able to compete with them effectively and produced consistently higher yields in the early sown crop. Furthermore, when no PRE herbicides were used (control), brome grass produced significantly greater number of seeds in TOS 2 (10048 seeds/m^2) than in TOS 1 (6754 seeds/m^2). This result highlights the superior crop competitiveness of early sown barley.

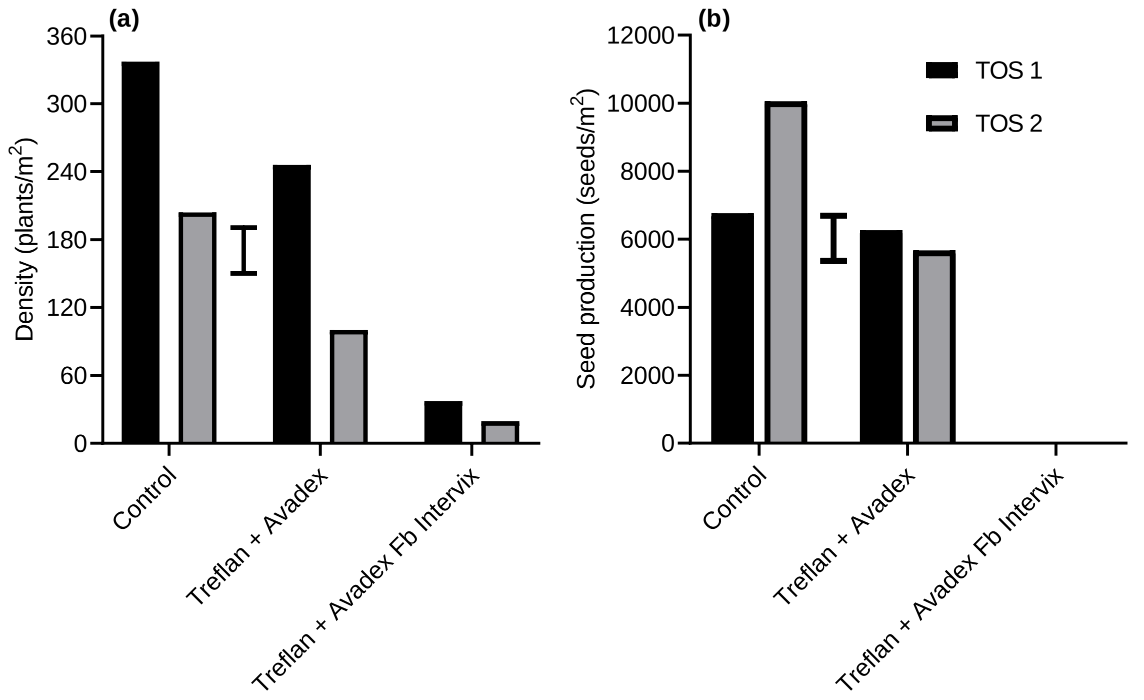

Figure 4. The effect of sowing time and herbicide treatments on brome grass plant density (a) and brome grass seed production (b) at Marrabel in 2018. The error bars represent LSD (P=0.05).

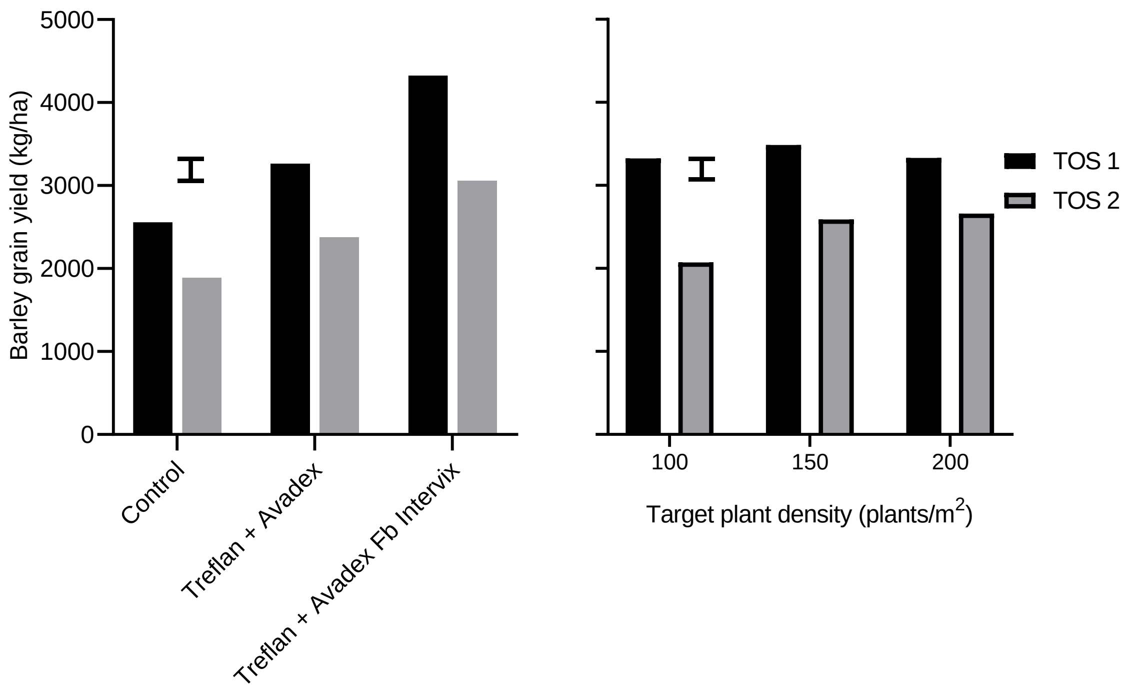

Figure 5. The effect of sowing time and herbicide treatments on barley grain yield (a) and sowing time x seed rates on barley grain yield (b) at Marrabel in 2018. The error bars represent LSD (P=0.05).

Conclusion

Field trial results from Washpool in 2019 showed no reduction in ryegrass in-crop density from the three-week delay in sowing wheat. Furthermore, delayed sowing reduced the competitive ability of wheat, which was reflected in greater ryegrass head numbers in TOS 2 than in TOS 1. Greater head density in weeds is invariably associated with increased seed production. Ryegrass also caused a greater yield loss in wheat in TOS 2 than in TOS 1, which can be seen by the difference between the control and herbicide treatments. Even more importantly, there was a large yield penalty from delayed sowing of 1t/ha due to reduced utilisation of resources, such as water, light and nutrients.

At Minnipa in 2018, delay in sowing of wheat was able to reduce in-crop ryegrass density and its seed production, but it was again associated with a significant yield penalty (25-43%). In the brome grass management trial at Marrabel in 2018, delayed sowing caused a large reduction in brome grass plant density in barley; however, surviving brome plants were more vigorous in TOS 2 and compensated for reduced plant density. The application of POST Intervix® after the PRE herbicide treatment completely prevented weed seed set in TOS 1 and TOS 2. Consistent with the other two trials, delay in barley seeding to improve weed control reduced barley grain yield by 26-29%. Increasing the density of wheat and barley improved the tolerance of these crops to competition from brome grass and ryegrass without negatively impacting on grain quality at all sites.

Growers should carefully consider the emergence patterns of field populations of brome grass and ryegrass, as this will have overarching implications to the both the efficacy of the PRE herbicides, and the water limited yield potential from delayed sowing.

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Acknowledgements

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Hart 2019

Chickpea fungicide evaluation for ascochyta blight – a study across three seasons

Jade Rose and Sarah Noack, Hart Field-Site Group

Key findings

- Growers and advisors should be vigilant in applying protective fungicide sprays in chickpea crops for ascochyta blight.
- Many current and minor use permit fungicides trialed at Hart in 2019 provided good preventative control (less than 10% of plants infected) for ascochyta blight including chlorothalonil, Aviator Xpro® and Cabrio ®.

Why do the trial?

Ascochyta blight (AB) is a foliar fungal disease in chickpeas. The disease can cause severe yield loss and reduce grain quality and therefore its marketability and value. The disease can be spread by seed and survive in stubble. Spores produced by the pathogen can be carried via wind or transferred by rain-splash during wet weather.

In 2018 severe infection of ascochyta was observed in various Genesis090 and PBA Monarch chickpea crops in SA such as the upper Yorke Peninsula and the lower north region. In 2019, ongoing reports of infection in Genesis090 crops along with volunteer plants were reported from these regions. Currently, all commercial chickpea varieties are rated moderately susceptible (MS) or susceptible (S). A number of fungicides still require permits to be used. See Pulse Australia for further details on minor use permits: http://pulseaus.com.au/growing-pulses/bmp/chickpea/2018-season-fungicide-guide.

To reduce infection and spread of disease, thiram based seed dressing is essential. Growers should plan for multiple (3 – 4) foliar fungicide applications ahead of rain events for all varieties. This study evaluated the effectiveness of current and new fungicides over three consecutive years in reducing AB infection and maintaining quality and grain yield in chickpeas.

How was it done?

Plot size	1.75 m x 10.0 m		
Seeding date	May 9, 2017	**Fertiliser**	MAP @ 75 kg/ha at seeding
	May 25, 2018		MAP @ 75 kg/ha at seeding
	May 16, 2019		MAP @ 80 kg/ha at seeding
Location	Hart, SA		

From 2017-2019, experimental field trials were conducted at Hart. The trials were randomised complete block design, replicated three times at each site. The trial looked at fungicide options in Monarch (2017) and Genesis090 (2018, 2019) chickpeas. These varieties were selected due to their AB ratings of moderately susceptible to susceptible and that they are commonly grown in South Australia. Infected chickpea stubble was spread uniformly across the trial area, post sowing, to increase the incidence of infection.

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

Chickpea (three sprays):

- Mid-vegetative
- Early flowering
- Podding
- Control = fortnightly sprays of chlorothalonil

A number of fungicide products with varying active ingredients and groups were trialed (Table 1). Chlorothalonil applications consisted of up to nine fortnightly sprays (2017, 2018, and 2019) from the period of June to early September.

Table 1. Fungicides trialed at Hart in 2017 - 2019.

Product name example	Active ingredient	Fungicide group
Aviator XPro®	Prothioconazole and bixafen	Group 3
Cabrio®	Pyraclostrobin	Group 11
CC Barrack ®	Chlorothalonil	Group M
Captan® 900	Phthalimide	Group M4
Veritas®	Tebuconazole and azoxystrobin	Group 3 and 11

In each season all plots were assessed for AB infection (either as % plant infection or reported as % plant infection and stem infection of 5 plants per plot). At harvest all plots were assessed for grain yield.

Results and discussion

Ascochyta blight in chickpeas

After a dry beginning to the 2019 season, AB was observed in the chickpea trial at Hart during late July. The highest level of infection was observed in untreated plots (Table 2) at 34.3% of all plants infected, along with 9.67% of all stems infected. This high infection rate was similar to both 2017 and 2018 in untreated control plots.

Across three seasons fungicide treatments decreased the level of infection in all plots compared to the untreated control. The fungicide treatments that provided the best control (<10% of plants infected) was fortnightly sprays of chlorothalonil (0% infection), followed by three sprays of Aviator XPro® or Cabrio®.

In terms of grain yield, 2017 was the only season where fungicide application increase grain yield with a trial average yield of 1.80 t/ha. Considering production costs, plant infection and grain yield, the treatments which provided best net return in 2017 (Table 3) were Aviator XPro® (treatment cost $33/ha), Cabrio® ($53/ha) and Veritas® ($25/ha).

Photo 1. Chickpea infected with ascochyta blight, taken October 3, 2018.

Grain yields were low in both 2018 (trial average 0.24 t/ha) and 2019 (0.65 t/ha) and made it hard to evaluate the benefit of fungicide application. The dry seasons reduced the spread of AB and the need for fungicide application (Table 3). Individual fungicide efficacy may differ in wetter, longer seasons as rainfall determines the spread of AB.

Table 2. Chickpea ascochyta blight infection measured as % of leaf (and stem 2019 only) infected.

Fungicide treatment	AB infection %			
	2017	2018	2019	
	leaf	leaf	leaf	stem
Untreated control	36.7	35.0	34.3	9.7
PPT + Aviator XPro® @ 600 mL/ha	6.7	18.3	3.0	1.3
PPT + Cabrio® @ 400 mL/ha	5.0	16.7	3.5	2.2
PPT + Fortnightly chlorothalonil @ 1 L	2.3	13.3	0.0	0.0
PPT + Captan® 900 @ 1.1kg	16.7	18.3	18.3	5.5
PPT + Veritas® @ 1 L	13.3	20	8.5	3.2
LSD fungicide (P≤0.05)	8.5	12.2	10.9	3.8

Table 3. Grain yield (t/ha) from fungicide treatments trialed at Hart, 2019.Cost of fungicide application based on seed treatment + three fungicide applications in season.

Year	*Fungicide treatment*	*Grain yield t/ha*	*Cost of fungicide $/ha**	*Net return $/ha***
2017	Untreated control	1.31	0	602
	PPT + Aviator XPro® @ 600 mL/ha	1.94	33	1042
	PPT + Cabrio® @ 400 mL/ha	1.97	53	1044
GSR: 191mm	PPT + Fortnightly chlorothalonil @ 1 L	2.03	198	944
	PPT + Captan® 900 @ 1.1kg	1.76	16	924
	PPT + Veritas® @ 1 L	1.81	25	952
	LSD(P≤0.05)	0.26		
2018	Untreated control	0.18	0	-245
	PPT + Aviator XPro® @ 600 mL/ha	0.28	33	-202
	PPT + Cabrio® @ 400 mL/ha	0.28	53	-223
GSR: 160 mm	PPT + Fortnightly chlorothalonil @ 1 L	0.29	198	-360
	PPT + Captan® 900 @ 1.1kg	0.19	16	-253
	PPT + Veritas® @ 1 L	0.20	25	-255
	LSD(P≤0.05)	ns		
2019	Untreated control	0.74	0	175
	PPT + Aviator XPro® @ 600 mL/ha	0.69	33	105
	PPT + Cabrio® @ 400 mL/ha	0.66	53	61
GSR: 162 mm	PPT + Fortnightly chlorothalonil @ 1 L	0.59	198	-135
	PPT + Captan® 900 @ 1.1kg	0.62	16	69
	PPT + Veritas® @ 1 L	0.62	25	60
	LSD(P≤0.05)	ns		

Fortnightly sprays = nine applications from late June to early September
*Cost of fungicides based on 2019 prices
**Net return based on production costs of $380 + fungicide application and returns on grain of $750/t (Farm Gross Margin Guide 2019)

Summary / implications

Effective disease management is paramount to maximising the yield and quality of chickpeas. To minimise disease pressure and reduce losses, applying a suitable fungicide early in the season and prior to canopy closure is important. This study highlights the efficacy of a number of fungicides available for the prevention of ascochyta blight, however it is important to stay up to date of new fungicide actives that are released. Current fungicides useful to preventing ascochyta blight are chlorothalonil, Aviator Xpro® and Cabrio®. The use of fungicides is season dependent, therefore staying up to date with current advice is important.

A number of management options should be used to reduce the risk of ascochyta blight infection such as crop rotation, variety selection, and paddock selection, regular crop monitoring and strict hygiene on and off farm.

Acknowledgements

The Hart Field-Site Group would like to thank researchers Jenny Davidson and Sara Blake (SARDI) for their assistance with fungicide treatment selection and trial methodology.

Photo: Jade Rose, Hart and Sara Blake, SARDI prepare to discuss 'Pulse Disease Management' with farmers at the 2019 Hart Field Day.

Field pea canopy management in the Mid-North

Jade Rose[1], Sarah Day[2] and Penny Roberts[2]
[1]Hart Field-Site Group, [2]South Australian Research and Development Institute

Key findings

- Variety mixtures have the potential to improve the ability of field pea crops to suppress and compete with weeds, maintain yields and reduce airborne disease spread.
- Canopy structure was successfully manipulated using mixtures of field pea varieties.
- Incorporating 75% PBA Oura + 25% PBA Percy reduced lodging at both sites compared to 100% PBA Percy.
- Grain yield was not affected by mixing varieties and yielded similarly to varieties sown alone.

Why do the trial?

Lodging in field peas is still an issue despite breeding advances in newer varieties to improve harvestability. Ascochyta blight (commonly known as blackspot) also remains an issue for field pea management. Currently there are no resistant field pea varieties commercially available for growers. Management options for blackspot include fungicide sprays, hygiene, and crop rotation. Breeding resistance into varieties is a slow process due to the complex nature of resistance and low investment in this area. There is a need for improved management tools to reduce yield losses from lodging and blackspot.

Individual field pea varieties have different characteristices (e.g. plant height, growth habit and lodging resistance) and a mixture of varieties at seeding may improve the harvestability while maintaining grain yield. In South Australia both conventional and semi-leafless field pea varieties are grown (Figure 1). Conventional field pea varieties have many leaflets on the tendrils (e.g. PBA Percy) and are known for their weed suppression, and yield stability. Semi-leafless field pea varieties have fewer leaflets and more tendrils (e.g. PBA Wharton). They are known for their high yield potential in the absence of weeds, and lodging resistance due to lower biomass production.


Figure 1. (L-R) PBA Wharton (semi-leafless) and PBA Percy (conventional). Photo source: Pulse Breeding Australia.

The aim of these trials was to utilise field pea variety mixtures to open up the crop canopy, reduce blackspot disease spread and lodging and maintain grain yield. A second component to the Hart trials investigated if variety mixtures with differing disease resistance levels could help manage blackspot in terms of reducing fungicide inputs.

How was it done?

Location: Hart

Plot size	2.0 m x 10.0 m	**Fertiliser**	MAP 80 kg/ha at seeding
Seeding date	May 16, 2019		

Location: Willowie (Annual rainfall: 156 mm, growing season: 126 mm)

Plot size	2.0 m x 10.0 m	**Fertiliser**	MAP 75 kg/ha at seeding
Seeding date	May 16, 2019		

This season at Hart and Willowie, field pea varieties were sown alone and mixed in different seeding rate combinations. The trial was a randomised complete block design with four replicates and included PBA Oura, PBA Percy, PBA Wharton, a breeding line (Hart) and Parafield (Willowie) (Table 1). Variety mixes included a conventional with a semi-leafless variety mix for a 'Kaspa type' field pea and a conventional with a semi-leafless variety for a 'dun type' field pea. The addition of canola was used in some treatments to assess if field pea varieties would use the canola as a trellis. The Hart and Willowie trials were both sown on May 16, targeting a plant population of 45 plants per m^2 for conventional field pea and 55 plants per m^2 for semi-leafless field pea. All seed was treated with P-Pickle T.

This trial was naturally infected with blackspot from adjacent blackspot trials. Throughout the season, fortnightly fungicide sprays were applied to half the trial (Hart only) in order to assess the level of disease infection in different field pea canopy structures. These sprays commenced on June 5, before blackspot infection had occurred. A number of measurements were taken for both sites in-season, such as plant establishment counts, lodging, normalised difference vegetation index (NDVI), grain yield, and disease scores as per Banninza et al. 2005.

Table 1. Field pea variety combinations (treatments) at Hart and Willowie, 2019. C = conventional, SL = semi-leafless

Treatments	
1	50% PBA Oura (SL) + 50% PBA Percy (C)
2	25% PBA Oura (SL) + 75% PBA Percy (C)
3	75% PBA Oura (SL) + 25% PBA Percy (C)
4	100% PBA Oura (SL)
5	100% PBA Percy (C)
6	50% PBA Wharton (SL) + 50% breeding line (C)
7	25% PBA Wharton (SL) + 75% breeding line (C)
8	75% PBA Wharton (SL) + 25% breeding line (C)
9	100% PBA Wharton (SL)
10	100% breeding line (C)
11	PBA Percy (C) + canola x2
12	PBA Oura (SL) + canola x2

Results and discussion

Manipulating field pea canopy

Plant establishment counts showed the trial achieved the target seeding rates and mixtures in most treatments (data not shown). However, due to poor establishment the canola was below the target seeding plant.

Using a Green Seeker, normalised difference vegetation index (NDVI) results showed differences between variety mixtures at a number of growth stages. On June 24, 100% PBA Percy (C) had higher vigour compared to 100% PBA Oura (SL). This was not surprising given conventional varieties produce more biomass. However, by August 20 (Figure 2), growth was the same for both PBA Percy (C) and PBA Oura (SL). By late August, 100% PBA Wharton had better canopy structure (higher NDVI) and ground cover compared to the 100% breeding line. It should be noted that a low to medium NDVI could beneficial for reducing disease spread, as these treatments may have less biomass and a more open canopy.

The Willowie site (data not shown) had similar results on the same sampling dates, where 100% Percy had higher NDVI values than all mixtures except 50% PBA Oura + 50% PBA Percy on June 26. On this date, the 75% PBA Oura + 25% PBA Percy mix also had higher NDVI than all PBA Wharton/Parafield mixtures.

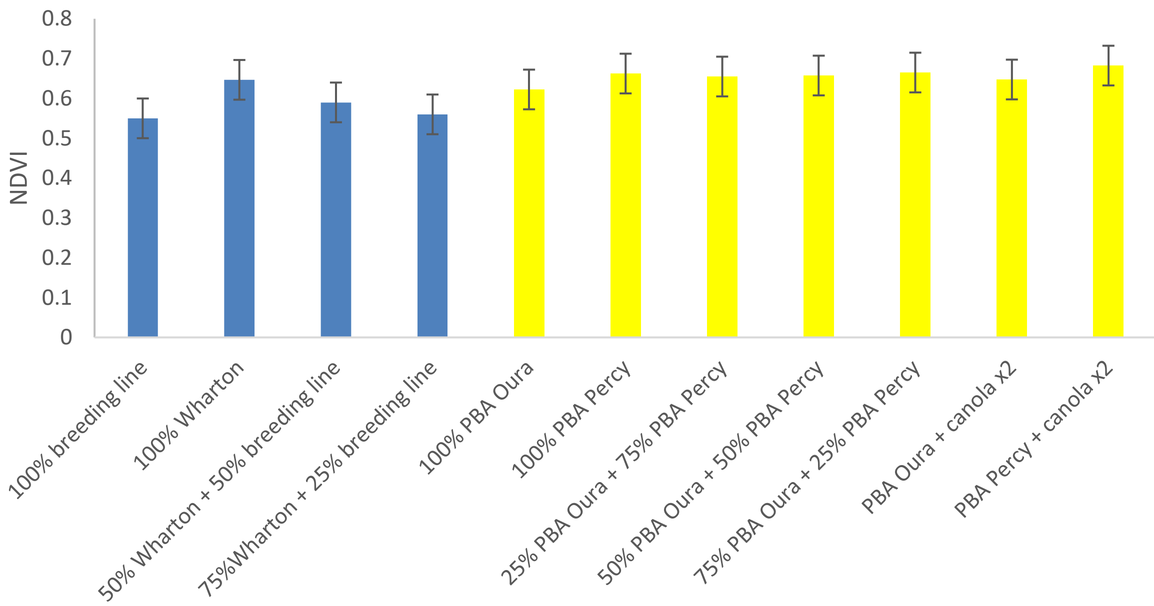

Figure 2. Field pea variety mixtures (Hart) with corresponding NDVI values on 20/8/19 (LSD=0.049 at P≤0.001). Error bars represent least significant difference.
Blue bars = 'Kaspa type' field pea. Yellow bars = 'dun type' field pea.

Lodging data showed 100% PBA Percy lodged more than 100% PBA Oura at Hart (Figure 3). However, the addition of canola had no effect on lodging due to poor establishment and therefore the field pea could not trellis up the canola. Incorporating a mix of 75% PBA Oura + 25% PBA Percy reduced lodging compared to 100% PBA Percy, and a 25% PBA Oura + 75% PBA Percy mix. A 50% PBA Percy + 50% PBA Oura had no reduction in lodging compared to 100% Percy. No differences were observed in treatments including the conventional breeding line, however increasing the breeding line to 75% and decreasing Wharton (SL) to 25%, increased lodging. Ascochyta blight severity can increase as the degree of lodging increases, therefore a reduction in lodging is desired (Banninza et al. 2005).

At the Willowie site, results showed 100% PBA Percy had higher lodging compared to 100% Oura. A mixture of 50% PBA Oura + 50% PBA Percy reduced lodging compared to 100% PBA Percy (data not shown). Increasing PBA Oura to 75% with 25% PBA Percy further reduced lodging compared to the 50% PBA Oura + 50% PBA Percy and 100% PBA Percy mix. The 100% PBA Oura and PBA Oura and canola mix showed similar results, and better lodging resistance to all other mixtures at Willowie. This site did not have a treatment including the breeding line.

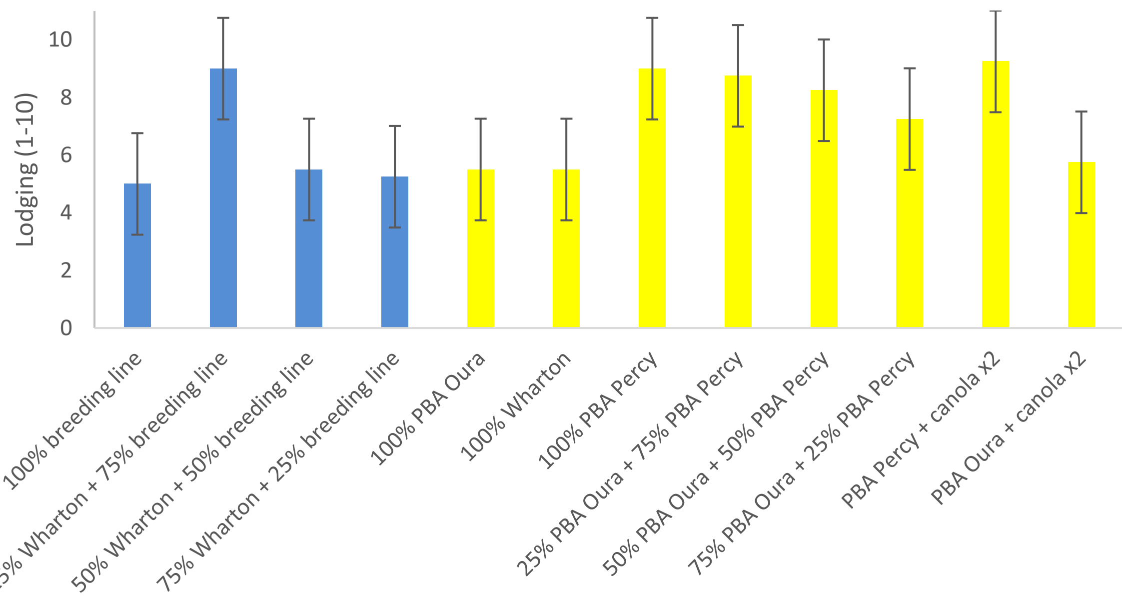

Figure 3. Field pea variety mixtures (Hart) with corresponding lodging values (1 = not lodged, 10 = lodged (LSD = 1.726 at P≤0.001). Error bars represent least significant difference. Blue bars = 'Kaspa type' field pea. Yellow bars = 'dun type' field pea.

Blackspot infection

Early in the season (June 21, 2019) blackspot infection was observed in the trial. However, the progression of blackspot in the canopy was low with minimal rainfall later in the growing season. Disease ratings showed no differences in the percentage of leaf or stem infection from blackspot between varieties and mixtures trialed.

Grain yield

Grain yields at Hart range from 1.16 t/ha to 1.48 t/ha (Figure 4). The highest yielding variety at Hart was the 100% breeding line (1.48 t/ha), which was 16% higher yielding than 100% PBA Wharton (1.27 t/ha). This season, variety mixtures did not improve or reduce grain yield. Long-term yield data will determine if mixing a conventional and semi-leafless field pea will have an effect on grain yield. At Willowie, all treatments yielded an average of 0.25 t/ha, due to drought conditions.

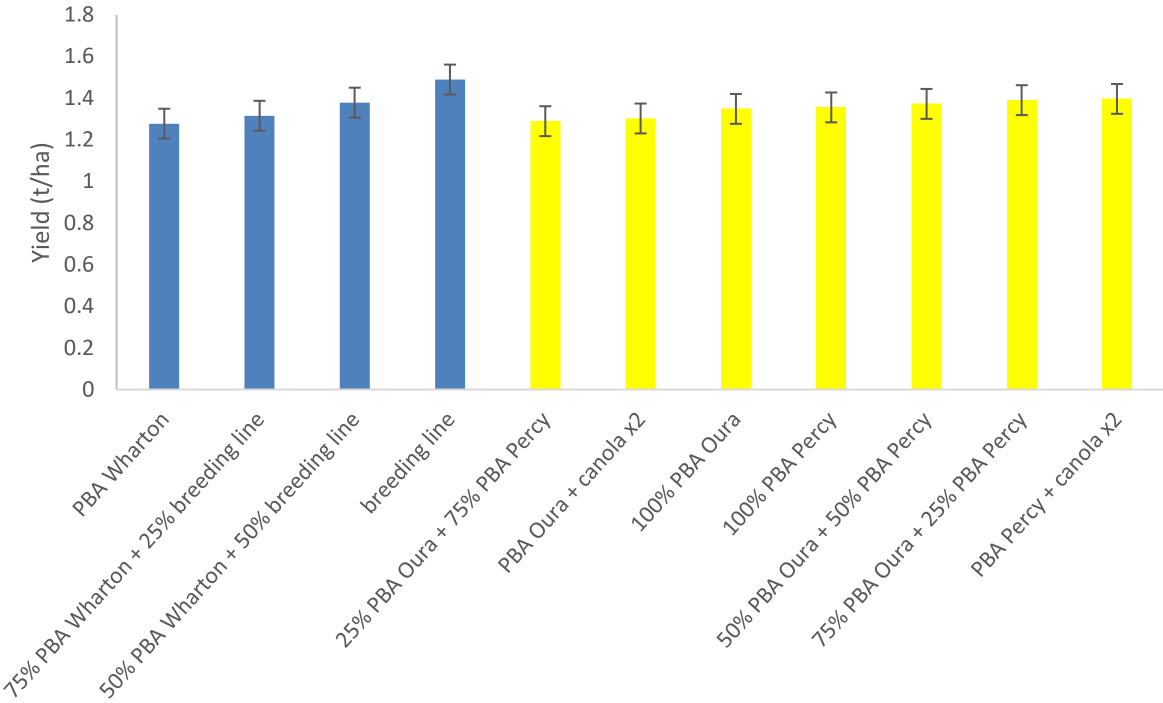

Figure 4. Field pea variety mixtures (Hart) with average grain yield (t/ha) (LSD=0.14 at P≤0.001). Error bars represent least significant difference. Blue bars = 'Kaspa type' field pea. Yellow bars = 'dun type' field pea.

Summary / implications

There is potential to manage blackspot infection through canopy or variety architectural traits. Previous research has shown mixing field pea varieties can minimise lodging, reduce blackspot severity and increase or improve yield stability. The trials at Hart and Willowie showed mixing field pea varieties can manipulate canopy structure (e.g. NDVI, lodging) compared to growing pure conventional and semi-leafless varieties alone. However, the benefit of these canopy differences was unable to be assessed under blackspot pressure due to the dry seasonal conditions.

In terms of grain yield there was no benefit from growing a field pea variety mixture. However, mixtures generally maintained the grain yield of the semi-leaf less and conventional field pea varieties sown on their own at both Hart and Willowie.

These trials were one season of data. To make accurate recommendations on the ability of field pea variety mixtures to suppress blackspot they need to be assess under high disease pressure in future seasons.

References

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Acknowledgements

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Managing your fertiliser dollar in wheat and barley – a study across three seasons

Jade Rose and Sarah Noack, Hart Field-Site Group

Key findings

- Across three seasons the N application rate to maximise returns in barley was different each year, for 2017 40 kg N/ha; 2018 80 kg N/ha and nil N applied in 2019.
- Nitrogen response in wheat was variable. In general, 80 kg N/ha applied at seeding or GS31 has resulted in the highest yield and protein level for maximum grade.
- It is important to look at seasonal climatic forecasts and Yield Prophet® to help assist in accurately determining potential yield and make decisions on nitrogen application rates and timing.

Why do the trial?

The two main grower questions regarding nitrogen (N) management are 1) how much N needs to be applied and 2) when should it be applied? An N budget is the most common way to manage N fertiliser inputs. However, decisions can often be 'reactive' to the season and based on previous season's experiences and attitude to risk.

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

- Assess simple N management strategies to determine the best return on investment from fertiliser N applications.
- Determine within a crop rotation (wheat and barley) where your fertiliser dollar was 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)
Seeding date	June 5, 2019		In season N rates: Table 1

Each trial was a randomised complete block design. The trials were blocked separately by crop type (Scepter wheat and Spartacus CL barley).

Prior to sowing (May 23, 2019) the trial area was assessed for available soil N (0-10, 10-30 and 30-60 cm). The total available soil N pre-seeding was 28 kg N/ha. All plots were assessed for grain yield and quality (protein, test weight kg/hL, retention % and screenings %).

Table 1. Nitrogen rates applied to wheat and barley nutrition trials at Hart in 2019.

Wheat	Barley
1. Nil	1. Nil
2. 80 kg N/ha @ seeding	2. 80 kg N/ha @ seeding
3. 20 kg N/ha @ GS31*	3. 20 kg N/ha @ GS31
4. 40 kg N/ha @ GS31	4. 40 kg N/ha @ GS31
5. 80 kg N/ha @ GS31	5. 80 kg N/ha @ GS31
6. 100 kg N/ha @ GS31	
7. 200 kg N/ha @ GS31	

*GS31 = first node can be seen 1 cm or more above the base of the shoot and the internode above it is less than 2 cm.

Results and discussion

Barley

Nitrogen rates trialed in Spartacus CL barley in 2019 showed applying nil N fertiliser was adequate to achieve the highest yield and protein to meet malt specifications (Table 2). The N supply for the crop in this treatment came from the soil (low starting soil available N of 28 kg N/ha) plus 10 kg N/ha applied at seeding. Increasing the N rate to 20 kg N/ha or above did not increase grain yield. However, grain protein was increased (14.5%) where 80 kg N/ha was applied at seeding. The increase in grain protein was not beneficial as it exceeded 12% protein (the maximum required for malt 1). This result was not consistent with 2017 and 2018 where 40 kg N/ha and 20 kg N/ha were required to maximise grain yield and protein to meet malt specification (Table 2). Both these seasons had either more growing season rainfall or some stored soil moisture increasing their yield potential and N requirement.

Across all three seasons screening levels were below 5% and test weight was > 65 kg/hL for all N rates and timings trialed. The only quality parameter to be affected by N treatment was grain retention. In 2017 and 2018 all retention levels were above 70 kg/hL. However, in 2019 applying a large amount of N upfront at seeding (80 kg N/ha) reduced retention to 50%. This treatment also had high protein and highlights the high early application of N set the crop up for a high yield and the dry finish resulted in smaller grains (lower retention).

Wheat

In 2019 at Hart, application of 20 kg N/ha at GS31 was sufficient to achieve the highest wheat yield (Table 3) of 1.4 t/ha. There was no yield benefit from increasing the N rate to 40, 80, 100 or 200 kg N/ha. However, an increased N rate was needed to achieve higher protein levels. The application of 80 kg N/ha at seeding provided enough N to achieve H1 grade. Even where 80 kg N/ha had been applied in-season or higher it did not achieve the same protein as the upfront N application. This can be attributed to the dry seasonal conditions favouring greater N uptake from early applications compared to holding off in-season where there was limited rainfall and soil moisture for N uptake.

The 2017 and 2018 seasons had higher growing season rainfall and/or starting soil moisture. It is not surprising that higher N rates were required to achieve maximum grain yield. In general, the data shows there is a trade-off between fertiliser rate (i.e. cost) and maximising grain yield and protein.

Other quality factors to affect the wheat receival standard are grain screenings and test weight. Across three seasons screening levels were largely unaffected by N rates from 0 – 200 kg N/ha. The 2019 season was the only year where wheat screening levels were above 5% (ranged from 5-9%) for all treatments. Grain test weights were all above the minimum of 76 kg/hL for all N treatments across three years.

Table 2. Barley grain yield and quality for the N treatments at Hart with varieties Spartacus CL (2017, 2019) and La Trobe (2018). Treatments shaded grey are not significantly different from the highest yielding/quality treatment.

Year	Treatment	Yield t/ha	Protein %	Screenings %	Test Weight kg/hL	Retention %	Receival grade	Net return* $/ha
2017	Nil	3.6^{b}	8.8^{b}	1.7^{c}	72.0	88.0^{a}	F1	477
GSR:	80 kg N/ha @ seeding	4.1^{a}	10.1^{a}	2.4^{bc}	71.8	83.3^{b}	Malt 1	699
191 mm	40 kg N/ha @ GS31	4.0^{a}	9.7^{a}	3.1^{ab}	71.8	79.9^{cd}	Malt 1	718
Starting soil N:	80 kg N/ha @ GS31	4.0^{a}	10.1^{a}	3.8^{a}	71.5	77.8^{d}	Malt 1	669
57 kg/ha	80 kg N/ha @ GS65	3.9^{a}	10.3^{a}	2.9^{ab}	71.6	81.6^{bc}	Malt 1	666
	LSD(P≤0.05)	**0.3**	**0.7**	**0.9**	**ns**	**2.3**		
2018	Nil	2.6^{a}	9.0^{a}	0.8	71.6^{c}	92.3^{b}	Malt 1	347
GSR:	80 kg N/ha @ seeding	3.0^{b}	12.2^{c}	2.1	70.0^{a}	70.3^{a}	F1	652
160 mm	20 kg N/ha @ GS31	3.0^{b}	9.7^{ab}	1.3	71.1^{bc}	88.5^{b}	Malt 1	442
Starting soil N:	40 kg N/ha @ GS31	3.0^{b}	10.7^{b}	1.5	70.6^{b}	81.5^{ab}	Malt 1	418
78 kg N/ha	80 kg N/ha @ GS31	3.1^{b}	12.4^{c}	2.3	70.5^{bc}	70.9^{a}	F1	254
	LSD(P≤0.05)	**0.2**	**1.5**	**ns**	**0.7**	**12.1**		
2019	Nil	1.4	10.5^{a}	0.8	69.7^{bc}	89.7^{c}	Malt 1	-13
GSR:	80 kg N/ha @ seeding	1.7	14.5^{d}	2.6	68.8^{a}	50.2^{a}	F1	-96
162 mm	20 kg N/ha @ GS31	1.6	11.6^{b}	1.1	69.9^{c}	81.3^{bc}	F1	-47
Starting soil N:	40 kg N/ha @ GS31	1.7	12.3^{bc}	1.4	69.2^{abc}	75.1^{bc}	F1	-47
28 kg N/ha	80 kg N/ha @ GS31	1.9	12.9^{c}	1.7	68.9^{ab}	69.7^{b}	F1	-46
	LSD(P≤0.05)	**ns**	**1.1**	**ns**	**0.9**	**15.7**		

*Cost of urea fertiliser based on 2019 prices. Net return based on production costs of $433 for malting barley or $423 of feed barley + fertiliser application and returns on grain of $300/t for malting barley or $250/t for feed barley.

Table 3. Wheat grain yield and quality for the N treatments at Hart with varieties Scepter (2018, 2019) and Mace (2017). Treatments shaded grey are not significantly different from the highest yielding/quality treatment.

Year	Treatment	Yield t/ha	Protein %	Screenings %	Test Weight kg/hL	Receival grade
2017 GSR: 191 mm Starting soil N: 57 kg/ha	Nil	3.6^{c}	8.8^{e}	0.66	81.0^{a}	ASW
	80 kg N/ha @ seeding	4.1^{a}	9.9^{d}	0.84	80.8^{ab}	ASW
	20 kg N/ha @ GS31	4.0^{a}	9.9^{d}	0.71	80.8^{ab}	ASW
	40 kg N/ha @ GS31	3.9^{a}	10.8^{c}	0.64	80.6^{bc}	APW
	80 kg N/ha @ GS31	3.9^{ab}	11.7^{b}	0.61	80.3^{cd}	H2
	100 kg N/ha @ GS31	3.9^{ab}	11.8^{b}	0.71	80.0^{d}	H2
	200 kg N/ha @ GS31	3.6^{bc}	12.5^{a}	0.65	80.0^{d}	H2
	LSD(P≤0.05)	**0.3**	**0.7**	**ns**	**0.4**	
2018 GSR: 160 mm Starting soil N: 78 kg N/ha	Nil	2.2^{c}	8.4^{ab}	0.9^{b}	80.1	ASW
	80 kg N/ha @ seeding	2.5^{bc}	11.6^{de}	0.9^{b}	79.6	H2
	20 kg N/ha @ GS31	2.7^{abc}	9.3^{bc}	1.1^{b}	80.3	ASW
	40 kg N/ha @ GS31	2.5^{bc}	9.6^{c}	1.1^{b}	78.1	ASW
	80 kg N/ha @ GS31	3.1^{a}	10.7^{d}	0.6^{a}	80.7	APW
	100 kg N/ha @ GS31	3.0^{ab}	11.8^{e}	0.7^{ab}	80.5	H2
	200 kg N/ha @ GS31	3.0^{ab}	13.2^{f}	0.8^{ab}	79.9	H1
	LSD(P≤0.05)	**0.5**	**1.0**	**0.3**	**ns**	
2019 GSR: 162 mm Starting soil N: 28 kg N/ha	Nil	1.1^{a}	8.8^{e}	8.9^{d}	77.9	AGP1
	80 kg N/ha @ seeding	1.4^{b}	13.3^{a}	4.9^{a}	77.3	H1
	20 kg N/ha @ GS31	1.2^{b}	9.5^{de}	6.8^{c}	79.2	AGP1
	40 kg N/ha @ GS31	1.3^{bc}	10.2^{d}	6.1^{bc}	78.0	AGP1
	80 kg N/ha @ GS31	1.2^{bc}	11.4^{c}	5.8^{ab}	77.7	AUH2
	100 kg N/ha @ GS31	1.3^{bc}	11.5^{c}	5.6^{ab}	77.6	AUH2
	200 kg N/ha @ GS31	1.3^{c}	12.4^{b}	5.8^{b}	76.0	AUH2
	LSD(P≤0.05)	**0.1**	**1.5**	**0.9**	**ns**	

Summary / implications

The results observed from 2017, 2018 and 2019 show the effect of rainfall, yield potential and N uptake of crops. It is important to look at seasonal climatic forecasts and Yield Prophet® to help assist in accurately determining potential yield and make decisions on N application rates and timing. In drier seasons results indicate that using lower N fertiliser (e.g. 20 kg N/ha (2018) and nil (2019) for barley and 20 kg N/ha for wheat for both years) was the best use of your fertiliser dollar.

Some key points to remember:

- Taking account of available soil N reserves prior to the main applications of N fertiliser in wheat is a key measure to improve N fertiliser management, N efficiency and avoiding losses to the atmosphere.
- Whilst N needs to be supplied to growing wheat crops throughout the growing season, it is important to recognise that 20 – 30% of a wheat crops needs are required prior to stem elongation.
- Targeting the majority of N to the wheat crop just prior to early stem elongation is the best way of matching N supply to crop demand.
- 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 N fertiliser to apply. Refer to Figure 2 of the article 'Yield Prophet® performance in 2019' (page 16, Hart Trial Results 2019).

Subsoil amelioration – five years on

Stuart Sherriff and Sam Trengove, Trengove Consulting

Key Findings

- Biomass responses to chicken litter, measured as NDVI, were evident at all sites in 2019, the fifth season after application.
- Biomass responses to fertiliser amendment, measured as NDVI, were evident at all cereal sites in 2019, but not at lentil sites.
- The application of chicken litter to the surface in 2015 as a soil amendment reduced grain yields in 2019 at four of five trial sites.
- Applying amendments to the subsoil did not improve grain yields. No cumulative benefit of subsoil amendment application has been measured over the five years of trials.
- Biomass and grain protein responses five years after amendment application indicate nitrogen inputs from amendments are still being observed as crop responses.

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 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 (Table 1) 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.

Table 1. Treatment list for the 7 subsoil manuring sites established in 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 synthetic fertiliser	No	Surface
7	3 t/ha synthetic fertiliser	Yes	Surface
8	3 t/ha synthetic fertiliser	Yes	Subsoil

Plot size	2.5 m x 12.0 m
Seeding date	Hart: May 21 Bute: May 11
Main treatments applied in 2015	As per treatment list (Table 1)
2019 crop and annual fertiliser	Hart: PBA Hallmark XT lentil, 50 kg/ha MAP + 2% Zn Bute: Compass barley, 80 kg/ha DAP, 80 kg/ha urea

Sites and soil types

Hart East	Calcareous gradational clay loam Subsoil constraint: High pH and moderate to high ESP below 30 cm
Hart West	Calcareous loam Subsoil constraint: High pH, Boron and ESP below 30 cm
Bute Northwest	Calcareous transitional cracking clay Subsoil constraint: High pH, Boron and ESP below 30 cm
Bute Mid	Calcareous loam Subsoil constraint: High pH, Boron and ESP below 60 cm
Bute South East	Grey cracking clay with high exchangeable sodium at depth Subsoil constraint: High pH, Boron and ESP below 30 cm
Hill River East	Black cracking clay
Hill River West	Loam over red clay Subsoil constraint: Moderate ESP below 60 cm 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 600 mm and applying large volumes of product to a depth of 400 mm. 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 practice fertiliser rates have been applied to all plots.

In 2019 the Hart sites were sown with narrow points and press wheels on 250 mm spacing. The Bute sites were sown using a concord seeder on 300mm spacing with 150 mm sweep points and press wheels and at Hill River the sites were sown using parallelogram knifepoint and press wheel seeder on 250 mm spacing.

The rate of chicken litter (20 t/ha) used in these trials was based on the rate being used in south western Victoria where the large yield responses had been observed. To assess if responses to chicken litter were attributed directly to the nutrition in the chicken litter, the 3 t/ha synthetic fertiliser treatment was designed to replicate the level of nutrition that is found in an average analysis of 20 t/ha of chicken litter. This treatment was 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 2. Average nutrient concentration from three chicken litter sources used in subsoil manuring trials established in 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 2019 include Green Seeker NDVI, grain yield and quality at the Bute site and Green Seeker NDVI and grain yield at the Hart site. No measurements were taken at the Hill River sites as the paddock was grazed with sheep and cut for hay in 2019.

2019 Results

Bute sites

Green Seeker NDVI measurements conducted on July 22 at the Bute sites indicated that both chicken litter and fertiliser amendments were generating a growth response over the untreated control (Tables 3-5). This is despite NDVI values approaching 'saturation', reducing the sensitivity of this measurement to treatment differences. At the Bute SE and Mid sites, the response to chicken litter was greater than for fertiliser amendment, whereas the responses were equivalent at the Bute NW site. At the Mid and North West sites there was also an increase in NDVI as a result of the deep ripping conducted in 2015, this was in the absence of additional nutrition.

Grain yield was reduced through the application of chicken litter by 26% at the South East site. The fertiliser application had less of an impact but still reduced yield when placed in the subsoil. Grain protein at the site was high, with the nil nutrition treatments averaging 11.3%. Where fertiliser or chicken litter was applied grain protein increased to between 14.9% (fertiliser + no ripping) and 17.9% (chicken litter + deep ripping). This result highlights a large amount of the nitrogen applied in 2015 is still available. As expected, grain size and test weight were inverse to the protein values.

There was no significant grain yield response to treatments at the Bute Mid site with the average yield of 3.83 t/ha. However, when nutrient source is analysed on its own (e.g. synthetic fertiliser versus chicken litter), chicken litter was reducing grain yield on average by 8.4%. Grain yield was correlated with NDVI, where by grain yield was reduced as NDVI in July increased. This suggests the crop may have produced too much biomass and used too much water early, then was unable to fill all of the grains before running out of water. Grain quality parameters were as expected where there is a negative relationship between NDVI and grain yield. Treatments that had lower biomass (measured as NDVI) led to lower protein and increased grain size. The protein of the nil nutrition treatments averaged 11.3% where the chicken litter and fertiliser treatments ranged from 13.9% to 17.5%. The protein response to the placement of the amendment was not consistent between treatments. Chicken litter placed in the subsoil had lower protein than when applied to the surface and fertiliser was the opposite. As for the South East site, grain size, measured as retention and screenings had the inverse relationship to protein.

The Bute North West site was the lowest yielding trial in this paddock, in part due to frost at this site, averaging 2.22 t/ha. Following a similar trend to the previous two sites, chicken litter reduced grain yield by 20% compared to the nil nutrition treatments. Fertiliser however did not have a negative impact on yield whether it was placed on the surface or in the subsoil. Ripping at this site did not affect grain yield. Grain quality at this site was poor, with retention averaging only 9% and with no significant treatment effects. Grain screenings were increased through the application of either nutrition treatment. Protein values were all high at this site, ranging from an average of 15.2% for the nil nutrition treatments up to an average of 18.7% for the chicken litter treatments and fertiliser applied to the surface with ripping.

Table 3. Green Seeker NDVI 22nd July, grain yield (t/ha) and grain quality parameters for the Bute South East subsoil manuring trial 2019.

Treatment	NDVI 22nd July	Grain yield (t/ha)	Protein (%)	Test Weight (kg/hL)	Retention (%)	Screenings (%)
1	0.857	3.88	11.2	70.5	93.6	1.1
2	0.853	3.88	11.5	69.7	91.4	1.5
3	0.889	3.04	16.5	68.0	75.1	3.9
4	0.886	2.70	17.9	66.7	70.2	5.5
5	0.869	2.89	16.8	67.1	69.0	5.1
6	0.873	3.69	14.9	68.5	81.8	2.7
7	0.868	3.32	16.3	68.1	76.8	3.8
8	0.868	2.95	16.9	67.5	76.1	4.1
LSD (0.05)	0.016	0.59	1.1	0.7	8.7	1.9

Table 4. Green Seeker NDVI 22nd July, grain yield (t/ha) and grain quality parameters for the Bute Mid subsoil manuring trial 2019.

Treatment	NDVI 22nd July	Grain yield (t/ha)	Protein (%)	Test Weight (kg/hL)	Retention (%)	Screenings (%)
1	0.744	4.05	11.1	69.6	88.3	1.9
2	0.790	3.99	11.4	69.7	87.2	2.1
3	0.867	3.77	17.0	65.3	49.1	7.4
4	0.887	3.48	17.4	64.6	42.2	9.6
5	0.859	3.79	15.7	67.4	63.5	5.1
6	0.803	3.98	13.9	67.0	73.8	3.7
7	0.839	3.93	15.3	66.9	65.7	4.8
8	0.860	3.63	17.5	64.6	45.2	8.8
LSD (0.05)	0.037	ns	1.4	2.1	10.7	2.8

Table 5. Green Seeker NDVI 22nd July, grain yield (t/ha) and grain quality parameters for the Bute North West subsoil manuring trial 2019.

Treatment	NDVI 22nd July	Grain yield (t/ha)	Protein (%)	Test Weight (kg/hL)	Retention (%)	Screenings (%)
1	0.850	2.48	14.4	58.3	10.2	5.8
2	0.864	2.33	16.0	66.3	8.8	6.6
3	0.873	2.01	19.2	58.7	12.0	9.5
4	0.873	1.62	19.1	63.0	8.4	8.8
5	0.875	2.16	17.5	61.9	6.7	7.4
6	0.870	2.63	15.5	60.1	7.5	6.1
7	0.872	2.21	19.1	59.5	10.1	8.9
8	0.878	2.30	16.7	60.4	8.1	7.0
LSD (0.05)	0.011	0.46	2.4	ns	ns	1.5

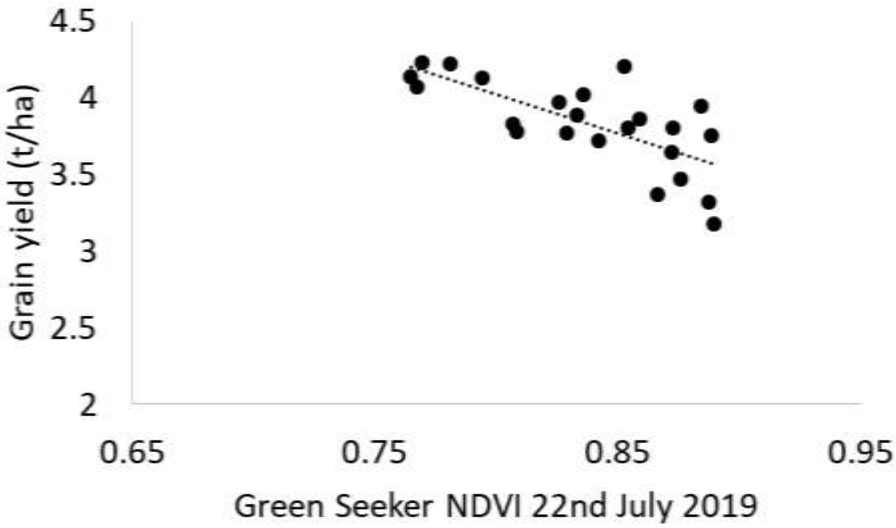

*Figure 1. Green Seeker NDVI recorded 22nd July 2019 and grain yield (t/ha) for the Bute Mid subsoil manuring trial 2019. Grain yield = -5.0317*NDVI + 8.0423, R2 = 0.5106*

Hart Sites

Lentil NDVI results for the two Hart sites were similar in 2019. At the West and East sites, the application of chicken litter to the surface increased NDVI by 25% and 16%, respectively. This has also been observed in previous lentil crops following application of chicken litter over the past 4 years. However, when chicken litter was applied into the subsoil this increase in NDVI did not occur. Also, as in previous seasons, the fertiliser treatment did not have the same effect as the chicken litter when applied to lentil.

In previous seasons where these trials have been sown to lentil there has been a yield reduction from the surface application of chicken litter. Unfortunately, at Hart this season lentil grain yield was severely affected by drought at the West site and drought plus frost at the East site. Average grain yields for these two sites were 0.48 t/ha and 0.20 t/ha for the West and East sites, respectively.

At the West site grain yield was highest in the nil nutrition treatments, or in treatments where the chicken litter or fertiliser was placed in the subsoil. This is similar to what has been found in previous seasons when sown to lentil. There was no significant difference between treatments at the East site.

Table 6. Green Seeker NDVI, 22nd August, and grain yield (t/ha) for the Hart West and East subsoil manuring trials 2019.

Treatment	Hart West		Hart East	
	NDVI 22nd August	Grain yield (t/ha)	NDVI 22nd August	Grain yield (t/ha)
1	0.528	0.51	0.633	0.24
2	0.499	0.60	0.623	0.23
3	0.640	0.44	0.717	0.19
4	0.650	0.35	0.740	0.10
5	0.510	0.53	0.617	0.17
6	0.557	0.47	0.613	0.23
7	0.526	0.42	0.583	0.20
8	0.516	0.51	0.673	0.21
LSD	(0.05) 0.049	(0.1) 0.11	(0.05) 0.083	ns

Cumulative grain yields for the five seasons

Over the past five seasons it is evident that subsoil amelioration treatments implemented in 2015 have not been able to increase grain yields in areas of the paddocks with shallow subsoil constraints. In the Bute paddock, the NW and SE site have more severe subsoil constraints at shallower depths (from 300 mm), compared with the Mid site (from 600 mm), as described in the soil descriptions. This is also reflected in the site yields over the past five seasons (Figure 2). With the subsoil machinery used placing amendments at ~400 mm, the subsoil amendment application was placed into the constrained subsoil at the NW and SE sites, whereas it was placed ~200 mm above the constrained subsoil at the Mid site. Long term grain yield results indicate that the subsoil treatments (treatments 5 and 8) have actually tended to reduce yield at the more constrained sites (NW and SE), whereas these treatments have had little impact at the less constrained Mid site (Figure 2). Therefore, these treatments have actually increased the yield gap between the better and poorer performing soil types.

Hart and Hill River long term results have not been presented as there was little change from the previous season, see previous report for more detail.

The greatest positive response observed over the past five years has come from large yield gains in 2016 which was a high rainfall and high yield potential season. In this year, standard fertiliser applications were not enough to achieve maximum grain yields, therefore the additional nutrition that came from either the chicken litter or the synthetic fertiliser was able to produce higher grain yields. However, in subsequent years where rainfall has been limiting the application of either nutrition treatment, but particularly chicken litter, to these soil types in 2015 has generally resulted in a decrease in grain yields. Further to that the disturbance caused by the ripping process, or deep placement of the nutrition treatment has also reduced yields at some sites.

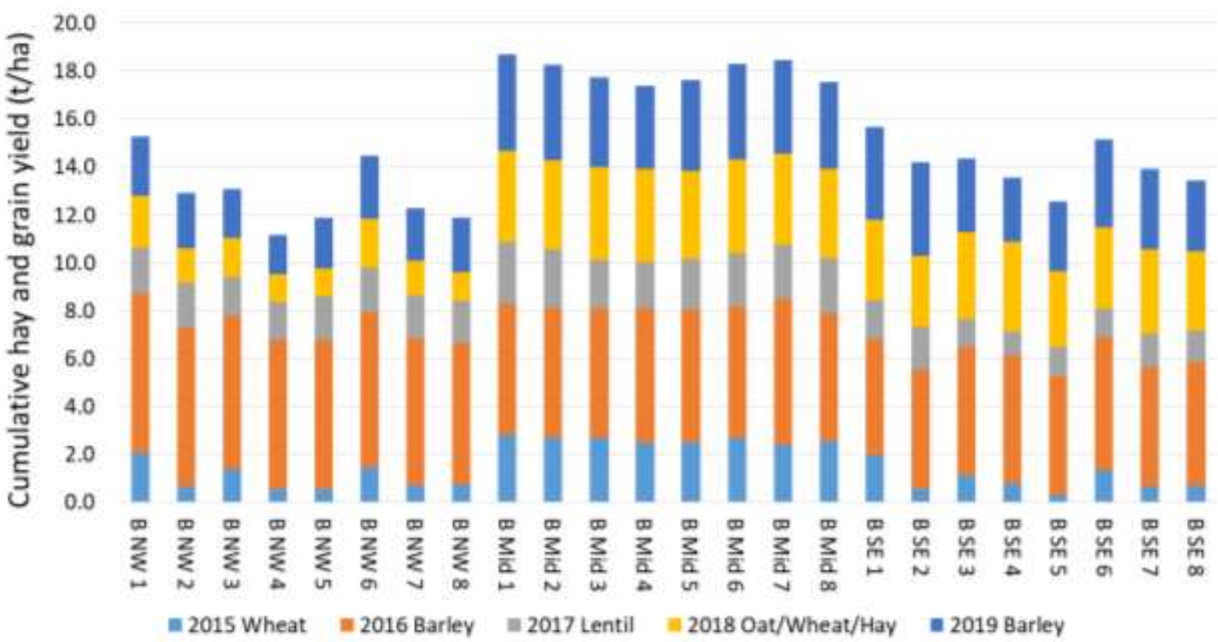

Figure 2. Cumulative hay and grain yield (t/ha) for the Bute North West (B NW), Bute Mid (B Mid) and Bute South East (B SE) sites for 2015 – 2019.

Acknowledgements

Trial co-operators Bill Trengove, Matt Dare and Craig Jaeschke, Vic DPI for loan of the subsoil manuring machine, Jim Maitland for providing chicken litter at the Hart site and Brett Roberts for providing facilities for grain quality analysis.

Improved phosphorus prescription maps – beyond phosphorus replacement

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Sean Mason; Agronomy Solutions

Key Findings

- At phosphorus responsive sites, fertiliser rates above 20 kg P/ha were able to increase crop early vigour measured as NDVI.
- For three of the four sites where there was a high predicted response to P fertiliser the highest partial gross margin was achieved at 32 – 40 kg P/ha.
- At three of the four sites where there was a low or moderate predicted P response there was no benefit to the partial gross margin from applying any P fertiliser.

Why do the trial?

The aim of this project is to increase the profitability derived from phosphorus (P) fertiliser application. This will be achieved through increasing P fertiliser use efficiency through a better understanding of the spatial variability in P availability, demand and P response.

Map data layers that can infer spatial information on P uptake, soil tie up and response are becoming increasingly available, such as grain yield, soil pH, soil EC and NDVI. However, the best methodology for integrating this data for improving P rate calculations is unknown. The aim of this project is to better understand how these data layers can be integrated to produce variable rate P prescription maps that optimise P rates across variable paddocks.

This will be achieved by analysing data layers (yield, soil pH, soil EC, NDVI) to identify the range in likely P response. This information will be used to locate a series of P rate trials, in two paddocks per year in 2019 and 2020 in the Mid North and YP regions. The yield responses observed in these trials will be used to determine the relative importance or weighting that each data layer has on the rate calculation and inform the best method for integrating these data layers for calculating optimal P rates.

How was it done?

Predicted P response was estimated through analysis of historical grain yield, NDVI and Veris pH data for two paddocks (Figure 1). Based on these estimates, eight sites were selected to cover the range of expected P response, with four in a paddock near Bute and four in a paddock near Koolunga.

The eight trials were established using knife points and press wheels and had three replicates. Treatments included P rates of 0, 5, 10, 20, 30 and 50 kg P/ha. Fertiliser was applied using MAP and nitrogen rates were matched between treatments using adjusted rates of urea. An additional treatment of 2.5 t/ha chicken litter was also included at each site. Analysis of the chicken litter showed a P content of 0.8%, equating to 20 kg P/ha applied. For application rates of MAP and matched urea see Table 1.

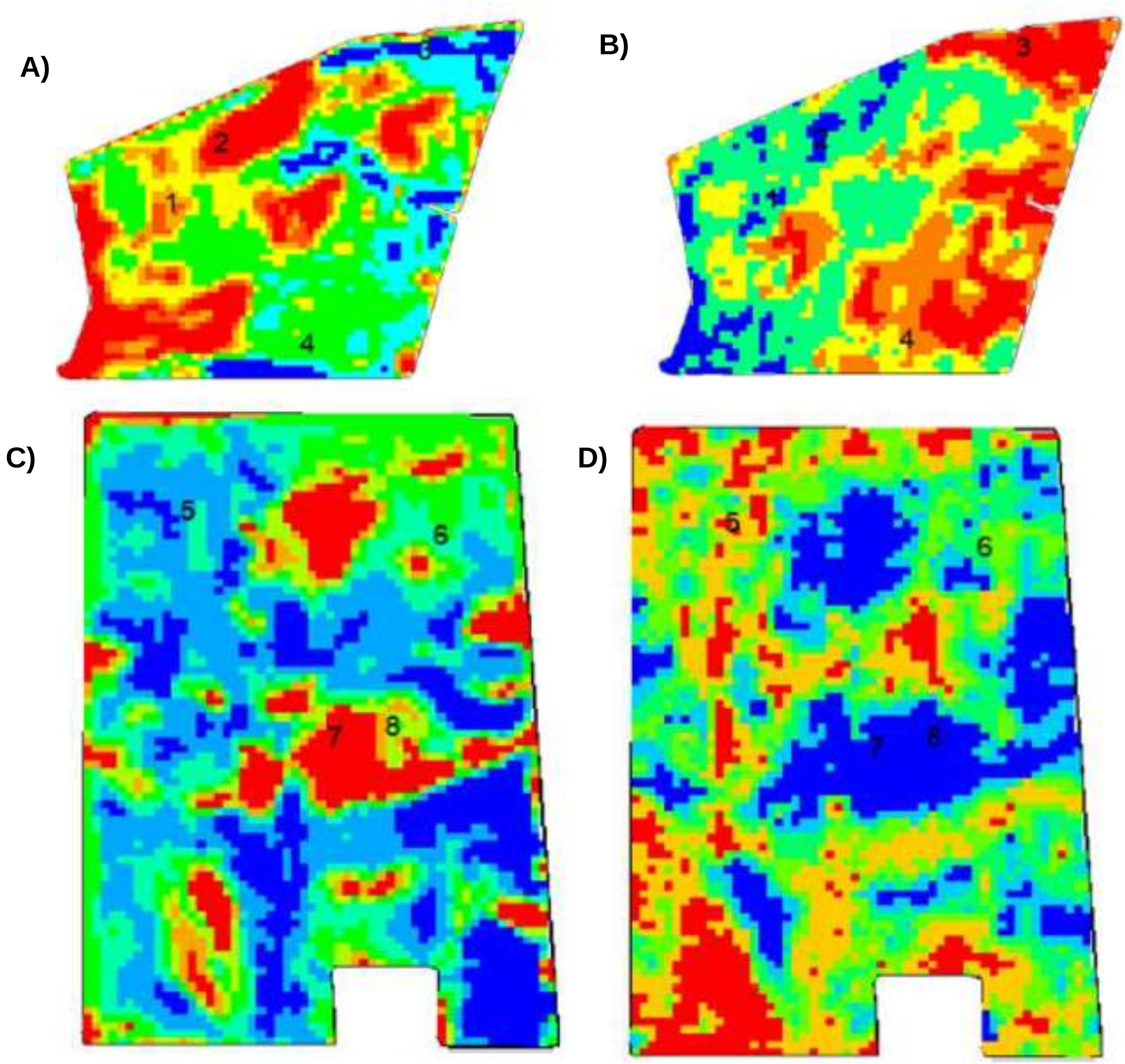

Figure 1. The two maps on the left are Landsat NDVI (2018) and on the right are soil pH (red = low, blue = high) for the trial paddocks at Koolunga, A) and B), and Bute, C) and D), respectively. Numbers within the maps show where P trials were established.

Table 1. Treatment list and application rates of MAP and urea for the eight P trials in 2019.

Treatment	P rate (kg/ha)	MAP (kg/ha)	Urea (kg/ha)
1	0	0	49.4
2	5	22.7	44.5
3	10	45.5	39.5
4	20	90.9	29.7
5	30	136.4	19.8
6	50	227.3	0.0
7	Chicken litter 2.5t	0	0

Sowing date: 23rd May 2019 Bute and Koolunga

Varieties: Bute – Compass barley, Koolunga – Scepter wheat

Measurements throughout the season included GreenSeeker NDVI, grain yield and grain quality on all treatments. Crop biomass, leaf tissue nutrient concentration, and grain nutrient concentration for selected treatments.

2019 Site descriptions and soil test results

Table 2. Historical yield, satellite NDVI and Veris pH and the predicted P response for each of the eight P trial sites in 2019.

Paddock	Site	Historical yield	Historical NDVI	Veris pH	Expected P response
Koolunga	1	High	Moderate	Alkaline	High
	2	Low-Mod	Low	Alkaline	High
	3	Reliable 3.5t	High	Acid	Low
	4	Variable	Moderate	Neutral	Moderate
Bute	5	High	Mod-High	Acid	Low
	6	Variable	Moderate	Neutral	Moderate
	7	Low	Low	Alkaline	High
	8	Moderate	Low	Alkaline	High

Table 3. Soil test analysis for each of the eight P trial sites in 2019.

Paddock	Site	Colwell P (mg/kg)	PBI	DGT-P	pH $CaCl_2$	Organic Carbon % (W&B)	Colwell K (mg/kg)
Koolunga	1	24	121	12	7.55	1.64	640
	2	35	131	21	7.48	2.11	480
	3	33	51	56	6.97	1.09	240
	4	62	77	62	6.61	1.57	430
Bute	5	27	20	103	5.46	0.48	150
	6	63	50	106	6.04	1.36	510
	7	20	71	22	7.68	0.92	270
	8	19	51	38	7.72	0.86	340

Results and Discussion

NDVI and biomass

NDVI measurements were taken in both paddocks in July (early tillering) and August at Bute (head emergence) and September at Koolunga (post flowering).

The NDVI data recorded in July (early tillering) gives a good indication of how the plots were visually responding to P fertiliser (Figure 2). Sites 3 and 4 at Koolunga and sites 5 and 6 at Bute were predicted to have a low or moderate response to the application of P. At Koolunga the response for these sites (3 and 4) flatten out at 10 kg P/ha (Figure 2). For the non-responsive sites at Bute (Sites 5 and 6) there was a low level of response, with little response beyond 5 kg P/ha.

In contrast, Sites 1 and 2 at Koolunga and 7 and 8 at Bute were predicted to be highly responsive and a greater response to P fertiliser was observed.

Later in the season (prior to flowering) NDVI showed a similar trend at Bute (Figure 2d). At the Koolunga sites the second NDVI reading was not taken until mid-grain fill and senescence had started to occur, the relationships here are not consistent with the earlier timing (Figure 2c). The NDVI at this timing did not represent the actual crop biomass and should be interpreted with caution.

Crop biomass was assessed in one replicate at each site in July and had a strong correlation with the NDVI taken at the same time. Biomass cuts were taken at flowering from two replicates, to estimate hay yield. As the biomass samples were not fully replicated, treatment differences could not be determined at individual sites. When the high P responsive sites were averaged (Sites 1, 2, 7 and 8) an increase in biomass was identified. Phosphorus rates of 20 and 50 kg/ha increased biomass by an average of 30% compared to the control.

Table 4. Crop dry matter (t/ha) production taken at flowering averaged across high P responsive trial sites 1, 2, 7 and 8.

P rate (kg/ha)	Flowering dry matter (t/ha) (sites 1,2,7,8)	Flowering dry matter (% of 0 kg P/ha)
0	4.9	0%
5	5.5	12%
10	5.7	16%
20	6.2	27%
50	6.5	33%
LSD (0.05)	1.7	

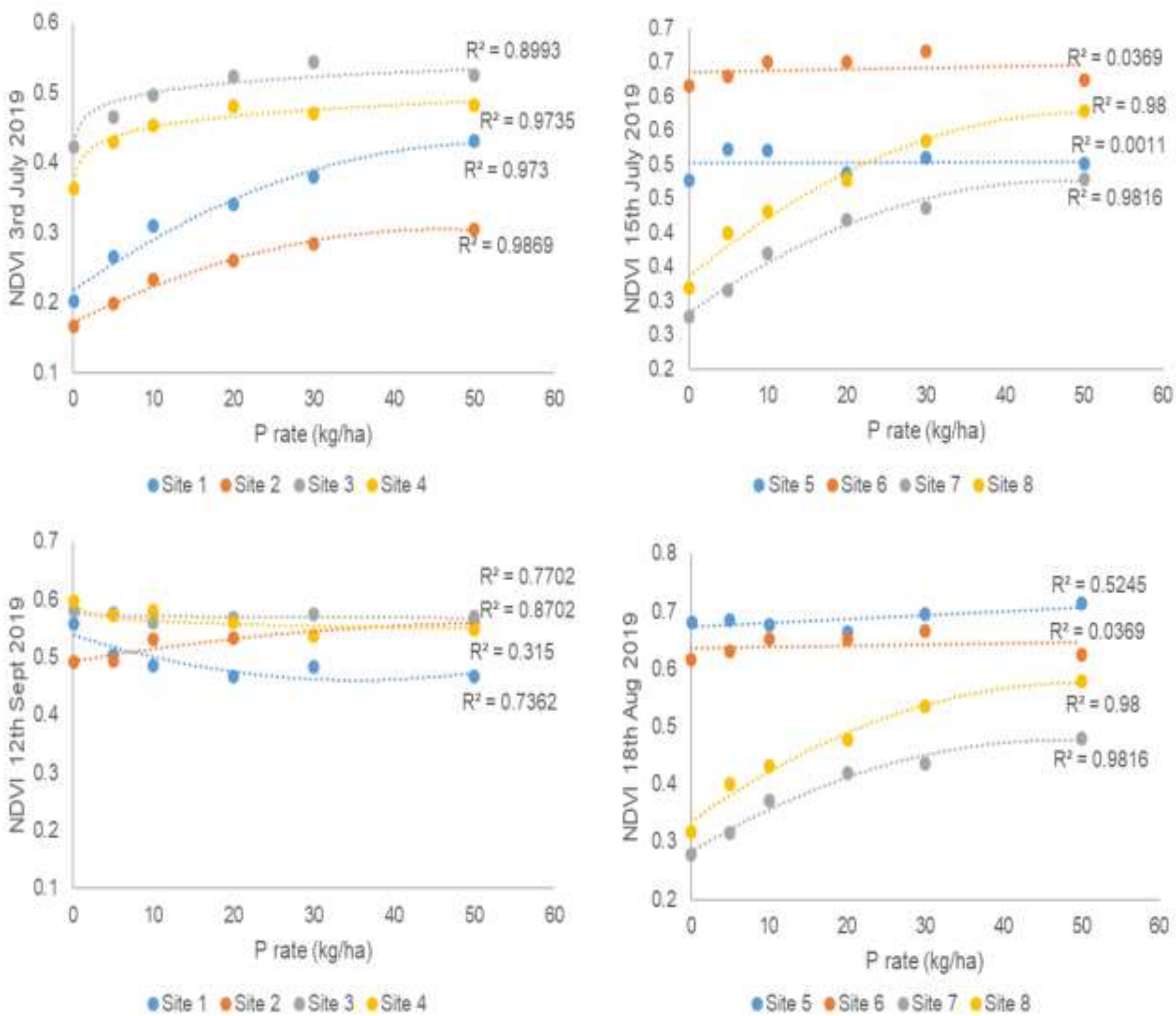

Figure 2. Green Seeker NDVI a) July 3 Koolunga, b) July 15 Bute, c) September 12 Koolunga and d) August 18 Bute for P trials 2019.

Grain yield

Grain yield was not affected by phosphorus rate at three of the eight sites (3, 5 and 6) indicating nil P fertiliser was needed to achieve maximum yield. These three sites along with one other (Site 4) were predicted to have a low or moderate response to P fertiliser. Site 4 was predicted to have moderate P response and grain yield was increased with the application of 30 or 50 kg P/ha by an average of 8.5% compared to the control. Lower rates of P fertiliser at this site did not increase grain yield compared to the nil.

At high P responsive sites (Sites 1, 2, 7 and 8) there were much larger grain yield responses. At Sites 1, 2 and 7, 50 kg P/ha was the highest yielding treatment producing an average 45% yield increase over the nil. At Site 8, 30 kg P/ha was able to achieve the same grain yield as 50 kg P/ha, producing a 27% increase over the nil.

Table 7. Wheat grain yield (t/ha) for P agronomy trials at Koolunga in 2019. Grain yield values appended by a different letter within a column are significantly different.

Koolunga			**Wheat grain yield (t/ha)**			
Treatment	**MAP (kg/ha)**	**Urea (kg/ha)**	**Site 1**	**Site 2**	**Site 3**	**Site 4**
0	0	49	1.71^{d}	2.05^{e}	3.01	2.59^{cd}
5	23	44	1.91^{c}	2.30^{d}	3.14	2.59^{bcd}
10	45	40	2.14^{b}	2.67^{c}	3.02	2.63^{bc}
20	91	30	2.15^{b}	2.72^{bc}	3.10	2.75^{abc}
30	136	20	2.25^{b}	2.86^{b}	3.30	2.77^{ab}
50	227	0	2.46^{a}	3.05^{a}	3.15	2.82^{a}
Chicken Litter			*1.87^{cd}*	*2.22^{d}*	*3.02*	*2.42^{d}*
LSD (P≤0.05)			*0.18*	*0.17*	*ns*	*0.18*

Table 8. Barley grain yield (t/ha) for P agronomy trials at Bute in 2019. Grain yield values appended by a different letter within a column are significantly different.

Bute			**Barley grain yield (t/ha)**			
Treatment	**kg MAP**	**kg Urea**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
0	0	49	4.98	4.58	3.35^{e}	4.21^{c}
5	23	44	4.95	4.49	3.62^{de}	4.76^{b}
10	45	40	5.07	4.54	4.07^{c}	4.95^{b}
20	91	30	5.05	4.66	4.29^{bc}	5.07^{ab}
30	136	20	5.26	4.71	4.48^{ab}	5.35^{a}
50	227	0	5.17	4.67	4.78^{a}	5.35^{a}
Chicken Litter			*5.12*	*4.81*	*3.97^{cd}*	*4.77^{b}*
LSD (P≤0.05)			*ns*	*ns*	*0.39*	*0.39*

Partial gross margin

Partial gross margins (PGM) were calculated to assess the economic return on the rates of fertiliser applied. Gross margins are sensitive to commodity prices and therefore price assumptions must be made. For these trials the partial gross margins are based on 2019 prices and are as follows; Wheat - $300/t, Barley - $270/t, MAP - $650/t, Urea - $500/t.

At three of the four low or moderate P responsive sites there was little or no grain yield response to application of P fertiliser. Therefore, not applying any P fertiliser produced the best PGM for that season.

Polynomial curves were fitted to the PGM data to identify the rate producing the maximum PGM. At the highly responsive sites 1 and 2 the maximum PGM was achieved at 35 kg P/ha and at sites 7 and 8 the maximum PGM was 40 kg P/ha and 32 kg P/ha respectively.

Increasing P rates from a typical rate of 15 kg P/ha to the maximum partial gross margin could result in an increased profit of between $29/ha and $101/ha for areas of the paddock that are responsive. Potential savings of the cost of P fertiliser being applied where it is not required are also significant.

Response to chicken litter

The chicken litter treatment was implemented by spreading 2.5 t/ha chicken litter on the surface of the plots prior to seeding. No additional fertiliser was applied with the seed. The results show chicken litter applied to the surface was not as effective as a fertiliser for the crop compared to banding the synthetic fertiliser with the seed. At the low and moderate responsive Sites 3, 4, 5 and 6 there was no significant positive response to chicken litter compared to the control.

At the sites where the predicted response was high, there was generally a positive response to chicken litter for NDVI recorded in July, August and September. There was an increase in grain yield of 13% and 19% at Sites 7 and 8 respectively at Bute. At Koolunga, application of chicken litter increased grain yield by 8% at site 1 however, no response was observed at Site 2. This response to chicken litter at Site 2, 7 and 8 was equivalent to applying 2.3, 11.5 and 8.4 kg P/ha as MAP, respectively. Chicken litter applied at 2.5 t/ha supplied 20 kg P/ha (a mixture of both plant available and unavailable P). The efficiency of P applied as chicken litter in the year of application ranged from 12 – 58%.

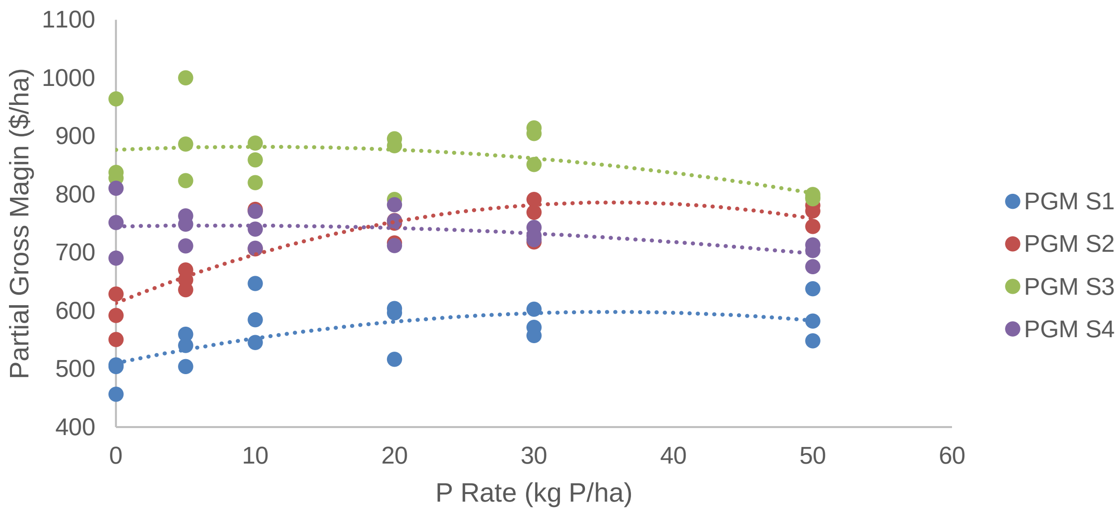

Figure 3. Koolunga P agronomy trials (Sites 1 – 4) partial gross margins, price assumptions, Wheat - $300/t, MAP - $650/t, Urea - $500/t. Polynomial functions for Sites 1, 2 and 3 are, $y = -0.0702x^2 + 4.98096x + 509.679$, $R^2 = 0.4497$, P-val = 0.01717, $y = -0.13533x^2 + 9.6654x + 613.27432$, $R^2 = 0.6963$, P-val = <0.001 an $y = -0.04981x^2 + 1.00197x + 843.37685$, $R^2 = 0.4351$, P-val = 0.02 respectively. Function for Site 4 was not significant.

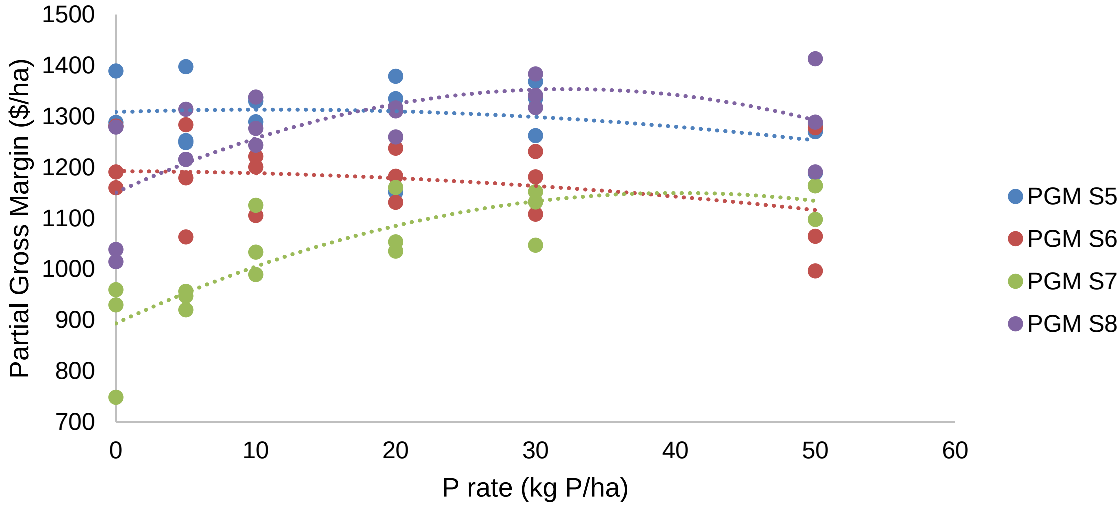

Figure 4. Bute P agronomy trials (Sites 5 – 8) partial gross margins, price assumptions, Barley - $270/t, MAP - $650/t, Urea - $500/t. Polynomial functions for Sites 7 and 8 are, $y = -0.15937x^2 + 12.78033x + 893.40713$, $R^2 = 0.6609$, *P-val = <0.001 and* $y = -0.19493x^2 + 12.58356x + 1150.44279$, $R^2 = 0.3938$, *P-val = 0.009 respectively. Functions for Sites 5 and 6 were not significant.*

Acknowledgements

Funding from SAGIT for this project (TC219) Improved phosphorous prescription maps – beyond replacement P, is gratefully acknowledged. Trial co-operators Bill Trengove and Leigh Fuller are thanked for supplying paddock data and area to conduct trials. Brett Roberts for use of grain sample quality analysis are gratefully acknowledged.

Improved productivity on sandy soils – Kybunga case study

Sam Trengove, Stuart Sherriff & Jordan Bruce; Trengove Consulting
Sean Mason; Agronomy Solutions

Key Findings

- All soil disturbance treatments behaved the same in the absence of chicken litter, increasing grain yield by 1.02 t/ha (24%) over the control.
- Chicken litter applied at 7.5 t/ha with ripping or spading increased grain yield by a further 0.66 t/ha compared to ripping or spading alone.
- Chicken litter application increased grain protein by 1.0 and 1.7% with ripping and spading, respectively.

How was it done?

Trial location	Kybunga (Blyth BOM annual rainfall 239 mm, growing season 208 mm)		
Plot size	1.90 m x 15.0 m		
Seeding date	May 15, 2019	**Fertiliser**	32:10 @ 100 kg/ha IBS, Urea @ 100kg/ha SOA @ 150 kg/ha (no chicken litter plots only)
Variety	Scepter		
Soil constraints	Low organic carbon, low cation exchange capacity, mild water repellence and compaction (anecdotal, not yet measured)		

The trial was a randomised complete block design with seven treatments and four replicates (refer to list below). The trial was located on a sand hill at Kybunga with two replicates across the top of the hill and two replicates on the western slope of the hill. Chicken litter was applied to the surface of plots prior to the implementation of soil disturbance treatments.

All soil disturbance treatments were implemented on May 13, 2019. Ripping treatments were conducted using a Williamson-Agri Ripper, a bent leg low disturbance ripping machine with four tynes per plot. Ripping depth was either shallow (30 cm) or deep (50 cm), Spading was conducted with a 1.8 m Farmax spading machine operated at 5 km/h to a depth of 30 cm.

Post emergent urea (July 25) was applied by the grower using commercial application equipment operated perpendicular to the plot lengths. Sulphate ofr ammonia (SOA) treatments were applied by hand on August 27.

Treatments

1 District practice (Control)
2 Shallow ripping to 30 cm (Rip30)
3 Deep ripping to 50 cm (Rip50)
4 Spading to 30 cm (Spade30)
5 Deep ripping + Spading (Rip50 + Spade)
6 Deep ripping + Chicken litter @ 7.5 t/ha (Rip50 + Chick)
7 Spading + Chicken litter @ 7.5 t/ha (Spade + Chick)

Crop measurements during the growing season included an emergence score and early vigour on July 3 and Green Seeker NDVI July 24, August 22 and September 23. The trial was harvested for grain yield on November 17, 2019 and grain quality was assessed post-harvest.

Results and Discussion

Green Seeker NDVI data recorded in late July showed ripping treatments, either shallow, deep or combined with spading improved early crop vigour. By late August there was no significant difference between any of the disturbance treatments. On average all disturbance treatments had NDVI values 26% higher compared to the control. There was still an increase in crop NDVI for these treatments by the September 23 scan, however this had reduced to 10%. The addition of chicken litter had a greater effect on the crop compared to disturbance treatments at the early NDVI assessment. For later assessments, chicken litter response was similar to the disturbance treatments.

Crop lower limit soil samples were taken from selected treatments to measure the difference between extracted moisture. No measurable difference was identified (data not shown).

Grain yield correlated with NDVI, indicating higher biomass resulted in higher grain yield (Figure 1) in this trial. The four disturbance treatments performed the same, producing an average 5.29 t/ha. This was a 1.02 t/ha (24%) increase compared to the control. The addition of chicken litter to either spading or deep ripping produced an additional 0.66 t/ha.

Grain protein did not vary between the control and the four disturbance treatments, averaging 10%. The addition of chicken litter to the deep ripping treatment increased protein to 10.7%, despite the significant increase in grain yield. The action of spading in the chicken litter appears to have increased the availability of nitrogen from the chicken litter, as this treatment had the highest protein, 11.6%. Test weight was lower in the chicken litter treatments (average 76.3 kg/hL) compared to the control treatments. However, this remained above the threshold for H1 quality classification (76 kg/hL). Grain screenings were not affected by any treatment (data not shown).

Partial gross margin (PGM) analysis shows in the first year after disturbance, large returns can be captured that cover the cost of treatment (Table 2). Return on investment (ROI) is greatest for ripping treatments, as it has a lower cost basis than spading. A positive return on chicken litter was observed in year one, however this would be cost neutral if not for the increase in grain protein and associated increase in pay grade. It has been demonstrated in several other trials that yield improvements are likely to continue beyond the first season, which is essential to justify the high costs for some treatments. This trial will be continued for another two seasons to monitor the longer-term treatment effects on productivity and profitability.

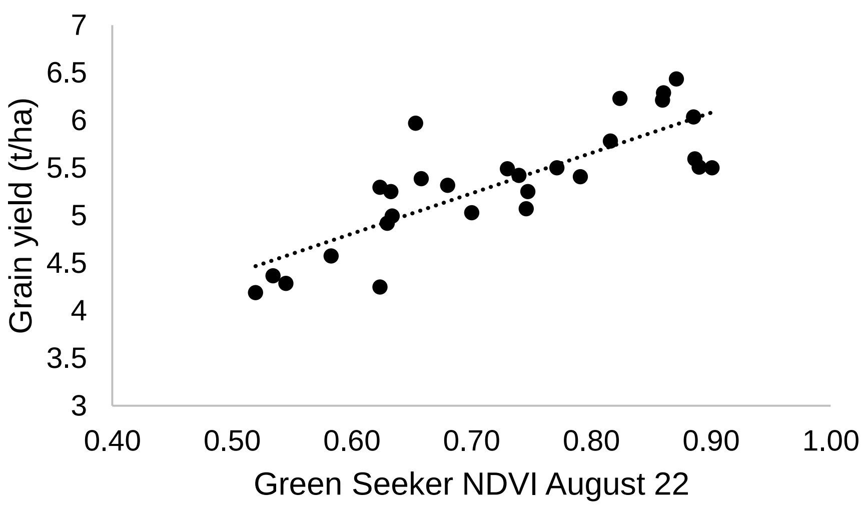

Figure 1. The relationship between Green Seeker NDVI recorded August 22 and grain yield (t/ha), y = 4.2389x + 2.2641, R^2 = 0.6526.

Table 1. Green Seeker NDVI recorded July 24, August 22 and September 23, grain yield (t/ha) and protein (%) for the Kybunga sandy soil trial, 2019.

Treatment		NDVI July 24 2019	NDVI Aug 22 2019	NDVI Sept 23 2019	Grain yield (t/ha)	Protein (%)
1	Control	0.545	0.553	0.602	4.27	10.3
2	Rip30	0.598	0.675	0.641	5.07	10.1
3	Rip50	0.643	0.695	0.676	5.42	9.7
4	Spade30	0.562	0.700	0.659	5.23	9.9
5	Rip50 + Spade	0.613	0.713	0.666	5.46	10.0
6	Rip50 + Chick	0.770	0.865	0.729	6.02	10.7
7	Spade + Chick	0.791	0.880	0.734	5.93	11.6
LSD (P≤0.05)		*0.048*	*0.059*	*0.039*	*0.51*	*0.6*

Table 2. Partial Gross Margin analysis for the first year of the Kybunga trial. Price assumptions, disturbance as per table, chicken litter $34.5/t incl spreading, SOA $400/t, wheat ASW $300/t, APW $310/t, H2 $320, cost of spading in Rip50 + Spade treatment reduced due to pre ripping.

Treatment	Disturbance ($/ha)	Chicken litter ($/ha)	SoA ($/ha)	Total ($/ha)	Grain yield (t/ha)	Income ($/ha)	Partial Gross Margin ($/ha)
Control			60	60	4.27	1282	1222
Rip30	50		60	110	5.07	1520	1410
Rip50	70		60	130	5.42	1626	1496
Spade30	200		60	260	5.23	1569	1309
Rip50 + Spade	250		60	310	5.46	1637	1327
Rip50 + Chick	70	260		330	6.02	1866	1536
Spade + Chick	200	260		460	5.93	1899	1439

Acknowledgements

Funding for this trial is gratefully acknowledged from GRDC project CSP00203 'Increasing production on sandy soils in low and medium rainfall areas of the Southern Region'. Kenton, Tracey and Will Angel are thanked for hosting the trial on their property and assistance with applications of pesticides and fertiliser throughout the season.

Long term comparison of seeding systems

Sarah Noack, Hart Field-Site Group

Key findings

- Below average rainfall resulted in wheat grain yields of 0.9 to 1.3 t/ha.
- There were small differences among seeder types in grain yield but, no effect of historic nitrogen application.
- Available soil nitrogen pre-seeding ranged from 95 to 151 kg N/ha following field pea grown in a marginal year. The high nutrition treatment had accumulated 40 kg N/ha more soil available nitrogen compared to the medium nutrition treatment.

Why do the trial?

The Hart cropping systems trial is unique, running since 2000, it provides SA grain growers with information on the long-term effects of cropping systems (a combination of seeders, tillage and stubble management) and nitrogen (N) fertiliser regime. There continues to be industry interest in disc seeders due to their ability to retain heavy stubble, minimise soil disturbance, increased seeding speed and seed depth uniformity. To date the trial has shown no one cropping system or nutrition regime is consistently higher in grain yield, quality or gross margin.

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

How was it done?

Plot size	45 m x 13 m	**Fertiliser**	MAP (10:22) at seeding @ 50 kg/ha
Seeding date	May 30 – No-till May 31 – Strategic June 4 – Disc	**Medium nutrition**	Urea (46:0) @ 50 kg/ha on Aug 6
Variety	Sheriff CL Plus Wheat @ 100 kg/ha	**High nutrition**	Urea (46:0) @ 50 kg/ha on Aug 6 Easy N (42.5:0) @ 70 L/ha + Twin Zn @ 0.5 L/ha on Sept 5

The trial was a randomised complete block design with three replicates, containing three tillage/seeding treatments and two N treatments. Stubble was uniformly managed across the trial area (previously a stripper front was used for the disc seeder) as the crop was field pea in 2018.

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

2000	2001	2002	2003	2004	2005	2006	2007
Sloop barley	ATR-Hyden canola TT	Janz wheat	Yitpi wheat	Sloop barley	Kaspa peas	Kalka durum	Janz wheat

2008	2009	2010	2011	2012	2013	2014	2015
Janz wheat	Flagship barley	Clearfield canola	Correll wheat	Gunyah peas	Cobra wheat	Commander barley	44Y89 (CL) canola

2016	2017	2018	2019
Scepter wheat	Scepter wheat	Wharton field pea	Sheriff CL wheat

Figure 1. Crop history of the long-term cropping systems trial at Hart 2000 – 2019.

Seeding treatments:

Disc – sown into standing stripper front stubble with John Deere 1890 single discs at 152 mm (6”) row spacing, closer wheels and press wheels.

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

No-till – sown into standing stubble in one pass with 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 (refer to previous page)

High – starter fertiliser plus two in-season N applications and Zn (refer to previous page)

All plots were assessed for soil available N (0-20, 20-40, 40-60 and 60-80 cm) on May 25, 2019. Plant establishment was assessed by counting 4 x 1 m sections of row and NDVI in each plot on August 2. All plots were assessed for grain yield at harvest (November 27). All data was analysed using ANOVA in Genstat.

Results and discussion

Soil available N was measured in autumn (post field-pea) and ranged between 95 kg N/ha to 151 kg N/ha (Figure 2). The high nutrition treatment had accumulated 39 kg N/ha more, averaging 149 kg N/ha for the high and 110 kg N/ha for the medium treatment. The difference indicates field pea fixed more N in the high treatment compared to the medium even in the dry 2018.

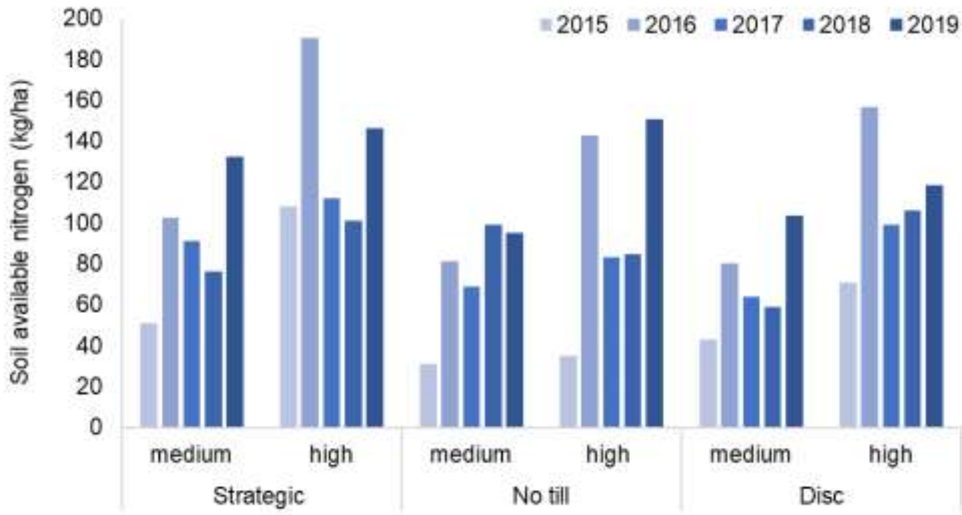

Figure 2. Soil available nitrogen (kg N/ha) pre-seeding for Hart long-term seeding systems trial from 2015 – 2019.

There was no difference in wheat plant establishment across the three seeders (data not shown). On average plant establishment was 172 plant/m^2 disc, 166 plants/m^2 for the strategic and 159 plants/m^2 for the no-till seeder.

Wheat grain yields across the trial ranged from 0.9 to 1.3 t/ha (Table 1). The dry season combined with later seeding dates (late May - early June) resulted in below average yields. The disc and strategic treatment provided the highest yields at 1.3 and 1.2 t/ha, respectively. However, there was only 0.4 t/ha differences across all treatments.

One of the main outcomes from this trial has been the lack of consistent performance in terms of grain yield from any one particular seeding system over the last 20 years. In the last five seasons (Table 1), four years have shown differences in grain yield among the seeding systems. In seasons where yield differences were observed, generally the no-till and disc alone or together outperformed the strategic treatment.

Grain quality values for screenings and test weight were not affected by seeding system or nutrition treatment (data not shown). The trial average screening level was less than 4% and test weight averaged 74 kg/hL. This lack of difference in grain quality among the seeder and nutrition treatments is consistent across the history of the trial.

Grain protein levels were high as a result of carry-over soil available N pre-seeding (Figure 2) and the accumulation of 39 kg N/ha more under the high nutrition treatment. It is not surprising that this translated to protein differences between the medium 12.8% (H2 classification) and high 14.1% (H1 classification) nutrition treatments.

Table 1. Grain yield (t/ha) for all seeder and nutrition treatments for the past five seasons.

Seeder type	Fertiliser strategy	2015 Canola	2016 Wheat	2017 Wheat	2018 Field pea	2019 Wheat	
		Yield (t/ha)					Protein (%)
Strategic	Medium	0.6	4.8	4.8	0.8	1.3	12.3
	High	0.6	5.9	5.9	0.7	1.2	14.9
No Till	Medium	0.6	4.2	4.2	0.9	0.9	13.7
	High	0.5	5.8	5.8	1.0	1.1	13.5
Disc	Medium	0.5	5.0	5.0	0.7	1.3	12.6
	High	0.5	5.9	5.9	0.7	1.3	13.8
LSD nutrition (P≤0.05)		ns			ns	ns	1.2
LSD seeder (P≤0.05)		ns			0.2	0.1	ns
LSD seeder x nutrition (P≤0.05)		ns	0.3	0.3	ns	ns	ns

Read the full summary of 16 years of results at:
http://www.hartfieldsite.org.au/pages/trials-results/hart-long-term-seeding-systems-trial.php

Acknowledgements

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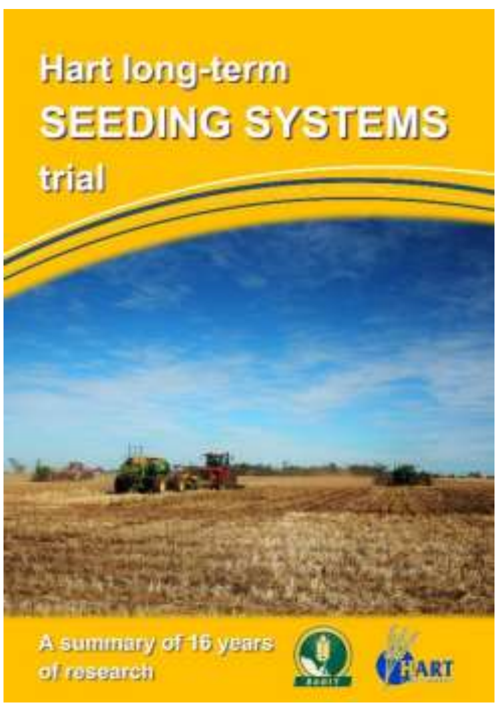

Hart Grower Guides

Download the full '**Hart long-term SEEDING SYSTEMS trial**' booklet on our website (look for Resources in the main menu).

You'll find other Grower Guides too:

- Improving pre-emergent herbicide spray coverage in stubble retention systems
- Soil Organic Matters – can soil carbon be increased through stubble retention
- Nitrogen management in wheat – why are nitrous oxide emissions an issue (and more)

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Optimising plant establishment – seeder comparison

Sarah Noack[1], Glenn McDonald[2], Stefan Schmitt[3], Claire Browne[4] and Genevieve Clarke[4]
[1]Hart Field-Site Group, [2]University of Adelaide, [3]Ag Consulting Co, [4]Birchip Cropping Group

Key findings

- Plant establishment for canola and lentil was low at Hart this season regardless of seeder type. This was largely due to marginal soil moisture at and after seeding.
- Across multiple sites and seasons the precision planter generally had more uniform interplant distances compared to the conventional seeder.
- The biggest yield gains observed for the precision planter have been at low seeding rates in canola.

Why do the trial?

Currently, there is little information on plant establishment from new and existing seeder types in winter crops across Australia. Crop patchiness and variability is sometimes observed in paddocks and can be attributed to both seeding conditions (e.g. soil temperature, moisture, pest pressure) and seeder setup (e.g. seeding depth).

Emerging plants compete against each other for resources to grow. The competitiveness of a plant is determined by a number of factors including seed vigour, proximity to neighbouring seeds/plants and the speed to germination and full emergence. Uniformity in seed placement could be beneficial to crop emergence and yield by reducing competitiveness between plants whilst retaining high plant densities and improving canopy architecture. This uniformity could be achieved by using a precision planter (seed singulation) at seeding time.

There is limited research into the use of precision planters in Australian winter crops, such as wheat, canola, lentils and faba beans. Benefits of using a precision planter could include seed input/cost reductions and increased yield. It aims to investigate our current seeding systems and review if precision planters have a fit in the southern and western winter grain growing regions of Australia.

How was it done?

Plot size	2.0 m x 10 m	**Fertiliser**	APP (15:22) @ 50 L/ha + 4.0 L/ha trace element mix
Row spacing	Narrow = 22.9 cm (9") Wide = 30.5 cm (12")		Easy N (42.5:0) @ 93 L/ha on June 28 - Canola only
Seeding date	May 14, 2019		
Location	Hart, SA		

Two crop types we evaluated; Hyola 559TT canola and Hurricane XT lentil. Each trial was a split-plot randomised design, blocked by seeder type (conventional and precision planter) and row spacing (narrow-22.9 cm (9") and wide-30.5 cm (12")). Both the conventional and precision planter seeder used the same double disc opening system. The only difference was the delivery of the seed where the conventional seeder mimicked an airseeding systems and the precision planter used a vacuum and singulation plates. The two trials were sown at six different seeding rates outlined in Table 1.

All plots were assessed for plant establishment number, interplant distance, seedling depth, biomass and harvest index during the season. Grain yield was assessed at harvest. Statistical analysis was performed on the data in Genstat using ANOVA.

Table 1. The six target plant densities (plants/m²) used in both the canola and lentil trials at Hart, 2019.

Plant density	Canola plants/m²	Equivalent seeding rate kg/ha	Lentil plants/m²	Equivalent seeding rate kg/ha
1	15	1.0	40	15
2	25	1.7	60	23
3	35	2.4	80	31
4	45	3.0	100	38
5	55	3.7	120	46
6	65	4.4	140	53

Results and discussion – Canola

Plant establishment and interplant distance

Seeder type did not affect the number of canola plants which established within the trial. Generally, there was only 1-5 plants/m² difference between the conventional and precision planter (Figure 1). However, both seeding rate and row spacing effected crop establishment. At low seeding rates (less than 25 plant/m²) crop establishment averaged 71%. This dropped to 60% for the higher seeding rates indicating a large portion of seed did not germinate or died back. These canola establishment rates are similar to those reported in the 2018 southern region paddock survey (McDonald 2019). In a separate study conducted at Birchip (Browne and McDonald 2020) canola establishment was higher, averaging 105% and 82% for the conventional and precision planter, respectively. This trial was sown into a moist seedbed and is likely to have contributed to the higher plant establishment compared to Hart.

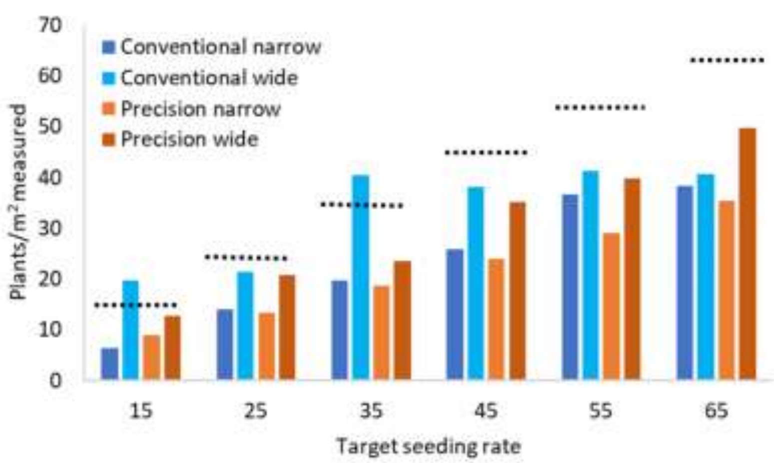

Figure 1. Average number of canola plants established (plants/m²) across the six different target densities in both the conventional seeder (blue) and precision planter (orange) for wide (12') and narrow (9') row spacings. Dashed black lines represent the target seeding rate. LSD (P≤0.05) seeder = ns, seeding rate = 7 and row spacing = 5.

The interplant distance coefficient of variation (CV%) indicates how consistently individual canola plants were spaced within crop rows. The interplant distance CV was affected by seeder type this season (data not shown). The conventional seeder had a lower CV of 80.5% compared to the precision planter 90.8%. This result was unexpected as the precision planter should achieve more uniform plant spacing. It is less than the variation measured in canola at Hart in 2018 (Pearse et al 2018) but, these CV% values are high and indicate there was a high degree of variability for both seeders. At seeding time, the disc struggled to penetrate into clay-loam soil and through the previous year's stubble rows (trial was sown perpendicular to oat stubble). This may have contributed to less uniform plant establishment. A number of skips (missed seeds) and multiples (more than one seed) were encountered when emergence counts were assessed.

Grain yield

The trial average canola grain yield was 0.6 t/ha. There was no interaction observed among the factors (seeder, row spacing and seeding rate) however, individually there were differences. Establishing at least 25 plants/m^2 was required to achieve highest grain yields and after this grain yield plateaued (that is, there was no yield benefit of having more than 25 plants/m^2). There was a 0.1 t/ha yield advantage from wide row spacing over narrow. The precision planter yielded 0.1 t/ha higher (a 17% yield difference in a dry season) compared to the conventional seeder.

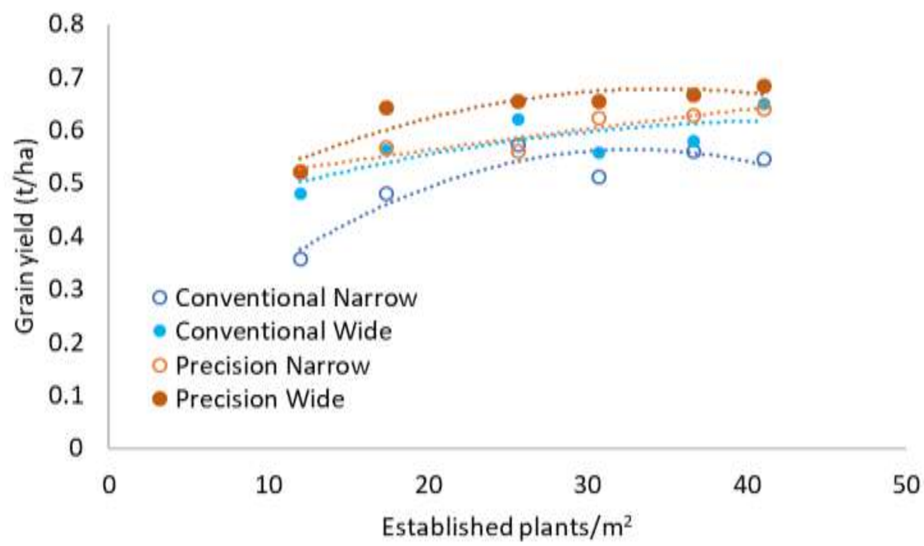

Figure 2. Average Hyola 559TT canola grain yield for the seeder, row spacing and seeding rate combinations at Hart, 2019. LSD (P≤0.05) seeder 0.04; seeding rate 0.06 and row spacing 0.04.

Lentil

Plant establishment and interplant distance

All trial factors seeder, seeding rate and row spacing effected the number of lentil plants which established. While these differences were significant, they were of little consequence in practical terms. For example, the conventional seeder on average had 10 plants/m^2 more compared to the precision planter. There were slightly more plants in the wide rows and plant number increased with seeding density. At the 40 plants/m^2 seeding rate, establishment percentage peaked at 80%. This dropped to 40 – 50% with increasing seeding which is often measured as sowing rate is increased. This is in contrast to similar research at Birchip where lentil plant establishment was generally greater than 90% across the trial (Browne and McDonald 2020). This also does not reflect observations at Hart in 2018 where lentils were achieving their target densities. Seeding into marginal soil moisture and achieving good soil-seed contact was an issue for both seeder treatments at Hart and may have reduced the plant establishment.

Similar to canola, the CV for lentil interplant distance was affected by seeder type. The precision planter had a lower CV of 70% compared to the conventional seeder 95%. However, similar to the lentils these values are high and indicate there was a large degree of variability for both seeders. In general, the lower CV% indicates the precision planter was able to evenly space lentil seeds to maintain a consistent distance between individual plants. This is in line with previous research which has shown the precision planter can more accurately singulate seed.

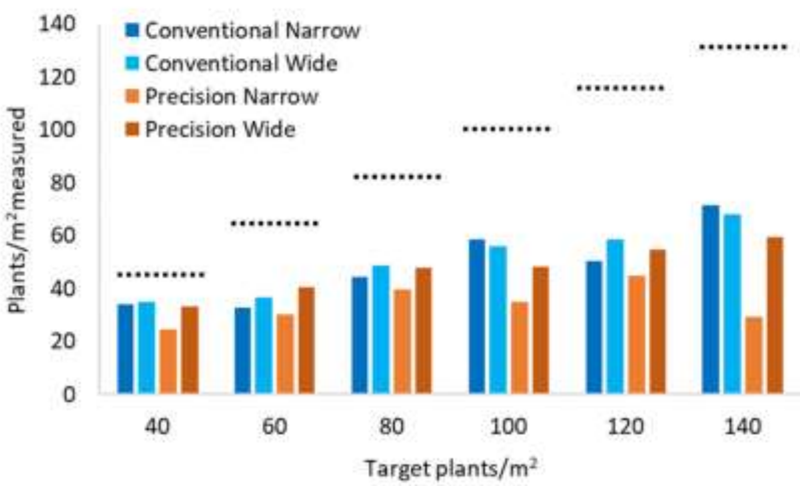

Figure 3. Average number of Hurricane XT lentil plants established (plants/m^2) across the six different target densities in both the conventional seeder (blue) and precision planter (orange) for wide and narrow row spacings. Dashed black lines represent the target seeding rate. LSD ($P \leq 0.05$) seeder × row spacing × seeding rate = 11 plants/m^2

Grain yield

Lentil grain yields averaged 0.7 t/ha (Figure 4) and were 0.1 t/ha higher for the precision planter compared to the conventional seeder. This was also observed in 2018, where the precision planter averaged 1.4 t/ha, compared to 1.2 t/ha in the conventional seeder. Row spacing also had a small effect with wide row spacing resulting in a 0.1 t/ha higher yield compared to narrow.

Where less than 45 plant/m^2 had established there was a reduction in grain yield. There was little effect of increasing target population above 45 plant/m^2 this season in yield gain. This result was similar at Hart in 2018. The average yield for plant densities 40 – 100 plants/m^2 ranged from 1.3 – 1.4 t/ha. Lentil varieties are recommended to be sown at 100 – 120 plants/m^2 (GRDC 2017) however, in two seasons trials establishing more than 40 – 45 plants/m^2 maintained the highest yields. With lower plant numbers will come lower competition for resources between the seedlings, reducing competition and potentially leading to increased plant growth and maintain high yields. It should be noted that this trial was managed under low weed and disease pressure.

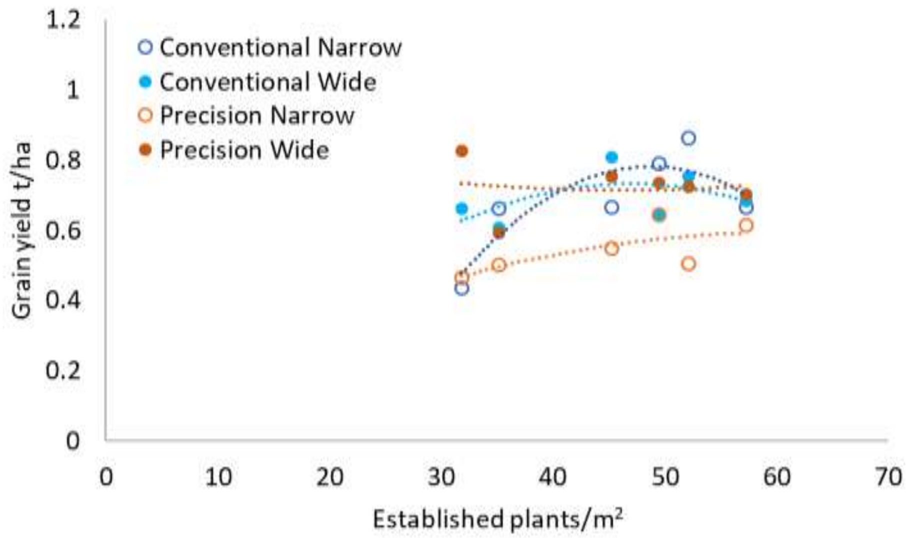

Figure 4. Average Hurricane XT lentil grain yield for the seeder, row spacing and seeding rate combinations at Hart, 2019. LSD P≤0.05 seeder 0.06 seeding rate 0.10 and row spacing 0.06.

Multi-site and season comparison of seeders

In the last two seasons a precision planter has been compared to a conventional seeder in a range of yield environments (Hart, Brichip and Roseworthy). The biggest gains observed for the precision planter have been at low seeding rates in canola (Figure 5). This is not unexpected, given one of the benefits outlined by growers using precision planters is a reduction in seeding rates due to better singulation / spacing of individual plants. As plant density increased (above 25 – 30 plants/m^2) there is a lack of consistent yield improvement but, the precision planter was able to maintain yield of the conventional seeder.

Within the lentil trials there have been two out of four trials where the precision planter resulted in a small yield improvement over the conventional seeder. In the other two trials lentil grain yields were the same. In contrast to canola, there was not a consistent response at low seeding rates. The shape of lentil seed has proven problematic for some of the precision planter seed plates. This is due to previous research and manufacturing focusing on corn, soybean and canola. Poor establishment in some of the lentil trials shows there are improvements to be made to the precision planter to accurately singulate this crop.

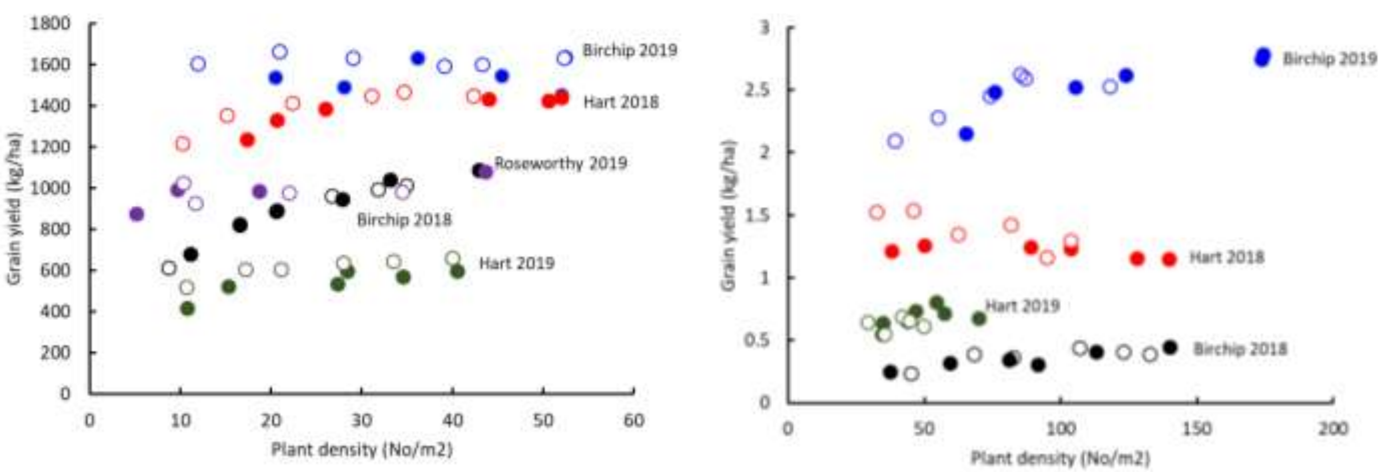

Figure 5. Grain yield for all precision planter and conventional seeder trials conducted across 2018 and 2019 (left) canola and (right) lentil. Closed symbols = conventional seeder; open symbols = precision planter.

Summary

Some of the key findings from this research so far have been:

- The precision planter was able to maintain and, in some cases, improve grain yields in lentils and canola at low seeding rates.
- Lentil grain yields were maintained at lower than recommended target seeding densities across a range of yield potentials. It should be noted that the trial was managed under low weed and pest pressure and this may not be observed under all paddock conditions.
- In general, the precision planter has been able to reduce the variation in interplant distance compared to the conventional seeder. However, there is still improvement to be made to the precision planter to achieve optimum singulation.

Acknowledgements

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Photo: Jade Rose & Sarah Noack; Hart Field-Site Group and Stefan Schmitt; Ag Consulting Co.

Seeder comparison: can we improve plant establishment and spacing?

Sarah Noack[1], Glenn McDonald[2], Claire Browne[3] and Genevieve Clarke[3]
[1]Hart Field-Site Group, [2]University of Adelaide and [3]Birchip Cropping Group

Key findings

- Lentil plant establishment was consistent across all seeders trialed at Condowie. However, at Birchip the precision planters had a higher establishment percentage, but this did not translate to higher grain yield.
- Precision planters were able to space lentil and canola plants more evenly compared to the grower tyne and disc machines.
- Across a variety of seeders, it was found that seeder set up had a greater impact on establishment than seeder age or type. This highlights the importance of checking your seeder setup before seeding.

Why do the trial?

Currently there is little information on plant establishment from new and existing seeder types in winter crops across Australia. Crop patchiness and variability is sometimes observed in paddocks and can be attributed to both seeding conditions (e.g. soil temperature, moisture, pest pressure) and seeder setup (e.g. seeding depth).

Emerging plants compete against each other for resources to grow. The competiveness of a plant is determined by a number of factors including seed vigour, proximity to neighbouring plants and the speed to germination and full emergence. Uniformity in seed placement could be beneficial to crop emergence and yield by reducing competitiveness between plants whilst retaining high plant densities and improving canopy architecture. This uniformity could be achieved by using a precision planter (seed singulation) at seeding time.

There is limited research into the use of precision planters in Australian winter crops, such as barley, canola, lentils and faba beans. Benefits of using a precision planter could include reduced seed input/cost and increased yield.

Trials were conducted at Condowie (lentil) and Birchip (canola) using commercial scale airseeders and precision planters.

The trials aimed to compare a number of commercial scale air-seeders and precision planters for plant establishment, early growth, yield and quality.

Lentil demonstration trial, Condowie SA

How was it done?

Plot size	Varied for each seed bar width x 50 m long	**Fertiliser**	MAP (10:22) @ 50 kg/ha or Ammonium polyphosphate APP (15:22) @ 50 L/ha, depending on seeder setup
Seeding date	June 4, 2019		
Crop	Jumbo 2 lentil		
Seeding rate	77 and 154 plants/m^2		

The trial was a randomised complete block design. Four seeders were trialed including two conventional seeders and two precision planters (Table 1). Each seeder sowed two ot three passes in 50 m strips. Apart from the sowing rates and fertiliser rate no other specifications were given for how to sow the trial. Decisions on seeder set up and speed of sowing were made by each operator. Ideally, each seeder was operated under 'optimal' conditions.

No herbicides were applied before sowing to minimise the risk of any interaction with the different seeders. The trial was managed during the season as per the surrounding crop.

The trial was sown into marginal soil moisture. The crop was Jumbo 2 lentil at two target plant densities of 77 and 154 plant/m^2, equivalent to 30 kg/ha and 60 kg/ha. All plots were assessed for plant establishment, interplant distance and grain yield. Grain yield was assessed using a plot harvester which harvested a single 50 m strip from each plot.

Table 1. Seeding systems trialed in lentils at Condowie, SA 2019.

Seeder	Type	Row spacing cm (inches)	Fertiliser placement
Horwood Bagshaw	Knife-point press wheel system	22.2 cm (8.75")	MAP applied at seeding
John Deere 1980	Single disc, closer wheels and press wheels	30.0 cm (12.0")	MAP applied at seeding
Horsch Maestro precision planter	Double disc	30.0 cm (12.0")	Demo machine – MAP was broadcast prior to sowing
Spot On Ag precision planter	Double disc	30.0 cm (12.0")	Demo machine – liquid APP

Results and discussion

Plant establishment and interplant distance

The number of lentil plants established was not affected by seeder type averaging 88% across all seeder treatments (Table 2; Photos 1 and 2). As expected, seeding rate had an effect on plant establishment number. On average 70 plants/m^2 established in the 30 kg/ha rate (91%) and 130 plants/m^2 in the 60 kg/ha seeding rate (84%).

Seeder type also did not affect average interplant distance (the distance between two adjacent seedlings in a row) in this trial. This is not surprising given all seeders were establishing a similar number of plants and therefore when averaged the distance between those plants is likely to be similar. To understand if precision planters were able to improve seed singulation compared to conventional grower equipment the coefficient of variation (CV%) for interplant distance can be used. The CV values indicate how consistently the lentil interplant distance was for each seeder, with lower values indicating less variability.

Photos 1. (L-R) Precision planter 1; 30 kg/ha and 60 kg/ha, Precision planter 2; 30 kg/ha and 60 kg/ha.

Photos 2. (L-R) Grower disc; 30 kg/ha and 60 kg/ha, Grower knife-point; 30 kg/ha and 60 kg/ha.

Both precision planters were able to reduce the variability in interplant distance (Table 2). At the low seeding rate (where precision planters are intended to be used) these values were low at 1.4% and 7.1 % compared with the average of 33% for both grower seeders and seeding rates (Table 2). That is, the precision planters were able to consistently space the seeds (low CV%) compared to the conventional seeders. The only treatment to show similar results was the grower knife-point seeder at the higher seeding rate which was unexpected. At the higher seeding rate, the uniformity of seed placement of the precision planters deteriorated as indicated by the increase in the CV%.

Table 2. Summary of plant establishment (plants/m^2), interplant distance (cm and coefficient of variation) and grain yield (t/ha) for the Hart lentil seeder demonstration trial, 2019. Values in parenthesis for plant establishment are % of the target plants that established.

Seeder	Seeding rate*	Plant establishment plants/m^2	Interplant distance cm	Interplant distance CV%	Grain yield t/ha
Grower knife-point	30 kg/ha	73 (95)	6.8	51.5	0.70
	60 kg/ha	138 (89)	2.4	2.8	0.70
Grower disc	30 kg/ha	69 (89)	5.4	46.0	0.47
	60 kg/ha	125 (81)	2.2	30.7	0.57
Precision planter 1	30 kg/ha	75 (97)	4.2	1.4	0.57
	60 kg/ha	149 (97)	2.3	14.7	0.61
Precision planter 2	30 kg/ha	63 (82)	5.3	7.1	0.40
	60 kg/ha	110 (71)	3.5	11.7	0.44
	Seeding rate	12.2	1.3		ns
	Seeder	ns	ns		0.08
	Seeder x seeding rate	ns	ns		ns

*Seeding rate 30 kg/ha was equivalent to targeting 77 plants/m^2 and 60 kg/ha is equivalent to targeting 154 plants/m^2.

Grain yield

Lentil grain yields ranged from 0.4 – 0.7 t/ha. The highest yielding seeder type was the grower knife-point at 0.70 t/ha (paddock owner). The second highest yields come from precision planter 1 and grower disc averaging 0.59 and 0.52 t/ha, respectively. The lowest yields came from precision planter 2 at 0.42 t/ha.

Canola demonstration trial, Birchip Vic

How was it done?

Plot size	Varied for each seed bar width x 50 m long	**Fertiliser**	MAP (10:22) @ 40 kg/ha or Ammonium polyphosphate APP (15:22) to match depending on seeder setup
Seeding date	April 12, 2019		
Crop	ATR Stingray canola		
Seeding rate	55 and 105 plants/m^2		

A comparison of six commercial seeders was conducted at Birchip. The six seeders included four conventional air seeders and two precision planters (Table 3). Three of the seeders were tyned and three were disc systems.

The trial was sown into a dry seedbed on April 12 at two sowing rate, 3.5 kg/ha (grower practice) and 1.75 kg/ha, using grower retained seed (318,470 seeds/kg). Due to the small seed size this was equivalent to 109 and 55 plants/$m^{2.}$ As a demonstration, one precision planter also sowed canola at 35 plants/m^2 (1.1 kg/ha).

Each seeder sowed two passes of 50 m in a randomised complete block design with three replicates. The seeding depth specified to all operators was 2 cm. Apart from the sowing rates and fertiliser rates no other specifications were given for how to sow the trial. Decisions on seeder set up and speed of sowing were made by each operator, so ideally, each seeder was operated under 'optimal' conditions. No herbicides were applied before sowing to minimise the risk of any interaction with seeders. The trial was managed during the season along with the surrounding crop.

Assessments included establishment counts and interplant spacings. Interplant spacings were measured once the canola had fully established and grain yield was measured with a plot header.

Table 3. Seeder information for the six seeders used in the trial at Birchip, 2019.

Seeder	Type	Row spacing (cm)	Fertiliser placement
Flexicoil 820	Tyne	30.5	With seed
Horsch 18NT sprinter	Tyne with coulters	25.0	With seed
Horwood Bagshaw scaribar	Tyne with coulters	37.5	Below seed
Morris RAZR disc	Disc	25.0	Below seed
Precision Planter (Spot on Ag)	Disc precision planter	33.3	Liquid only
Horsch Maestro	Disc precision planter	25.0	Demo machine (fert was broadcast prior to sowing)

Results and discussion

Plant establishment and interplant distance

Canola plant establishment across the trial averaged 63% (range 41 to 93%). Unlike the lentil trial, there were differences in establishment among the seeders (Table 4). The precision planter sowing at 35 plants/m^2 achieved 100% establishment. This highlights that precision seeders have the ability to achieve high establishment at low plant densities.

The precision planters had smaller interplant distance (average 6.8 cm) than the conventional seeders (average 8.2 cm). The CV% of the interplant distance indicates how consistently canola plants were spaced for each seeder. Using precision planters resulted in more evenly spaced canola plants compared to the conventional air seeders: average CV% for the precision planters was 83% and the CV% for the conventional seeder was 91%.

Table 4. Canola plant establishment percent (%) and interplant distance (cm) and grain yield (t/ha) for the six seeders. Different letters indicate significant difference.

Seeder	Target plants/m^2	Plant establishment (plants/m^2)	Establishment (%)	Interplant distance (cm)	Grain yield (t/ha)
Conventional tyne 1	55	40^{bcd}	74	8.8	2.4^{cd}
	109	63^{bc}	58	5.4	2.3^{d}
Conventional disc 1	55	41^{bcd}	75	10.3	3.0^{a}
	109	47^{bcd}	43	5.6	2.9^{ab}
Conventional tyne 2	55	31^{cd}	56	10.2	2.4^{cd}
	109	101^{a}	93	3.6	2.3^{d}
Conventional tyne 3	55	26^{c}	47	14.7	2.4^{cd}
	109	46^{bcd}	42	7.0	2.5^{cd}
Precision planter 1	55	25^{d}	45	10.2	2.5^{cd}
	109	56^{bcd}	51	4.9	2.6^{bc}
Precision planter 2	35	36^{bcd}	103	7.7	2.3^{d}
	55	37^{bcd}	68	8.3	2.3^{d}
	109	67^{b}	61	4.3	2.3^{d}
	LSD	15		1.3	0.3
	CV (%)	18.1	26.3	19.1	6.9

Grain yield

Canola grain yields varied from 2.3 t/ha to 3.0 t /ha. The conventional disc seeder at the low sowing rate had the highest yield (Table 4), 0.4 t/ha higher than the next seeder, a precision planter. The average grain yield of the four conventional seeders was 0.1 t/ha higher than the two precision planters. The disc seeders in the trial yielded 0.2 t/ha more than the tyne seeders. The dry sowing conditions at sowing favoured disc systems this season. Under wet conditions sowing logistics may become more challenging with a disc.

Sowing density did not affect grain yield, averaging 2.5 t/ha for both the 55 plants/m^2 and 109 plants/m^2. The canola sown with the precision planter at 35 plants/m^2 had an establishment percent of 103 per cent and yielded 2.3 t/ha. This result highlights the potential for seed saving costs (particularly if using hybrid seed) while maintain grain yield of the other seeder types.

Implications

Investing time in seeder set up for particular crops can optimise establishment. The trial results indicated good establishment can be achieved using either conventional or precision equipment. There appears to be no strong relationship between plant establishment and final grain yield. This shows plant establishment percentage is not the only factor influencing grain yield. The large range in plant establishment percentage in these trials (particularly for canola) indicates there is room to improve crop establishment.

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Hart Field Day

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Notes


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