2021

HART TRIAL RESULTS

Sponsors

The board of the Hart Field-Site Group Inc would like to acknowledge the significant financial contribution of our committed sponsors, supporters, collaborators and partners.

Principal Sponsor

All logos are clickable

Sponsors

Contents

HART INFORMATION

CROP VARIETIES

CROP AGRONOMY

Contents

WEED MANAGEMENT AND HERBICIDES

PEST AND DISEASE MANAGEMENT

SOIL AND CROP NUTRITION

CROPPING SYSTEMS AND MANAGEMENT

NOTES

Front cover photo by Rebekah Allen.

Thanks also Sandy Kimber, Rebekah Allen, Declan Anderson 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 2022 calendar

HART FIELD DAY

September 20

Our main Field Day attracts over 600 visitors from all over 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 is included in the entry fee.

This is Hart's main event of the year.

Hart AGM

October 2022

Getting The Crop In

March 9

8am – 12:30pm

At this annual seminar, industry guest speakers from across the county cover a wide range of topics, all relevant to broadacre cropping.

Winter Walk

July 19

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 18

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
Andrew Cootes
Rob & Dennis Dall
Matt Dare
Trevor Day
Jack Desbiolles
Ben Fleet
Leigh Fuller
Gurjeet Gill
Simon Honner
Peter Hooper
Damien Hooper
Michael Jaeschke
Roger Kimber
Larn McMurray
Tim Murphy
Daniel Neill
Sarah Noack
Anthony Pfitzner
Ashley Pilkington
Chris Preston
Tom & Ashley Robinson
Rural Solutions, Nuriootpa
Andre Sabeeney
Stefan Schmitt
Stuart Sherriff
Damien & Ben Sommerville
Kelvin Tiller
Rob & Glenn Wandel
Reinhold Wehrmann
Glen Wilkinson
Justin, Bradley & Dennis Wundke

We would also like to thank various organisations for the provision of seed and/or products that were trialed in the 2021 research program.

ADAMA
Advanta Seeds
Australian Grain Technologies
Barenbrug
BASF
Bayer Crop Science
Corteva Agriscience
FMC
Global Grain Genetics
Imtrade
InterGrain
LongReach Plant Breeders
Nufarm
Nuseed
PGG Wrightson Seeds Australia
Pioneer Seeds
Plant Science Consulting
Pulse Breeding Australia
S & W Seeds
SARDI Clare
SARDI Vetch Breeding Program
SARDI Agronomy & Crop Sciences
Seednet
Seed Force
Sumitomo
Syngenta
University of Adelaide
UPL

Thank you also to the following people who volunteer on Hart's Research Committee.

Rob Dall
Matt Dare
Ash Hentschke
Simon Honner
Simon McCormack
Sarah Noack
Rob Price
Stuart Sherriff
Scott Weckert
Glen Wilkinson

And finally, thank you to those who have volunteered their time to support Hart's 'BEEN FARMING LONG?' workshop series for early career farmers.

Jim & Katherine Maitland
Andrew Mitchell
Rob Pratt
Deb Purvis
Scott & Jeff Weckert
Ben Wundersitz
Ben Marshman

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

Hart Field-Site Group board

Andre Sabeeney (Clare) .... Chairman
Ryan Wood (Clare) .... Vice-chairman, sponsorship
Sandy Kimber (Clare) .... Executive officer
Deb Purvis (Wallaroo) .... Finance officer
Matt Dare (Marola) .... Commercial crop manager, sponsorship
Simon Honner (Blyth) .... Board member
Rob Dall (Kybunga) .... Board member
Glen Wilkinson (Snowtown) .... Sponsorship
Stuart Sherriff (Clare) .... Board member
Scott Weckert (Blyth) .... Sponsorship, community engagement
Josh Reichstein (Blackwood) .... Board member
James Venning (Barunga Gap) .... Board member

Rebekah Allen .... Research & extension manager
Declan Anderson .... Regional intern
Gabrielle Hall .... Media

Site Management

<u>SARDI, Agronomy Clare:</u>
Patrick Thomas, John Nairn, Sarah Day, Navneet Aggarwal, Penny Roberts, Dylan Bruce, Greg Walkley, Amber Spronk, Dili Mao and Jacob Nickolai

<u>Hart Field-Site Group:</u>
Rebekah Allen and Declan Anderson

Contact us in person…

Chairman
Andre Sabeeney
04718 835 599

Research & Extension Manager
Rebekah Allen
0428 782 470

Executive Officer
Sandy Kimber
0427 423 154
admin@hartfieldsite.org.au

Or find out more about us…


HART
SA's premier cropping field site
Hart Field Day
September 20, 2022
celebrating
40
YEARS
of research & extension
www.hartfieldsite.org.au

The Hart site

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

In 2021, Quarter 3 hosted our trials.

Quarter 4 was sown with Mulgara oats and was cut for hay to tidy the site in preparation for 2022 trials.

Quarters 1 and 2 were sown with canola as our commercial crop.

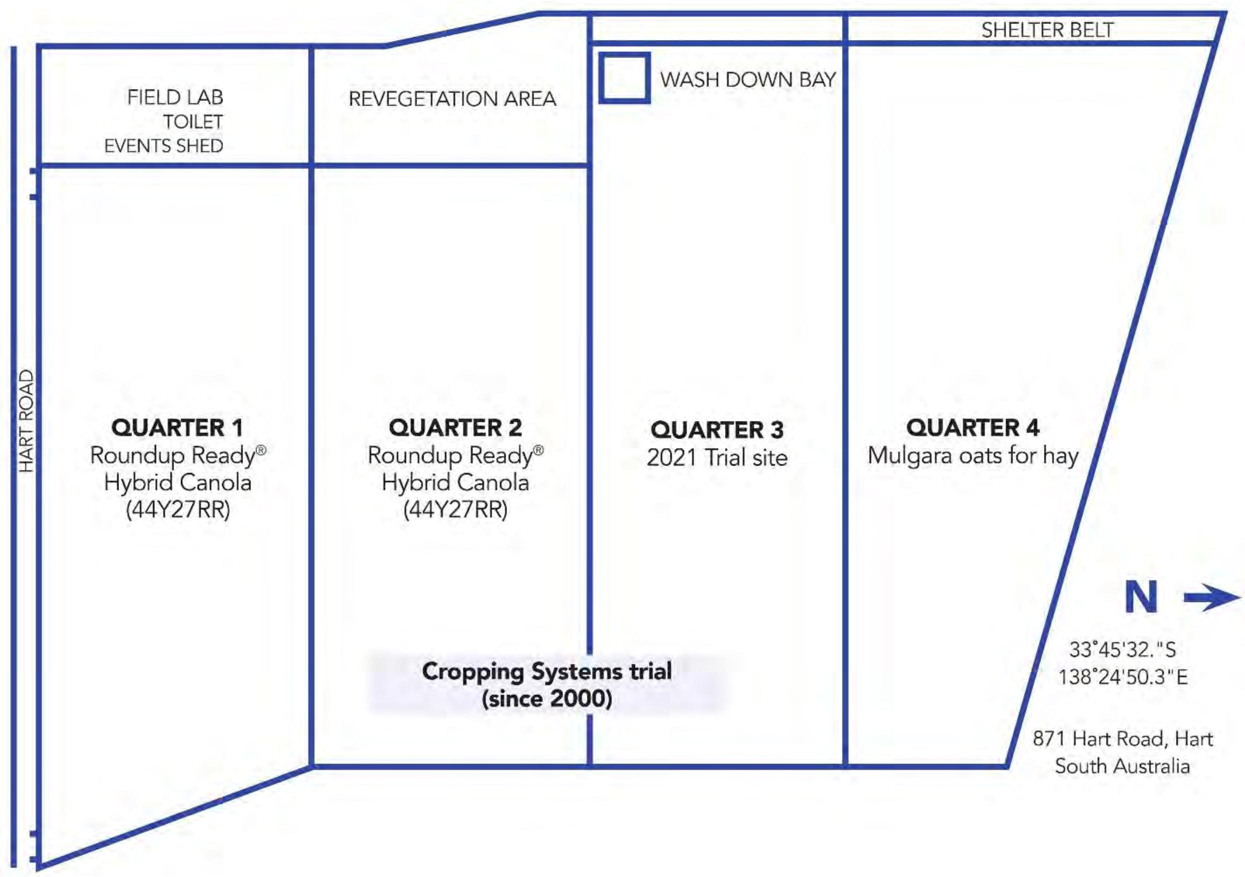


Photo. Hart field site, 2021 harvest.

Hart commercial crop report

Matt Dare; Hart Field-Site Group

The 2021 commercial crop was Round Up Ready Hybrid Canola (Pioneer 44Y27 RR), dry sown in Quarters 1 and 2 and the south carpark of the site on April 26. Seeding rate was 2.35 kg/ha plus 80 kg DAP with flutriafol at label rates.

Conditions at Hart were relatively dry until May 25, with a few minor rainfall events on May 9, 11 and 15 resulting in very patchy emergence of canola and generally a thin crop. A relatively small amount of mouse activity was also present on parts of the site. 1.0 L/ha of Crucial (600 g/L glyphosate) + 70 ml Archer (750 g/L clopyralid) was applied on June 28 when the crop was at 2 – 5 leaf stage. No more applications of glyphosate were applied as Pioneer 44Y27 RR is not tolerant of glyphosate after 6 leaf stage.

Thanks to Jamie Wilson of Pioneer Seeds for organising seed, and Andre Sabeeney of Nufarm for supplying the Crucial herbicide.

Nitrogen was applied to the commercial canola crop as 100 kg/ha urea on July 1 and another application of 75 kg/ha of urea was made on August 18.

Rob Wandel windrowed the canola October 24 and applied 2.35 L/Ha of Crucial (600 g/L Glyphosate) under the windrow to control later germinating ryegrass and other weeds. Thanks to Andre Sabeeney and Nufarm for supplying the Crucial herbicide.

The site was hit with a strong wind event on October 29, resulting in canola windrows blowing across the site..

The commercial crop was harvested by Rob Wandel on November 19 and delivered to Owen by Angus Dare.

Despite the patchy emergence, lack of spring rain and severe wind post-windrowing and pre-harvest the commercial canola crop yielded 16.3 t (0.96 t/ha) with 41% oil content. GM Canola was sold to Viterra for $830/t.

Quarter 4 of the site was sown to Mulgara oats for hay on May 28 in preparation for the 2022 trial site.

The oats were cut just after the field day by Rob Wandel and was baled on October 12.

Quarters 1, 2 and 4 were sprayed for summer weeds by Scott Weckert on December 13. Quarter 3 was sprayed late January (post trials harvest) for summer weeds by SARDI.

I would like to thank all who helped out with the commercial crop this past year, in particular Rob Wandel who windrowed and harvested in amongst his own busy cropping program.

The 2021 season at Hart; rainfall, temperature and soil analysis

Rebekah Allen and Declan Anderson; Hart Field-Site Group

The Mid-North region had a dry start leading into the 2021 growing season. A lack of rainfall across summer months until late May meant there was very little stored soil moisture (Figure 1). Some sowing windows across the district were pushed back due to poor seasonal conditions, with delayed and patchy emergency an issue for early sown paddocks.

A late and much needed break of 19 mm of rainfall was received on May 25 (Table 1).

Seeding at Hart commenced on April 19, with early sown winter wheat and vetch trials. The majority of Hart's trials were sown by mid-May, although no significant rain had occurred. The program was slightly delayed, with all remaining trials sown by June 10. By this time, we had received 60 mm growing season rainfall (GSR).

Starting soil nitrogen on the trial site was 88.5 kg/ha (0 – 60 cm), after oaten hay was grown in 2020 (Table 2).

Trials at Hart began to emerge on May 26. Growth was slow but consistent with winter rainfall providing optimism for the remainder of the season. However, September and October saw well below average rainfall, which reduced crop yield potential across most trials at the Hart field site.

Hart received 401 mm of annual rainfall in 2021, placing it at a decile 5 rainfall year (average annual rainfall 400 mm). Growing season rainfall (April – October) of 231 mm was 70 mm below Hart's 100 year average growing season rainfall (300 mm), equivalent to a decile 3.

Large November rains increased available stored soil moisture for the 2022 season (Figure 2).

Daily minimum and maximum temperature data at Hart in 2021 is provided in Figure 3.

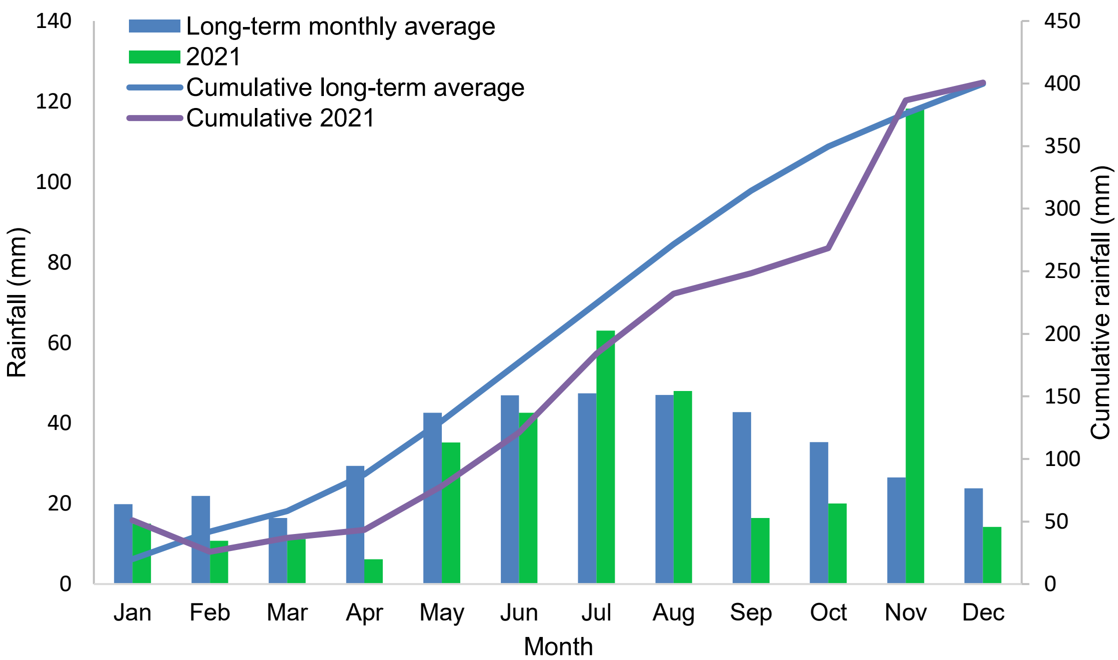


Figure 1. Hart rainfall graph for the 2021 season and long-term average. Lines are displayed to present cumulative rainfall for long-term average (blue) and 2021 (purple).

Table 1. Hart rainfall chart 2021 (Mesonet).

	January	February	March	April	May	June	July	August	September	October	November	December
1	0	0	0	0	0	0	0	16	0	2.4	0	0
2	0	0	0	0	0	0	2.6	0	0	0.2	0	0
3	0	0	0	0	0	1.6	2.8	4	1.8	1.4	0.4	0
4	0	0	0	0	0.2	1	3.6	4.8	1.4	0.8	0.6	0
5	0	3.6	0	0	0	0	4.6	3.2	3	0	0	0
6	0	2.4	0	0	0	0	0.2	0.6	0.4	0	0	0
7	0	0.2	0	0	0	0	0	0.6	0	0	4.8	0.2
8	0	0	0.2	0	0	8.2	0	0	0.4	0	0	0
9	0	0	0	0	4	7.2	0	0	0	0	0	0
10	0	0	0.2	0	3.2	0.4	2	0	0	0	2.8	0
11	0	0	8.8	0.2	1.6	0	0	0.6	0	0	6.2	0
12	0	0	0	0	0	0.2	0	6	0.6	0	47.2	0
13	0	0	0	0	0	0	0	0.2	2.8	2.4	21.2	0
14	0	0	0.8	0.4	2.6	0	11.6	0.2	0.2	1.4	2	0.4
15	0	0	0	0	0.4	0	0	0	0	8	4.6	1.4
16	0	0	0	0	0	5.6	3.6	0	0	0.2	0.6	0
17	0	0	0	0	0	1	4.8	0	0	0	0.2	0
18	0	0	0	0	0	7.2	0.2	0.2	0	0	0	12.2
19	0	0	0	0	0	2	0	0	0	0	1.4	0
20	0	0	0	0	0	0.2	1.2	0.4	1.2	0	11	0
21	0	4.6	0	4.6	0	0	0.6	0.6	1.6	0	0.4	0
22	0	0	0	0	0	0	3.2	0.2	0	0	0	0
23	0	0	0	0.6	0	1.8	4.8	3.4	0	0.4	1.6	0
24	0	0	0	0.2	0	0.2	1	0.6	0.2	0	10.4	0
25	0	0	0.2	0.2	18.6	3.2	4.8	1.2	0	0	2.8	0
26	14.8	0	0	0	4	2.2	0.2	0.4	0	0	0	0
27	0.2	0	1	0	0.4	0.4	0	0.2	0	0	0	0
28	0	0	0	0	0.2	0.2	11	0	0	0.6	0	0
29	0		0	0	0	0	0.2	4.6	2.6	1.2	0	0
30	0		0	0	0	0	0	0	0.2	1	0	0
31	0		0		0		0	0		0		0
Montly total	**15.0**	**10.8**	**11.2**	**6.2**	**35.2**	**42.6**	**63.0**	**48.0**	**16.4**	**20.0**	**118.2**	**14.2**
GSR rainfall				6.2	41.4	84.0	147.0	195.0	211.4	231.4		
Total rainfall	15.0	25.8	37.0	43.2	78.4	121.0	184.0	232.0	248.4	268.4	386.6	400.8

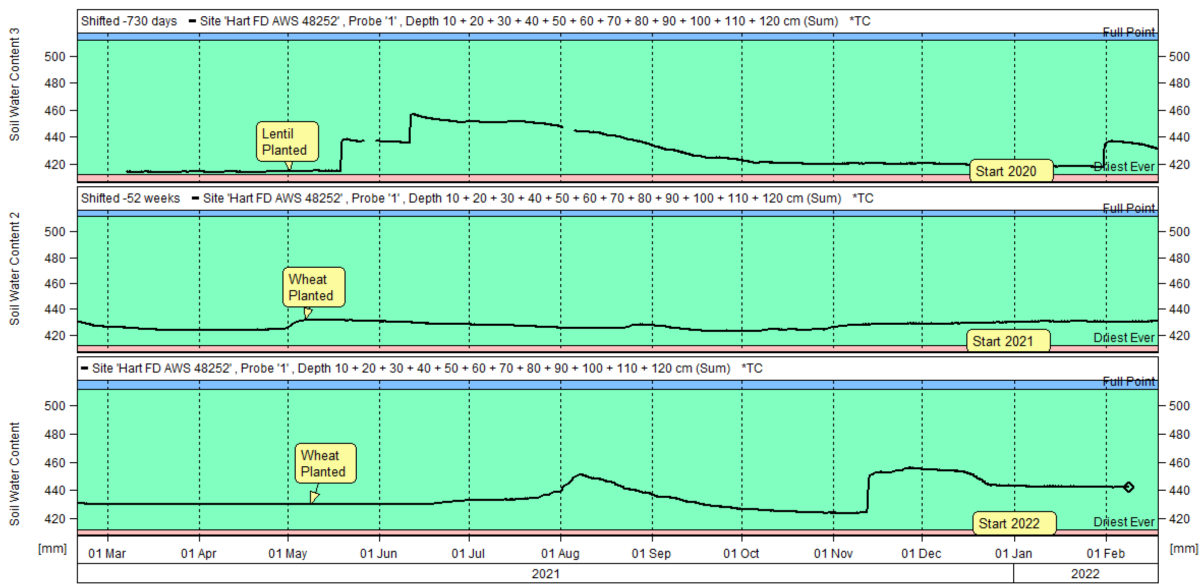


Figure 2. Soil moisture probe summed comparison (80 cm) for 2019 (top), 2020 (middle) and 2021 (bottom) at the Hart field site.

Hart soil moisture data is free to view courtesy of Agbyte: http://www.hartfieldsite.org.au/pages/live-weather/soil-moisture-probe.php

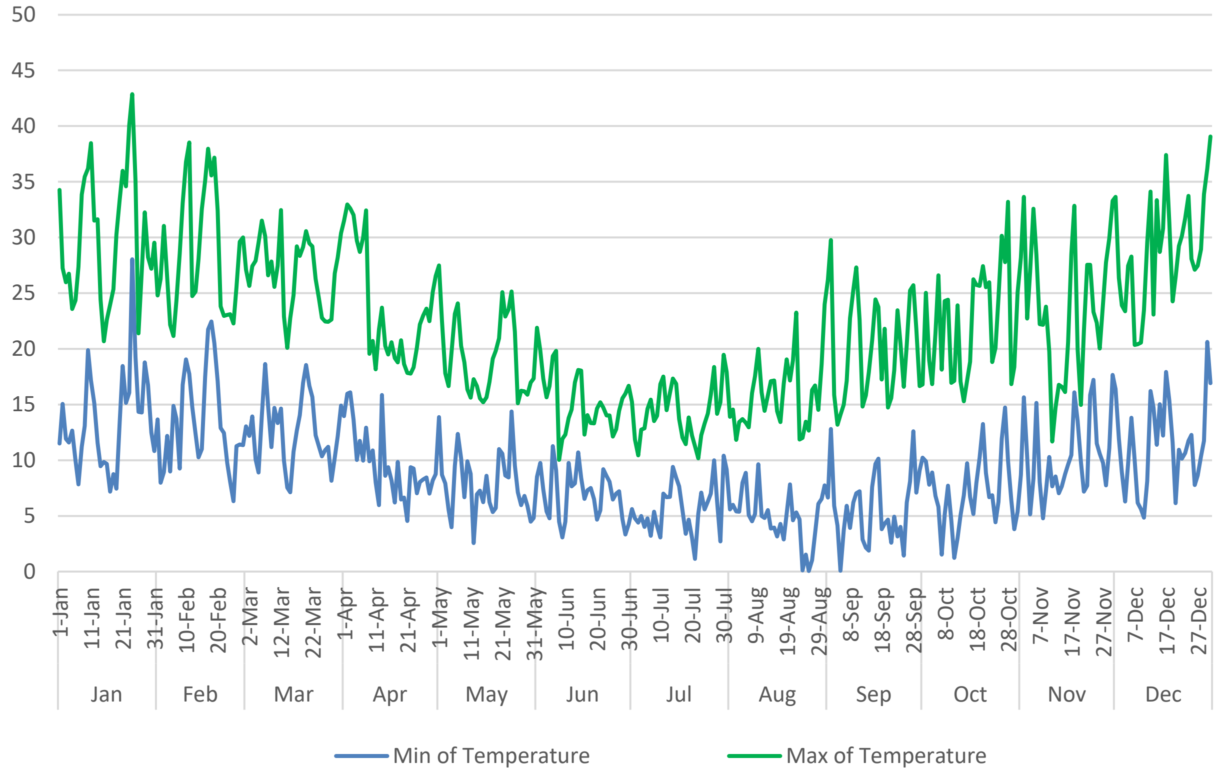


Figure 3. Daily minimum and maximum daily temperature (°C) from January 1 to December 31 at Hart in 2020 and 2021.

Table 2. Actual soil physical and chemical properties for the Hart field site, sampled April 6, 2021.

Soil property	Units	Sampling Depth (cm) 0 – 15 cm	15 – 35 cm	35 – 55 cm	55 – 75 cm	75 – 105 cm	Total profile (0 – 60 cm)
Texture		Loam	Loam	Loam	Loam	Loam	
Gravel	%	15 – 20	15 – 20	35 – 40	35 – 40	35 – 40	
Phosphorus Colwell	mg/kg	10	16	23	11	20	
Potassium Colwell	mg/kg	304	229	306	260	308	
Available soil N	kg/ha	23.4	28	33.6	15	18	88.5
Sulphur	mg/kg	5.2	6.2	4.8	34.5	70.2	
Organic Carbon	%	0.97	0.68	0.71	0.37	0.4	
Conductivity	dS/m	0.177	0.197	0.257	0.51	0.675	
pH ($CaCl_2$)		7	7	7.4	7.4	7.9	

Yield Prophet® performance in 2021

Rebekah Allen; Hart Field-Site Group

Key findings

- Yield Prophet® simulation of wheat grain yields sown on May 1 at Hart in 2021 predicted 2.61 t/ha above actual harvested yield.
- Differences observed between predicted and actual wheat grain yields were attributed to crops receiving above average rainfall in July and August, followed by dry seasonal conditions influencing actual nitrogen, moisture uptake and yield potential.
- Differences between the 20%, 50% and 80% yield probabilities in the final simulation (October) were small, however, damaging weather conditions pre-harvest at Hart contributed to significant grain loss.

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 information such as plant available water (PAW) and soil nitrogen (N) levels, as well as historical climate data and current 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 to provide information of this accuracy at such a useful time of the season is currently available to growers.

How was it done?

Location	Hart, SA	**Fertiliser**	May 1: 30 kg N/ha
Seeding date	May 1, 2021		July 21: 40 kg N/ha
Variety	Scepter wheat @ 180 plants/m^2		

Yield Prophet® simulations were issued monthly during the growing season (June – October) to track the progress of wheat growth stages and changes in predicted grain yield. This data was published for 8 Mid-North sites and can be viewed online through Hart's Hart Beat Newsletter.

Soil at the Hart field site ranges from a loam to clay-loam texture (0 – 30 cm) and provides moderate infiltration and PAW. The estimated starting available soil N entered in Yield Prophet® at Hart in 2021 was 61 kg/ha.

Results

The first yield prediction was simulated on June 28 for wheat sown on May 1 and was estimated to yield 3.6 t/ha in 50% of years. In 20% of years, the same crop would achieve a grain yield of 3.9 t/ha and in 80% of years, 3.1 t/ha (Figure 1). The 20%, 50% and 80% level of probability refers to the percentage of years where the predicted yield estimate would have been met, according to the previous 100 years of rainfall data at Hart.

By the end of July, Hart had received 46 mm rainfall since the first simulation in June, bringing growing season rainfall (GSR) to 147 mm. At this time, wheat grain yield predictions increased to 4.5 t/ha due to above average rainfall (Figure 2). The soil moisture profile was 26% full (Figure 3), increasing plant available water (PAW) to 54 mm.

The August Yield Prophet® prediction estimated similar yields of 4.9 t/ha with a prediction of 78 mm rainfall left for the growing season, based on historic rainfall data. September and October both received well below average rainfall with the simulation on October 8 predicting a lower yield of 3.65 t/ha, similar to that estimated in June, reflecting a dryer finish to the season.

In 2021 at Hart, Scepter wheat yielded 47% below the predicted yield (at 50% probability) for August, yielding 2.29 t/ha.

The differences observed between the predicted and actual harvested yield can be attributed to Hart receiving above average rainfall for July and August, leading to an increase in soil moisture, yield potential and the application of N at this time. Actual rainfall events following this prediction were below average, with September and October months receiving only 36 mm rainfall. Damaging weather conditions pre-harvest also contributed to grain loss.

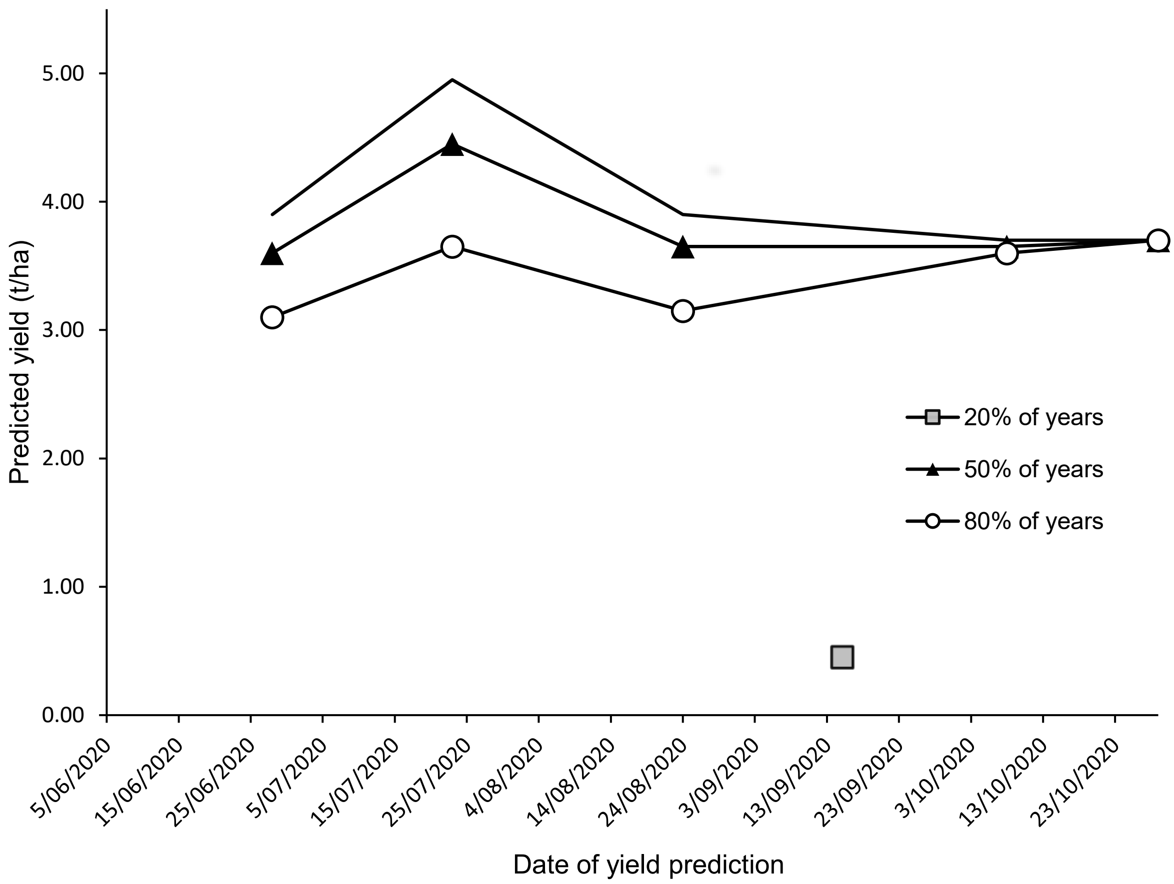


Figure 1. Yield Prophet® predicted yields at 20%, 50% and 80% probabilities at Hart, 2021.

Table 1. Long-term average (100 years) and 2021 rainfall at Hart. Shaded values show months with above average rainfall (mm).

	Long-term rainfall average (mm)	2021 monthly rainfall (mm)	Rainfall difference (mm)
January	20	15	-5
February	22	11	-11
March	16	11	-5
April	29	6	-23
May	43	35	-7
June	47	43	-4
July	47	63	16
August	47	48	1
September	43	16	-26
October	35	20	-15
November	27	118	91
December	24	14.2	-10
Rainfall total	400	401	

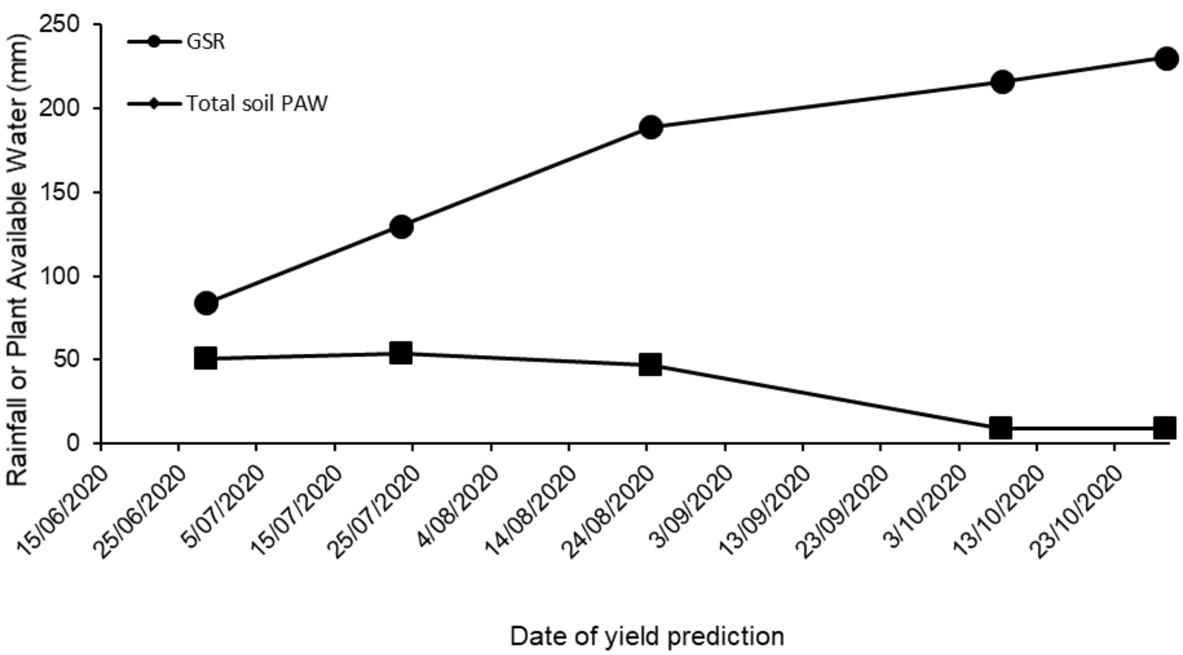


Figure 2. Growing season rainfall (GSR) and plant available water (PAW) on simulation dates at Hart in 2021.

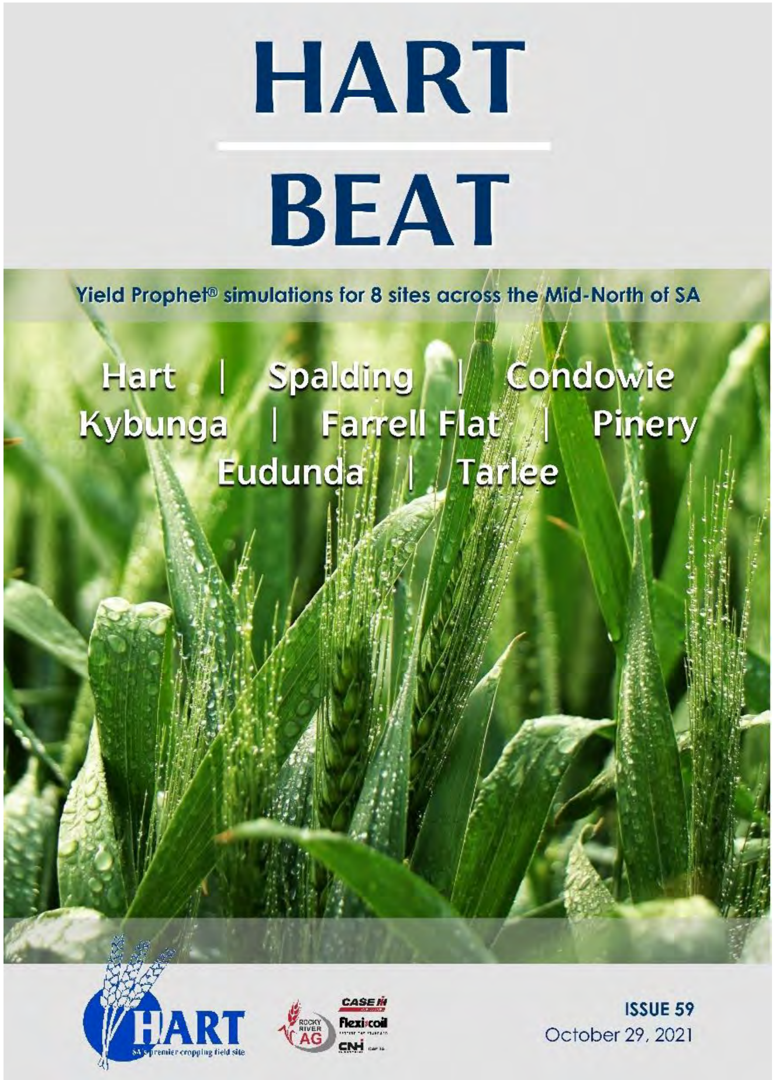
Acknowledgements

This trial is funded by

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank Andrew Cootes, Daniel Neil, Justin Wundke, Rob Dall, Kelvin Tiller, Damien Sommerville, Trevor Day and Anthony Pfitzner for providing local weather data and paddocks for sampling in 2021.

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



VIEW & SUBSCRIBE ON THE HART WEBSITE

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

Rainfall variability trial at Hart in 2021

Declan Anderson and Rebekah Allen; Hart Field-Site Group

Key findings

- A 17 mm (8%) difference in rainfall was recorded across the 40 ha Hart field site during the 2021 growing season (April – October).
- Rainfall patterns were variable, with results showing that no single location in the paddock received significantly higher rainfall at each rain event.
- Rainfall received for winter and spring months had the most consistent distribution of rainfall across the site when compared to Autumn, with a coefficient of variation (CV) percentage of 8.4% and 10.4%, respectively.

Why do the trial?

Rainfall distribution is known to be widely variable across agricultural areas. The variability of measured rainfall across these regions is common, due to factors that include the duration and intensity of weather events. The use of remote weather stations, including the Mid-North Mesonet have become useful tools for growers to track rainfall events and compare measured rainfall against various locations, however, the variation of rainfall distribution across smaller cropping areas, is not well known.

This trial aims to identify seasonal rainfall trends and capture the variability of rainfall differences for individual rain events, at a paddock-scale.

How was it done?

In 2021, 11 manual rain gauges were positioned across 40 ha at the Hart field site (Figure 1). Rainfall measurements from the gauges were measured and recorded after each rainfall event.

Rainfall events ranged from 1 – 5 days, dependent on the persistence of rainfall during this time. This is displayed in Table 1, showing that 44 rainfall events were recorded manually at Hart, compared to the Mesonet with 95 actual rainfall days.

All gauges were calibrated prior to the first rainfall event, ensuring the volumetric capacity of water (mm) was consistent for measurement accuracy. Events below 0.4mm were not recorded.

Rainfall at the Hart field site was mapped using a GIS program to display rainfall patterns for each event, through inverse distance weighted (IDW) interpolation maps (Figure 2).

The variability of autumn, winter and spring rainfall, growing season rainfall, annual rainfall and individual rainfall events was measured.

Table 1. Growing season and annual rainfall summary for the 2021 season at Hart. Rainfall data was sourced from the Mid-North Mesonet.

	Rainfall (mm)	Decile
Annual rainfall	401.0	5
Growing Season (GSR)	231.6	3
	Mesonet (rainfall days)	**Manual gauges (recorded rainfall events)**
Number of recorded rainfall events	95	44

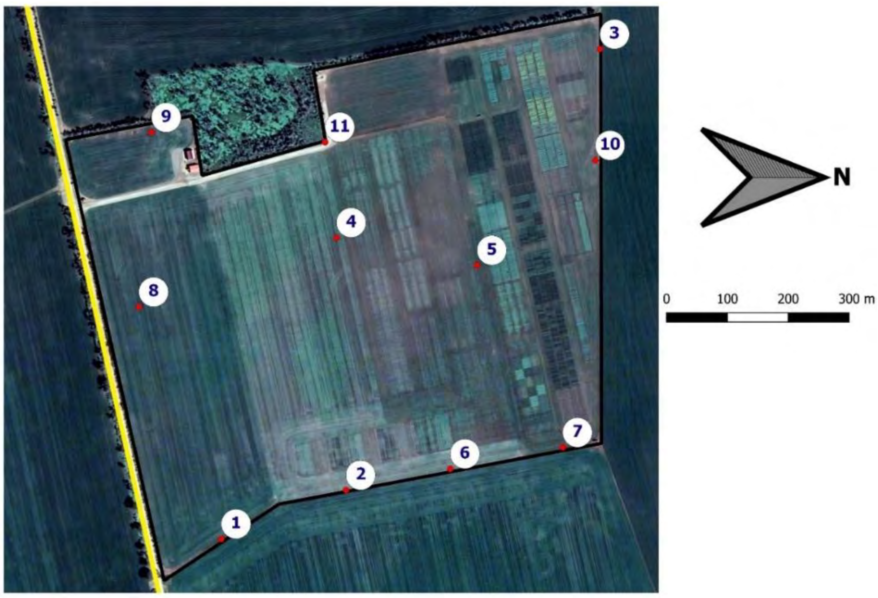


Figure 1. Location of manual rain gauges positioned across the Hart field site in 2021.

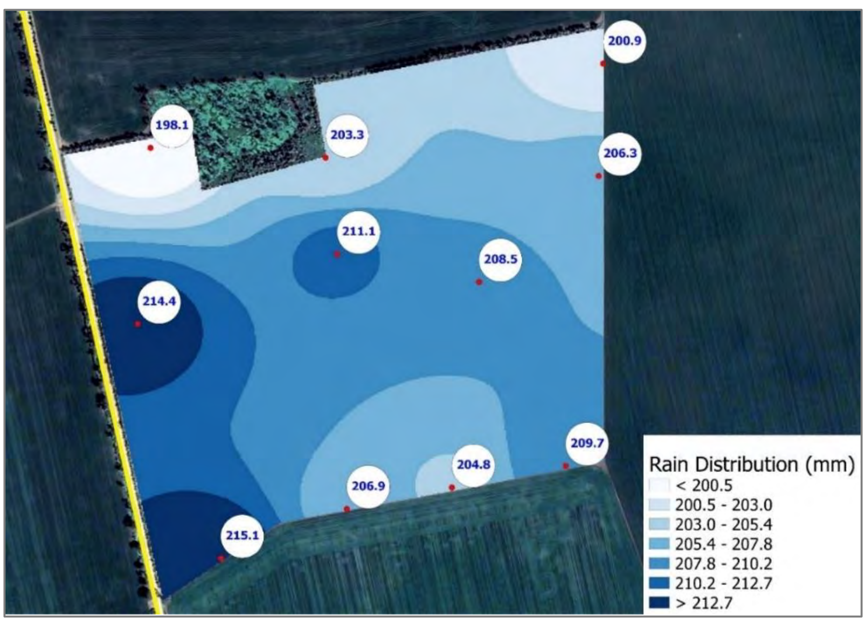


Figure 2. The distribution of recorded rainfall for the duration of the growing season (April – October) for each gauge at Hart.

Results and discussion

Growing season rainfall

At the Hart field site in 2021, a total of 44 rainfall events were recorded across the growing season, totalling 209 mm of measured rainfall. The highest gauge recorded 215 mm rainfall, compared to the lowest of 198 mm. These observations show that there was a 17 mm (8%) difference in rainfall recorded across the 40 ha site at Hart from April – October (Figure 2).

Comparison of single rainfall events

Rainfall events at Hart less than (<) 5 mm had a higher coefficient of variation (CV%) when compared to events over 5 mm. This means that there were greater differences in rainfall observed for smaller events across the 40 ha paddock, compared to events greater than (>) 5 mm.

Measured rainfall at Hart for events < 5 mm varied by 40 – 80% at each rainfall timing. This means that the recorded rainfall can range from 3 mm to 5 mm across the paddock, as a result of spatial variation. This is considerably higher when compared to events > 5 mm, showing that differences between the lowest and highest rainfall readings for all gauges varied by up to 18%.

Rainfall patterns observed were variable, with results showing that no single location in the paddock received significantly higher rainfall at every recorded rain event. This is displayed in Figure 3.

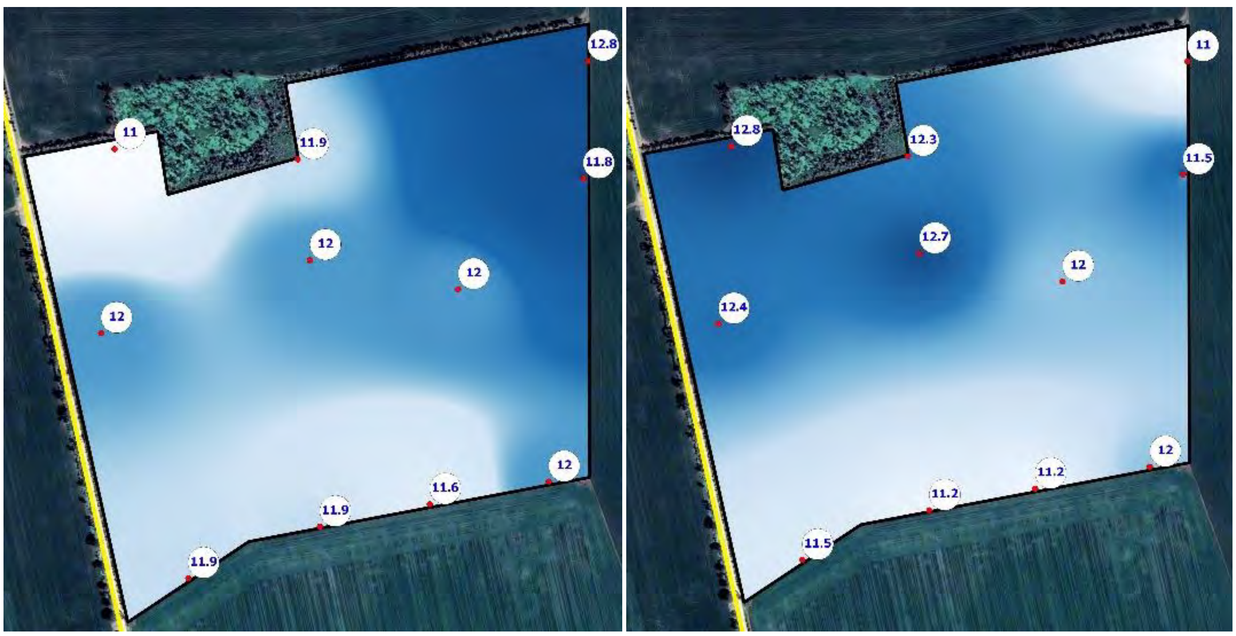


Figure 3. Rain distribution maps of two ~12 mm rainfall events on July 5 (left) and August 3 (right) at Hart in 2021.

Rainfall variability across seasons

The 2021 growing season at Hart had below average rainfall across autumn and winter months. Hart also had below average rainfall for spring, until late November when 118 mm was received. Rainfall for winter and spring months had the most consistent distribution and spread of rainfall across the 40-ha field site, with a CV% of 8.4% and 10.4%, respectively (Table 2). Autumn rainfall was less consistent across the 40 ha site, with a CV% of 19.1%.

Table 2. Seasonal rainfall data including; coefficient of variation (CV%), rainfall event average (mm), rainfall days and total seasonal rainfall (mm) (sourced from the Mesonet).

	Autumn	Winter	Spring
CV%	19.1	9.4	10.4
Event Average (mm)	3.8	3.6	4.3
Rainfall days	14	43	36
Total season rainfall (mm)	52.6	153.8	153.7

At Hart in 2021, seasonal rainfall patterns were variable in their distribution of rainfall across the 40 ha field site (Figure 4). Further rainfall observations would be required to validate trends seen in 2021.

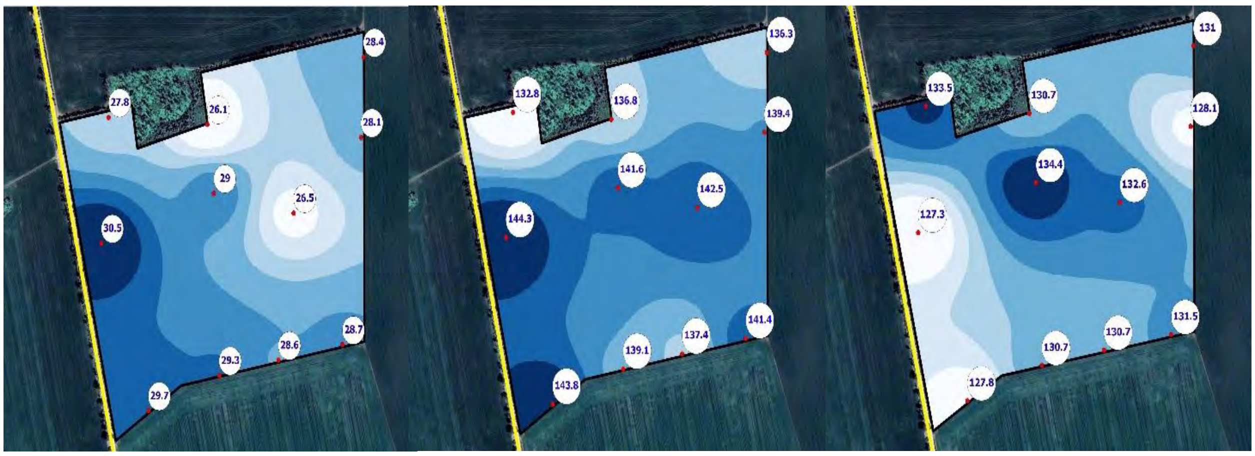


Figure 4. (L-R) Rainfall distribution maps for autumn, winter and spring months at the Hart field site. Dark blue sharding represents greater rainfall areas and white shading represents lower rainfall areas for each season at the Hart field site.

Acknowledgements

This trial is funded by HART SA's premier cropping field site

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

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 $P \leq 0.05$), 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.

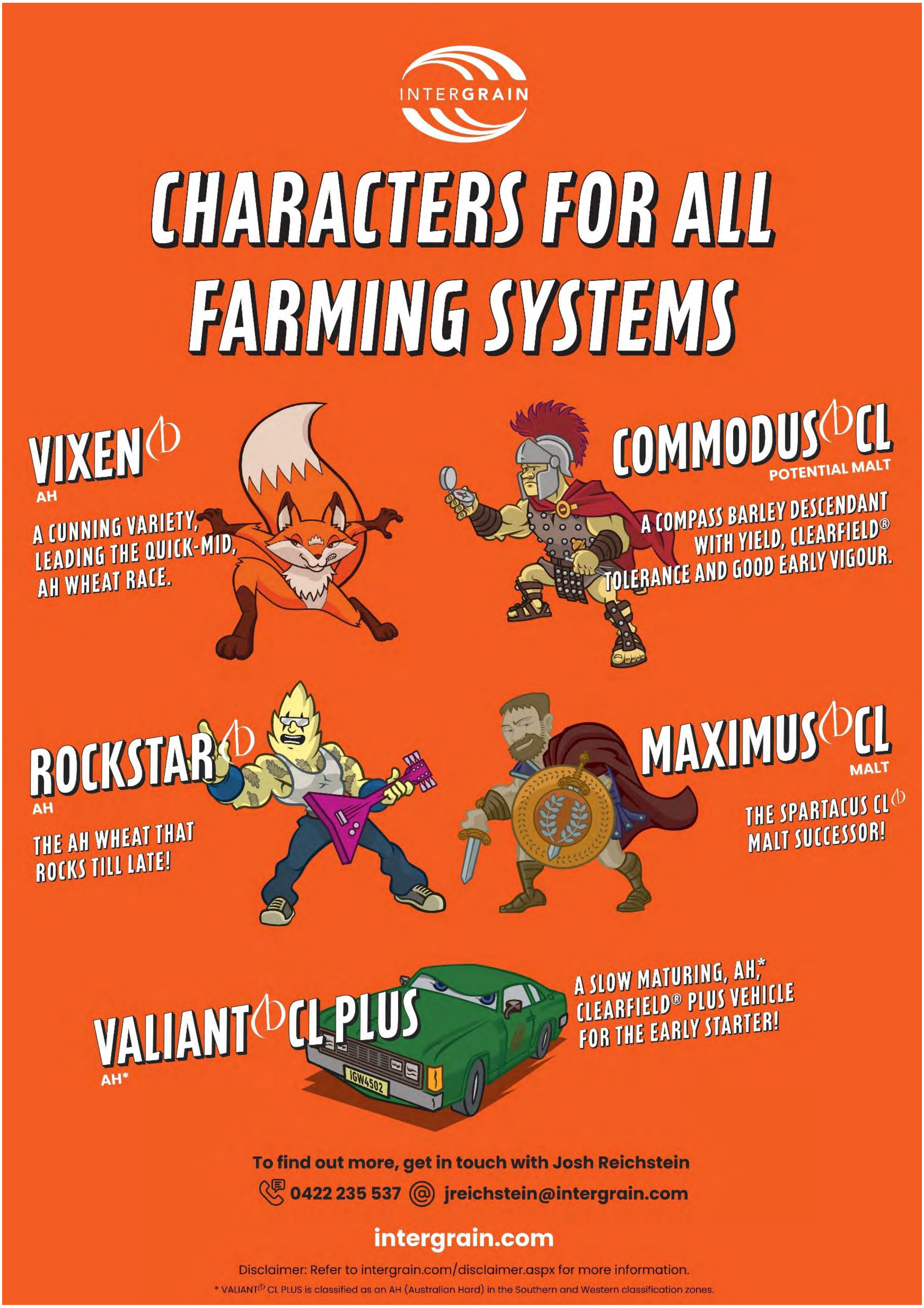
Variety	**Grain yield (t/ha)**	**Protein (%)**	**Screenings (%)**
Arrow	3.50^{c}	10.3^{a}	0.2
Cosmick	3.98^{b}	8.4^{b}	1.0
Mace	3.75^{bc}	9.1^{b}	0.5
Scout	4.05^{b}	8.9^{b}	0.9
Trojan	4.77^{a}	8.4^{b}	0.4
LSD ($P \leq 0.05$)	**0.40**	**0.9**	**NS**

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.


INTERGRAIN
CHARACTERS FOR ALL FARMING SYSTEMS
VIXEN
AH
A CUNNING VARIETY, LEADING THE QUICK-MID, AH WHEAT RACE.
COMMODUS CL
POTENTIAL MALT
A COMPASS BARLEY DESCENDANT WITH YIELD, CLEARFIELD® TOLERANCE AND GOOD EARLY VIGOUR.
ROCKSTAR
AH
THE AH WHEAT THAT ROCKS TILL LATE!
MAXIMUS CL
MALT
THE SPARTACUS CL MALT SUCCESSOR!
VALIANT CL PLUS
AH*
A SLOW MATURING, AH,* CLEARFIELD® PLUS VEHICLE FOR THE EARLY STARTER!
IGW4502
To find out more, get in touch with Josh Reichstein
0422 235 537 jreichstein@intergrain.com
intergrain.com
Disclaimer: Refer to intergrain.com/disclaimer.aspx for more information.
* VALIANT CL PLUS is classified as an AH (Australian Hard) in the Southern and Western classification zones.

Comparison of wheat varieties

Rebekah Allen; Hart Field-Site Group

Key Findings

- The average wheat grain yield for varieties trialed at Hart in 2021 was 2.03 t/ha.
- Vixen, Scepter and Calibre (tested as RAC2721) were the highest yielding AH varieties.
- The highest yielding APW varieties were Sheriff CL Plus, Chief CL plus and LongReach Trojan, yielding 2.18, 2.08 and 1.75 t/ha, respectively.
- Grain test weights were high, with a trial average of 81.3 kg/hL and screenings were variable, ranging from 1.9 – 10.3%.

Why do the trial?

To compare the performance of new wheat varieties alongside current commercial standards.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	Seeding: DAP (18:20) Zn 1% + Impact @ 80 kg/ha
Seeding date	May 3, 2021		June 12: Easy N (42.5:0) @ 70 L/ha
Location	Hart, SA		August 20: Easy N (42.5:0) @ 70 L/ha
Harvest date	November 9, 2021		

The trial was a randomised complete block design with three replicates and 21 wheat varieties. This trial was managed with the application of pesticides to ensure a weed, insect and disease-free canopy. All plots were assessed for grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%). The in-season nitrogen (N) budget was managed to target a wheat grain yield of 3.5 t/ha; however, yield potential was water-limited with dry spring conditions following applications of N in August.

Available N at Hart pre-seeding (0 – 60 cm) was 88.5 kg/ha, following oaten hay in 2020.

Wheat varieties emerged on May 26. Due to a poor-quality seed source, Devil had low seedling emergence and crop establishment. Grain yield and quality data was not analysed for this variety.

Results and discussion

Grain yield

Across all varieties trialed, wheat grain yields at Hart ranged from 1.55 – 2.64 t/ha, with a trial average of 2.03 t/ha (Table 1). The highest yielding Australian Hard (AH) varieties were Vixen, Scepter and Calibre (tested as RAC2721), yielding 2.64, 2.29 and 2.27 t/ha, respectively. Vixen, Scepter and Calibre were also ranked in the top ten yielding varieties within the National Variety Trials at Spalding and Turretfield (National Variety Trials, 2021).

Long-term yield data shows that Vixen and Scepter continue to perform well, yielding above the trial average across multiple seasons at Hart (Table 2). New varieties Ballista, Calibre, Hammer CL Plus and Australian Prime Hard (APH) variety Sunblade CL Plus have performed well, but still require further evaluation across a range of seasons.

Sheriff CL Plus, Chief CL plus and LongReach Trojan were the highest performing Australian Premium White (APW) varieties yielding from 1.89 – 2.18 t/ha. Although long-term yield data for APW varieties trialed at Hart remains variable, Sheriff CL Plus and Chief CL plus have performed well over the past two seasons, consistently yielding above the trial average (Table 2).

Cutlass and LongReach Trojan, both later maturing spring wheats, have also performed well in three out of five seasons at Hart.

Grain quality

Grain protein for all wheat varieties was similar, with a trial average of 13%. All APW and ASW varieties met APW1 and ASW1 receival standards (> 10.5%).

All varieties were above 76 kg/hL for test weight, meeting standards for maximum grade, ranging from 78.1 – 83.2 kg/hL, with a trial average of 81.3 kg/hL. Hammer CL Plus, Scepter and Valiant CL Plus (tested as IGW4502) had the highest test weights of 83.2, 82.8 and 82.5 kg/hL respectively.

Wheat screenings were variable for varieties trialed. Australian Hard varieties Ballista, LongReach Scout, Sunblade CL Plus and Vixen had high levels of screenings ranging between 5.9% – 10.3%. APW variety Trojan and test line BSWDH04-062 also had screenings > 5% and did not meet maximum grade.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) for wheat varieties at Hart in 2021. Shaded values within each column show the highest performing varieties.

Quality	Variety	Grain yield t/ha	% of site average	Protein %	% of site average	Test Weight kg/hL	% of site average	Screenings %	% of site average
APH	Sunblade CL Plus⊕ (SUN968G)	2.14	105	12.3	95	80.5	99	10.3[e]	208
AH	Ballista⊕ (RAC2598)	2.04	100	13.0	100	78.1	96	8.3[de]	167
	Catapult⊕	1.94	95	13.3	102	81.0	100	4.3[abc]	86
	Calibre⊕ (RAC2721)	2.27	112	12.1	93	80.3	99	5.4[c]	109
	Grenade CL Plus⊕	1.88	93	13.7	105	80.2	99	4.5[abc]	91
	Hammer CL Plus⊕	2.19	108	13.0	100	83.2	102	2.7[ab]	54
	LongReach Scout⊕	1.75	86	14.2	109	80.9	100	9.2[e]	186
	Rockstar⊕	1.63	80	13.6	104	80.0	98	4.5[abc]	90
	Scepter⊕	2.29	113	12.3	95	82.8	102	3.4[abc]	68
	Valiant CL Plus⊕ (IGW4502)	1.89	93	13.7	105	82.5	102	1.9[a]	39
	Vixen⊕	2.64	130	12.0	92	80.0	98	5.9[cd]	118
	H1 receival standard			>13.0		>76.0		<5.0	
APW	Chief CL Plus⊕	2.08	102	12.8	99	81.4	100	3.8[abc]	76
	Cutlass⊕	1.55	76	14.1	108	80.7	99	3.4[abc]	69
	Denison⊕	1.74	86	13.7	105	81.5	100	3.8[abc]	77
	Sheriff CL Plus⊕	2.18	107	12.6	97	82.3	101	3.8[abc]	77
	LongReach Trojan⊕	1.89	93	12.9	99	82.9	102	5.3[bc]	106
	APW1 receival standard			>10.5		>76.0		<5.0	
ASW	Razor CL Plus⊕	2.26	111	12.1	93	82.3	101	3.6[abc]	72
	ASW1 receival standard			>10.5		>76.0		<5.0	
Unclassified	BSWDH04-062	2.06	101	12.8	99	82.3	101	5.3[bc]	107
	IGW6683	2.34	115	12.2	94	81.9	101	4.2[abc]	84
	LPB17-6157	2.14	105	12.3	94	82.2	101	4.2[abc]	84
	Site Average	2.03	100	13.0	100	81.3	100	5.0	100
	LSD (P≤0.05)	0.45		NS		1.99		2.68	

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

		% Trial average					Grain yield (t/ha)
Quality	**Variety**	**2017**	**2018**	**2019**	**2020**	**2021**	**2021**
APH	Sunblade CL PlusⓅ (SUN968G)					105	2.14
AH	BallistaⓅ				95	100	2.04
	CalibreⓅ (RAC2721)					112	2.27
	CatapultⓅ			97	107	96	1.94
	DevilⓅ			104	109		1.78
	Emu RockⓅ	98	104	104	111		
	Grenade CL PlusⓅ	95	110	93	93	93	1.88
	Hammer CL PlusⓅ				106	108	2.19
	Longreach ScoutⓅ	107	107	107	106	86	1.75
	MaceⓅ	102	95	95	100		
	RockstarⓅ			104	108	80	1.63
	ScepterⓅ	111	113	106	101	113	2.29
	Valiant CL PlusⓅ (IGW4502)					93	1.89
	VixenⓅ			111	109	130	2.64
APW	Chief CL PlusⓅ		87	85	113	102	2.08
	CutlassⓅ	104	117	98	81	76	1.55
	DenisonⓅ (WAGT734)					86	1.74
	Longreach Trojan Ⓟ	113	106	102	94	93	1.89
	NighthawkⓅ				74		
	Sheriff CL PlusⓅ			96	100	107	2.18
ASW	Razor CL PlusⓅ	103	104	109	98	111	2.26
Unclass	BSWDH04-062					101	2.06
	IGW6683					115	2.34
	LPB17-6157			98	98	105	2.14
	Trial mean yield t/ha	**3.83**	**2.13**	**1.50**	**2.50**	**2.03**	
	Sowing date	May 8	May 14	May 15	May 6	May 3	
	Apr-Oct rain (mm)	191	160	162	336	232	
	Annual rain (mm)	331	224	189	503	401	

Acknowledgements

This trial is funded by

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank InterGrain, AGT and LongReach Plant Breeders for providing seed to conduct this trial.

References

The National Variety Trials program (2021) https://nvt.grdc.com.au

Early sown winter and awnless wheats

Declan Anderson and Rebekah Allen; Hart Field-Site Group

Key Findings

- Catapult, Denison and Scepter were the highest performing varieties, yielding 2.28, 2.24, and 2.23 t/ha, respectively.
- Early sowing did not provide yield gains at Hart in 2021 due to dry seasonal conditions between time of sowing (TOS) 1 and 2.

Why do the trial?

Early sown winter wheats

The use of winter wheats can allow growers to sow earlier and utilise early April rainfall. Winter wheats are suited for earlier sowing times as they have a vernalisation requirement, meaning flowering will not occur until a cold requirement is met. Spring maturing varieties will flower too early when sown in early April and be at risk of frost damage in early spring.

Awnless wheats

The use of awnless wheat varieties provides a management technique for frost prone environments. Awnless wheats are dual purpose as they can be grazed or cut for hay after frost events, producing a safer hay option for stock due to no awns.

LRPB Orion has been the most commonly grown awnless variety in the Mid-North and was released 12 years ago (Noack et al 2021). LongReach Plant Breeding have released two new lines of awnless wheat, LRPB Dual, AH classification, and LRPB Bale, APW classification. This gives growers new variety options with improved grain quality for frost prone environments.

The aim of this trial is to compare the performance of longer season spring and winter wheats to Scepter wheat sown at its optimal timing and evaluate newly released awnless varieties for hay and grain yield.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	Seeding: DAP (18:20) Zn 1% + Impact @ 80 kg/ha
Seeding date	TOS 1 – April 19		June 12: Easy N (42.5:0) @ 70 L/ha
	TOS 2 – May 3		August 20: Easy N (42.5:0) @ 70 L/ha
Location	Hart, SA		
Harvest date	November 29, 2021		

The trial was a split plot design with three replicates, two TOS and nine wheat varieties. This trial was managed with the application of pesticides to ensure a weed, insect and disease-free canopy. All plots were assessed for grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%).

Awnless varieties were also assessed for hay production (t/ha) by sampling 4 x 1 m sections of row at watery ripe (GS71) for each variety. Samples were oven dried at 60°C for 48 hours and weighed to measure hay production (t/ha). Trialed varieties are listed in Table 1.

Table 1. Summary of wheat varieties, including development and quality (Schilling et al 2021).

Variety	Release year	Company	Development	Quality	Awnless
Scepter	2015	AGT	Mid spring	AH	N
DS Bennett	2018	Seednet	Mid – slow winter	ASW	Y
Nighthawk	2019	LRPB	Very slow spring	APW	N
LPRB Orion	2010	LRPB	Mid – slow spring	SFE1	Y
LPRB Bale	2021	LRPB	Slow spring	APW	Y
LPRB Dual	2021	LRPB	Mid – slow spring	AH	Y
Illabo	2018	AGT	Quick – mid winter	AH	N
Catapult	2019	AGT	Mid – slow spring	AH	N
Denison	2020	AGT	Slow – very slow spring	APW	N

Results and discussion

Catapult, Denison and Scepter were the highest performing varieties with wheat grain yields of 2.28, 2.24, and 2.23 t/ha, respectively (Figure 1 and Table 2). These results are similar to those recorded at Hart in 2020, with Scepter and Catapult also high yielding. In 2021, the earlier sowing date of April 19 did not increase wheat grain yields due to below average rainfall received between TOS 1 and TOS 2. This resulted in all wheat germinating on May 31 after a significant rain event at the end of May (19 mm).

LRPB Bale, LRPB Dual and Bennett performed similarly for awnless wheat grain yield in 2021, with yields ranging from 1.81 – 1.96 t/ha (Figure 1). LRPB Dual also performed well in 2020, yielding similarly to Scepter and Catapult (Table 2).

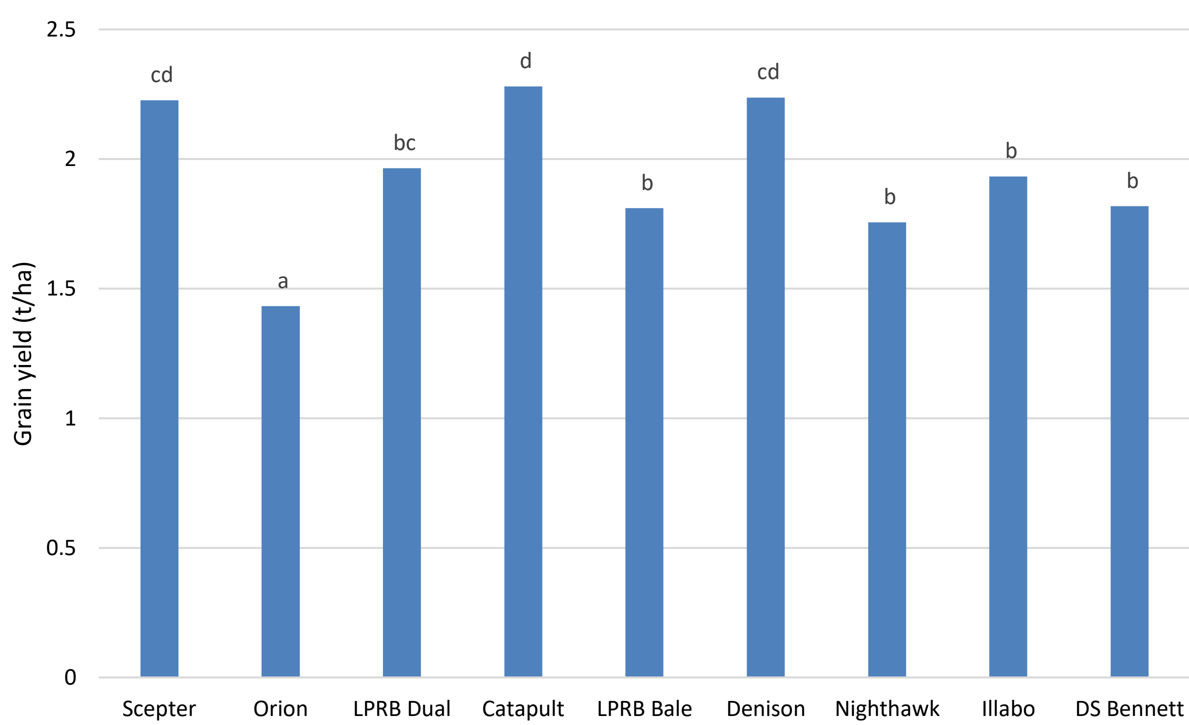


Figure 1. Grain yield of wheat varieties trialed at Hart. Varieties are ordered from quick to slow maturity.

Table 2. Summary of average grain yields for wheat varieties in TOS 1 and TOS 2 at Hart in 2020 – 2021. Shaded values indicate the highest performing treatments.

Variety	2020 April 20	2020 May 6	2021 April 19	2021 May 3
	Grain yield (t/ha)		Grain yield (t/ha)	
Catapult	2.13^{def}	2.92^{ab}	2.34	2.22
Denison	1.91^{ef}	2.43^{bcd}	2.18	2.3
Illabo	1.65^{f}	2.00^{def}	2.05	1.82
Scepter	1.65^{f}	3.03^{a}	2.18	2.28
Nighthawk	2.28^{cde}	1.97^{def}	1.74	1.77
DS Bennett	2.19^{cde}	2.25^{cde}	1.94	1.69
LPRB Dual	2.02^{def}	2.64^{abc}	1.94	1.99
LPRB Bale	1.98^{def}	2.04^{def}	1.75	1.87
Orion	2.06^{de}	2.00^{def}	1.41	1.46
Average yield	**1.99^{a}**	**2.34^{b}**	**1.95**	**1.93**
LSD (P≤0.05)	**0.17 (0.49 in each TOS)**		**NS**	

Values with the same letters are not significantly different.

Australian Hard (AH) varieties did not meet receival specifications for protein and ranged from 10.8 – 12.6% (Table 3), however, test weights were high (78.4 – 80.7 kg/hL) with screenings below 5%.

All APW 1 varieties met specifications for protein (%), test weight (kg/hL) and screenings (%).

Table 3. Summary of grain quality for all wheat varieties trialed at Hart in 2021. Shaded values show the highest performing varieties.

Quality	Variety	Protein %	Test weight kg/hL	Screenings %
AH	Scepter	10.8^{a}	79.1^{bc}	3.1^{bc}
	Illabo	12.6^{cd}	78.4^{b}	2.4^{a}
	Catapult	10.9^{a}	79.6^{cd}	2.4^{a}
	LRPB Dual	12.4^{cd}	80.7^{f}	2.2^{a}
H1 receival standard		> 13.0	> 76	< 5.0
APW	Nighthawk	13.0^{de}	80.4^{ef}	3.8^{d}
	LRPB Bale	12.4^{cd}	82.8^{g}	2.1^{a}
	Denison	11.4^{ab}	79.9^{de}	2.6^{ab}
APW1 receival standard		> 10.5	> 76	< 5.0
ASW	DS Bennett	13.5^{e}	81.0^{f}	3.8^{d}
ASW1 receival standard		NA	> 76	< 5.0
SFE1	LRPB Orion	11.8^{bc}	71.3^{a}	3.6^{cd}
SFW1 receival standard		NA	> 70	< 10
	LSD (P≤0.05)	**0.85**	**0.70**	**0.53**

Values with the same letter are not significantly different.

At Hart in 2021, LRPB Bale produced the highest hay yields of 5.98 t/ha (Figure 2). LRPB Dual and LRPB Bale both had improved yields when compared to DS Bennett due to this variety better suited to longer growing season regions.

Although LRPB Bale has a longer maturity when compared to LRPB Dual, it is best suited for hay production, whereas LPRB Dual is suitable for both grain and hay production, likely leading to a small hay yield penalty, but also providing growers in the low and medium rainfall zones additional flexibility when managing frost.

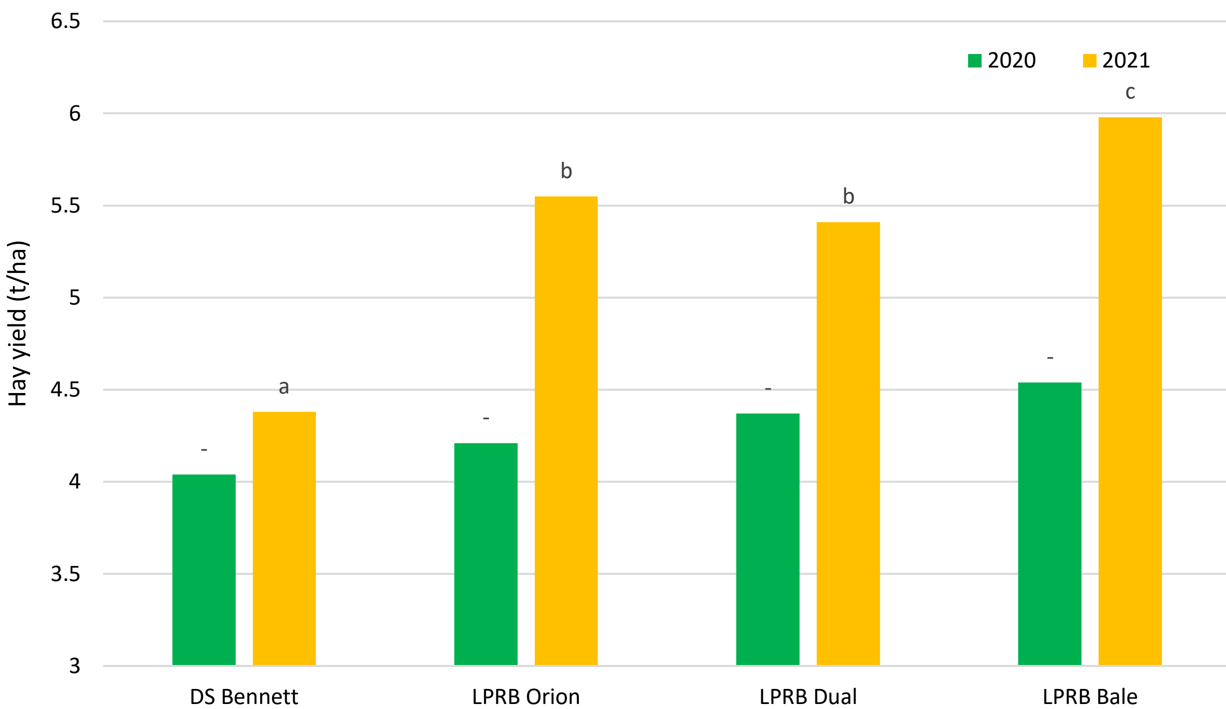


Figure 2. Summary of hay yields of awnless wheats trialed at Hart in 2020 and 2021. 2020 yield data is not significant.

Acknowledgements

This trial is funded by

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank Seednet, Australian Grain Technologies (AGT) and LongReach Plant Breeding for providing seed to conduct this trial.

References

Noack S, Allen R & Guidera B 2021, 'Early sown winter and awnless wheats', *2020 Hart Trial Results*

Schilling R, McCallum M, Peirce C, Wallwork H & Garrard T 2021, 'Wheat', *2022 South Australian Crop Sowing Guide*

Comparison of barley varieties

Rebekah Allen; Hart Field-Site Group

Key Findings

- The average barley yield for all varieties trialed at Hart in 2021 was 2.61 t/ha.
- Compass, Leabrook, Commodus CL, Maximus CL, Laperouse, Beast, Cyclops, Minotaur, Rosalind and Fathom were the highest yielding barley varieties (2.75 – 2.92 t/ha).
- Beast (pending malt accreditation) and Leabrook met Malt 1 receival standards for protein (%), test weight (kg/hL), screenings (%) and retention (%).
- Screenings and retention across all malt varieties at Hart was poor, averaging 13.5%, 9.7% and 52.1%, respectively.

Why do the trial?

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

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	Seeding: DAP (18:20) Zn 1% + Impact @ 80 kg/ha
Seeding date	May 3, 2021		June 12: Easy N (42.5:0) @ 70 L/ha
Location	Hart, SA		August 20: Easy N (42.5:0) @ 70 L/ha
Harvest date	November 1, 2021		

The trial was a randomised complete block design with three replicates and 14 barley varieties. The trial was managed with the application of pesticides to ensure a weed, insect and disease-free canopy. All plots were assessed for grain yield (t/ha), protein (%), test weight (kg/hL), screenings (2.2mm screen) and retention (2.5mm screen).

New varieties trialed at Hart in 2021, include Minotaur (tested as AGTB0113) and Cyclops (tested as AGTB0200), both were released by AGT in 2021. Commodus CL was released by InterGrain in 2020 and was also new to Hart this season.

Yield and quality data is not reported for Kraken barley.

Results and discussion

Grain yield

The highest yielding malt varieties at Hart were Compass, Leabrook and Maximus CL, yielding between 2.51 – 2.91 t/ha. RGT Planet, Spartacus CL and Scope CL were lower yielding this season with grain yields ranging from 1.98 – 2.23 t/ha (Table 1). Long-term yield data shows that Compass and RGT Planet have performed similar or greater than the annual trial average over a number of years.

Leabrook has also performed well over the past two seasons at Hart (Table 2).

All varieties currently pending malt accreditation, including Beast, Commodus CL, Cyclops, Laperouse and Minotaur were high yielding with yields ranging from 2.62 – 2.92 t/ha. Long-term yield data for these varieties is not yet available.

Feed varieties trialed at Hart in 2021 were Rosalind and Fathom. Both varieties yielded similarly with grain yields of 2.75 and 2.79 t/ha, respectively. Historic data shows that both varieties yield well at Hart across a number of seasons (Table 2).

Grain quality

The grain protein content for all malting barley (and pending malt accreditation) varieties was higher than the acceptable Malt 1 receival standards, ranging from 12.8 – 14.6%. High protein levels were likely attributed to applications of nitrogen and below average rainfall leading into grain fill.

All malting varieties had acceptable test weights to meet maximum grade (> 65 kg/hL) with a trial average of 70.7 kg/hL. RGT Planet, Scope CL and Spartacus CL had the highest test weights, ranging from 71.1 – 71.6 kg/hL. Varieties currently pending malt accreditation also performed well, with test weights > 65 kg/hL for maximum grade. Feed varieties, Fathom and Rosalind also met BAR 1 receival standards for test weight.

Barley screenings in 2021 were high across most varieties trialed at Hart, ranging between 3.8% and 15.7%. Malting varieties which met Malt 1 specifications were Compass (5.1%) and Leabrook (5.6%). Beast, previously tested as AGTB0113 (pending malt accreditation) also had the lowest screenings of 3.8%.

Retention for most malting barley varieties was low with a trial average of 52.1%. Malting variety Leabrook and Beast (pending malt accreditation) had grain retention > 70%, meeting maximum grade requirements.

Table 1. Barley grain yield and quality results from Hart in 2021. Values shaded blue in the same column show the highest performing varieties.

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	Fathom	2.79[d]	107	13.2	98	69.3	98	7.7[abc]	79	59.8[cd]	115
	Rosalind	2.75[d]	106	13.0	97	70.6	98	13.9[bc]	143	36.7[abc]	70
Bar 1 Receival Standards				NA		>62.5		15.0		NA	
Malt	Compass	2.91[d]	112	12.8	95	69.9	99	5.1[a]	53	67.4[d]	129
	Leabrook	2.79[d]	107	13.1	97	70.2	99	5.6[ab]	58	70.5[d]	135
	Maximus CL (IGB1705T)	2.51bc[d]	96	13.9	103	70.5	99	15.3[c]	158	36.1[ab]	69
	RGT Planet	2.23[abc]	86	14.6	109	71.1	100	9.4[abc]	97	50.4[bcd]	97
	Scope CL	1.98[a]	76	14.4	107	71.2	100	10.3[abc]	106	41.2[abc]	79
	Spartacus CL	2.17[ab]	83	14.3	106	71.6	101	15.7[c]	162	25.7[a]	49
Malt 1 Receival Standards				9-12%		>65		7.0		>70%	
Pending malt accreditation	Beast (AGTBO113)	2.9[d]	111	13.0	97	69.4	101	3.8[a]	39	70.3[d]	135
	Commodus CL	2.61[bcd]	100	13.6	101	69.9	101	10.4[abc]	107	53.0[bcd]	102
	Cyclops (AGTBO200)	2.69[cd]	103	13.3	99	71.5	101	8.1[abc]	84	56.7[bcd]	109
	Laperouse	2.92[d]	112	12.4	92	71.9	102	5.1[a]	53	68.4[d]	131
	Minotaur (AGTBO213)	2.62[bcd]	101	13.3	99	72.1	102	15.6[c]	161	40.5[abc]	78
	Site Average	**2.61**	**100**	**13.5**	**100**	**70.7**	**100**	**9.7**	**100**	**52.1**	**100**
	LSD (P≤0.005)	0.47		NS		1.14		8.46		23.1	

Table 2. Long term barley variety performance at Hart for 2017 – 2021 (expressed as % of trial average).

		% Trial average					Grain yield (t/ha)
Quality	**Variety**	**2017**	**2018**	**2019**	**2020**	**2021**	**2021**
Feed	Fathomⓟ	94	109	104	112	107	2.79
	Fleetⓟ	104	106	100			
	Hindmarshⓟ	98	100	103			
	Keel	102	105	101			
	Rosalindⓟ	91	102	107	100	105	2.75
Malt	Commanderⓟ	102	104	93	95		
	Compassⓟ	106	105	106	99	112	2.91
	GrangeRⓟ	108	89	93			
	La Trobeⓟ	104	99	107	94		
	Leabrookⓟ				107	107	2.79
	Maximus CLⓟ (IGB1705T)			102	95	96	2.51
	Navigator	111	96	93			
	RGT Planetⓟ	134	97	101	111	86	2.23
	Scope CLⓟ	89	89	91	93	76	1.98
	Spartacus CLⓟ	98	98	100	89	83	2.17
Pending malt accreditation	Beastⓟ (AGTBO113)				99	111	2.90
	Commodus CLⓟ					100	2.61
	Cyclopsⓟ (AGTBO200)					103	2.69
	Laperouseⓟ				105	112	2.92
	Minotaurⓟ (AGTBO213)					101	2.62
	Mean yield (t/ha)	**4.36**	**2.86**	**2.25**	**3.18**	**2.61**	
	Sowing date	May 8	May 14	May 15	May 16	May 3	
	April - Oct (mm)	191	160	162	355	232	
	Annual rainfall (mm)	331	224	189	503	401	

Acknowledgements

This trial is funded by HART

SA's premier cropping field site

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank InterGrain, AGT and Seednet for providing seed to conduct this trial.

Comparison of durum varieties

Rebekah Allen and Declan Anderson; Hart Field-Site Group

Key findings

- Durum yields ranged from 1.29 – 1.65 t/ha at Hart in 2021.
- Westcourt, DBA Spes, Bitalli and DBA-Aurora were the highest yielding durum varieties, yielding 1.65, 1.64,1.55 and 1.53 t/ha, respectively.
- Grain protein levels were high (trial average 15%) and screenings were variable ranging from 2.2 – 15.9%.
- Test weights for all durum varieties trialed were high, averaging 79.5%, meeting DR1 receival standards.

Why do the trial?

To compare the performance of new durum varieties alongside current commercial standards.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	Seeding: DAP (18:20) Zn 1% + Impact @ 80 kg/ha
Seeding date	May 3, 2021		June 12: Easy N (42.5:0) @ 70 L/ha
Location	Hart, SA		August 20: Easy N (42.5:0) @ 70 L/ha
Harvest date	November 9, 2021		

The trial was a randomised complete block design with three replicates and five durum varieties. This trial was managed with the application of pesticides to ensure a weed, insect and disease-free canopy. All plots were assessed for grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%).

There were no new release durum varieties last season. The newest durum varieties trialed at Hart were Bitalli, Westcourt and DBA Artemis, released in 2019. These varieties have been evaluated at Hart across three seasons from 2019 – 2021.

Results and discussion

Grain yield

The highest yielding durum varieties at Hart this season were Westcourt, DBA Spes, Bitalli and DBA-Aurora, yielding 1.65, 1.64, 1.55 and 1.53 t/ha respectively (Table 1). DBA Artemis was low yielding at Hart in 2021, yielding 1.29 t/ha, however, it has performed well, within the top 10 durum varieties, across Mintaro and Turretfield NVT sites (National variety trials 2021). Long-term yield data shows that Westcourt, DBA Spes and DBA-Aurora continue to perform well across multiple seasons at Hart (Table 2).

Grain quality

In 2021, protein levels for all durum varieties were high, ranging from 14.5 – 15.7%, exceeding the minimum standards of 13% for DR1 receival standards (Table 1.). Test weights were similar with all varieties meeting minimum receival standards of 76kg/hL.

Screenings (%) for Westcourt, DBA Artemis, DBA-Aurora and DBA Spes were similar, however, only Westcourt and DBA Artemis made DR1 receival standards (< 5%). Bitalli had the highest level of screenings at 15.9%. Westcourt has continued to perform well, meeting DR1 receival standards across all grain quality characteristics at Hart in 2021.

Table 1. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) for durum varieties at Hart in 2021. Values shaded within each column show the highest performing varieties.

Variety	Grain yield t/ha	% of site average	Protein %	% of site average	Test weight kg/hL	% of site average	Screenings %
Westcourt	1.65[b]	108	14.6[a]	98	80.3	101	2.2[a]
DBA Artemis	1.29[a]	84	15.4[b]	103	79.1	99	3.9[a]
DBA Aurora	1.53[b]	100	14.5[a]	97	79.4	100	6.0[a]
DBA Spes	1.64[b]	107	15.7[b]	105	79.5	100	6.8[a]
Bitalli	1.55[b]	102	14.6[a]	97	79.1	99	15.9[b]
DR1 receival standards			≥ 13.0		> 76		< 5%
Site Average	**1.53**	**100**	**15.0**	**100**	**79.5**	**100**	**6.9**
LSD (P≤0.05)	**0.179**		**0.69**		**NS**		**5.03**

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

	% Trial average					Grain yield (t/ha)
Variety	**2017**	**2018**	**2019**	**2020**	**2021**	**2021**
Bitalli			99	103	101	1.55
DBA-Aurora	100	102	103	106	100	1.53
DBA Artemis			95	79	84	1.29
DBA Spes		102	105	104	107	1.64
DBA Vittaroi		104	96	99		
Hyperno	96	95	95			
Saintly	100	90	97			
Westcourt			107	110	108	1.65
Trial average yield t/ha	**4.08**	**4.24**	**2.31**	**2.63**	**1.53**	
Sowing date	May 10	May 9	May 15	May 15	May 3	
Apr-Oct rain (mm)	356	191	160	162	232	
Annual rain (mm)	485	331	224	189	401	

Acknowledgements

This trial is funded by HART SA's premier cropping field site

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank Seednet and The University of Adelaide for providing seed to conduct this trial.

References

The National Variety Trials program (2021) https://nvt.grdc.com.au

Comparison of canola varieties; including new genetically modified (GM) options

Rebekah Allen; Hart Field-Site Group

Key findings

- The total average trial yield achieved for canola varieties was 1 t/ha at Hart in 2021.
- Most conventional and Clearfield® varieties were high yielding, leading to higher $/ha returns in the 2021 season.
- A number of genetically modified varieties yielded well, with yields ranging from 1.09 – 1.28 t/ha, demonstrating that GM options can provide yield benefits equal to or beyond traditional herbicide tolerance traits (Clearfield®, Triazine Tolerant).
- Canola oil content (%) was generally high, with most varieties achieving > 42% leading to oilseed premiums.

Why do the trial?

To compare the performance of new canola varieties, including genetically modified (GM) options now available to South Australian mainland growers, alongside current commercial standards including conventional, triazine tolerant and Clearfield® varieties.

How was it done?

Plot size	2.0 m x 10.0 m	**Fertiliser**	Seeding: DAP (18:20) Zn 1% + Impact @ 80 kg/ha
Seeding date	May 3, 2021		
Location	Hart, SA		June 12: Easy N (42.5:0) @ 70 L/ha
Harvest date	November 9, 2021	**Soil available N**	88.5 kg N/ha

At Hart in 2021, 27 canola varieties were trialed. Canola varieties were blocked by technology as a randomised design with three replicates and was managed with the appropriate application of pesticides to ensure a weed, insect and disease-free canopy. All plots were assessed for crop establishment (plants/m^2), flowering date (50% flower), crop yield (t/ha) and oil content (%). Canola gross margins were also calculated for the 2021 season (Table 3).

Results and discussion

Crop establishment

Crop establishment was assessed for all canola varieties due to the late and staggered emergence of plants. This was a result of dry conditions with below average rainfall in May. No correlation was observed between establishment and crop yield (t/ha), meaning that establishment was variable across the site and did not directly influence yield results for each variety (data not shown). Target crop density was 45 plants/m^2, however an average of only 20 plants/m^2 was achieved across the trial site, equating to 44% of that target.

Oilseed yield

The total average trial yield achieved for canola varieties was 1 t/ha at Hart in 2021.

Conventional varieties Nuseed Diamond and Nuseed Quartz were high yielding, achieving 1.26 and 1.2 t/ha respectively (Table 1).

Yields for Triazine Tolerant varieties ranged from 0.66 – 1.13 t/ha, with InVigor T 4510 and HyTTec Trident (an alternative to ATR Bonito) achieving the highest yields of 1.13 and 1.10 t/ha respectively. Both of these early-maturing varieties are well adapted to environments within the low – medium rainfall zones, reaching 50% flower by September 1 (Table 2).

Saintly CL (1.32 t/ha) and Pioneer 44Y94 CL (1.35t/ha) were high yielding Clearfield® varieties at Hart providing a good $/ha return in 2021 (Table 3). Banker CL, Pioneer 43Y92 CL and Pioneer 45Y95 CL were lower yielding; however, still performed well at Hart, yielding between 1.04 – 1.23 t/ha.

At Hart in 2021, many genetically modified canola varieties performed well, averaging 1.1 t/ha. The highest yielding GM varieties were; Hyola Garrison XC, Nuseed Emu, InVigor R 4022P, Nuseed Raptor TF, Pioneer 44Y27 RR and Pioneer 45Y28 RR, with yields ranging from 1.09 – 1.28 t/ha.

Results from Hart in 2021 demonstrate that GM varieties can provide yield benefits equal to or beyond the traditional herbicide tolerance traits South Australian growers have had access too, with many providing yields similar to Clearfield® varieties.

Oil content

Most canola varieties trialed at Hart in 2021 achieved high oil content (> 42%) with some above that level leading to oilseed premiums (Table 1).

Although lower yielding, ATR Bluefin and SF Spark TT had the highest levels of oil content for TT varieties, ranging from 44 – 44.8%, providing a minimum increase of $16.50/tonne as a result of oilseed premiums.

Roundup Ready® varieties Pioneer® 45Y28 RR and InVigor R 4022 P also performed well with high oil content (> 42%). TruFlex® varieties Hyola 530 XT (stacked tolerance) and Hyola 410 XX were lower yielding but achieved high oil content ranging from 44.3 – 43.8%. All other GM varieties had significantly lower oil content, but still performed well.

In addition to crop yield (t/ha), Saintly CL and Pioneer 44Y94 CL, achieved the highest levels of oil content for Clearfield® varieties, with 43.4% and 42.5% respectively.

Table 1. Summary of oilseed yield (t/ha) and oil content (%) for canola varieties trialed at Hart in 2021. Shaded values in each column show the highest performing varieties within each technology.

Technology	Variety	Oilseed yield (t/ha)	% of average	Oil content (%)	% of average
Conventional	Nuseed Diamond	1.26	102	42.6	101
	Nuseed Quartz	1.20	98	41.4	99
	Average	**1.23**	**100**	**42.0**	**100**
	LSD (P≤0.05)	**NS**		**NS**	
Triazine Tolerant and stacked	ATR Bluefin	0.66	72	44.8	105
	Hyolaɸ Blazer TT	0.99	108	41.3	97
	Hyolaɸ Enforcer TT	0.98	107	43.6	102
	ATR Bonitoɸ	0.72	78	43.4	102
	HyTTecɸ Trifecta	0.91	99	42.0	99
	HyTTecɸ Trophy	0.89	97	41.3	97
	InVigorɸ T 4510	1.13	123	41.5	98
	SFR65-028TT	0.87	95	40.9	96
	SF Spark TT	0.89	97	44.0	103
	SF Dynatron TT™	0.96	105	43.0	101
	HyTTecɸ Trident	1.10	120	42.3	99
	Average	**0.92**	**100**	**42.6**	**100**
	LSD (P≤0.05)	**0.12**			
Roundup Ready®, TruFlex® and stacked	Hyolaɸ Battalion XC	0.98	88	42.0	97
	Pioneerɸ 44Y27 RR	1.26	114	43.0	99
	Pioneerɸ 45Y28 RR	1.28	115	44.6	103
	Hyolaɸ 530 XT	0.79	71	43.8	101
	Hyolaɸ 410 XX	1.05	95	44.3	102
	Hyolaɸ Garrison XC	1.09	98	43.2	100
	Nuseed Emu	1.25	113	43.4	100
	InVigorɸ R 4022 P	1.13	102	43.9	101
	Nuseed Raptor TF	1.16	105	41.6	96
	Average	**1.11**	**100**	**43.3**	**100**
	LSD (P≤0.05)	**0.19**		**0.92**	
Clearfield®	Banker CL	1.04	85	40.6	97
	Saintly CL	1.32	108	43.4	104
	Pioneerɸ 43Y92 CL	1.23	100	42.0	100
	Pioneerɸ 44Y94 CL	1.35	110	42.5	101
	Pioneerɸ 45Y95 CL	1.18	96	41.1	98
	Average	**1.22**	**100**	**41.9**	**100**
	LSD (P≤0.05)	**0.10**		**0.97**	

Table 2. Flowering dates (50% flower) for canola varieties trialed at Hart in 2021.

Technology	Variety	Maturity	Days to 50% flower	Date of 50% flower
Conventional	Nuseed Diamond	Early	89	August 23
	Nuseed Quartz	Mid	103	September 6
Triazine Tolerant	ATR Bluefin	Early	88	August 27
	Hyola Blazer TT	Mid-Early	91	August 30
	Hyola Enforcer TT	Mid	98	September 6
	ATR Bonito	Early-Mid	93	September 6
	HyTTec Trifecta	Mid	93	September 1
	HyTTec Trophy	Early-Mid	93	September 1
	InVigor T 4510	Early-Mid	93	September 1
	SFR65-028TT	Early-Mid	98	September 6
	SF Spark TT	Early	93	September 1
	SF Dynatron TT™	Mid	98	September 6
	HyTTec Trident	Early	87	August 26
Roundup Ready®, TruFlex® and stacked	Hyola Battalion XC	Early-Mid	91	August 30
	Pioneer 44Y27 RR	Early-Mid	91	August 30
	Pioneer 45Y28 RR	Mid	98	September 6
	Hyola 530 XT	Early-Mid	98	September 6
	Hyola 410 XX	Early-Mid	98	September 6
	Hyola Garrison XC	Mid	98	September 6
	Nuseed Emu	Early	84	August 23
	InVigor R 4022 P	Early-Mid	93	September 1
	Nuseed Raptor TF	Early-Mid	98	September 6
Clearfield®	Banker CL	Mid	98	September 9
	Saintly CL	Mid to Early-Mid	87	August 28
	Pioneer 43Y92 CL	Early	98	September 6
	Pioneer 44Y94 CL	Early-Mid	93	September 1
	Pioneer 45Y95 CL	Mid	98	September 6

Table 3. Gross margins (excluding oilseed premiums) for trialed Roundup Ready®, TruFlex®, CL and TT canola technologies.

Technology	Variety	Hart yield (t/ha)	Gross margin $/ha	
			Hart $/ha	MRZ average $/ha
Conventional	Nuseed Diamond	1.26	$222.73	$316.00
	Nuseed Quartz	1.2	$190.49	
Triazine Tolerant	ATR Bluefin	0.66	-$105.38	$203.00
	Hyolaⓑ Blazer TT	0.99	$77.63	
	Hyolaⓑ Enforcer TT	0.98	$72.26	
	ATR Bonito	0.72	-$67.47	
	HyTTecⓑ Trifecta	0.91	$34.64	
	HyTTecⓑ Trophy	0.89	$23.89	
	InVigorⓑ T 4510	1.13	$152.87	
	SFR65-028TT	0.87	$13.14	
	SF Spark TT	0.89	$23.89	
	SF Dynatron TT™	0.96	$61.51	
	HyTTecⓑ Trident	1.10	$136.75	
Roundup Ready, TruFlex and stacked	Hyolaⓑ Battalion XC	0.98	$1.89	$215.00
	Pioneerⓑ 44Y27 RR	1.26	$134.89	
	Pioneerⓑ 45Y28 RR	1.28	$144.66	
	Hyolaⓑ 530 XT	0.79	-$94.71	
	Hyolaⓑ 410 XX	1.05	$32.30	
	Hyolaⓑ Garrison XC	1.09	$51.84	
	Nuseed Emu	1.25	$130.00	
	InVigorⓑ R 4022 P	1.13	$71.38	
	Nuseed Raptor TF	1.16	$86.04	
Clearfield	Banker CL	1.04	$83.56	$246.00
	Saintly CL	1.32	$234.03	
	Pioneerⓑ 43Y92 CL	1.23	$185.67	
	Pioneer ⓑ 44Y94 CL	1.35	$250.15	
	Pioneer ⓑ 45Y95 CL	1.18	$158.80	

Values (input costs and sale price) sourced from the 2021 Farm Gross Margin and Enterprise Planning Guide.
Average canola yield used for the medium rainfall zone (MRZ) is 1.4 t/ha (TT = 1.3 t/ha, conventional = 1.5 t/ha).
This data should be used a guide and is based on 2021 forecasted values only.

Acknowledgements

The Hart Field-Site Group would like to acknowledge SAGIT for funding this trial.

We would also like to thank BASF, Nuseed, Pioneer® Seeds, SeedForce and Pacific Seeds for providing canola seed to conduct this trial.

References

2021 Farm Gross Margin and Enterprise Planning Guide (2021).

Comparison of lentil and field pea varieties

Rebekah Allen[1] and Sarah Day[2]

[1]Hart Field-Site Group, [2]South Australian Research and Development Institute (SARDI)

Key findings

- Lentil yields for all varieties trialed ranged from 1.50 – 1.74 t/ha, at Hart.
- The highest yielding lentil varieties were GIA2002L, PBA Jumbo2 and GIA Leader.
- The average grain yield for all field pea varieties was 1.61 t/ha with yields ranging between 1.14 and 1.82 t/ha, at Hart.
- The highest yielding field pea varieties were Kaspa and PBA Butler, yielding 1.82 and 1.73 t/ha respectively.

Why do the trial?

To compare the performance of newly released pulse varieties alongside current commercial standards.

How was it done?

Plot size (field pea)	2.0 m x 10.0 m	**Fertiliser**	MAP (10:22) + 2% Zn @ 80 kg/ha
Plot size (lentil)	1.75 m x 10.0 m		
Seeding date	May 18, 2021		
Field pea harvest date	November 1, 2021		
Lentil harvest date	November 8, 2021		
Location	Hart, SA		

Each trial was a randomised complete block design with three replicates.

Five field pea varieties were trialed, including GIA Kastar and GIA Ourstar, released in 2020.

Seven lentil varieties were trialed, including PBA Kelpie and GIA Leader, released in 2020 alongside one new pre-commercial line; GIA2002L.

Both trials were managed with the application of pesticides to ensure a weed, insect and disease-free canopy. All plots were assessed for grain yield (t/ha) and 1000-grain weight (g).

Results and discussion

Lentil

The average grain yield for lentils was 1.30 t/ha, with yields ranging from 1.07 – 1.48 t/ha, at Hart in 2021. The highest yielding varieties were GIA2002L, PBA Jumbo2 and GIA Leader (Table 1). Although GIA Leader was high yielding, it also performed similarly to all XT varieties trialed.

PBA Jumbo2 was the highest yielding conventional red lentil available for South Australian growers and is a key variety choice where herbicide residues or broadleaf weeds are not an issue.

GIA Leader is a newly released IMI tolerant red lentil that was developed from PBA Jumbo2 and is well adapted to good soil types in medium to high rainfall zones. GIA2002L is an IMI tolerant small red lentil being considered for commercial release. It is a broadly adapted and high yielding line, with high yields in variety trials in 2020 and 2021.

Grain yield for all lentil varieties trialed in 2020 at Hart were similar, ranging from 1.5 – 1.74 t/ha (Table 1).

Table 1. Lentil and field pea grain yields at Hart in 2020 and 2021. Values shaded within each column show the highest performing varieties. NS = not significant (P≤0.05).

Field pea	Grain yield t/ha	Lentil	Grain yield t/ha
2020		**2020**	
GIA Kastarⓓ	1.35	PBA Kelpie XTⓓ	1.74
GIA Ourstarⓓ	1.54	PBA Hallmark XTⓓ	1.57
Kaspaⓓ	1.55	PBA Hurricane XTⓓ	1.50
PBA Ouraⓓ	1.40	PBA Highland XTⓓ	1.64
PBA Butlerⓓ	1.30	PBA Jumbo2ⓓ	1.71
PBA Whartonⓓ	1.15	GIA Leaderⓓ	1.58
Average grain yield	**1.38**	**Average grain yield**	**1.62**
LSD (P≤0.05)	**NS**	**LSD (P≤0.05)**	**NS**
2021		**2021**	
GIA Kastarⓓ	1.41^{a}	PBA Kelpie XTⓓ	1.07^{b}
GIA Ourstarⓓ	1.50^{a}	PBA Hallmark XTⓓ	1.27^{b}
PBA Whartonⓓ	1.57^{a}	PBA Hurricane XTⓓ	1.24^{b}
PBA Butlerⓓ	1.73^{b}	PBA Highland XTⓓ	1.29^{b}
Kaspaⓓ	1.82^{b}	PBA Jumbo2ⓓ	1.43^{c}
		GIA Leaderⓓ	1.35^{bc}
		GIA2002L	1.48^{c}
Average grain yield	**1.61**	**Average grain yield**	**1.30**
LSD (P≤0.05)	**0.16**	**LSD (P≤0.05)**	**0.14**

Field pea

Kaspa and PBA Butler were the highest yielding field pea varieties, yielding 1.82 and 1.73 t/ha respectively (Table 1). The average field pea yield at Hart was 1.61 t/ha, with varieties ranging from 1.41 – 1.82 t/ha.

PBA Butler is a high yielding Kaspa type field pea with broad adaptation and improved resistance to bacterial blight over Kaspa. PBA Butler has wide adaptation across South Australia, performs well in medium to long growing season, and is higher yielding than other field pea varieties in the low rainfall zone.

GIA Ourstar and GIA Kastar are the first commercial field pea varieties with improved tolerances to Group 2 (previously Group B) herbicides and will be a good fit where herbicide residues are an issue.

Seasonal conditions at Hart in 2021 favoured Kaspa and PBA Butler which are both late flowering varieties. Cold spring weather events (below 2° Celsius at 1.2 m) in late September and early October affected pod fill of mid-flowering, mid-maturing varieties like GIA Kastar, GIA Ourstar and PBA Wharton.

Newly released variety PBA Taylor, although not tested at this site in 2021, has shown similar or improved grain yield compared to PBA Butler in National Variety Trials in the Mid North region.

Acknowledgements

This trial is funded by HART SA's premier cropping field site

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank Global Grain Genetics, Seednet and SARDI Clare for providing seed to conduct this trial.

Field pea (above) and lentil (below) seedling emergence at Hart on June 7, 2021.

Comparison of oat varieties; including imidazolinone (IMI) tolerant variety

Declan Anderson and Rebekah Allen; Hart Field-Site Group

Key findings

- Wintaroo and Kingbale yielded similarly for oaten hay production at Hart in 2021, producing 3.89 and 3.91 t/ha, respectively.
- No yield penalty was observed for Kingbale with the application of Sentry® IBS, at 50 g/ha.
- Kingbale (+/- Sentry®) produced the highest grain yield, ranging from 1.49 – 1.59 t/ha.
- In 2021, hay quality was similar for Wintaroo and Kingbale (+/- Sentry®) across crude protein (%), neutral detergent fibre (% aNDFom), acid detergent fibre (% ADF) and water-soluble carbohydrates (% WSC).

Why do the trial?

Herbicide tolerant crops are becoming increasingly common within our farming systems, due to the benefits of improved weed control options. As a result, the risk of plant back restrictions from these herbicides in a following year's crop has increased.

Kingbale is the first single gene imidazolinone (IMI) tolerant oat variety to be developed and was released by InterGrain in 2019. This variety has an improved tolerance to Group 2 (previously Group B) soil residual herbicides. A registration for the use of Sentry® (active ingredient imazapic and imazapyr) was approved in 2021 as a pre-emergent herbicide. The release of this variety provides growers additional management tools to reduce the risk of plant back issues from IMI herbicides, particularly where hay production is a common rotational option and additional grass weed control is required.

Preliminary trial data suggests that Kingbale is agronomically similar to Wintaroo, with a similar disease profile and comparable hay and grain properties.

This trial compares the hay yield, hay quality and grain yield of Kingbale standalone, and with the application of Sentry® IBS (incorporated by sowing) compared to Wintaroo, a commonly grown oat variety.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 1% Zn + Impact @ 80 kg/ha
Seeding date	May 18, 2021		Easy N (42.5:0) 70 L/ha on June 12, 2021
Location	Hart, SA		Easy N (42.5:0) 70 L/ha on August 20, 2021
Harvest date	November 30, 2021		

The trial was a randomised complete block design with three replicates and two varieties (Kingbale +/- Sentry® IBS). It was managed with the application of pesticides to ensure a weed, insect and disease-free canopy. All plots were assessed for hay yield (t/ha), hay quality and grain yield (t/ha). Hay cuts were conducted at watery-ripe (GS71) by cutting 4 x 1 metre of row at ground level. The Sentry® herbicide treatment was applied IBS at 50 g/ha prior to seeding.

Results and discussion

Hay yield

At Hart in 2021, Wintaroo and Kingbale yielded similarly for oaten hay production, producing 3.89 and 3.91 t/ha, respectively. No yield penalty was observed for Kingbale + Sentry® IBS at 50 g/ha, with a hay yield of 3.75 t/ha (Figure 1).

Hay yield data from Hart in 2019 also supports the result observed in 2021, with varieties yielding similarly. The exception to this was 2020, where Kingbale had a lower hay yield compared to Wintaroo (Table 1). Results from the Agrifutures funded, National Hay Agronomy project (conducted across Southern and Western Australia) have also shown that Kingbale has consistently yielded similar to Wintaroo. In only one of four years, Kingbale yielded lower than Wintaroo at Muresk, WA (Peirce & Schilling 2021). Results at Hart showed that there was no hay yield penalty associated with the application of Sentry® herbicide to Kingbale oats.

Grain yield

Kingbale + Sentry® applied IBS was the highest performing variety, with a grain yield of 1.59 t/ha, showing that no grain yield penalty occurs with the application of Sentry®. Kingbale standalone achieved a grain yield of 1.49 t/ha, compared to Wintaroo of 1.39 t/ha (Figure 1).

Similar results were also observed at Hart in 2020. However, Kingbale yielded lower than Wintaroo in 2019, under Decile 1 conditions at Hart (Table 1).

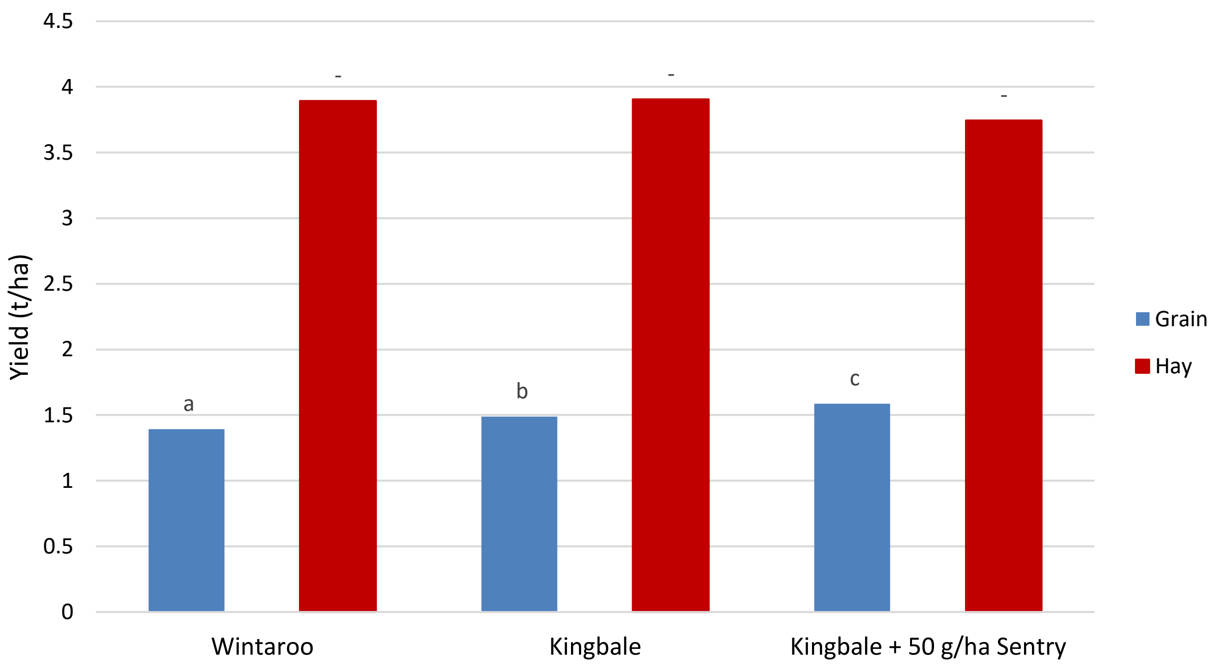


Figure 1. Grain and hay yield of Wintaroo and Kingbale treatments in the 2021 trial at Hart. Yields with the same letter are not significantly different.

Table 1. Long-term oaten hay and grain performance for Group B tolerant oats trial at Hart (expressed as % trial average).

	% of trial average						Hay yield (t/ha)	Grain yield (t/ha)
	2019		2020		2021			
Variety	**Hay**	**Grain**	**Hay**	**Grain**	**Hay**	**Grain**	**2021**	
Wintaroo	92	86	104	99	101	93	3.89	1.39
Kingbale	82	80	88	106	101	100	3.91	1.49
Yallara	126	134						
Kingbale + Sentry IBS					97	107	3.74	1.59
Mulgara			108	94				
Average yield (t/ha)	**2.83**	**0.68**	**2.98**	**2.10**	**3.85**	**1.49**	**3.85**	**1.49**
Sowing date	May 30		May 6		May 18			
April - Oct (mm)	162		336		232			
Annual rainfall (mm)	189		503		401			

Hay quality

In 2021, hay quality was similar for Wintaroo and Kingbale (+/- Sentry®) across crude protein (%), neutral detergent fibre (% aNDFom), acid detergent fibre (% ADF) and water-soluble carbohydrates (% WSC). Similar results were also observed in 2019 for both varieties (Table 2).

Crude protein is the measurement of protein content (%) within a feed sample. In 2021, Kingbale and Wintaroo did not meet requirements for export fodder, as displayed in Table 2. All varieties trialed in 2019 met protein requirements, showing that protein content is likely influenced by in-crop management practices and seasonal conditions.

Neutral detergent fibre (NDF) is a measure of insoluble fibre in feed and correlates to the dry matter intake (DMI) of an animal. Higher levels of NDF result in a reduced DMI, and a low NDF can result in increased DMI. All varieties in 2019 and 2021 met the minimum requirements for export fodder. Neutral detergent fibre values across both seasons are similar, suggesting NDF is influenced by variety selection and cut timing.

Lower levels of ADF provide improved digestibility (AEXCO 2016). Results in 2019 and 2021 show that Wintaroo and Kingbale have similar results across multiple seasons. Acid detergent fibre results for 2021 show that Kingbale meets the export fodder requirements, with Wintaroo slightly above the requirement.

Water soluble carbohydrates (WSC) are readily digestible sugars that can contribute to protein synthesis and influence palatability (AEXCO 2016) and were low in Kingbale and Wintaroo across 2019 and 2021.

In 2019, Yallara was the only variety to meet minimum export fodder requirements for WSC, producing a better quality hay for export compared to that of Kingbale and Wintaroo in that year.

Table 2. Feed quality analysis for oaten hay treatments at Hart in 2019 and 2021.

Variety	Crude Protein (% CP)	Neutral Detergent Fibre (% aNDFom)	Acid Detergent Fibre (% ADF)	Water soluble carbohydrates (% WSC)
Minimum export fodder standards	4 – 10%	< 57%	< 32 %	> 18%
2019				
Kingbale	8.80	50.5	29.70^{b}	16.90^{a}
Wintaroo	9.80	49.3	29.10^{b}	11.20^{a}
Yallara	9.00	45.0	25.00^{a}	34.50^{b}
LSD (P≤0.05)	**NS**	**NS**	**3.00**	**5.90**
2021				
Kingbale	13	47.4	31.9	12.6
Kingbale + 50 g/ha Sentry	12.9	45.9	31.0	13.9
Wintaroo	11.9	47.1	32.5	14.2
LSD (P≤0.05)	**NS**	**NS**	**NS**	**NS**

Minimum standards for export hay quality requirements were sourced from AEXCO, 2016. Other quality parameters not shown.

References

AEXCO 2016, 'Market requirements', *Producing Quality Oaten Hay*

Peirce C, Schilling R 2021, 'National hay agronomy update', *2021 Hart Field Day Guide*

Acknowledgements

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank InterGrain and Wayne Heading for providing seed, and Nufarm for providing Sentry® herbicide to conduct this trial. We would also like to kindly acknowledge Balco for conducting the feed test analysis.

Improving vetch dry matter production

Declan Anderson and Rebekah Allen; Hart Field-Site Group

Key findings

- All common and woolly-pod vetch varieties had similar hay production, averaging 2.3 t DM/ha at Hart in 2021.
- Timok, RM4, and Studenica produced the highest amount of dry matter (DM) for early grazing opportunities, ranging from 0.93 – 1.13 t DM/ha.
- At Hart in 2021, small increases in dry matter production (t DM/ha) were observed when gibberellic acid (GA) was applied at 10 and 20 g/ha to Timok vetch at early grazing timings, however, vetch responses to GA across a number of seasons and trial locations has not been consistent and the management of this product cannot be recommended across low-medium rainfall environments.
- Hay yields (t DM/ha) were not influenced by the application of gibberellic acid.

Why do the trial?

Vetch is a commonly grown break crop across many regions of the Mid-North and is used as a grazing and hay option within mixed farming systems.

Gibberellic acid (GA) is a plant growth regulator that promotes cell elongation. It is often utilised in intensive grazing systems to promote rapid growth in climates where growth is often slow due to wet conditions and low temperatures (Matthew *et al.* 2009).

This trial aims to improve biomass production of vetch with relatively low cost and input strategies. Multiple agronomical techniques were tested in this trial; varietal selection, fertiliser, seeding rates, inoculation and the application of the plant growth hormone, gibberellic acid.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertilizer**	DAP (18:20) + 1% Zn + Impact @ 80 kg/ha
Seeding date	April 19, 2021		
Location	Hart, SA	**GA Application Date**	Grazing: July 29, 2021 Hay: August 26, 2021

The trial was a randomised complete block design with three replicates and 15 treatments comparing vetch variety, nutrition, seeding rate and the application of gibberellic acid (GA) to increase vetch biomass. This trial was managed with the application of pesticides to ensure a weed, insect and disease-free canopy.

Common vetches *(Vicia sativa)* are the most widely grown vetch, produced within most cropping regions of South Australia. Common vetch varieties trialed at Hart in 2021 were Studenica, Timok, and Morava which are very early, mid and late maturing varieties, respectively.

The second most commonly grown vetch is woolly-pod *(Vicia villosa)*. This trial included both Capello and RM4 which have been developed for forage and hay production and are generally later maturing. Grain harvested from woolly-pod vetches should only be used for seed as it cannot be fed to livestock due to high toxin levels (Nagel et al 2021a).

Recommended seeding rates for dry matter production varied for each vetch type, with the aim of achieving 70 plants/m^2 (Nagel et al 2020). Woolly-pod vetch varieties were sown at 40 kg/ha and common vetches at 50 kg/ha. A lentil treatment sown at 120 plants/m^2 was also included to compare the biomass, hay production and hay quality to vetch.

Additional Timok treatments were included to compare standard basal phosphorus (P) inputs to high rates of basal P. This was conducted by applying DAP fertiliser at a rate of 120 kg/ha at seeding. Top-up urea was added to the standard P treatment to balance the nitrogen inputs across both treatments.

Timok was also sown at a high seeding rate to compare differences between the standard seed rate of 50 kg/ha to a high rate of 80kg/ha. An inoculation treatment was also included and was achieved by applying a group E/F peat to the vetch seed (product used NoduleN®). This was done to ensure ideal conditions for nitrogen fixation in the soil.

Applications of GA (product applied was ProGibb®) were also applied to Timok vetch plots at early branching on July 29 and budding on August 26, just prior to flowering. The rates at which GA was applied was 10 and 20 g/ha respectively.

Timok plots +/- GA were cut at three weeks post the first application to measure early biomass differences. Biomass cuts were also taken again at four weeks post first application for all plots. Hay cuts were conducted on all plots when they individually reached 50% flower (50% pod), as highlighted in Table 1.

Table 1. Maturity characteristics (Nagel et al 2020) and cut dates for all varieties sown at Hart in 2021.

Variety	Maturity	Hay Cut Date	Days to reach hay maturity
Studenica	Very early	September 10	144
Timok	Mid	September 14	148
PBA Jumbo 2	Mid	September 22	156
Morava	Late	October 5	169
RM4	Mid	October 8	172
Capello	Late	October 8	172

Results and discussion

Variety performance

Variety selection strongly influenced crop biomass production early in the growing season at Hart.

The best performing varieties for early biomass production were Timok, Studenica and woolly-pod vetch variety RM4, yielding 1.11, 0.93 and 1.13 t DM/ha respectively (Figure 1).

Common vetch varieties Timok and Studenica were suited to the conditions experienced at Hart in 2021. The later start to the season suited very early variety Studenica and mid-maturing variety Timok. The woolly-pod vetch variety RM4 also has a mid-maturity for a woolly pod, but is later than the common vetch lines.

RM4 performed similarly to Timok for dry matter production, although it also had the same number of days to hay cut as Capello which is a late maturing woolly-pod variety. The early performance of RM4 can be explained by its early establishment characteristics (Nagel 2021b).

Variety selection did not influence total hay production at Hart this season. All varieties, including the lentil treatment, yielded similarly with an average hay yield of 2.3 t DM/ha.

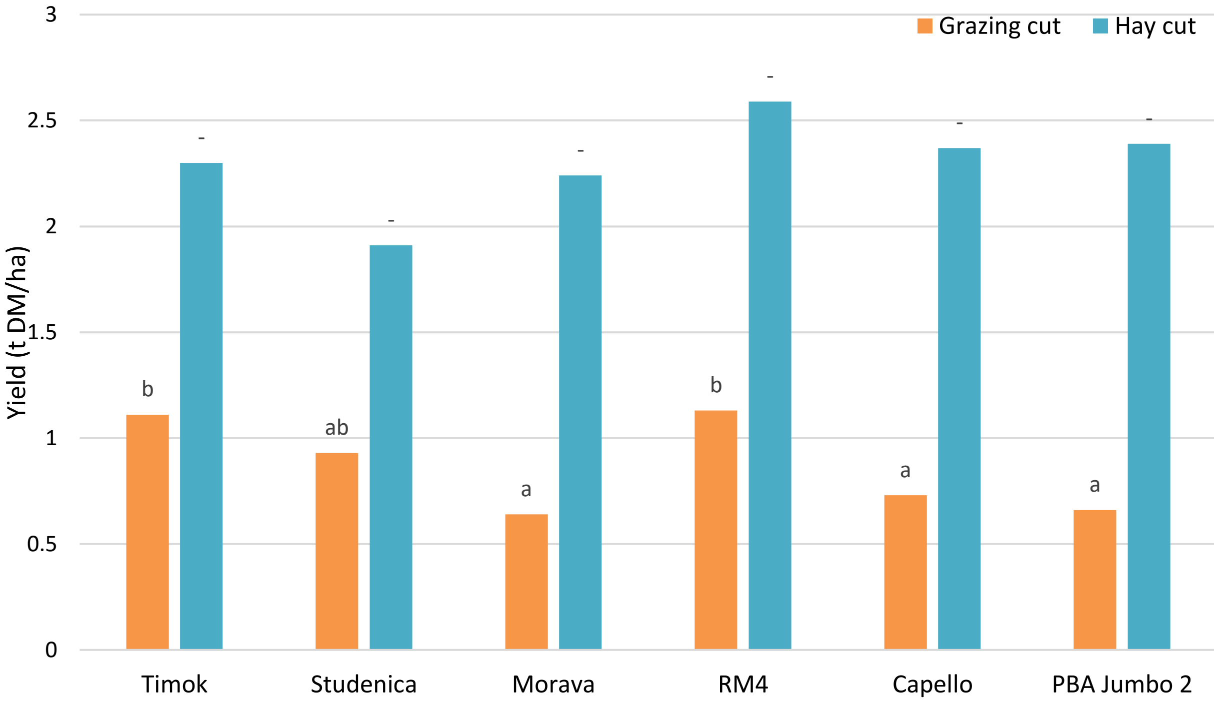


Figure 1. Biomass production of each vetch and lentil variety at grazing (four weeks after first spray), and hay cuts (when individual hay cut timings were met) at Hart in 2021. Hay yield was not significant.

Effects of gibberellic acid in vetch

At Hart in 2021, applications of gibberellic acid at 10 and 20 g/ha, applied at early branching, improved the dry matter (DM) production of Timok vetch by up to 110 kg DM/ha when cuts were taken three weeks after application (Table 2). By four weeks, no DM (t/ha) differences between treatments was observed.

There was no increase of hay yield when gibberellic acid was applied at 10 or 20 g/ha at Hart in 2021.

Results from Hart in 2020, showed vetch DM increasing by 270 kg/ha (0.27 t/ha) four weeks after GA application when applied at rates of 20 g/ha (Allen *et al* 2021).

Previous results from trials conducted in Kimba and Booleroo displayed no biomass responses to gibberellic acid when applied at vegetative and early podding stages at equivalent rates (Day & Roberts 2021). Similar results were also seen at Pyramid Hill in Victoria (Bennet 2020).

This shows that there is an inconsistent response to the application of gibberellic acid in vetch across the low and medium rainfall environments of South Australia and Victoria.

Table 2. Biomass production of gibberellic acid treatments at early grazing (three weeks after first spray), grazing (four weeks after first spray), and hay cuts (three weeks after second spray).

Treatment	Grazing 3 weeks after GA application (t DM/ha)	Grazing 4 weeks after GA application (t DM/ha)	Hay cut (t DM/ha)
Timok	0.58^{a}	1.11	2.30
Timok + 10 g/ha GA	0.67^{b}	1.12	2.55
Timok + 20 g/ha GA	0.69^{b}	0.93	2.72
LSD (P≤0.05)	**0.056**	**NS**	**NS**

Although no DM differences were observed, a height response was noted four weeks after gibberellic acid was applied. Increases in height by 6.5 and 7.9 cm were observed for applications of GA applied at 10 and 20 g/ha, respectively. No height response was observed later at the hay cut timing.

At Booleroo and Kimba, an increase in plant height was observed at the late vegetative stage, while gibberellic acid applications at early podding decreased plant height (Day & Roberts 2021). The same response was also seen at Pyramid Hill (Bennett 2020).

Similarly to Hart in 2020, colour differences in vetch treatments were noted for plots with applications of gibberellic acid (Figure 2).

Figure 2. Comparison between 20 g/ha of GA applied before hay cutting (left) and standalone Timok (right) at Hart in 2021. Photo taken on September 6, 2021.

Table 3. Plant height for +/- gibberellic acid treatments at grazing (four weeks after first spray), and hay cuts (three weeks after second spray).

	Plant height (cm)	
Treatment	**Grazing**	**Hay**
Timok	27.2[a]	50.1
Timok + 10 g/ha GA	33.7[b]	59.0
Timok + 20 g/ha GA	35.1[b]	63.8
LSD (P≤0.05)	**4.9**	**NS**

Feed quality

Varieties

Feed quality for all vetch varieties at grazing was similar across multiple testing characteristics, including crude protein (%), water soluble carbohydrates (WSC %) and net energy (MJ/kg) of 26.9%, 9.0 % and 5.85 MJ/kg, respectively.

The only differences observed were neutral detergent fibre (NDF) levels. Timok, Morava, Capello and RM4 had the lowest level of NDF (aNDFom). Lower levels of aNDFom can result in increased dry matter intake due to the feed having higher levels of easily digestible plant matter.

Capello and RM4 were also observed to have the highest levels of NDFDom30 and lowest uNDFom240, meaning these varieties provided the greatest grazing value to livestock through increased digestibility and improved dry matter intake.

Grazing

Grazing feed quality was negatively affected by applications of both 10 and 20 g/ha of GA. The application of 20 g/ha produced decreased crude protein levels (%) in vetch DM after three weeks. After four weeks, applications of both 10 and 20 g/ha of GA resulted in a decrease in crude protein (%) and an increase the neutral detergent fibre content in the dry matter.

Table 4. Comparison of feed test results for varieties trialed at Hart in 2021. Shaded values show the highest performing varieties for each feed test characteristic.

	Variety	Crude protein (CP) (%)	aNDFom (%)	NDFDom30 (%)	uNDFom240 (%)	WSC (%)	Net energy of maintenance (MJ/kg)
Grazing cut	Timok	27.97	21.5^{ab}	46.49^{ab}	9.5^{b}	8.23	5.96
	Studenica	24.33	27.97^{c}	23.32^{b}	10.67^{b}	10.57	5.66
	Morava	28.1	21.33^{ab}	39.42^{a}	10.5^{b}	8.57	5.96
	Capello	28.33	19.83^{ab}	76.39^{c}	1.3^{a}	9.47	5.67
	RM4	26.7	16^{a}	79.25^{c}	6^{ab}	8.57	5.77
	PBA Jumbo 2	25.8	25.97^{bc}	53.32^{b}	9.7^{b}	8.93	5.99
	LSD (P≤0.05)	**NS**	**6.231**	**10.05**	**6.31**	**NS**	**NS**
Hay Cut	Timok	19.7^{bc}	30.93^{bc}	37.53^{bc}	17.27^{ab}	12.43^{b}	5.69^{bc}
	Studenica	19.53^{bc}	29.33^{ab}	28.1^{ab}	18.27^{b}	14.87^{c}	5.79^{c}
	Morava	20^{c}	32.23^{bc}	22.9^{a}	22.7^{c}	12.03^{ab}	5.27^{a}
	Capello	18.23^{b}	34.03^{c}	44.23^{c}	16.17^{a}	10.6^{a}	5.36^{ab}
	RM4	19.6^{bc}	34.77^{c}	44.57^{c}	16.47^{a}	10.9^{ab}	5.47^{abc}
	PBA Jumbo 2	15.63^{a}	26.6^{a}	27.53^{ab}	16.97^{ab}	18.9^{d}	6.28^{d}
	LSD (P≤0.05)	**1.659**	**4.156**	**10.81**	**1.498**	**1.715**	**0.402**

Lentil as a grazing and hay option

PBA Jumbo2 was trialed to assess its potential as a grazing and hay option. PBA Jumbo2 lentils produced poor biomass and average quality feed when compared to vetch, however, when cut for hay at the optimal timing (50% pod), PBA Jumbo 2 produced similar levels of biomass compared to vetch, as well as having improved feed characteristics. It should be noted that the lentil treatment was sown at almost double the seeding rate of the vetch.

PBA Jumbo 2 had low neutral detergent fibre levels (aNDFom), low uNDFom240 levels, high water-soluble carbohydrates and higher net energy than most vetch varieties (Table 4). While PBA Jumbo2 was cut for hay at an optimum timing, there is a potential for lentils to be cut later; after significant frost damage in some environments. This means quality would likely be decreased when compared to results observed in 2021 (Hawthorne 2007), however, pulses do not lose hay quality as quickly as cereals after frost events.

Table 5. Feed test results for Timok vetch +/- gibberellic acid treatments at Hart in 2021. Shaded values show the highest performing treatment for each feed test characteristic.

	Variety quality @ grazing	Crude protein (CP) (%)	aNDFom (%)	NDFDom 30 (%)	uNDFom240 (%)	WSC (%)	Net energy of maintenance (MJ/kg)
Grazing cut (3 weeks post application)	Nil	29.1^{bc}	20.9^{a}	32.3	11.6	7.33	5.79
	10 g/ha	29.23^{bc}	21.67^{a}	28.6	13.4	5.7	5.75
	20 g/ha	28.53^{b}	22.77^{a}	30.9	13.83	6.17	5.7
Grazing cut (4 weeks post application)	Nil	27.97^{b}	21.5^{a}	46.3	9.5	8.23	5.97
	10 g/ha	26^{a}	25.7^{b}	42.1	12.33	8.53	5.66
	20 g/ha	25.93^{a}	25.73^{b}	43.1	12.57	9.13	5.86
LSD (P≤0.05)		**0.759**	**1.911**	**NS**	**NS**	**NS**	**NS**
Hay cut	Nil	19.7	30.93	37.5	17.27	12.43	5.69
	10 g/ha	19.23	32.3	33.3	18.7	11.2	5.61
	20 g/ha	19.73	34.3	38.2	19.03	12.23	5.43
LSD (P≤0.05)		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Common management techniques

Increasing the seeding rates of vetch was trialed as a technique to increase biomass, however, no significant increase in dry matter production was observed.

Increasing seed rate is not a recommended management practice for vetch or lentil due to the increased likelihood of disease infection (Day & Roberts 2021).

The inoculation of Timok vetch seed was conducted to see if the addition of rhizobia to the soil could increase crop biomass. No response was expected as a PREDICTA® rNod test was completed across the trial area, indicating an adequate background level of rhizobia for successful inoculation. There was no response in plant biomass or root nodulation between treatments.

Applying higher levels of phosphorus (P) fertiliser has seen some positive responses in vetch trials (Dzoma et al 2019). Although no response was seen at Hart in 2021 when a base rate of 16 kg P/ha was compared to a higher rate of 24 kg P/ha (applied at seeding). This is likely a response to adequate background levels of P the Hart field site.

Acknowledgements

This trial is funded by HART SA's premier cropping field site

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank the SARDI/GRDC National Vetch Breeding Program for providing seed to conduct this trial, Ross Ballard from SARDI Plant & Soil Health for conducting Rhizobia testing and Balco for conducting the feed test analysis.

References

Allen R, Noack S and Guidera B 2021, 'Increasing vetch dry matter production through the application of gibberellic acid', *2020 Hart Trial Results*

Bennet B 2020, 'Gibberellic acid in vetch', *Birchip Cropping Group*

Day S & Roberts P 2021,'Alternative end use for lentil and novel management strategies for vetch', *Upper North Farming Systems Annual Research and Extension Compendium – 2020 Results*

Dzoma B, Wilhelm N, Telfer P & Zeppel K 2019, 'Effect or rate and placement of phosphorus on vetch performance', *Agronomy Australia Conference, 25-29 August 2019, Wagga Wagga*

Hawthorne W 2007, 'Managing pulses to minimize frost damage', *Australian Pulse Bulletin*

Matthew, C, Hofmann, W.A & Osborne, M.A 2009,'Pasture response to gibberellins: A review and recommendations, *New Zealand Journal of Agricultural Research*, Vol. 52, Issue 2, pp. 213-225

Nagel S, Kennedy A & Kirby G 2020, 'Vetch', *2021 South Australian Crop Sowing Guide*

Nagel S, Kirby G & Kennedy A 2021a, 'Vetch agronomy and management', *GRDC Research Update Adelaide, South Australia*

Nagel S 2021b, 'O – Vetch Varieties', *2021 Hart Field Day Guide*

Photo. Timok ready for hay cutting (September 14); vetch biomass trial at Hart.

Gibberellic acid effects on head emergence in oats

Declan Anderson and Rebekah Allen; Hart Field-Site Group

Key findings

- Applications of gibberellic acid at 40 g/ha did not promote head emergence from the boot for Mulgara or Tammar oats.
- Variety selection and seasonal conditions strongly influenced hay yield (t DM/ha) and quality at Hart in 2021.

Why do the trial?

Quality is a significant driver in the profitability of hay and optimising cutting date is a critical tool used to achieve this. Crops that have experienced a dry spring, or are sown late face environmental stresses affecting head emergence (Guidera *et al.* 2020). This can result in a longer curing time once hay has been cut, or a sharp decrease in quality by the time the head has fully emerged (Agrifutures Australia 2021).

Gibberellic acid (GA) is a plant growth regulator that promotes cell elongation. It is often utilised in intensive grazing systems to promote rapid growth in climates where growth is often slowed due to wet conditions and low temperatures (Matthew *et al.* 2009).

This trial aims to investigate the effects of gibberellic acid on oaten hay head emergence from the boot, and hay quality, for two oaten hay varieties at Hart in 2021.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 1% Zn + Impact @ 80 kg/ha
Seeding date	May 3, 2021		Easy N (42.5:0) 70 L/ha on June 12, 2021
Location	Hart, SA		Easy N (42.5:0) 70 L/ha on August 20, 2021
Harvest date	November 30, 2021		

The trial was a randomised complete block design with three replicates and six treatments. This trial was managed with the application of pesticides to ensure a weed, insect and disease-free canopy.

Hay varieties trialed at Hart in 2021 were a mid-maturing variety Mulgara, and Tammar, a late maturing variety. Each had a nil treatment and two GA treatments usiong ProGibb® SG at 40 g/ha, at GS31 and GS30 (growth stage) (Table 1).

Table 1. Date of application for gibberellic acid treatments at each timing for Mulgara and Tammar.

Variety	GS31 application date	GS39 application date
Mulgara	August 13	August 25
Tammar	August 25	September 8

To determine hay yield (t DM/ha), 4 x 1m rows were taken from each plot at GS71 and oven dried at 60°C for 48 hours, then weighed. Hay quality was conducted using Near Infrared (NIR) technology to observe the effect of GA on crude protein, aNDFom, NDFDom30, uNDFom240, water soluble carbohydrates and net energy of maintenance.

Plant height (cm) and head emergence (cm) assessments were conducted at GS71 prior to cutting, to measure the effects of GA on plant growth and head emergence from boot (Figure 1). Both Mulgara and Tammar were cut for commercial hay on September 22 and October 5 respectively (Table 1). Grain yield (t/ha) was also assessed.

Results and discussion

Head emergence

No differences were observed for head emergence in either Mulgara or Tammar oats when GA was applied at GS31 or GS39. The measured distance between the flag leaf ligule and head for nil treatment of Mulgara was - 5.2, compared to - 4.9 when applied at GS39. This means that at the time of cutting (GS71), 4.9 cm of the head was remaining in the boot (Table 1).

A potted experiment conducted in a growth chamber at Waite in 2020 also displayed similar trends for oat varieties Mulgara, Brusher and Williams; no response to head emergence from applications of GA was observed with similar rates across six timings, from GS13 – GS69 (Guidera *et al.* 2021).

Variety selection influenced head emergence of oats at Hart in 2021. Mulgara had significantly less head remaining in the boot when compared to Tammar, averaging -5 and -9.2, respectively. This response is likely the result of Mulgara having a shorter maturity, compared to Tammar which is a longer season variety, maturing later under dry seasonal conditions.

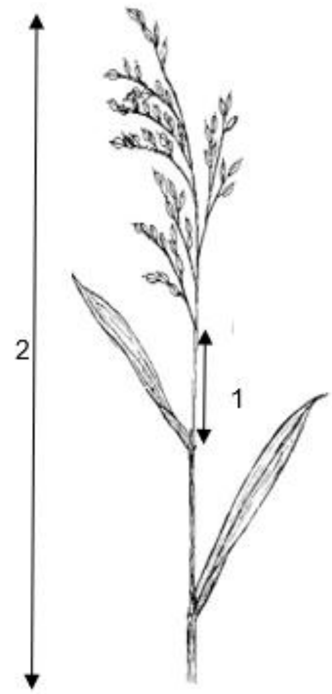


Figure 1. Head emergence and plant height measurements assessed at Hart in 2021. Head emergence (1) assessed the distance between flag leaf ligule and the base of the head (main stem). If this value was negative, the base of the head was still within the boot of the stem. Plant height (2) was measured from the soil surface to the highest point of the plant. Sourced from Guidera et.al *2020.*

Table 1. Head emergence of Mulgara and Tammar from the boot measured at GS71. Values with the same letters are not significantly different.

Variety	Treatment (+/- GA)	Head emergence (cm)	Average head emergence (cm)
Mulgara	Nil	- 5.19[a]	- 5.02[a]
	GS31	- 5.00[a]	
	GS39	- 4.85[a]	
Tammar	Nil	- 8.20[b]	- 9.17[b]
	GS31	- 9.57[b]	
	GS39	- 9.73[b]	
LSD (P≤0.05)		**2.68**	**1.55**

Plant height

Gibberellic acid had no effect on plant height, meaning that variety selection alone influenced height differences.

Label recommendations for ProGibb® SG outline that plant growth peaks seven days after the application of GA and ceases after 21 – 28 days. At Hart, it took between 28 and 40 days for oat varieties to reach the optimal hay cut timing (GS71). Applications of GA were applied at GS31 and GS39 which means that cut dates were outside of the peak response period and seasonal conditions would have influenced plant growth at this time.

Mulgara had superior plant height (69.5 cm) when compared to Tammar at 61.7 cm. Both varieties are classed as tall hay oats (Hoppo et al. 2021), meaning that differences observed were due to the shorter maturity of Mulgara, most suitable to the shorter growing season and drier conditions experienced at Hart. Similar responses were observed in the potted experiment at Waite in 2020 (Guidera *et al.* 2021).

Hay yield and cut timing

Mulgara had a greater hay yield when compared to Tammar, yielding 5.15 and 3.94 t DM/ha, respectively.

Gibberellic acid did not affect hay yield (Figure 2), however, a small difference in cut time was noted. Mulgara treated with gibberellic acid at GS39, delayed hay cutting by two days, reaching GS71 on September 24, compared to nil and GS31 treatment reaching GS71 on September 22. This effect was not observed for Tammar.

Grain yield

Mulgara achieved a higher average grain yield of 1.56 t/ha, when compared to Tammar with a yield of 1.2 t/ha. This result was likely due to the benefits of a shorter maturity under seasonal conditions at Hart.

Gibberellic acid did not negatively affect grain yield for Mulgara and Tammar oats. Similar results were also seen in a trial at Warmur, Victoria, where GA did not affect grain yield or quality of trialed oat varieties (Lemon *et. al* 2017).

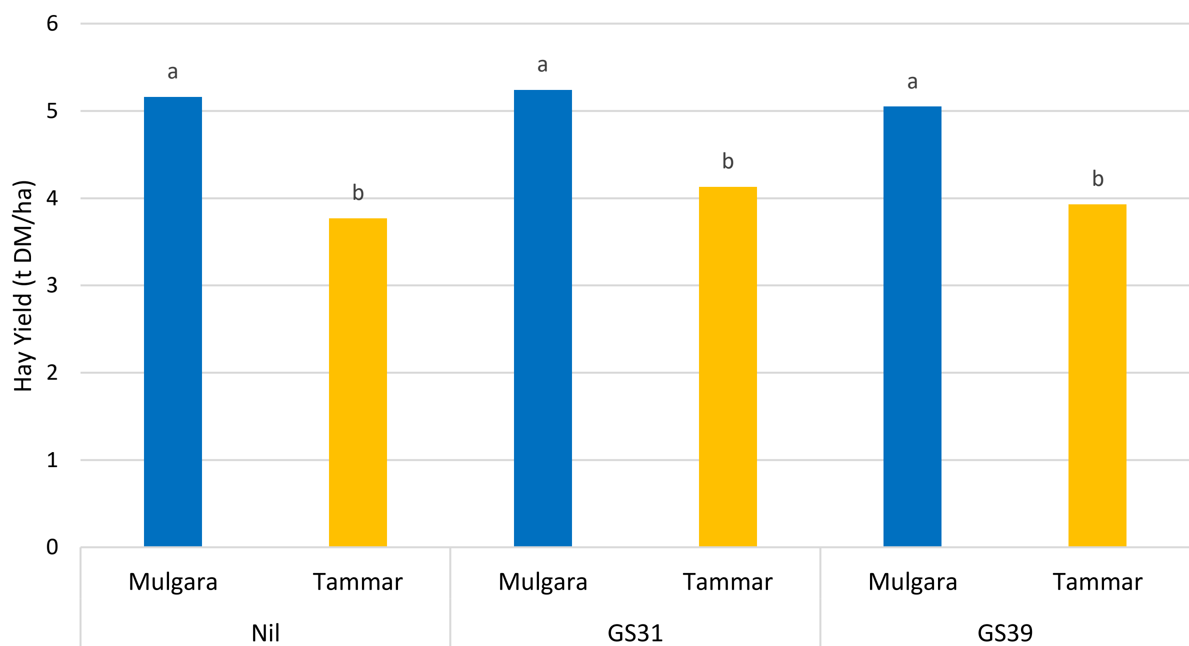


Figure 2. Hay yield (t DM/ha) of Mulgara and Tammar oats +/- gibberellic acid.

Hay quality

At Hart in 2021, the application of GA at GS31 and GS39 did not affect hay quality (Table 2).

A trial in Warmur, Victoria also tested the hay quality of GA treated oats at similar rates. No differences were observed for hay quality characteristics when compared to the nil treatment (Lemon *et. al* 2017).

In comparison to Tammar, Mulgara had increased levels of water-soluble carbohydrates (WSC) and lower levels of aNDFom and uNDFom240 (Table 3), showing improved palatability of the hay, while also assisting protein synthesis (AEXCO 2016b).

Table 2. Feed test results for hay samples from application timing of gibberellic acid within the trial at Hart in 2021.

Feed Test Parameter	Minimum export standards	Nil	GS31	GS39	LSD ($P \leq 0.05$)
Crude protein (%)	4 – 10%	13.5	12.6	12.7	**NS**
aNDFom (%)	< 57%	47.0	46.6	48.0	**NS**
NDFDom30 (%)	-	58.5	54.5	54.4	**NS**
uNDFom240 (%)	-	14.4	15.8	16.1	**NS**
Water soluble carbohydrates (%)	> 18%	17.0	18.0	18.0	**NS**
Net energy of maintenance (MJ/kg)	-	6.1	6.1	6.2	**NS**

Minimum standards for export hay quality requirements were sourced from AEXCO, 2016a.
Other quality parameters not shown.
aNDFom = neutral detergent fibre free form ash
NDFDom30 = measure of the percentage of neutral detergent fibre (NDF) that has been digested after 30 hours
uNDFom240 = percentage of dry matter that will go undigested in an animal

Table 3. Feed test results for Mulgara and Tammar at Hart in 2021. Shaded values indicate the best performing variety for each feed quality characteristic.

Feed Test Parameter	Minimum export standards	Mulgara	Tammar	LSD ($P \leq 0.05$)
Crude protein (%)	4-10%	12.1	13.5	**0.528**
aNDFom (%)	< 57%	44.24	50.08	**2.456**
NDFDom30 (%)	-	56.6	55.1	**NS**
uNDFom240 (%)	-	14.09	16.76	**1.692**
Water soluble carbohydrates (%)	> 18%	20.88	14.49	**2.459**
Net energy of maintenance (MJ/kg)	-	6.25	5.98	**NS**

Minimum standards for export hay quality requirements were sourced from AEXCO, 2016a. Other quality parameters not shown.

Acknowledgements

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank SARDI Waite Agronomy team for providing seed to conduct this trial.

We would also like to kindly acknowledge Balco for conducting the feed test analysis.

References

AEXCO 2016a, 'Market requirements', *Producing Quality Oaten Hay*

AEXCO 2016b, 'What the market wants', *Producing Quality Oat Hay*

Agrifutures Australia 2021, 'National Hay Agronomy Project: 2020 Results'
Available Online: https://www.agrifutures.com.au/product/national-hay-agronomy-project-2020/

Guidera, B, Peirce, C & Noack, S 2021,'Can gibberellic acid improve oat head emergence?', *2020 Hart Trial Results*

Hoppo, S, Zwer, P & Rattey, A 2021, 'Oat', *2022 South Australia Crop Sowing Guide*

Lemon, J, Clarke, G & Wallace A 2017, 'Gibberellic acid and grazing in oats', *2016 BCG Season Research Results.*

Matthew, C, Hofmann, W.A & Osborne, M.A 2009,'Pasture response to gibberellins: A review and recommendations, *New Zealand Journal of Agricultural Research*, Vol. 52, Issue 2, pp. 213-225

Grains Research and Development Corporation 2017, 'GRDC GrowNotes: Oats Southern Region 2017. Available Online: https://grdc.com.au/GN-Oats-South

Exploring novel management and delayed sowing to improve and expand southern region chickpea production

Sarah Day[1,2], Dylan Bruce[1], Penny Roberts[1,2]
[1]SARDI Agronomy Clare, [2]University of Adelaide Affiliate

Key findings

- Opportunities to expand chickpea production into frost prone environments can be explored through delayed sowing.
- Gibberellic acid and companion crop species were not beneficial to improving chickpea plant height or podding height.

Why do the trial?

Chickpea production area in South Australia has expanded by 18,800 hectares in the last decade, with 44,000 tonnes of grain produced in 2021 (PIRSA 2022). High grain prices for chickpea in recent years has driven this production expansion, despite the high level of disease management required due to a break down in ascochyta blight resistance (Blake, Kimber et al. 2017, GRDC 2017). However, local chickpea agronomic research, including novel management approaches and variety evaluation, is limited and growers are seeking opportunities to improve and expand their production. Opportunities to improve chickpea harvestability through improving crop and podding height, and a pilot study to expand chickpea production in frost prone environments through delayed sowing was explored in 2021.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	80 kg/ha MAP
Seeding date	May 17, 2021		
Location	Condowie, SA		

Delayed sowing for frost avoidance

A pilot time of sowing (TOS) experiment was undertaken at the Farrell Flat Frost Learning Centre in 2021 to investigate agronomic opportunities in expanding pulse production into frost prone environments through delayed sowing. Three varieties of chickpea and faba bean were included with varying phenology characteristics, however, only chickpea results will be discussed for the purpose of this report.

PBA Royal is a medium size kabuli that is well adapted to medium rainfall growing regions of south eastern Australia, with early-mid flowering and mid maturity traits. PBA Drummond is a desi chickpea bred for Central Queensland with mid-flowering and early-mid maturity traits. Chill 1 is a breeding line with a chilling tolerance gene, giving the chickpea the ability to flower and set pod/seeds under suboptimal temperatures.

The first TOS was completed on May 20, followed by the second TOS on August 17. The trial was sown in a split-plot design, with crop type and TOS randomly assigned to the main plot and variety randomly assigned to the sub plot to ensure each crop received appropriate agronomic management. Data was analysed using a split-plot ANOVA model in GenStat 21st Edition.

Novel management to improve chickpea harvestability

With the aim of improving plant height and harvestability of chickpea, four treatments and two varieties were evaluated at Condowie, 2021. Two varieties were selected with contrasting plant height and growth habit characteristics.

PBA Slasher is a desi seed type with short-medium plant height and semi-spreading growth habit, while CBA Captain is a medium-tall desi type with an erect growth habit. To improve podding and plant height, four treatments were applied to each variety; 1. chickpea was sown with a companion species (canola), and gibberellic acid was applied at either 2. early flowering, or 3. early pod set, compared to 4. untreated control. Measurements included plant height and grain yield. Plant height was measured prior to and following the gibberellic acid applications by recording the height of five randomly selected plants within each plot, excluding the edge rows. Data was analysed using a two-way ANOVA in GenStat 21st Edition.

Results and discussion

Delayed sowing for frost avoidance

Rainfall at Farrell Flat was slightly below average with 436 mm annual rainfall, compared to the long-term average of 472 mm. However, several months during the growing season received above average rainfall, including June (+11 mm), July (+58 mm) and November (+58 mm). Temperatures recorded at the site included frost events, most frequent during the spring months of September and October (Table 1). The September and October frosts coincided with all chickpea varieties from the first TOS entering the full flowering growth phase. Whereas all chickpea varieties from the second TOS were entering the flowering growth phase towards the end of October, thereby having less exposure to frost events during this critical reproductive growth phase.

It is estimated from phenological assessments that the flowering growth phase (before the commencement of podding) of the first TOS lasted approximately six weeks, compared to four weeks for the second TOS. This resulted in pod formation of the first TOS chickpeas occurring in mid-November, and early-December for the second TOS. During the pod formation periods there was increased temperatures, however, there was sufficient available soil moisture to complete grain maturity in both TOS.

PBA Drummond had no grain yield penalty from a delayed TOS in 2021, with an average grain yield of 2.68 t/ha across TOS (Figure 1). In contrast, Chill 1 and PBA Royal experienced grain yield reductions with delayed sowing. It is hypothesised the different germplasm groups responded differently to the delayed sowing conditions. This is similar to chickpea TOS experimental findings from Riverton in 2020.

Table 1. Number of events where temperatures reached equal to or less than 0°C at the Farrell Flat Frost Learning Centre in 2021. Temperature sensors were placed at 90 cm above the ground.

	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan
No. Days ≤0°C	1	1	3	5	14	12	4	2	0

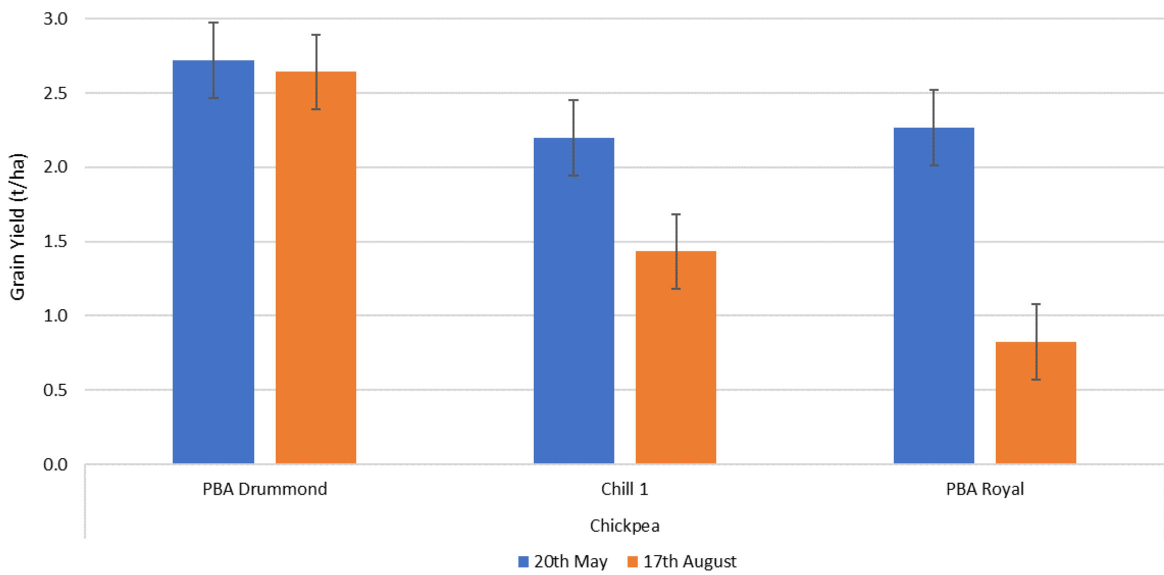


Figure 1. Grain Yield (t/ha) response of chickpea varieties to different times of sowing at Farrell Flat, 2021. Error bars represent standard error (P≤0.05).

Novel management to improve chickpea harvestability

The use of gibberellic acid applied at early flowering or early podding, or the use of canola as a companion crop species, were not beneficial to improving harvestability through increasing plant height or pod height in 2021. The use of the companion species resulted in interspecies competition that reduced resource availability for the chickpea crop and in turn the chickpea had reduced plant height and pod set. However, chickpea and canola intercropping combinations have been successful in previous seasons and other environments (Roberts and Day 2021).

CBA Captain is a taller desi chickpea variety and had a 4 cm average height advantage over PBA Slasher throughout the growing season (Table 2). CBA Captain control and gibberellic acid treatments plots were the highest yielding, but no higher than PBA Slasher that received gibberellic acid at early podding (Figure 2).

Table 2. Plant height (cm) of chickpea varieties sown at Condowie, 2021.

Variety	**Date**			
	18 Aug	**31 Aug**	**5 Oct**	**22 Oct**
CBA Captain	34.42	46.6	49.2	48.2
PBA Slasher	29.83	42.5	45.3	44.4
LSD (P≤0.05)	**1.06**	**1.75**	**2.81**	**3.12**

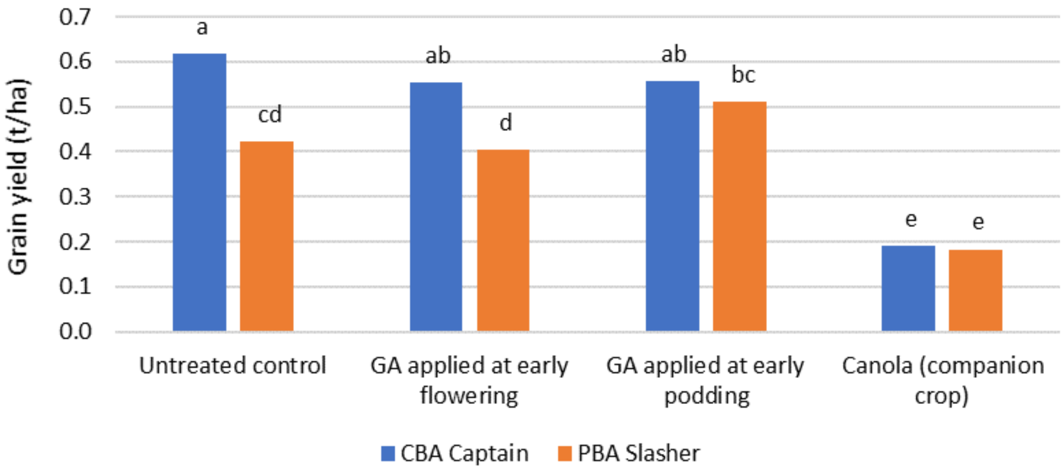


Figure 2. Grain yield (t/ha) in response to the interaction between variety and treatment applied to improve harvestability, at Condowie 2021. Bars labelled with the same letters are not significantly different (P≤0.05).

Conclusion

The results from chickpea delayed sowing pilot experimentation suggests this strategy could be a useful reproductive frost avoidance strategy. Further research is needed in this space to validate early results and determine a suitable germplasm for delayed sowing within this environment, while determining sowing window limits to avoid frost incidence, and the quantity of plant available soil moisture required for podding and grain fill growth phases when temperatures increase.

Opportunities remain to further explore novel management to improve harvestability of chickpea. Earlier gibberellic acid applications need further exploration, to improve early plant vigour rather than improving plant height during reproductive growth stages. Further validation of improving chickpea production with canola as a companion species warrants further evaluated, with the option of terminating the canola at early flowering to reduce competition for resources.

Acknowledgements

The authors would like to thank growers and funding partners for their continued support. The novel management to improve chickpea harvestability work was undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC (UOA2105-013RTX – SA Grain Legume Validation). The delayed sowing for frost avoidance pilot experiment was co-funded by SARDI and the SAGIT/GRDC Frost Learning Centre investment. The continued assistance in trial management from SARDI Agronomy Clare is gratefully acknowledged and appreciated.

References

Blake, S., R. Kimber, S. Day, L. McMurray, J. Brand, J. Paull and J. Davidson (2017). Pulse diseases 2016. GRDC Grains Research Updates, Adelaide.

GRDC. (2017). "Chickpeas lose disease resistance so monitor closely in 2017." from https://grdc.com.au/news-and-media/news-and-media-releases/south/2017/05/chickpeas-lose-disease-resistance-so-monitor-closely-in-2017.

PIRSA (2022). Crop and Pasture Reports South Australia. G. o. S. A. D. o. P. Industries.

Roberts, P. and S. Day (2021). Mixed species cropping and intercropping: where, how and why? Eyre Peninsula Farming Systems Summary 2020. A. Cook, N. Wilhelm, F. Tomney et al. Port Lincoln: 131-134.

Legume and oilseed herbicide tolerance

Rebekah Allen; Hart Field-Site Group

Key findings

- Most IBS treatments trialed had no crop effect on legume and oilseed crops; however, all IBS herbicides showed an increased level of crop damage to chickpeas at Hart in 2021.
- A number of post-emergent treatments applied at 5 – 6 node provided a high level of control on legume and oilseed crops.
- The new generation of Group 14 spike herbicides including Voraxor® (saflufenacil + trifludimoxazin) and Terra'dor® (tiafenacil) provided an additional level of control across all crop types.

Why do the trial?

To compare the tolerance and control of canola and legume varieties to a range of herbicide timings and rates.

How was it done?

Plot size	2.0 m x 2.0 m	**Fertiliser**	MAP (10:22) + 1% Zn + Impact @ 80 kg/ha
Seeding date	May 19, 2021		
Location	Hart, SA		

This trial was set up as a demonstration and is a non-replicated matrix. Seventeen varieties were sown in strips across 11 different crop types including canola, faba bean, field pea, chickpea, lentil, vetch, sub clover and barrel medic. Wheat, barley and oats were also included in 2021 with 48 herbicide treatments applied across all 17 crops at various timings.

The trial was sown dry, with 23 mm rainfall received within the first two weeks of the applied IBS and PSPE treatments, providing good conditions for herbicide activity.

Application timings:

Incorporated by sowing (IBS)	May 19
Post seeding pre-emergent (PSPE)	May 19
Early post emergent (3 – 4 node)	June 28
Post emergent (5 – 6 node)	July 19
Post emergent (Group 14 spike at 3 – 4 node)	June 29

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

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 in this demonstration are not registered for crops that have been sprayed. It is important to check herbicide labels before following these strategies used. In 2021, a number of herbicide treatments displayed varying crop tolerances that were not expected. Care should be taken when interpreting these results, as herbicide effects can vary between seasons and is also dependent upon conditions at application, soil type and weather conditions.

Results and discussion

Herbicide Tolerance

Mateno® Complete is a new pre-emergent herbicide included in at Hart in 2021. It combines three active ingredients across three modes of action, including diflufenican, pyroxasulfone and aclonifen (new herbicide mode of action for Australia). It is registered for use IBS in both wheat and barley for the control of grass and some broadleaf weeds. It is also on label for early post-emergent (EPE) control in wheat only. Mateno® Complete provided an increasing – severe damage (rating 4 – 5) in canola, but was safe on wheat and barley as expected (Table 1). Reflex® was seen to be safe on most legumes (rating 1 = no effect). Overwatch did not cause damage to wheat or barley, however, slight – moderate affects were observed in canola, reducing plant height. Most IBS treatments trialed had no crop effects compared to the nil treatment, however, all IBS herbicides showed an increased level of crop damage to chickpeas when compared to previous years. This result could be due to crop disease which was exacerbated by herbicides.

Balance® + simazine applied PSPE, had moderate to high damage across most crops in this trial. This is in contrast to 2020 at Hart, where negligible effects on faba bean, field peas and chickpeas seen. Diuron, simazine and Terbazine displayed severe crop effects on canola varieties without tolerance to triazine herbicides, as well as medic and clover. Slight (negligible) effects were observed across some herbicide treatments on chickpeas.

Thristrol Gold® is registered for use on medic and clover (2 – 4 L/ha) and has shown good crop safety when applied at 3 – 4 node to Sultan SU medic and Zulu II clover across two seasons at Hart. Kingbale oats are an IMI tolerant variety with a registration of Sentry® at IBS only, and when Intercept® (active ingredient imazamox + imazapyr) was applied at 3 – 4 leaf, moderate crop damage was observed. Ecopar® is registered in faba beans, vetch, field peas and pastures; however similarly to 2020, slight to moderate damage (rating 2 – 3) was observed.

Pulse control

Callisto® is registered for the control of volunteer chickpea, faba bean, field pea, lentil and vetch when applied IBS, however only slight – moderate effects were observed at Hart in 2021.

Similarly to Hart in 2020, Saracen® + Banjo® and Paradigm + MCPA LVE + Uptake® and Talinor® + Hasten® (excluding chickpeas = rating 4) provided excellent control of all oilseed and legume crops (rating 5 – 6) when applied at 5 – 6 node. Lontrel® Advanced also had very good control of all legume varieties, which are not registered for on-label use. Triathlon® and Flight® EC performed equally, providing moderate – severe control across all legume and oilseed crops, except for field peas (slight damage only).

Most Group 14 (previously Group G) herbicides provided a high level of control across oilseed, legume and cereal crops. The new generation of Group 14 spike herbicides including Voraxor® (saflufenacil + trifludimoxazin) and Terra'dor® (tiafenacil) provided an additional level of control (rating 5 and 6) across all crop types at Hart in 2021. Terra'dor® is also registered for grass weed control at higher application rates of 40 g/ha and Voraxor provides residual herbicide activity.

Table 1. Crop damage ratings for the legume and oilseed herbicide tolerance trial at Hart in 2021.

Trial layout – Part A

		CROP SAFETY		Canola			Bean		Pea		C/pea	Lentil		Vetch		Medic	Clover	Wheat	Barley	Oats
	Timing	**Treatment**	**Rate**	HyTTec Trophy	Pioneer 44Y94	Pioneer 43Y29 RR	PBA Bendoc	PBA Samira	Wharton	GIA Ourstar	Genesis090	Jumbo 2	PBA Hallmark XT	RM4	Timok	Sultan SU	Zulu II	Scepter	Compass	Kingbale
1	IBS May 19	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	IBS May 19	Sakura	118 g	1	1	2	1	1	1	1	4	1	1	1	1	1	2	1	1	3
3	IBS May 19	Boxer Gold	2500 mL	1	1	2	1	1	1	1	4	1	1	1	1	1	1	1	1	1
4	IBS May 19	Propyzamide	1000mL	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	2
5	IBS May 19	Tenet	1800 ml	1	2	1	1	1	1	1	4	1	1	3	1	1	2	1	1	2
6	IBS May 19	Ultro	1700 g	1	2	1	1	1	1	1	4	1	1	1	1	1	1	1	2	1
7	IBS May 19	Reflex	1000 ml	3	3	4	2	1	1	1	4	1	1	1	1	1	1	1	1	1
8	IBS May 19	Luximax	500 ml	2	2	1	1	1	1	1	3	1	1	2	1	1	1	1	1	1
9	IBS May 19	Overwatch	1250 ml	1	2	4	1	1	1	1	4	3	1	1	1	1	1	1	1	1
10	IBS May 19	Sentry	50g	6	2	5	1	1	1	1	4	3	1	1	3	1	3	3	4	1
11	IBS May 19	Mateno Complete	1L	4	4	5	1	2	1	1	4	1	1	1	1	1	3	1	1	3
12	IBS May 19	Terrain	180g	3	3	2	1	1	1	1	4	1	1	1	1	1	2	1	1	1
13	PSPE May 19	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	PSPE May 19	Diuron (900 g/kg)	825 g	4	2	3	1	1	1	1	1	3	1	1	1	1	2	1	1	1
15	PSPE May 19	Simazine (900 g/kg)	825 g	2	5	5	1	1	1	1	2	1	1	1	1	5	3	1	1	1
16	PSPE May 19	Metribuzin (750 g/kg)	280g	2	6	6	1	1	1	1	1	1	1	2	2	4	5	3	1	1
17	PSPE May 19	Terbazine (875 g/kg)	1000 g	1	5	6	1	1	1	1	3	1	1	1	1	4	5	1	1	1
18	PSPE May 19	Balance + Simazine	99 g + 830 g	5	6	6	4	5	2	3	3	5	5	5	4	6	5	1	1	4
19	3-4 Node June 28	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	3-4 Node June 28	Metribuzin (750 g/kg)	280 g	2	6	6	4	5	1	1	2	2	3	3	3	3	5	1	1	1
21	3-4 Node June 28	Broadstrike + Wetter 1000	25 g + 0.2%	6	2	5	2	4	2	1	1	2	1	4	5	2	1	1	1	1
22	3-4 Node June 28	Thistrol Gold + Banjo	2000 mL + 0.5%	5	5	5	3	4	3	2	1	3	4	4	5	1	1	1	1	1
23	3-4 Node June 28	Brodal Options	150 mL	3	3	4	3	4	2	2	3	2	1	2	3	2	2	1	1	1
24	3-4 Node June 28	Brodal Options + MCPA Amine 750	150 mL + 100 mL	3	4	5	4	5	2	2	4	2	3	3	4	2	2	1	1	1
25	3-4 Node June 28	Spinnaker + Wetter 1000	70 g + 0.2%	5	1	5	1	3	1	2	1	4	1	2	4	2	4	4	3	2
26	3-4 Node June 28	Ecopar + Wetter 1000	800 mL + 0.2%	2	3	4	2	2	3	3	2	2	3	1	2	1	2	1	1	1
27	3-4 Node June 28	Intercept + Hasten	750ml + 0.5%	6	1	6	1	5	5	1	5	6	1	5	5	1	6	5	6	3

Table 2. Crop damage ratings for the legume and oilseed herbicide tolerance trial at Hart in 2021.

Trial layout – Part B

PULSE CONTROL				Canola			Bean		Pea		C/pea	Lentil		Vetch		Medic	Clover	Wheat	Barley	Oats
				HyTTec Trophy	Pioneer 44Y94	Pioneer 43Y29 RR	PBA Bendoc	PBA Samira	Wharton	GIA Ourstar	Genesis090	Jumbo 2	PBA Hallmark XT	RM4	Timok	Sultan SU	Zulu II	Scepter	Compass	Kingbale
	Timing	**Treatment**	**Rate**																	
1	**IBS May 19**	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2		Callisto	200ml	2	2	2	3	3	3	3	1	1	2	2	2	1	1	1	1	1
3	**3-4 Node June 28**	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4		Raptor + Wetter 1000	45 g + 0.2%	6	1	5	1	3	1	1	2	5	1	2	3	2	3	5	6	2
5	**5 - 6 node July 19**	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6		Ally + Wetter 1000	7 g + 0.1%	6	1	5	4	5	6	5	5	5	4	6	2	5	6	1	1	1
7		Lontrel Advanced	150 mL	1	1	1	5	5	5	5	6	6	6	5	6	5	5	1	1	1
8		Ecopar + MCPA Amine 750	400 mL + 330 mL	3	3	4	3	2	2	1	1	1	3	1	1	1	1	1	1	1
9		Carfentrazone + MCPA Amine 750	100 mL + 330 mL	5	5	6	3	3	3	3	5	4	4	3	3	5	3	1	1	1
10		Velocity + Uptake	670 mL + 0.5%	5	5	5	4	4	5	5	2	4	4	4	3	5	4	1	1	1
11		Talinor + Hasten	750 mL + 1 %	5	5	5	5	5	6	6	4	5	5	5	6	6	6	1	1	3
12		Saracen + Banjo	100 mL + 1.0%	6	4	6	5	6	5	5	6	6	5	6	5	4	5	1	1	1
13		Paradigm + MCPA LVE + Uptake	25 g + 500 mL + 0.5%	6	5	6	5	5	5	5	6	5	5	6	6	5	6	1	1	1
14		**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15		Flight EC	720 mL	4	5	5	4	4	2	2	5	4	4	2	3	3	3	1	1	1
16		Triathlon	1000 mL	5	5	6	4	5	2	2	6	4	5	3	4	4	3	1	1	1
18		Rexade + Wetter 1000	100 g + 0.25%	5	1	5	3	5	5	4	3	5	4	5	5	5	5	1	1	5
19	**Group G spike June 29**	**NIL**		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20		Crucial + MSO	600 mL + 1%	5	6	1	5	4	5	5	4	5	5	4	3	5	5	6	6	6
21		Crucial + MSO	1200 mL + 1%	6	6	1	6	5	5	5	6	6	6	6	5	6	6	6	6	6
22		Carfentrazone 600 + Crucial + MSO	10mL + 600 mL + 1%	6	6	6	5	5	5	5	5	6	5	4	4	6	6	6	6	6
23		Sharpen + Crucial + MSO	17g + 600 mL + 1%	6	6	6	6	6	5	5	6	6	6	5	5	6	6	6	6	6
24		Sledge + Crucial + MSO	50mL + 600 mL + 1%	5	5	4	5	4	5	5	4	4	4	3	3	4	4	6	6	6
25		Valor + Crucial + MSO	30g + 600 mL + 1%	5	5	4	5	5	5	5	6	5	5	5	4	6	6	6	6	6
26		B-Power + Crucial + MSO	55mL + 600 mL + 1%	4	4	4	5	4	5	5	6	5	4	4	4	5	6	6	6	6
27		Terrad'or + Crucial + MSO	15g + 600 mL + 1%	6	6	6	5	6	5	5	6	6	6	5	6	6	6	6	6	6
28		Oxyflurofen 240 + Crucial + MSO	75mL + 600 mL + 1%	5	5	3	5	4	6	5	4	5	5	3	3	5	5	6	6	6
29		Voraxor + Crucial + MSO	100mL + 600 mL + 1%	6	6	6	6	6	5	5	6	6	6	6	6	6	6	6	6	6
30		Terrad'or + Crucial + MSO	40g + 800 mL + 1%	6	6	6	6	6	5	5	6	6	5	5	5	6	6	6	6	6

Management of annual ryegrass in genetically modified (GM) canola for the medium rainfall zone

Rebekah Allen; Hart Field-Site Group

Key findings

- Pre-emergent herbicides performed well at Hart, and in some cases reduced annual ryegrass populations by up to 80%.
- Trial results at Hart and Spalding show that equal control of annual ryegrass (ARG) was observed for various application timings and rates, particularly treatments with two in-crop spray regimes.
- The incorporation of clethodim to glyphosate tank mixes at the early in-crop timing (2 – 4 leaf), provided similar but effective control of ARG weeds on susceptible weed populations at Hart and Spalding.
- In susceptible ARG populations, lower rates of on-label glyphosate perform similarly to higher label rates.

Why do the trial?

In 2021, the genetically modified (GM) moratorium in South Australia lifted, providing mainland growers the opportunity to grow GM canola for the first time.

Canola technologies that growers have had access to include triazine tolerant and Clearfield® (imidazolinone tolerant) options, however, the development of metabolic resistance to these chemistries, including Group 1 (previously Group A) herbicides in weeds like annual ryegrass (ARG) has become of concern. Current resistance levels of annual ryegrass in South Australia (tested within the past 5 years) show that approximately 49% of paddocks have confirmed resistance to imidazolinone herbicides and > 10% to clethodim (Boutsalis et al. 2021).

New GM technology options including Roundup Ready® (RR) TruFlex® (XX) and LibertyLink®, in addition to other mixed tolerance options provide additional weed management tools on-farm, assisting growers to manage in-crop weeds through the use of glyphosate and glufosinate.

This project aims to demonstrate a best-use-approach for in-crop management of ARG in GM canola, particularly through the use of on-label glyphosate options. The trials also compare new technologies to current TT and CL management practices as a benchmark.

How was it done?

Hart			
Plot size	2.0 m x 10.0 m	**Water rate**	100 L/ha
Seeding date	May 7, 2021		
Location	Hart, SA		
Harvest date	November 9, 2021		
Spalding			
Plot size	2.0 m x 10.0 m	**Water rate**	100 L/ha
Seeding date	April 24, 2021		
Location	Spalding, SA		
Harvest date	NA		

Two SAGIT funded trials were conducted across the Mid-North region in 2021 at Hart and Spalding. The trials were set up as a randomised complete block design and were managed with the application of pesticides to ensure an insect and disease-free canopy. In-crop herbicide regimes focused on a two-spray approach, targeting the medium rainfall environments (Table 1 and 2). All in-crop applications of glyphosate targeted young ARG plants prior to tillering (Figure 1).

Hart

The main trial conducted at the Hart field site trialed 17 herbicide treatments comparing various rates and timings of glyphosate in Roundup Ready® and TruFlex® variety options (Table 2). Clearfield® and TT treatments were also included to compare new GM technologies to current options growers have access to. Technologies with LibertyLink® traits were also included.

Annual ryegrass seed with a known susceptibility to trialed herbicides was broadcast to trial plots and lightly incorporated prior to the application of herbicide treatments on May 7, 2021. Canola plots were then sown using a standard knife-point press wheel system on 22.5 cm (9") spacings. All plots were assessed for crop establishment (%), ARG weed counts (plants/m^2), ARG head counts (heads/m^2) and grain yield (t/ha).

Spalding

The second trial was located at Spalding due to dry seasonal conditions affecting early ARG populations and crop establishment at Hart. This trial was located in a paddock sown to TruFlex® canola, targeting eight in-crop spray regimes, comparing rates and application timings of two glyphosate products registered for in-crop use; Roundup Ready® PL and Crucial™, at label rates (Table 1). All plots were assessed for ARG weed counts (plants/m^2) after each application timing. At this site, the pre-emergent herbicide used was trifluralin at 1.5 L/ha.

Table 1. Glyphosate treatments trialed at Spalding in 2021.

	Crop stage 6-8 L (1)		**Crop stage 8-10 L (2)**		**1st Flower (3)**	
	Treatment	**Rate**	**Treatment**	**Rate**	**Treatment**	**Rate**
1	Roundup Ready® PL	1.67 L	-	-	-	-
2	Roundup Ready® PL	1.15 L	Roundup Ready® PL	1.15 L	-	-
3	Roundup Ready® PL	1.67 L	Roundup Ready® PL	1.67 L	-	-
4	-		Roundup Ready® PL	1.67 L	Roundup Ready® PL	1.67 L
5	Roundup Ready® PL	1.67 L	-	-	Roundup Ready® PL	1.67 L
6	Roundup Ready® PL + Clethodim 240 + Hasten™	1.15 L + 500 mL + 1%	Roundup Ready® PL	1.15 L	-	-
7	Crucial™	1.5L	Crucial™	1.5L	-	-
8	Crucial™	1L	Crucial™	1L	Crucial™	1L

Table 2. Herbicide treatments trialed at Hart in 2021.

	Technology	Pre-emergent (1)		PSPE (2)		Crop stage 2-4 L (3)		Crop stage 6-8 L (4)		1st Flower (5)	
		Treatment	Rate	Treatment	Rate	Treatment	Rate	Treatment	Rate	Treatment	Rate
1	CL	Propyzamide	1L	-	-	-	-	-	-	-	-
2	CL	Overwatch®	1.25 L	-	-	-	-	-	-	-	-
3	CL	Propyzamide	1L	-	-	Clethodim 240 + Intervix® + Hasten™	500 ml + 600 ml + 1%	-	-	-	-
4	CL	Overwatch®	1.25 L	-	-	Clethodim 240 + Intervix® + Hasten™	500 ml + 600 ml + 1%	-	-	-	-
5	TT	Propyzamide + Simazine	1L + 1kg	-	-	Clethodim 240 + Atrazine + Hasten™	500 ml + 1kg + 1%	-	-	-	-
6	TT	Overwatch®	1.25 L	-	-	Clethodim 240 + Atrazine + Hasten™	500 ml + 1kg + 1%	-	-	-	-
7	RR	Propyzamide	1L	-	-	Roundup Ready® PL	1.67 L	-	-	-	-
8	LibertyLink® + TT	Propyzamide	1L	Atrazine	1kg	Liberty® + Clethodim 240 + Uptake®	2L + 500 ml + 0.5%	Liberty® + Uptake®	2L + 0.5%	-	-
9	LibertyLink® + XX	Propyzamide	1L	-	-	Liberty® + Roundup Ready® PL+ Uptake®	2 L + 1.67 L + 0.5%	Liberty® + Uptake®	2L + 0.5%	Roundup Ready® PL	1.67L
10	XX	Propyzamide	1L	-	-	Roundup Ready® PL	1.67 L	-	-	-	-
11	XX	Propyzamide	1L	-	-	Roundup Ready® PL	1.15 L	Roundup Ready® PL	1.15 L	-	-
12	XX	Propyzamide	1L	-	-	Roundup Ready® PL	1.67 L	Roundup Ready® PL	1.67 L	-	-
13	XX	Propyzamide	1L	-	-	Roundup Ready® PL	1.67 L	-	-	Roundup Ready® PL	1.67 L
14	XX	Propyzamide	1L	-	-	Roundup Ready® PL + Clethodim + Hasten™	1.15 L + 500 mL + 1%	Roundup Ready® PL	1.15 L	-	-
15	XX	Overwatch®	1.25 L	-	-	Roundup Ready® PL + Clethodim + Hasten™	1.15 L + 500 mL + 1%	Roundup Ready® PL	1.15 L	-	-
16	XC	Propyzamide	1L			Roundup Ready® PL + Intervix® + Hasten™	1.67 L + 600 mL + 1%	Roundup Ready® PL	1.67L		
17	XT	Terbyne® Xtreme®	1kg			Roundup Ready® PL + atrazine + Hasten™	1.15 L + 1kg + 1%	Roundup Ready® PL	1.67L		

Results and discussion

Seasonal conditions

Early growing season conditions at Hart were dry, with significant opening rain events occurring by May 25, approximately three weeks post-seeding. Poor seasonal conditions led to the late and staggered emergence of both canola and ARG. Dry April and May conditions were also followed by average June rainfall (43 mm) and a wetter than average July, of 63 mm. August was moderately dry, preventing conducive conditions to germinate late ryegrass populations.

Growing season rainfall trends experienced at Spalding were similar to Hart in 2021.

Pre-emergent herbicides

At Hart in 2021, pre-emergent herbicides performed well, and in some cases reduced annual ryegrass populations by up to 80% across the site (data not shown).

Propyzamide trialed at 1 L/ha provided increased weed control compared to Overwatch® at 1.25 L/ha at initial weed assessments; however, this result was likely due to the increased persistence of propyzamide in soils after a significant opening rain event in May (23 mm) following dry conditions and controlling ARG for a longer period of time.

By the second assessment timing, following the application of in-crop herbicides at crop stage 6 – 8 leaf, no differences in weed control were observed between treatments with propyzamide or Overwatch® applied.

In-crop weed management

Spalding trial results showed equal control of ARG for all treatments, particularly those incorporating two in-crop sprays. This result means that the same level of control was gained by applying two applications of glyphosate early in-season from crop stages 2–10 leaf, or applying one early, followed by a second application at flowering (Figure 2). These results were also observed at Hart and is a result of dry seasonal conditions, preventing the germination of later ARG populations emerging.

It was also evident that lower rates of on-label glyphosate, in this case Roundup Ready® PL at 1.15 L/ha performed similarly to higher label rates of 1.67 L/ha. This gives growers confidence that lower rates may be applied to susceptible ARG populations to achieve good in-crop weed control and reduce input costs (Table 3).

Preliminarily data also suggests that TT, CL and LibertyLink® options trialed at Hart in 2021 provide similar levels of ARG control to glyphosate options, however, further trials will be required across multiple seasons to explore this further.

The incorporation of tank mixes at early in-crop timings, in this case clethodim (Group 1) at Hart and Spalding, provided similar but effective control of ARG. This result is likely due to susceptible ARG populations, however, incorporating additional modes of action into a spray program can reduce the potential development of metabolic resistance to herbicides while continuing to provide effective weed control.

Previous research conducted by Plant Science Consulting has shown that some populations of ryegrass have resistance to clethodim, glyphosate or both herbicides (Boutsalis et al. 2021). Pot studies conducted in 2020 show that tank mixes of 1.15L/Roundup Ready® PL and 500 ml/ha Clethodim 240 had effective control across most populations tested, with control of ARG averaging 95%, compared to 73% for standalone glyphosate and 79% for standalone clethodim (Boutsalis et al. 2021).

Figure 1. L-R: Plot treated with an in-crop application of glyphosate at 6 – leaf, compared to a plot prior to the planned application at 8-leaf, at Spalding.

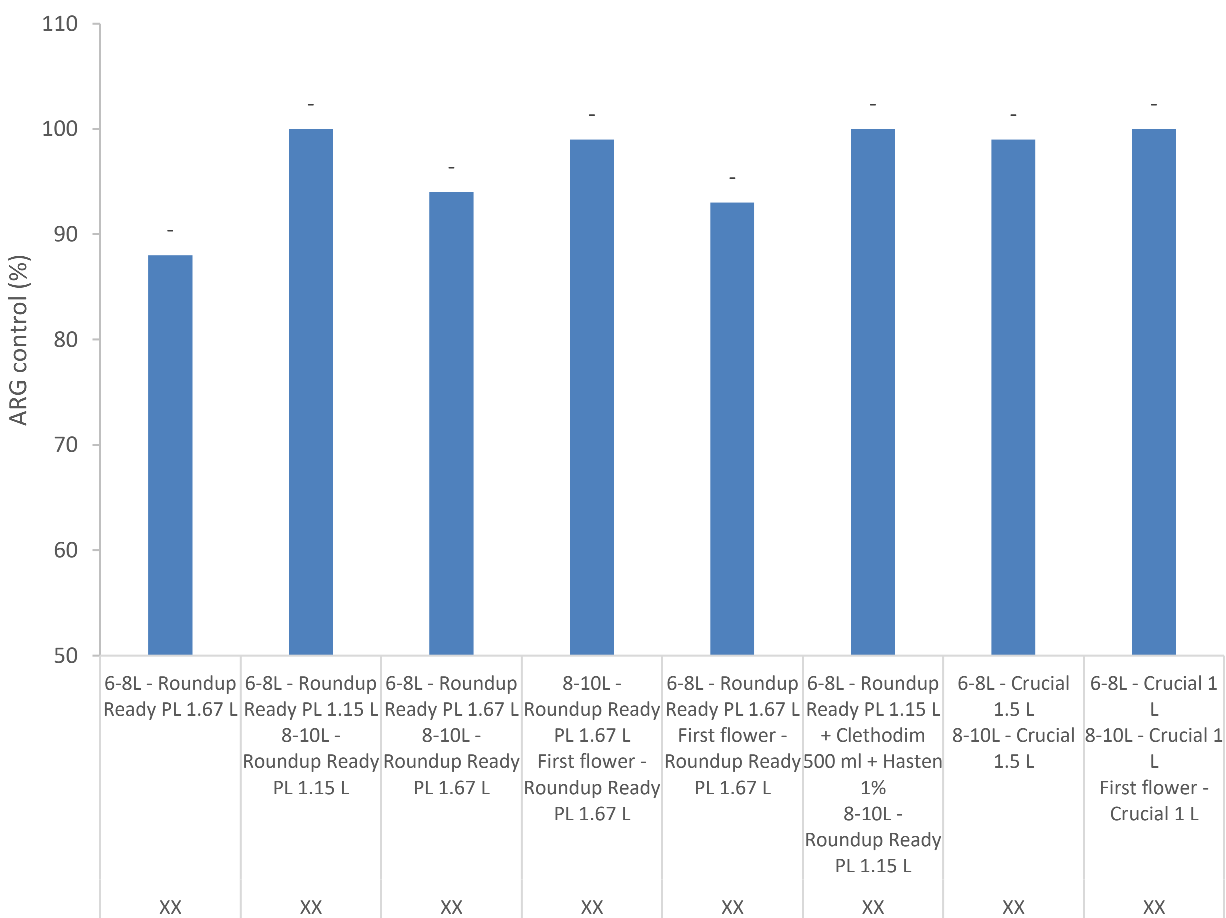


Figure 2. Annual ryegrass control (%) in TruFlex® canola at Spalding, 14 days post the application of in-crop glyphosate applied at first flower.

Table 3. Gross margins for various Roundup Ready®, TruFlex®, CL and TT canola technologies for targeted in-crop weed management strategies. This data is based on one season and should be used a guide only. An average canola yield for the medium rainfall zone has been used at 1.4 t/ha (TT = 1.3 t/ha).

Technology	Weed management strategy	Rates/ hectare	Gross margin $/ha
Clearfield®	IBS: Propyzamide Post-emergent – Clethodim 240 + Intervix + adjuvant	1L 500 ml + 600 ml + 1%	$ 287.82
Clearfield®	IBS: Propyzamide Post-emergent: Clethodim 240 + Intervix + adjuvant Pre- harvest: glyphosate	1 L 500 ml + 600 ml + 1% 2 L	$ 277.02
Triazine Tolerant	IBS: Propyzamide + Simazine Post emergent: Clethodim 240 + Atrazine + adjuvant	1 L 500 ml + 1 kg + 1%	$ 238.55
Roundup Ready®	IBS: Propyzamide Post-emergent: Roundup Ready PL (1 application)	1 L 1.67 L	$ 215.79
TruFlex®	IBS: Propyzamide Post-emergent: Roundup Ready PL (2 applications)	1 L 1.15 L + 1.15 L	$ 212.39
	IBS: Propyzamide Post-emergent: Roundup Ready PL (2 applications)	1 L 1.67 L + 1.67 L	$ 206.77
	IBS: Propyzamide Post-emergent: Roundup Ready PL + Clethodim Post-emergent: Roundup Ready PL	1 L 1.15 L + 500 ml 1.15 L	$ 203.28
	IBS: Propyzamide Post-emergent: Roundup Ready PL + Clethodim Post-emergent: Roundup Ready PL	1 L 1.67 L + 500 ml 1.67 L	$ 197.66
	IBS: Propyzamide Post-emergent: Roundup Ready PL + Clethodim Post-emergent: Roundup Ready PL Post-emergent: Roundup Ready PL	1 L 1.15 L + 500 ml 1.15 L 1.15 L	$ 197.07
	IBS: Propyzamide Post-emergent: Roundup Ready PL Post-emergent: Roundup Ready PL Post-emergent: Roundup Ready PL	1 L 1.15 L 1.15 L 1.15 L	$ 206.18

Values sourced from: Farm Gross Margin and Enterprise Planning Guide, 2021.

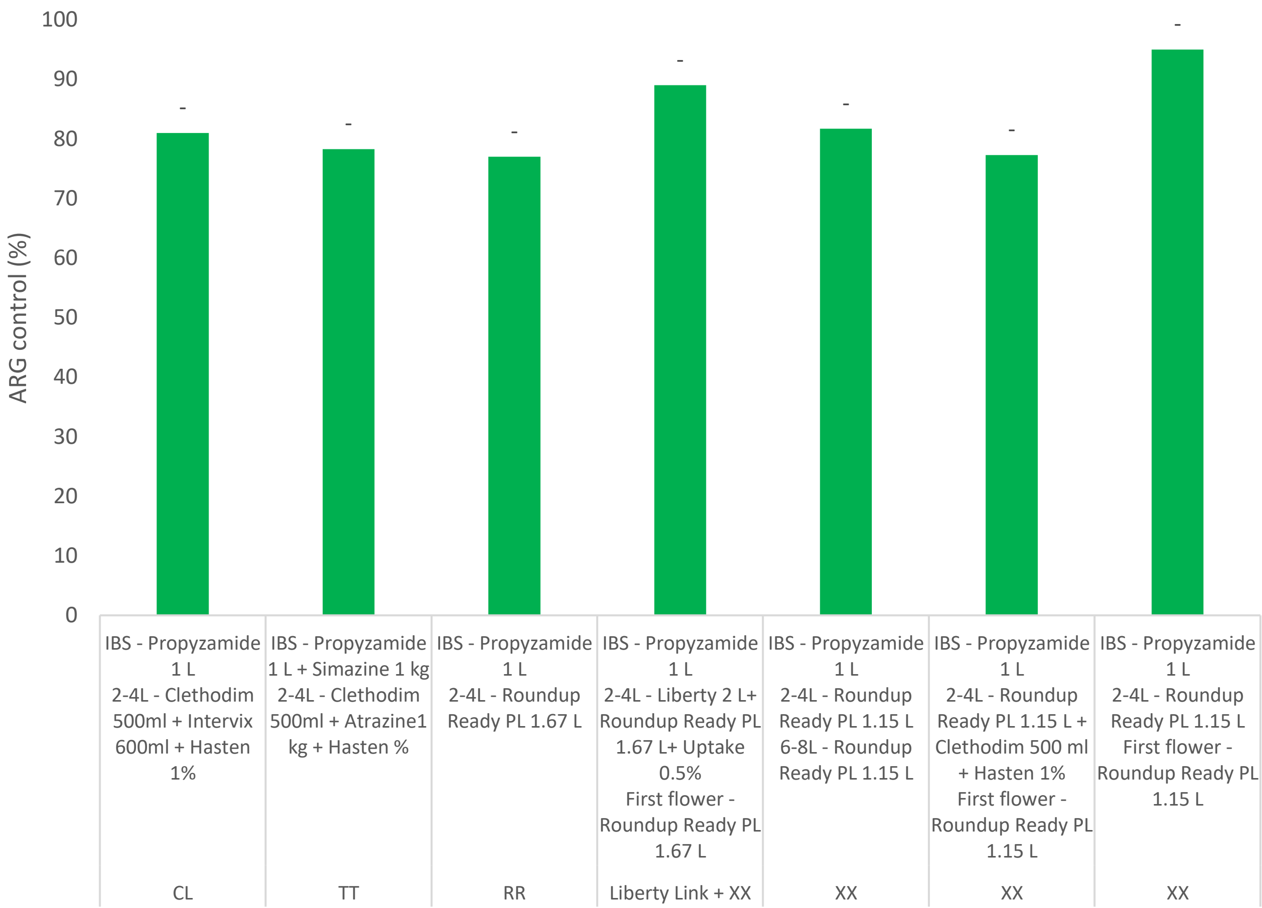


Figure 3. Annual ryegrass control (%) after the application of in-crop glyphosate was applied at first flower.

Acknowledgements

The Hart Field-Site Group would like to acknowledge SAGIT for funding this project.

We would also like to thank BASF, Nuseed, Pioneer® Seeds and Pacific Seeds for providing seed, and Nufarm, Bayer and BASF for providing herbicides trialed.

Hart kindly acknowledges the support from the growers who hosted these trial sites.

References

Boutsalis P, Kleeman S, Preston C (2021) Canola technologies and herbicide resistance. 2021 Hart Field Day Guide, 1-3.

2021 Farm Gross Margin and Enterprise Planning Guide (2021).

Comparing TruFlex®, Roundup Ready® and triazine tolerant canola in high rainfall environments

Tim Murphy; Bayer CropScience

Key findings

- All applications of in-crop herbicides reduced annual ryegrass (ARG) weed numbers compared to the untreated control.
- The inclusion of a pre-emergent herbicides reduced weed numbers compared to reliance on post-emergent programs alone.
- A fully Integrated Weed Management program provided effective control of all weeds, whilst reducing the potential for increasing the onset of metabolic resistance developing.
- No significant differences were observed between the pre-emergent herbicides propyzamide or Overwatch® for yield and weed control.

Why do the trial?

South Australian mainland growers could grow genetically modified (GM) canola varieties for the first time in 2021. This technology allows for the application of glyphosate over the top of established canola for the control of annual ryegrass and broadleaf weeds.

This trial was set up to compare spray programs, using both pre-emergent and post-emergent herbicide options. Spray programs were compared for differences in weed control when using Roundup Ready® or TruFlex® technology on weed control and crop yield.

As there is a developing metabolic resistance to Group 9 (previously Group M) herbicides in SA there is also a need to evaluate the benefits of including additional herbicide mode of action groups into a canola spray programs.

How it was done?

Plot size	2.0 m x 10.0 m	**Fertiliser**	MAP @ 80 kg/ha
Seeding date	April 28, 2021 Hart, SA	Seeding	DAP (18:20) + 1% zinc @ 80 kg/ha
		June 15	Urea 100 kg/ha
		July 10	Urea 100 kg/ha
		July 30	Urea 100 kg/ha
Fungicide	July 10	Aviator® Xpro 600 mL/ha (100 L water /ha)	
	August 26	Aviator® Xpro 800 mL/ha (100 L water /ha)	
Water rates	Pre-emergent (A) – 100 L/ha 2 – 4 leaf (B), 6 leaf (C), 8 – 10 leaf (D) and 1 flower (E) – 75 L/ha		

Various combinations of glyphosate rates and timings were trialed at Giles Corner in 2021 (Table 1).

Annual ryegrass seed at a 5 kg/ha was broadcast over the trial area just prior to seeding on April 28 and was incorporated by seeding (IBS) 2 – 3 hours prior. No knockdown herbicides were required due to dry conditions and no weed emergence across the site. Seeding was carried out with a knife-point press wheel system on a 20 cm row spacing.

Table 1: Variety and herbicide treatments trialed at Giles Corner.

No.	Variety	Pre-emergent (A) (April 28)	2 - 4 Leaf (B) (June 11)	6 Leaf (C) (July 10)	8 - 10 Leaf (D) (July 30)	First flower (E) (August 12)
		Treatment (rate/ha)				
1	ATR Bonito	UTC	UTC	UTC	UTC	UTC
2	ATR Bonito	Propyzamide 1 L + Atrazine 1.1 kg				
3	Hyola 410 XX	UTC	UTC	UTC	UTC	UTC
4	Hyola 410 XX	Propyzamide 1 L				
5	Hyola 410 XX	Nil	Roundup Ready© PL 1.67 L		Roundup Ready© PL 1.67 L	
6	Hyola 410 XX	Propyzamide 1 L	Roundup Ready© PL 1.67 L		Roundup Ready© PL 1.67 L	
7	Hyola 410 XX	Nil	Roundup Ready© PL 1.67 L			
8	Hyola 410 XX	Nil	Roundup Ready© PL 1.15 L	Roundup Ready© PL 1.15 L		Roundup Ready© PL 1.15 L
9	Hyola 410 XX	Nil		Roundup Ready© PL 1.67 L		Roundup Ready© PL 1.67 L
10	Hyola 410 XX	Nil	Roundup Ready© PL 1.67 L			Roundup Ready© PL 1.67 L
11	Hyola 410 XX	Propyzamide 1 L				Roundup Ready© PL 1.67 L
12	Hyola 410 XX	Nil				Roundup Ready© PL 1.67 L
13	Hyola Garrison XC	Propyzamide 1 L	Roundup Ready© PL 1.15 L + Intervix© 500 mL	Roundup Ready© PL 1.15 L		Roundup Ready© PL 1.67 L
14	Hyola 410 XX	Propyzamide 1 L	Roundup Ready© PL 1.15 L + Clethodim 240 500 mL + Hasten© 1%	Roundup Ready© PL 1.15 L		Roundup Ready© PL 1.67 L
15	Pioneer 43Y29 RR	Propyzamide 1 L	Roundup Ready© PL 1.15 L	Roundup Ready© PL 1.15 L		
16	Pioneer 43Y29 RR	Propyzamide 1 L	Roundup Ready© PL 1.15 L			Roundup Ready© PL 1.67 L
17	Hyola 410 XX	Overwatch© 1.25 L	Roundup Ready© PL 1.15 L + Clethodim 240 500 mL + Hasten® 1%	Roundup Ready© PL 1.15 L		Roundup Ready© PL 1.67 L
18	ATR Bonito	Overwatch© 1.25 L		Clethodim 240 500 mL + Atrazine 1.1 kg + Hasten© 1%		

Results and Discussion

The dry start to the 2021 season resulted in a delayed germination of both canola crops and weed seeds until sufficient soil moisture was received, with crop emergence observed on May 20.

Despite the dry start, good rainfall was received over the trial period, allowing for continued weed germination throughout the season (Figure 1). This was particularly evident in treatments that did not incorporate pre-emergent herbicides and only relied on post-emergent application for weed control only, allowing weeds to continually germinate in these treatments (Figure 2).

As a result of the delayed germination, patchy establishment occurred with crop growth stages ranging slightly across all plots. Where establishment was varied, increased weed germination was observed due to reduced crop competition. Timing of applications were made based on the most advanced plants using the variety Hyola 410 XX as a guide.

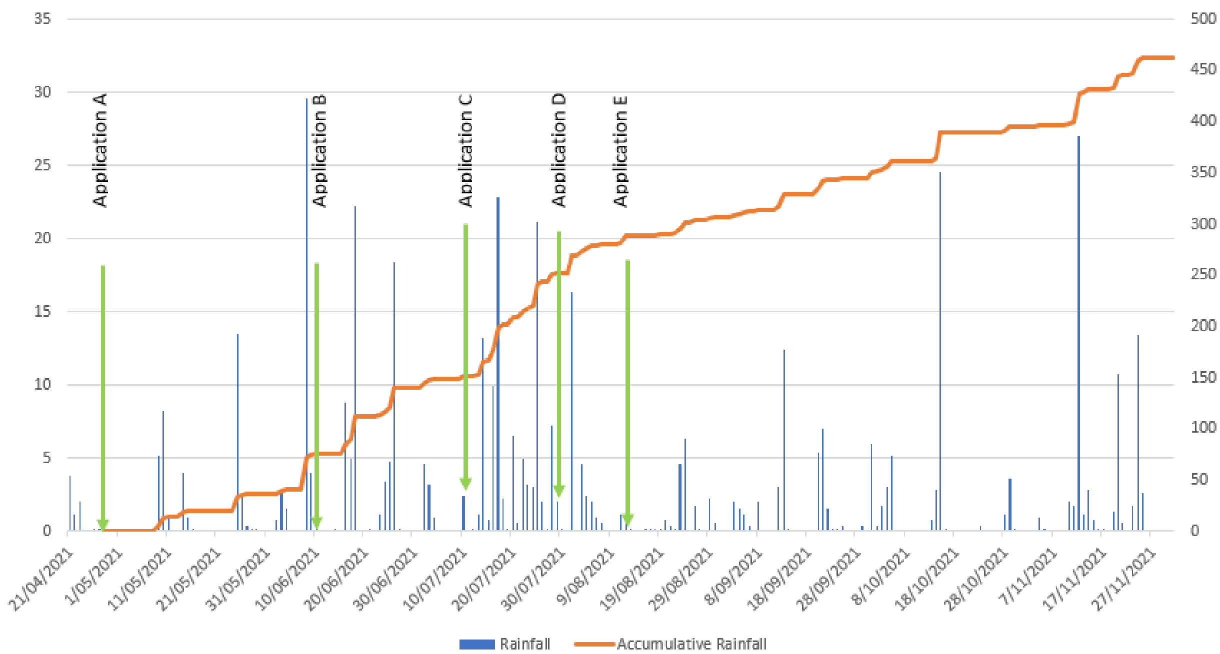


Figure 1. Rainfall records at Giles Corner 2021.

Weed control

The highest level of weed control was gained from treatments incorporating a pre-emergent herbicide, in addition to three in crop applications of Roundup Ready® PL (Figure 2). Treatments 13,14 and 17 included either propyzamide (Group 3) or Overwatch® (Group 13) as a pre-emergent herbicide (Figure 2 and Appendix 1) and the highest number of modes of action (MOA), reducing the potential of annual ryegrass developing metabolic resistance to Group 1 (previously Group A) and 9 (previously Group M) herbicides.

The use of a spray program that only utilised in-crop post-emergent herbicides provided an effective level of weed control but whilst not been significantly different, offered a reduced level of control compared to the full spray programs (treatments 13,14 and 17).

Roundup Ready® and TruFlex®

The 2021 season saw a dry start and staggered germination, resulting in gaps in the crop (Figure 3). TruFlex® varieties that received the later application of Roundup Ready® PL at first flower (E) provided a higher level of weed control.

Yield differences between the Roundup Ready® and TruFlex® traits was not significantly different, with weed control providing more influence on yield than variety.

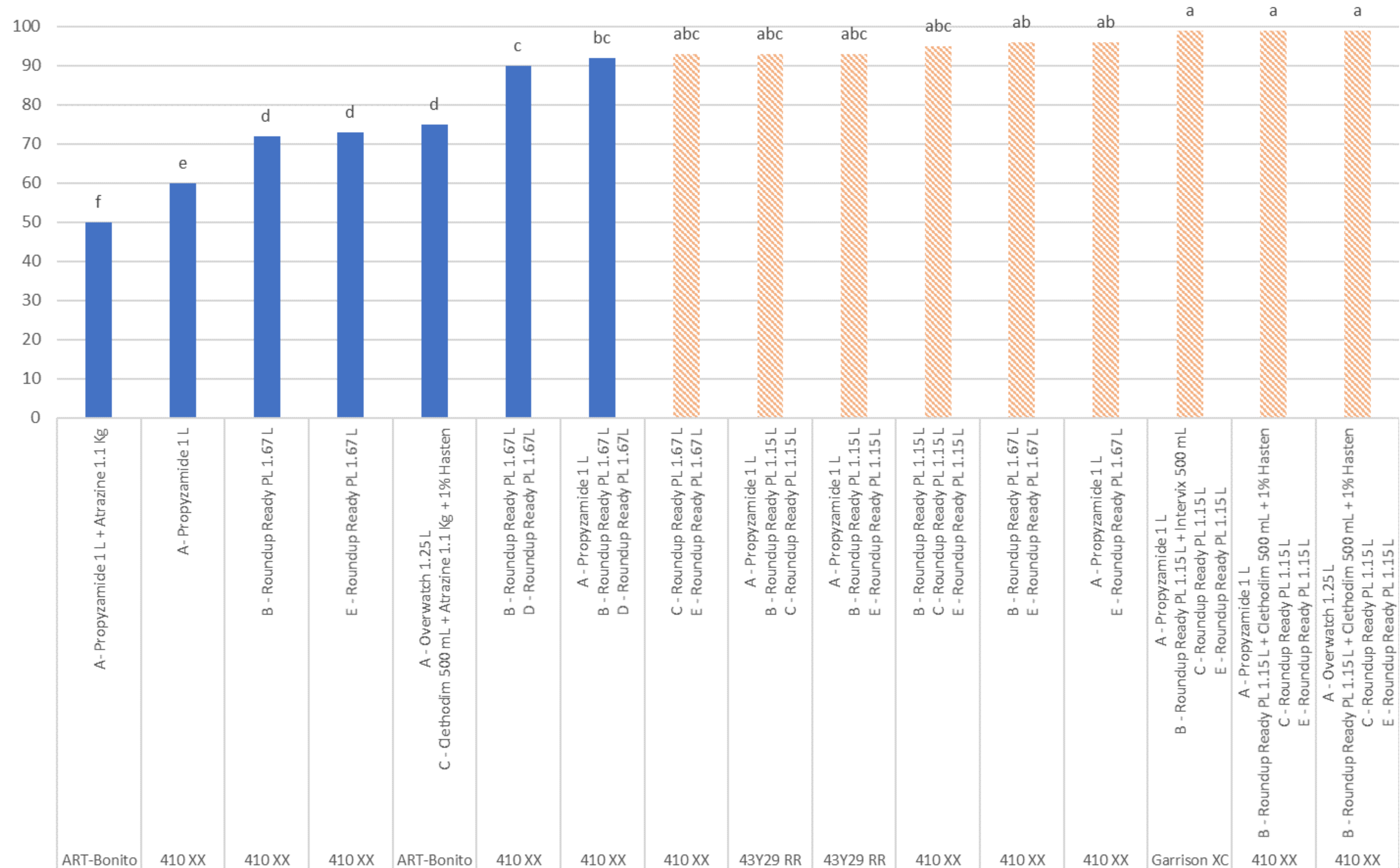


Figure 2. Annual ryegrass control (%) for selected treatments at Giles Corner.

Treatment 16, that included an application of Roundup Ready® PL at first flower on a Roundup Ready® variety, is an off-label application and whilst no significant difference was measured, in many trials this timing has impacted yield and increased crop phytotoxicity and is not recommended.

Impact of pre-emergent herbicides

Overwatch® provided an increased level of weed control (4%) compared to propyzamide applied pre-emergent and prior to the 2 – 4 leaf application. No significant differences were observed between the pre-emergent herbicides after post-emergent herbicide where applied.

Overwatch® produced a level of crop effect, bleaching of young canola leaves (Figure 3) in both varieties treated. Hyola 410 XX recovered 84 days after application A (84 DAA), whereas symptoms in ATR Bonito were still evident at this stage. No crop vigour difference was observed following the use of Overwatch® in this trial.

TruFlex® and Roundup Ready® canola varieties were both suitable options when used with an effective spray program for the control of in-crop weeds in this trial.

The use of a pre-emergent herbicide is a vital tool to be used in either a TruFlex® or Roundup Ready® canola crops to increase the level of weed control gained.

Whist Overwatch® displayed some level of crop effect, the crop recovered, and no yield penalty was received. Crop vigour played a role in recovery times from any herbicide crop effect, the more vigour the variety had, the more rapid the recovery time.

The use of pre-emergent herbicides in conjunction with an early tank mix of Roundup Ready® PL and Clethodim or Intervix© at the 2 – 4 leaf crop stage provided the most effective post-emergent weed control and may reduce the potential of developing metabolic resistance to these groups of herbicides.

Figure 3. (L-R) Staggered crop emergence at 65 DAA and Overwatch® phytotoxicity on Hyola 410 XX seeding at 65 DAA.

Acknowledgements:

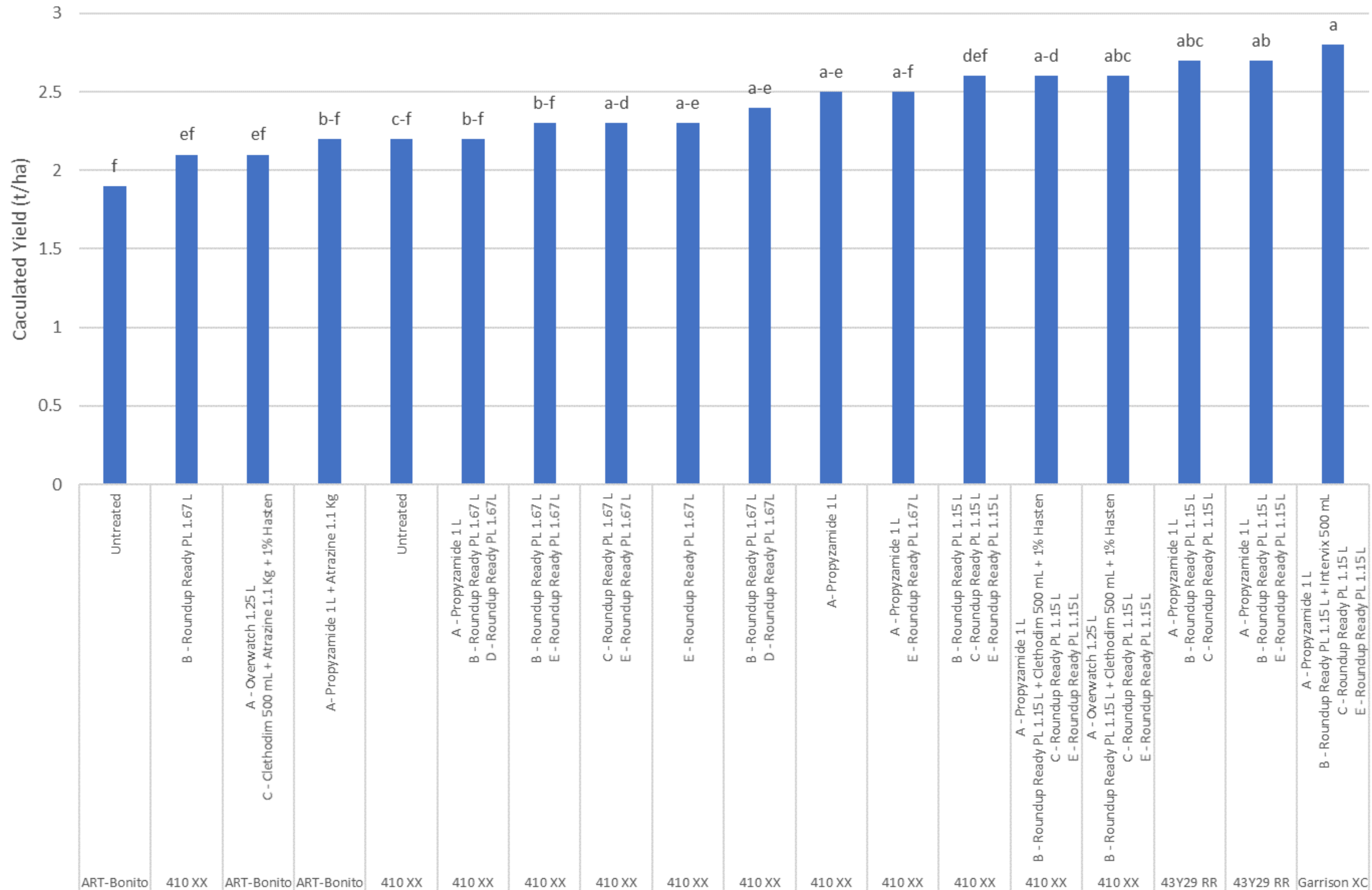
Mid North High Rainfall Zone group for allowing this trial to be conducted on their trial site and SARDI for assisting in seeding and harvest of the trial.

Appendix

Appendix 1. Annual ryegrass control (%) for treatments trialed.

Variety	Spray program	Mode of Action in spray program	11-June 2021 2 to 4 Leaf (B)		10-July-2021 6 Leaf (C)		30-July-2021 8 Leaf (D)			26-August-2021 120 DAA	
ART-Bonito	Untreated		0	c	0	h	0	i	h	0	g
ART-Bonito	A- propyzamide 1 L + atrazine 1.1 Kg	Group 3 & 5	95	ab	78	e	53	h	g	50	f
410 XX	Untreated		0	c	0	h	0	i	h	0	g
410 XX	A- propyzamide 1 L	Group 3	93	b	65	g	60	g	f	60	e
410 XX	B - Roundup Ready PL 1.67 L D - Roundup Ready PL 1.67L	Group 9	0	c	92	c	72	f	ab	90	c
410 XX	A - propyzamide 1 L B - Roundup Ready PL 1.67 L D - Roundup Ready PL 1.67L	Group 3 & 9	93	b	93	bc	90	c	b	92	bc
410 XX	B - Roundup Ready PL 1.67 L	Group 9	0	c	90	cd	80	e	d	72	d
410 XX	B - Roundup Ready PL 1.15 L C - Roundup Ready PL 1.15 L E - Roundup Ready PL 1.15 L	Group 9	0	c	87	d	95	b	ab	95	ab
410 XX	C - Roundup Ready PL 1.67 L E - Roundup Ready PL 1.67 L	Group 9	0	c	0	h	97	ab	ab	93	bc
410 XX	B - Roundup Ready PL 1.67 L E - Roundup Ready PL 1.67 L	Group 9	0	c	90	cd	63	g	e	96	ab
410 XX	A - propyzamide 1 L E - Roundup Ready PL 1.67 L	Group 3, 9	93	b	73	f	50	h	g	96	ab
410 XX	E - Roundup Ready PL 1.67 L	Group 9	0	c	0	h	0	i	h	73	d
Garrison XC	A - propyzamide 1 L B - Roundup Ready PL 1.15 L + Intervix 500 mL C - Roundup Ready PL 1.15 L E - Roundup Ready PL 1.15 L	Group 2, 3 & 9	95	ab	96	ab	99	a	a	99	a
410 XX	A - propyzamide 1 L B - Roundup Ready PL 1.15 L + clethodim 500 mL + 1% Hasten C - Roundup Ready PL 1.15 L E - Roundup Ready PL 1.15 L	Group 1, 3 & 9	93	b	96	ab	99	a	a	99	a
43Y29 RR	A - propyzamide 1 L B - Roundup Ready PL 1.15 L C - Roundup Ready PL 1.15 L	Group 3, 9	93	b	96	ab	99	a	a	93	bc
43Y29 RR	A - propyzamide 1 L B - Roundup Ready PL 1.15 L E - Roundup Ready PL 1.15 L	Group 3, 9	92	b	96	ab	83	de	c	93	bc
410 XX	A - Overwatch 1.25 L B - Roundup Ready PL 1.15 L + clethodim 500 mL + 1% Hasten C - Roundup Ready PL 1.15 L E - Roundup Ready PL 1.15 L	Group 1, 3 & 9	97	a	99	a	99	a	a	99	a
ART-Bonito	A - Overwatch 1.25 L C - clethodim 500 mL + atrazine 1.1 Kg + 1% Hasten	Group 1, 5 & 13	97	a	96	ab	84	d	c	75	d
	LSD P=.05		3.1		3.4		3.8			3.9	
	Standard Deviation		1.9		2		2.3			2.4	
	CV		3.53		2.92		3.37			3.11	

Values with the same letters are not significantly different.



Appendix 2. Yields (t/ha) for all treatments trialed at Giles Corner in 2021.

Pre-emergent herbicides and mixtures for annual ryegrass control

Declan Anderson and Rebekah Allen; Hart Field-Site Group

Key findings

- All pre-emergent herbicides provided good control of annual ryegrass at Hart in 2021.
- Seasonal conditions in July assisted the least soluble herbicides trifluralin, Arcade® and Sakura® to move actively through the soil and increase weed control.
- Seasonal conditions allowed pre-emergent herbicides to move rapidly through the soil profile, increasing crop bleaching in some herbicides, like Overwatch®.
- Penalties for wheat grain yield were observed at Hart for some trialed herbicide mixtures by up to 15%.

Why do the trial?

Pre-emergent herbicides are the most effective tools used within a spray regime for the control of early weed populations. For annual ryegrass (ARG) control in wheat, pre-emergent herbicides have become important control tactics due to resistance across many post-emergent herbicides (Preston *et al.* 2020). Herbicides with new modes of action, including Overwatch® (active ingredient bixlozone) and Luximax® (active ingredient cinmethylin) provide additional herbicide rotation options for annual ryegrass control, reducing the risk of resistance.

Mateno® Complete is a new herbicide, with commercial registration expected in 2022. The herbicide has three modes of action (active ingredients aclonifen, diflufenican and pyroxasulfone) with use patterns for IBS (incorporated by sowing) and early post-emergent (EPE) in wheat (not durum) and barley. Aclonifen, developed by Bayer, is also a new mode of action (Group 32).

This trial evaluates new pre-emergent herbicides, applied IBS and EPE, standalone or in mixtures, for the control of annual ryegrass in wheat.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 1% Zn + Impact @ 80 kg/ha
Seeding date	May 6, 2021		Easy N (42.5:0) 70 L/ha on June 12, 2021
Location	Hart, SA		Easy N (42.5:0) 70 L/ha on August 20, 2021
Harvest date	November 29, 2021		

The trial was a randomised complete block design with three replicates and 18 herbicide treatments. This trial was managed with the application of pesticides to ensure an insect and disease-free canopy.

All plots were assessed for crop establishment (%), ARG weed counts (plants/m^2), ARG head counts (heads/m^2) and grain yield (t/ha).

Annual ryegrass seed with a known susceptibility to Group 15 herbicides (previously Groups J and K) was broadcast to trial plots and lightly incorporated on May 6, prior to the application of herbicide treatments. Scepter wheat was sown after IBS treatments had been applied using a standard knife-point press wheel system on 22.5 cm (9”) spacings.

Early post emergent treatments were applied on June 28 when ryegrass was at the two-leaf stage, however populations were very low. Herbicides and rates trialed are listed in Table 1.

Table 1. Pre-emergent and early post emergent herbicide treatments applied at Hart in 2021.

Herbicide Treatment		IBS Product Rate (/ha)	EPE Product Rate(/ha)
1	Nil	-	-
2	Sakura®	118 g	-
3	Sakura® + Avadex® Xtra	118 g + 2 L	-
4	Mateno® Complete	1 L	-
5	Luximax®	500 mL	-
6	Luximax® + Avadex® Xtra	500 mL + 2 L	-
7	Luximax® + Arcade®	500 mL + 3 L	-
8	Luximax® + Sakura®	500 mL + 118 g	-
9	Overwatch®	1250 mL	-
10	Overwatch® + Avadex® Xtra	1250 mL + 2 L	-
11	Overwatch® + Arcade®	1250 mL + 3 L	-
12	Overwatch® + Sakura®	1250 mL + 118 g	-
13	Trifluralin + Avadex® Xtra	1.5 L + 2 L	-
14	Boxer Gold® + Avadex® Xtra	2.5 L + 2 L	-
15	Trifluralin + Avadex® Xtra + Mateno® Complete (EPE)	1.5 L + 2 L	1 L
16	Trifluralin + Avadex® Xtra + Arcade® (EPE)	1.5 L + 2 L	3 L
17	Trifluralin + Avadex® Xtra + Boxer Gold® (EPE)	1.5 L + 2 L	2.5 L

Results and discussion

Annual ryegrass control

Early growing season conditions at Hart were dry, with a significant opening rain event occurring on May 25, approximately three weeks post-seeding. Rainfall initiated crop germination with wheat emerging on May 31. Dry April and May conditions were followed by average June rainfall (43 mm) and a wetter than average July, of 63 mm (Figure 1).

Rainfall events in May allowed ARG to germinate and pre-emergent herbicides to move quickly through the soil profile, (Preston, 2021) increasing the potential for crop damage. This was exacerbated by herbicides with higher water solubility, particularly when soil conditions had previously been dry (Preston, 2021). Crop bleaching was observed in plots where Overwatch® herbicides were applied IBS. The effects observed in these plots at Hart displayed slight and temporary discolouration and crop establishment was not affected.

Dry conditions after mid-August resulted in no further ARG emergence.

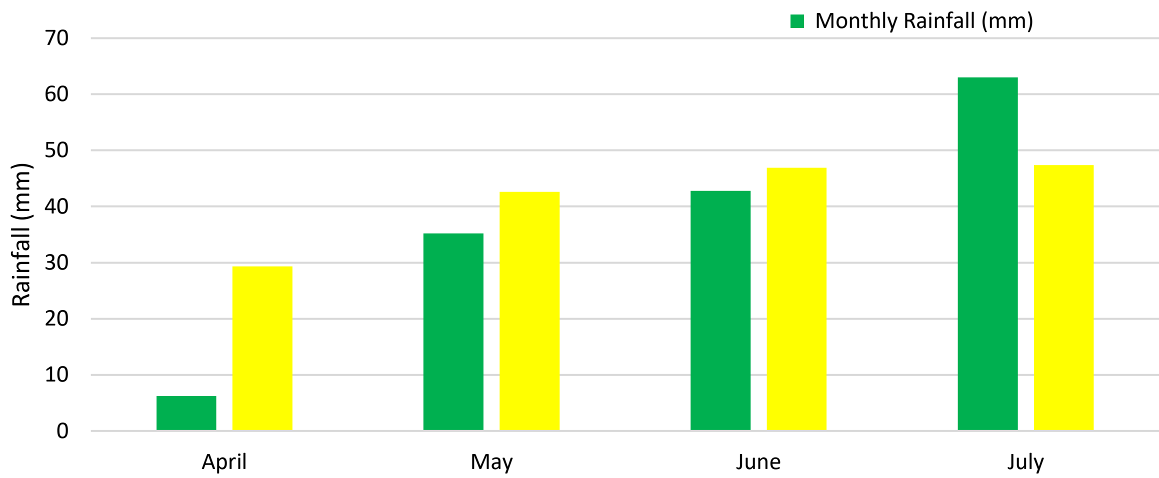


Figure 1. Total monthly rainfall and the 100-year average rainfall for April – July for Hart in 2021.

Table 2. The effect of pre-emergent herbicides on crop establishment, ARG plant counts (8 weeks after sowing) and ARG head counts at Hart in 2021.

Herbicide Treatment	Crop Establishment (plants/m²)	Annual Ryegrass (plants/m²)	Annual Ryegrass (heads/m²)
Nil	132	160ᵇ	105ᶜ
Sakura®	135	6ᵃ	0ᵃ
Sakura® + Avadex® Xtra	137	3ᵃ	0ᵃ
Mateno® Complete	110	3ᵃ	0ᵃ
Luximax®	137	11ᵃ	6ᵇ
Luximax® + Avadex® Xtra	124	3ᵃ	6ᵇ
Luximax® + Arcade®	145	3ᵃ	2ᵃ
Luximax® + Sakura®	135	2ᵃ	0ᵃ
Overwatch®	128	7ᵃ	2ᵃ
Overwatch® + Avadex® Xtra	139	5ᵃ	2ᵃ
Overwatch® + Arcade®	140	3ᵃ	1ᵃ
Overwatch® + Sakura®	134	2ᵃ	0ᵃ
Trifluralin + Avadex® Xtra	155	8ᵃ	3ᵃᵇ
Boxer Gold® + Avadex® Xtra	145	5ᵃ	3ᵃ
Trifluralin + Avadex® Xtra + Mateno® Complete (EPE)	126	0ᵃ	0ᵃ
Trifluralin + Avadex® Xtra + Arcade® (EPE)	154	4ᵃ	0ᵃ
Trifluralin + Avadex® Xtra + Boxer Gold® (EPE)	118	6ᵃ	1ᵃ
LSD (P≤0.05)	**NS**	**12.0**	**3.48**

Values with the same letter are not significantly different.

All pre-emergent herbicides provided good control of annual ryegrass at Hart in 2021 (Table 2).

The pre-emergent herbicides trialed had similar levels of control for ARG, providing up to 100% control (0 plants/m^2) when compared to the nil treatment (160 plants/m^2). May rainfall events, followed by consistent winter rainfall assisted the least soluble herbicides of trifluralin, Arcade® and Sakura® to control ARG populations, which would otherwise be difficult in drier years (Preston, 2021).

These results are in contrast to the 2020 growing season at Hart, where Luximax® and Overwatch® both provided greater control of ARG under very dry winter conditions, likely due to their greater water solubility when compared to Sakura® and Arcade® (Preston *et al*. 2020).

All pre-emergent herbicides provided excellent control of ARG head emergence at Hart in 2021. Results from pre-emergent herbicides trialed in 2020 show that Luximax® and Overwatch® standalone and in mixtures were able to reduce ARG seed set, when compared to other chemistries in dry conditions. Sakura®, although less soluble than Overwatch® and Luximax®, has also shown the ability to reduce seed set of ARG by disrupting growth of established plants, even when higher populations are present (Preston *et al*. 2020).

The nil treatment (160 plants/m^2) was observed to be one of the highest yielding treatments, showing that crop competition across moderate ARG populations is good, and that yield reductions observed were the result of herbicide mixtures trialed.

The most significant yield penalty observed was for the Luximax® and Sakura® mixture. This mix is not on label and is not recommended due to the increase in crop damage.

Table 3. Grain yield (t/ha) of all herbicide treatments at Hart in 2021. Shaded values show the highest performing treatments.

Herbicide Treatment	**Grain yield (t/ha)**
Nil	2.54^{cde}
Sakura®	2.50^{abc}
Sakura® + Avadex® Xtra	2.47^{abc}
Mateno® Complete	2.49^{abc}
Luximax®	2.35^{ab}
Luximax® + Avadex® Xtra	2.40^{abc}
Luximax® + Arcade®	2.57^{cde}
Luximax® + Sakura®	2.32^{a}
Overwatch®	2.71^{de}
Overwatch® + Avadex® Xtra	2.57^{cde}
Overwatch® + Arcade®	2.56^{cde}
Overwatch® + Sakura®	2.38^{abc}
Trifluralin + Avadex® Xtra	2.55^{cde}
Boxer Gold® + Avadex® Xtra	2.57^{cde}
Trifluralin + Avadex® Xtra + Mateno® Complete (EPE)	2.55^{cde}
Trifluralin + Avadex® Xtra + Arcade® (EPE)	2.73^{e}
Trifluralin + Avadex® Xtra + Boxer Gold® (EPE)	2.52^{bcd}
LSD (P≤0.05)	**0.197**

Values with the same letters are not significantly different.

Acknowledgements

This trial is funded by

The Hart Field-Site Group would like to acknowledge the generous support of our sponsors who provide funding that allows us to conduct this trial. Proceeds from Hart's ongoing commercial crop also support Hart's research and extension program.

We would like to thank Peter Boutsalis for providing the annual ryegrass seed to conduct this trial.

References

Preston C 2021, 'Pre-emergent herbicide performance in 2021', *2021 Hart Field Day Guide, 67 – 68.*

Preston C & Allen R 2020, 'Annual ryegrass control with new pre-emergent herbicides and mixtures', *2020 Hart Trial Results Book, 63 – 65.*

Photo. Pre-emergent herbicides and mixtures for annual ryegrass control; the trial at Hart, 2021.

Increasing productivity and sustainability of mixed farming enterprises through improved pasture management in non-arable hills of the Mid-North

Stuart Sherriff and Sam Trengove; Trengove Consulting

Key findings

- Pasture growth responses were consistent with soil test results. Where low levels of nutrition was measured, the application of phosphorus and nitrogen increased dry matter production by up to 33%.
- The variability of results across four trial sites shows that selective soil sampling from specific soil types or areas of varying pasture production will be important to identify zones within a paddock where nutrient response will occur.
- Weed control varied depending on species. In some cases, significant damage to beneficial plants such as clover species occurred, but despite this, two years of control could be achieved with a single application of herbicide.

Why do the trial?

The hills pasture landscape in the Mid-North of South Australia is predominately made up of mixed farmers with a primary focus on grain crop production. Consequently, much of the hills pasture landscape area is set stocked to simplify the stock operation during the cropping season and in some cases, it can be over grazed leaving the hills vulnerable to erosion. The pastures are rarely fertilised to increase production as it is difficult to measure the return on investment in this environment. This method of grazing promotes weedy pastures that are often dominated by stemless thistle *(Onopordum acaulon)*, nutgrass (*Cyperus rotundus)* and storksbill *(Erodium botrys and Erodium cicutarium)*. These weed species offer little feed value or soil protection.

Identifying simple management practices that can be readily adopted, will have a significant positive benefit to increase profitability, increase ground cover, increase water infiltration, and ultimately reduce erosion risk. These practices are also likely to compliment improved grazing management practices, moving away from set stocking to better manage rotational grazing. Without simple tools for mixed farmers to use, it is likely that the hills pasture landscape of the Mid North will continue to be degraded and in drought seasons, put the landscape at significant risk of erosion such as events seen between 2017 and 2019.

The aim of the project is to improve pasture production in the non-arable hills and rangeland pasture landscape of the Mid North, SA, to reduce the risk of erosion, increase water infiltration and ultimately improve production and profitability of South Australian landholders.

How was it done?

Plot size	2.0 m x 12.0 m	**Site 1**	Matters 1
Location	Spalding, SA	**Site 2**	Broughton Park
		Site 3	Stephenson

Two main trial sites, Matters 1 and Broughton Park, were implemented near Spalding in March, 2021. All trials were randomised complete block designs with three replicates. Soil samples were taken for analysis at 0 – 10 cm and 0 – 60 cm.

Due to high nitrogen and phosphorus levels identified at Matters 1, a third site, Stephenson, was established on July 14. A fourth site, Matters 2, with reduced treatments was established on August 11 after observing nitrogen deficiency and poor pasture growth in another area in Matters 1 paddock.

Fertiliser trials

Fertiliser treatments at the two sites were implemented June 6 in front of a 27 mm rainfall event that occurred over the following two days.

Stock were removed from the Matters 1 trial on August 11 and the Broughton Park trial was fenced to exclude stock on September 6. The additional Stephenson and Matters 2 sites were not grazed post fertiliser treatment application.

Trial assessments were made using Greenseeker NDVI and biomass cuts were taken at 4 cm from the soil surface between October 11 and October 13. In addition to biomass measurements, grass species scores (0 – 9) were also conducted to assess shifts in species population.

Herbicide trials

The two main herbicide trials Matters 1 and Broughton Park were established in March with the first treatments applied on June 28. A third herbicide trial, Stephenson, was established to the east of Spalding on July 20. Treatments for these trials are shown in Table 2.

Weed control assessments were made using scores from 0 (no effect) to 9 (100% control) at 15, 43 and 71 days after the first application (DAA) at Matters 1 and Broughton Park. At the Stephenson site a weed control score was conducted 43 DAA.

Table 1. Application timings and weed descriptions for herbicide trials 2021.

Trial site	Herbicide timing 1	Herbicide timing 2	Weed species	Weed size at first herbicide timing	Clover size at first herbicide timing
Matters 1	June 28	September 1	Common storksbill	4 cm	NA
Broughton Park	June 28	September 1	Long-beaked storksbill	4 cm	2 – 3 trifoliate leaves
Stephenson	July 21	NA	Stemless thistle	4 – 15 cm	NA
			Long-beaked storksbill	5 cm	NA

An additional herbicide trial has been included in this report that was established August 18 to investigate control strategies for stemless thistle *(Onopordum acaulon)*. Control scores were conducted 63 DAA and ranged from 1 – 6, where 1 = unaffected and 6 = complete control.

Results and Discussion

Fertiliser trials

Matters 1 and Broughton Park

Matters 1 and Broughton Park fertiliser trials both had high levels of background nutrition with 0 – 10 cm nitrogen (N) at 132 kg N/ha and 68 kg N/ha, respectively. Colwell P at 0 – 10 cm was also 94 mg/kg and 38 mg/kg, for Matters 1 and Broughton Park. This resulted in minimal response to any fertiliser treatment. The high nutrition treatment (500 kg single super + 200 kg urea) showed some visual responses at these sites during the growing season where the height of the pasture was visibly taller and the plants were visibly darker green. However, no significant differences were measured for NDVI or dry matter production in October.

Additional fertiliser sites

The additional sites established in July and August were selected based on poor pasture production observed during the season. Soil test results from these sites indicate low nutrition with Colwell P values 26 mg/kg and 11 mg/kg for the Matters 2 and Stephenson trials, respectively. Nitrogen and sulphur levels were also low at these sites.

Matters 2

Positive biomass responses to the application of nitrogen were observed at the Matters 2 trial with an average increase of 0.9 t DM/ha (23%) recorded for all urea treatments (Figure 1). The application of P as single superphospate at any rate alone did not have any impact on pasture production and single super plus urea did not further increase biomass production over urea applied alone. This indicates that nitrogen was the main limiting nutrient in this grass dominant pasture.

Stephenson

At the Stephenson trial site, only combinations of single super and urea were able to significantly increase dry matter production producing an average of 2.7 t DM/ha compared to 2.1 t DM/ha in the control (nil treatment); a 33% increase in production. Increasing rates of single super and urea to 200 kg and 100 kg/ha, respectively, showed an increase in dry matter production above the lower application rates. These results indicate that this site has more severe P and/or S deficiency compared to the Matters 2 trial, and this is supported by the lower P soil test values (Colwell P – 11 mg/kg).

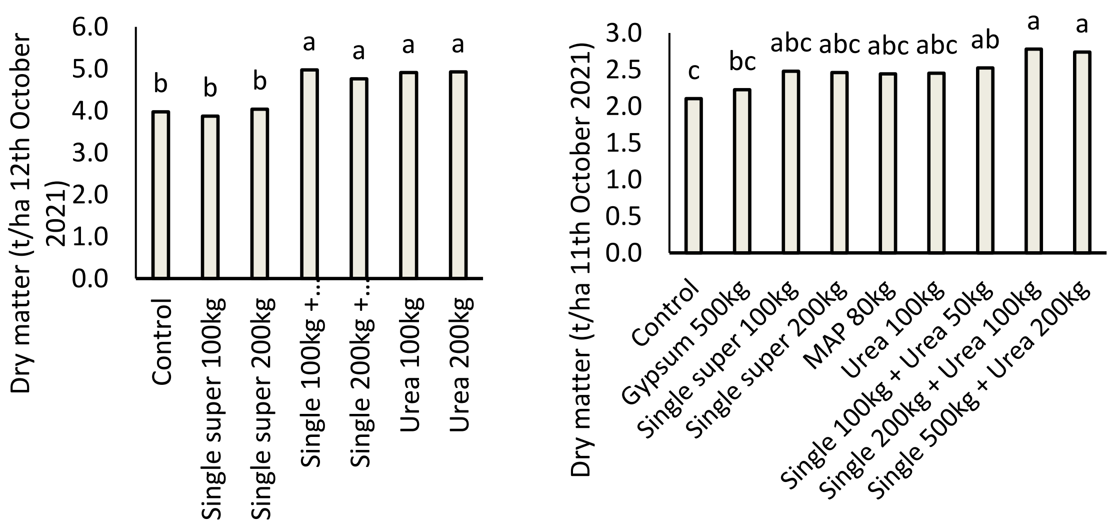


Figure 1. (L) Dry matter production (t/ha) October 11 (61 days after application) for the Matters 2 fertiliser trial in 2021. (R) Dry matter production (t/ha) October 11 (61 days after application) for the Stephenson fertiliser trial in 2021.

Impact of fertiliser application on grass species

At the Broughton Park and Matters 1 trials, some high input fertiliser treatments appeared to reduce the proportion of wild oats and increase barley grass that was present in the plots. However, a score of the population composition, between wild oat and barley grass was conducted prior to biomass cuts for dry matter yield and scores did not show any differences.

It is expected that after several seasons of fertiliser application, species composition may be altered; however, long-term replicated trials are required to make better assessments of this impact.

Herbicide trials

Matters – Common Storksbill (Erodium cicutarium)

The Matters herbicide trial was dominated by barley grass *(Hordeum leporinum)* and common storksbill with a low level of wild oats *(Avena fatua)* present. Herbicide treatments Ecopar® + MCPA and Igran® + MCPA provided good early control of common storksbill and had little impact on the grass species present (Table 2). Thistrol Gold® is a slower acting herbicide but still had some significant effect at the early score. At the later assessment, (43 DAA) the best performing treatments were still Ecopar® + MCPA, Igran® + MCPA. The T-rex® + 2,4-D treatment had now provided complete control with a herbicide score of 9 out of 9.

The two Verdict treatments provided excellent control of the erodium and controlled most of the barley grass and wild oats. A low population of silver grass *(Vulpia bromoides)* was present at the site and this became the dominant species in these treatments after the other grass species were removed. These treatments were also left more exposed compared to other treatments and would have been at a higher risk to wind and water erosion.

Broughton Park – Long-beaked Storksbill (Erodium botrys)

The early score at the Broughton Park herbicide trial was conducted 15 days after treatment. Similar to the Matters trial, the Ecopar® + MCPA and Igran® + MCPA treatments had the fastest impact on the long-beaked storksbill providing an average score of 8.3, 15 DAA (Table 2).

Broadstrike® + Diuron and Broadstrike® + bromoxynil also performed well on long-beaked storksbill in this trial. Broadstrike® + Buttress® and Broadstrike® + MCPA did not provide any control at this assessment. Therefore, it is presumed that it is the Group 5 herbicide component of diuron or bromoxynil that is providing the control in the Broadstrike® mixtures. This treatment contains a higher loading of bromoxynil (400 g ai/ha) compared to the Thistrol Gold® + bromoxynil treatment (140 g ai/ha) and had a greater impact at this earlier score.

Clover herbicide tolerance was also scored in this trial to assess the effects on the desired broadleaf pasture species. The Broadstrike® + diuron treatment produced a score of 5.7 out of 9 at this assessment timing indicating a high level of damage. However, there was some recovery and by 43 DAA the score for this treatment reduced to 2.7. In contrast the T-Rex® + 2,4D amine treatment was slower to kill the clover but by 43 DAA none remained.

As expected, the Verdict® treatments caused severe damage to the grasses, however as in the Matters trial, silver grass that was not visible in the other treatments now dominated some areas of those plots. Storksbill control of in these treatments was excellent and clover was unaffected. The addition of Broadstrike® did not improve storksbill control but it was noted that grass control appeared slower compared to Verdict applied alone.

This trial became infested with brown pasture looper (Ciampa arietaria) after the first herbicide application and no data on erodium botrys was collected beyond the 15DAA score.

Stephenson – Stemless thistle (2021 and 2020)

Stemless thistle was the hardest weed to control in this trial series. In the trial established in 2021 the best herbicide control score achieved was 4.0 out of 9 from the application of Thistrol Gold at 4000 mL/ha although this was statistically similar to Broadstike + Butress, Thistrol Gold at 2000 mL/ha and MCPA Amine + Saracen (these four treatments averaged a score of only 3.7) (Table 3). This level of control is not satisfactory and indicates that getting good control with treatments that do not damage legume-based pasture will be difficult to achieve.

In 2020, a trial was established in a similar location to the 2021 trial. In this trial more treatments were included that were known to be damaging to legume-based pastures.

Table 2. Herbicide score for grasses including barley grass (Hordeum leporinum) and wild oat Avena fatua), common storksbill (Erodium cicutarium), long beaked storksbill (Erodium botrys) (0 = no effect, 9 = complete control and approximate ground cover of Clover and Wild oat) for the Matters and Broughton Park herbicide trials 2021, refer to Table 3 for herbicide application rates.

	Broughton Park Score 0 - 9					Broughton Park approx. % cover		Matters Score 0 - 9				
Treatment	**Grass 15 DAA**	**Long beaked storksbill 15DAA**	**Grass 43 DAA**	**Long beaked storksbill 43 DAA**	**Clover 43 DAA**	**Clover 71 DAA**	**Wild oat 71 DAA**	**Grass 16 DAA**	**Clover 15DAA**	**Common storksbill 15DAA**	**Grass score 43 DAA**	**Common Storksbill score 43 DAA**
Nil	0.0	0.0	0.0	4.0	0.0	25	90	0.0	0.0	0.0	0.0	0.0
Tigrex 750mL	0.3	2.3	0.0	9.0	0.3	12	77	0.0	0.3	1.0	0.0	6.7
Jaguar 750ml	0.0	2.7	0.3	9.0	0.3	23	77	0.0	0.3	1.3	0.0	2.0
Broadstrike 25g + Butress 2L + Banjo	0.3	1.7	0.0	9.0	0.3	12	83	0.3	1.3	1.7	0.0	5.3
Broadstrike 25g+ MCPA Amine 330mL + Banjo	0.3	2.7	0.3	9.0	0.0	13	80	0.3	1.3	3.0	0.0	6.7
Broadstrike 25g + Diuron 600g + Banjo	3.0	8.3	2.0	9.0	2.7	3	70	3.3	5.7	5.3	3.0	8.7
Broadstrike 25g + Bromoxynil 2L + Banjo	0.7	7.3	0.0	9.0	0.7	18	90	1.7	2.0	1.7	0.3	7.0
Verdict 100mL + Uptake	6.7	8.0	8.3	9.0	0.0	67	0	7.0	0.0	7.7	8.0	8.0
Broadstrike 25g + Verdict 100mL + Uptake	6.7	6.0	8.3	9.0	0.0	53	0	6.3	1.0	5.7	8.0	7.7
Brodal Options 200mL	0.0	0.7	0.3	9.0	0.7	8	83	1.0	0.3	1.0	0.0	2.7
Igran 500mL + MCPA Amine 330mL	1.3	8.0	0.0	9.0	1.3	10	83	1.7	3.3	7.0	0.3	9.0
Ecopar 500mL + MCPA Amine 330mL	0.3	8.7	0.0	9.0	1.3	7	83	0.3	2.0	8.3	0.0	9.0
Tigrex 750mL + 2,4DAmine625 750mL	1.0	4.7	0.0	9.0	9.0	0	47	0.0	2.7	3.3	0.0	9.0
Thistrol Gold 2L + Banjo	0.3	2.7	0.0	9.0	0.0	8	80	0.7	1.0	6.0	0.0	7.0
Thistrol Gold 4L + Banjo	1.0	3.7	0.0	9.0	0.3	18	87	1.3	1.3	5.3	0.0	7.0
Thistrol Gold + Banjo + Bromoxynil	1.0	2.3	0.0	9.0	1.3	13	87	1.0	1.3	4.7	0.0	7.7
T2_Broadstrike 25g + Butress 2L + Banjo	0.0	0.0	0.0	4.7	0.0	18	87	0.0	0.0	0.0	0.0	0.0
T2_Thistrol Gold 2L + Banjo	0.0	0.0	0.0	5.0	0.0	18	90	0.0	0.0	0.0	0.0	0.0
T2_Tigrex 1L	0.0	1.0	0.0	6.3	0.0	17	77	0.0	0.0	0.0	0.0	0.0
LSD (0.05)	0.7	2.2	0.5	1.5	1.1	13	16	0.9	1.0	2.5	0.9	2.3

These treatments included the herbicides dicamba, clopyralid and metsulfuron-methyl. The clopyralid treatment provided almost 100% control with an average score of 4.7 out of 5 (data not presented). Dicamba + 2,4D amine provided control with a score of 3.7 out of 5 on the same scale. Treatments that were similar in both trials produced equivalent levels of control in both years.

The site established in 2020 was revisited in 2021 and a score of population was conducted. Results were variable due to the scattered population, but it was reasonably clear that the two best treatments in 2020, dicamba and clopyralid had the lowest population of stemless thistle almost a year after application. This indicates that although damaging to the pasture species, if good control is achieved in year one, benefits remain in the following season. If a non-residual herbicide treatment such as dicamba + 2,4D amine is used it is likely that clover or medic pasture species would be able to regenerate in the following season, providing there is an adequate seed bank remaining in the soil.

Table 3. Herbicide score for stemless thistle (Onopordum acaulon) and common storksbill (Erodium botrys) (0 = no effect, 9 = complete control) 43 days after application for the Stephenson herbicide trial 2021, refer to Table 3 for herbicide application rates.

Product(s)	**Stemless thistle**	**Common storksbill**
Nil	1.0	1.0
Tigrex 750mL	2.7	4.0
Broadstrike 25g + Butress 2L + Banjo	3.3	4.0
Broadstrike 25g + MCPA Amine 330mL + Banjo	3.0	3.3
Igran 500mL + MCPA Amine 330mL	2.7	6.7
Ecopar 500mL + MCPA Amine 330mL	2.7	8.3
Tigrex 750mL+ 2,4DAmine625 750mL	2.2	6.7
Thistrol Gold 2L + Banjo	3.7	2.5
Thistrol Gold 4L + Banjo	4.0	5.0
MCPA Amine 1L + Saracen 100mL + Banjo	3.7	8.3
LSD (P≤0.05)	**0.9**	**2.6**

Pasture growth responses are consistent with soil test results and variable within the same paddock. Where low levels of nutrition were measured, the application of phosphorus and nitrogen increased dry matter production by up to 33% in this trial series. This increase in production also generates greater ground cover resulting in reduced risks to wind and water erosion and opportunity for increased meat and wool production in the area. The variability of results across the four trial sites shows that selective soil sampling from specific soil types or areas of varying pasture production will be important to identify zones within a paddock where nutrient response will occur and which nutrients are likely to be most responsive.

Weed control in these trials varied depending on species. Both long beaked storksbill and common storksbill were effectively controlled where desired pasture species were able to be retained. However, this was not the case for the more difficult to control stemless thistle. For this species, it was necessary to use herbicides that caused significant damage to beneficial plants such as clover species. Despite this, it was noted that two years of control could be achieved with a single application of herbicide.

Acknowledgements

Australian Government | Future Drought Fund

This project received funding from the Australian Government Future Drought Fund.

The authors would like to acknowledge trial co-operators Sam and Tom Trengove and Tyler and Pauline Stephenson for the use of land to conduct these trials, and Nufarm for providing some herbicide products trialed.

Effect of combinations of sowing time, seed rate and herbicides on ryegrass management in faba beans (Washpool, SA)

Ben Fleet[1], Rebekah Allen[2] and Gurjeet Gill[3]

[1]University of Adelaide, [2]Hart Field-Site Group

Key findings

- Propyzamide provided stable and effective ryegrass control at both sowing times. In contrast, simazine + trifluralin standalone or followed by clethodim, was more effective in time of sowing (TOS) 2 than in TOS 1.
- Increased crop ground cover from higher faba bean seed rates reduced ryegrass growth and head density. An increase in faba bean seed rate from 20 to 40 seeds/m^2 reduced ryegrass head density from 35 to 21 heads/m^2 (41%).
- The combination of propyzamide followed by Factor + clethodim was able to almost eliminate ryegrass head production (0.1 heads/m^2).
- Faba beans sown on May 26 produced significantly greater grain yield than the crop sown on 22 June. This is consistent with general grower experience of superior performance of faba beans when sown early.
- As ryegrass density at the trial site was low (< 35 plants/m^2), grain yield of faba beans in herbicide treatments ranged from 2.48 to 2.65 t/ha and was unaffected by herbicide treatments (P=0.309). These results suggest faba beans can tolerate low ryegrass densities without suffering any loss in grain yield.

Why do the trial?

Delayed sowing can provide opportunities to exhaust the seedbank of weeds before seeding the crop, but late sown crops can be less competitive with weeds and allow them to set a large amount of weed seeds. Faba beans are generally considered highly responsive to earlier sowing when soils are warmer and crop growth rates tend to be high. Early sown faba bean crops have been shown to out yield crops sown later in the season. Some growers start seeding their faba bean crops before ANZAC day every year to take advantage of good growing conditions. Therefore, it is important to investigate sowing time in combination with other practices across different rainfall zones. The review of Widderick *et al.* (2015) also recommended research on sowing time in many crops.

Crop seed rate is an easy tactic for the growers to adopt, provided they are convinced of its benefits to weed management and profitability. Faba beans are a very large seeded crop, which means increasing plant density can have serious effects on seed costs as well as logistics during seeding. Growers are also reluctant to increase faba bean seed rates due to concerns about the negative impact of high seed rate on foliar fungal disease pressure.

This field trial was undertaken at Washpool in the Mid North, which is in the medium rainfall zone of South Australia. The aim of the trial was to investigate factorial combinations of sowing time, seed rate and herbicides on the management of annual ryegrass in faba beans.

How was it done?

This field trial was established in a split-split plot design and investigated combinations of the faba bean sowing time, seed rate and herbicides for annual ryegrass control.

Location	Washpool, South Australia
Seedbank soil cores	21 April, 2021
Plot size	1.37 m x 10 m
Seeding date	TOS 1: May 26, 2021; TOS 2: June 22, 2021
Seeding rate	20, 30 and 40 seeds/m^2
Herbicide treatments	1) Simazine 1.1 kg + Trifluralin 800 mL/ha IBS 2) Simazine 1.1 kg + Trifluralin 800 mL/ha IBS Fb Clethodim 500 mL/ha GS13 ARG 3) Propyzamide 2 L/ha IBS 4) Propyzamide 2 L/ha IBS Fb Factor 150 g + Clethodim 500 mL/ha GS13 ARG
Replicates	Three
Variety	Bendoc
Seeder	Knife points, press wheels, 22.8 cm (9”) row spacing

Measurements collected include; pre-sowing weed seedbank, crop establishment (plants/m^2), weed density (plants/m^2), ryegrass head density (heads/m^2), ryegrass seed production and faba bean grain yield (t/ha).

At Washpool in 2021, It was an extremely dry start to seeding, with only 5.4 mm rainfall received in April (Table 1). Summer months were also extremely dry with well below average rainfall, meaning very little soil moisture was available at the site. Sowing was delayed until May 26 (TOS 1) to allow good soil moisture conditions for pre-emergent herbicide activity. Once winter started, rainfall received at the site was well above the long-term average. Spring rainfall was below average but the month of November was extremely wet (128.2 mm). However, the crop had already reached maturity at this stage and did not benefit from late rain.

Table 1. Rainfall received at Gulnare near Washpool in 2021 and the long-term average for the site.

	Rainfall (mm)	
Month	**2021**	**Long-term average**
Jan	13.2	21.1
Feb	8.6	21.5
Mar	14.1	18.2
Apr	5.4	32.0
May	26.2	48.6
Jun	85.6	57.4
Jul	102.0	57.8
Aug	43.6	57.2
Sep	16.8	52.1
Oct	37.8	42.7
Nov	128.2	32.6
Dec	1.4	25.6
Annual total	**482.9**	**466.8**
GSR total	**317.4**	**347.8**

Results and Discussion

Faba bean plant density

Crop density was significantly influenced by the time of sowing (P=0.027), crop seed rate (P=0.001) and the interaction between sowing time and seed rate (P=0.024). It is important to note that established plant density was very close to the target plant density. The interaction between the sowing time and crop seed rate appears to be associated with much higher crop density at the highest seed rate in TOS 2 (35.9 compared to 45.2 plants/m^2).

It is quite likely that dry soil conditions at sowing in TOS 1 may have reduced faba bean establishment. Faba beans are a very large seeded legume crop and the germination and establishment can be reduced by dry soil conditions, particularly at high seed rates.

Table 2. Effect of the interaction between crop sowing time and seed rate on the establishment of faba beans.

	Faba bean density (plants/m^2)	
Crop seed rate (seeds/m^2)	**TOS 1**	**TOS 2**
20	20.9	22.6
30	31.6	33.7
40	35.9	45.2
LSD (P≤0.05)	**3.52**	

Ryegrass plant density and head density

The soil seedbank for ryegrass at the site was low (102 ± 48 ryegrass seeds/m^2). Ryegrass plant density in this trial was significantly influenced by interaction between crop sowing time and the herbicide treatments (P=0.002). Propyzamide treatments provided stable ryegrass control in both sowing times (Table 3). In contrast, simazine + trifluralin by itself or followed by (Fb) clethodim provided greater weed control in TOS 2 than in TOS 1. It is possible that increased soil moisture conditions at sowing in TOS 2 may have been conducive to improved weed control from this treatment.

Ryegrass head density (m^2) was significantly affected by crop seed rate (P=0.038), herbicide treatment (P=0.001) and the interaction between time of sowing and herbicides (P=0.03). An increase in crop ground cover through higher seed rates was able to reduce ryegrass growth and head density. Increasing faba bean seed rate from 20 to 40 seeds/m^2 reduced ryegrass head density from 35 to 21 heads/m^2 (41%). Consistent with the trends observed for ARG plant density, simazine + trifluralin treatments had about half the ARG head density in TOS 2 than in TOS 1.

As stated earlier, better soil moisture in TOS 2 is likely to have improved efficacy of simazine + trifluralin than in TOS 1 (Table 4). The combination of propyzamide fb Factor + clethodim was able to almost eliminate ARG head production (0.1 heads/m^2). These results indicate the likely presence of clethodim resistance in the ryegrass population present at this site. Previous studies have shown improvement in ryegrass control when Factor (butroxydim) is added to clethodim when treating clethodim resistant populations.

Table 3. Interaction between crop sowing time (TOS) and herbicides on annual ryegrass (ARG) plant density (ARG plant/m^2).

	ARG plants/m^2	
Herbicide treatment	**TOS 1**	**TOS 2**
Propyzamide 2 L/ha IBS	5.4	5.0
Propyzamide 2 L/ha IBS Fb Factor 150 g + Clethodim 500 mL/ha GS13 ARG	1.0	0.8
Simazine 1.1 kg + Trifluralin 800 mL/ha IBS	34.4	14.1
Simazine 1.1 kg + Trifluralin 800 mL/ha IBS Fb Clethodim 500 mL/ha GS13 ARG	14.7	5.2
LSD (P≤0.05)	**9.04**	

Table 4. Interaction between crop sowing time (TOS) and herbicides on annual ryegrass (ARG) head density (ARG heads/m2).

	ARG heads/m^2	
Herbicide treatment	**TOS 1**	**TOS 2**
Propyzamide 2 L/ha IBS	19.6	16.0
Propyzamide 2 L/ha IBS Fb Factor 150 g + Clethodim 500 mL/ha GS13 ARG	1.2	0.1
Simazine 1.1 kg + Trifluralin 800 mL/ha IBS	80.7	40.8
Simazine 1.1 kg + Trifluralin 800 mL/ha IBS Fb Clethodim 500 mL/ha GS13 ARG	26.8	13.4
LSD (P≤0.05)	**23.01**	

Faba bean grain yield

Grain yield of faba beans in this trial was significantly influenced by the time of sowing (P=0.029) and crop seed rate (P=0.001). Faba beans sown on May 26 produced significantly greater grain yield than the crop sown on June 22 (Figure 1). This is consistent with general grower experience of superior performance of faba beans when sown early. If rainfall conditions in April had been more favourable, it would have been possible to sow even earlier to achieve higher yields.

Growers are often reluctant to sow faba beans at seed rates greater than 30 seeds/m^2. This is largely due to high seed costs as well as logistical issues of sowing a large seeded crop at high seed rates. However, the results of this trial showed yield benefits of higher seed rate up to 40 seeds/m^2 (Figure 2). Therefore, it's important for local growers to carefully consider gross margins of higher seed rates in their situation.

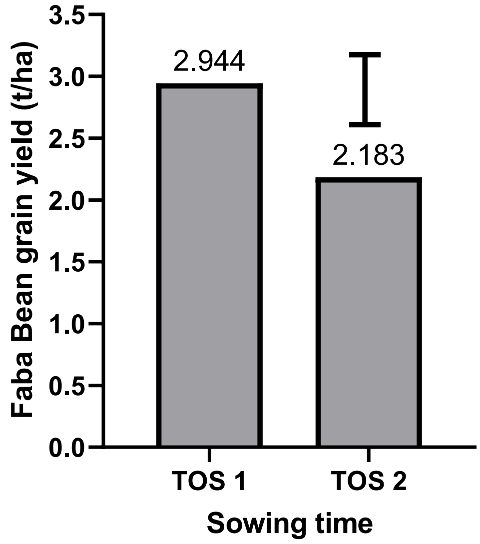


Figure 1. Effect of faba bean sowing time on its grain yield (P=0.029).

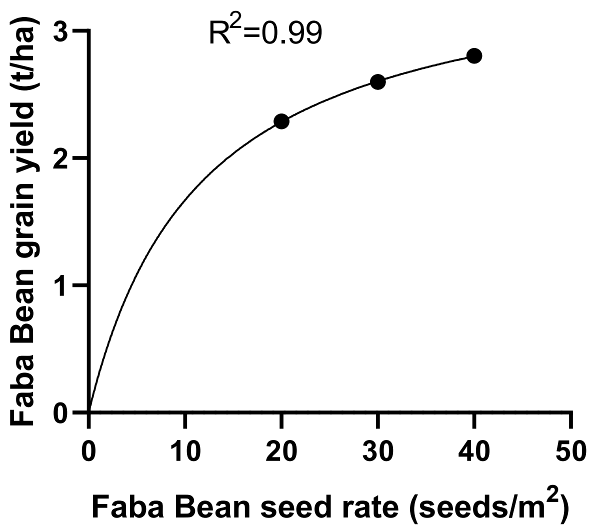


Figure 2. Effect of faba bean seed rate on its grain yield. The hyperbolic relationship accounted for 99% of variability in the trend.

As ryegrass density at the trial site was low (< 35 plants/m^2), grain yield of faba beans in herbicide treatments ranged from 2.48 to 2.65 t/ha and was unaffected by herbicide treatments (P=0.342). These results suggest faba beans can tolerate low ryegrass densities without any loss in grain yield. However, failure to effectively control low ryegrass densities can lead to large build-up in ryegrass seedbank for subsequent crops.

Acknowledgements

The research undertaken in this project (GRDC project 9175134) was made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the authors would like to thank them for their continued support.

Collaboration with the Hart Field-Site Group is also gratefully acknowledged.

Developing management practices for septoria tritici blotch in wheat for medium rainfall zones

Declan Anderson[1], Tara Garrard[2] and Rebekah Allen[1]

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

Key findings

- Seasonal conditions at Hart in the 2021 growing season were not conducive to septoria tritici blotch disease development.
- Fungicide applications for septoria tritici blotch management were not economical in the trials conducted at Hart in 2021.

Why do the trial?

Septoria tritici blotch (STB) is a foliar fungal (*Zymoseptoria tritici*) disease in wheat that is prevalent in high rainfall environments (GRDC 2020). Septoria tritici blotch survives on wheat stubble, causing disease in wheat crops through the infection of windborne spores in following cropping years. In seasons found to be suitable for the rapid development of STB, wheat yield losses of up to 20 – 60% have been experienced (GRDC 2014, GRDC 2020).

Variety selection has shown a considerable influence on the control of STB in wheat during a given growing season (GRDC 2014). Varieties with higher resistance ratings, like Sunlamb, rated moderately resistant (MR), tend to experience lower levels of wheat grain yield loss than varieties rated susceptible (S), like Scepter. Previous research has shown that varieties with an increased resistance rating to STB will assist in reducing inoculum load and reduce the risk of infection and yield loss in following seasons (Milgate 2020).

Fungicides have proven to be a valuable tool when managing STB in crops, managing the effects of disease on crop yield potential. Current management practices have been developed for the high rainfall zone (HRZ), consisting of multiple fungicide applications within one growing season. Fungicide Mode of Action groups are also commonly rotated to manage disease resistance due to the high potential of mutation for STB, forming resistance to fungicides, similar to other foliar diseases, like rust (CropLife 2021).

More recently, STB prevalence has increased across the low (LRZ) and medium rainfall zones (MRZ). This is likely to have occurred as a result of conducive conditions beginning in the early 2010's, establishing high background levels of inoculum due to high rainfall events across multiple seasons (Milgate 2020). In addition to these higher levels of inoculum, varieties with low levels of genetic resistance to STB that are commonly grown across the low and medium rainfall zones, have contributed to the increase in occurrence of disease infection.

The aim of this trial is to develop integrated disease management strategies for STB in low and medium rainfall zones through variety and fungicide management strategies. Two trials were conducted at Hart in 2021 for this purpose. Trial sites were also located at Booleroo Centre in South Australia, as well as Horsham, Hamilton, Watchupga, and Longerenong in Victoria.

How was it done?

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 1% Zn + Impact @ 80 kg/ha
Seeding date	June 1, 2021		Easy N (42.5:0) 70 L/ha on June 12, 2021
Location	Hart, SA		Easy N (42.5:0) 70 L/ha on August 20, 2021
Harvest date	November 29, 2021		

Two trials were conducted at Hart in 2021 to investigate fungicide timing on crop yield losses and variety resistance (Table 1 and 2). Trials were managed with the application of pesticides to ensure a weed and insect free canopy. All plots were assessed for grain yield (t/ha), protein (%), test weight (kg/hL), screenings (%) and disease severity (%).

Trials were inoculated with STB on August 4 and 20 using a hand-held sprayer containing a mixture of water and STB spores. The solution was applied to all + disease plots in the variety resistance trial and all plots in the fungicide timing trial, in cool and damp conditions, conducive for the infection of septoria (GRDC 2020).

The variety resistance trial was a randomized split plot design with six replicates, six varieties and two treatment blocks +/- disease. To reduce the spread of disease across treatment blocks, barley buffer plots were sown between each block of wheat.

Table 1: Varieties trialed in the STB variety resistance trial with maturity and genetic resistance rating.

Variety	Maturity	Resistance Rating to STB
LPRB Impala	Mid	SVS
Scepter	Mid	S
Hammer CL Plus	Quick-mid	MSS
LPRB Lancer	Mid-slow	MS
Orion	Mid-slow	MRMS
Sunlamb	Very slow	MR

VS = Very susceptible, SVS = Susceptible – very susceptible, S = Susceptible, MSS = Moderately susceptible – susceptible, MS = Moderately susceptible, MRMS= Moderately resistant – moderately susceptible

The fungicide timing and grain yield loss trial was a randomised complete block design with six replicates and six treatments. Barley buffer plots were included between each plot to reduce the potential drift of fungicide at application. The trial was sown to Scepter, a susceptible variety to STB.

Table 2: Fungicide treatments trialed in the fungicide timing and grain yield loss trial.

Treatment Timing	Fungicide Actives	Fungicide Groups
Nil	-	-
Seed treatment	Fluquinconazole	3
Foliar spray @ GS31	Benzovindiflupyr + Propiconazole	7 + 3
Foliar spray @ GS39	Epoxiconazole	3
Foliar spray @ GS31 + GS39	Benzovindiflupyr + Propiconazole @ GS31 + Epoxiconazole @ GS39	7+3 3
Seed treatment + foliar @ GS39	Fluquinconazole + Epoxiconazole	3 + 3

Results and discussion

2021 season at Hart

The growing season at Hart in 2021 received below average rainfall with a dry start to the season, followed by a dry spring finish (Mesonet rainfall at Hart, Figure 1). This influenced disease pressure as well as crop yield potential and performance.

Throughout many regions of the Mid-North, crops emerged late due to below average rainfall between April – May (41.4 mm). This saw slow crop growth and plant vigour as crops emerged later into cooler conditions.

As opening rains were delayed, so was the STB infection in crops. A conducive environment did not present until July, which provided humid conditions and above average rainfall.

Following the inoculation of trials on August 4 and 20, temperatures were low, which resulted in very slow disease development in trial plots (Tables 3 & 4). In addition to low temperatures, rainfall from mid-August was minimal, resulting in the reduction and spread of STB disease.

Overall, conditions in 2021 were not conducive for the development of STB. Rainfall and temperature trends, in addition to later establishment of crops reflected low disease levels observed.

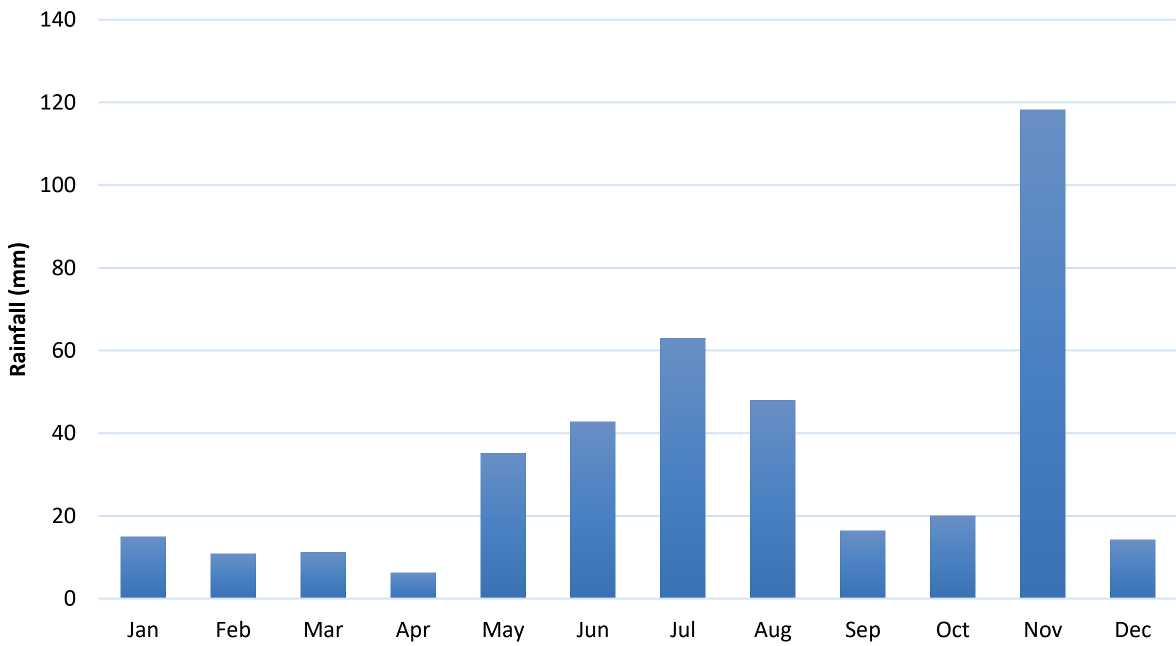


Figure 1: Hart rainfall data from Mesonet station, total annual rainfall 401 mm, growing season rainfall April-October 231.6 mm.

Variety resistance

Susceptible variety Scepter and SVS variety Impala had the highest disease severity levels in the variety resistance trial (Table 2). Despite whole plant severity averaging out to 11.3% in Impala and 8.7% in Scepter there was no infection on the flag leaves and less than 0.1% infection on flag-1 leaves for + disease plots.

Grain yields at Hart were slightly higher in the -disease plots compared to +disease plots (Figure 1). However, no significant differences were found in the GenStat data analysis. Therefore, the disease development of STB throughout the 2021 growing season at Hart was not at a high enough level to cause yield losses in any of the varieties in the trial regardless of resistance rating.

Table 3: STB average disease severity of whole plants at Hart Field Site in 2021.

Rating	**Variety**	**Average disease severity %**	
		+ Disease	**- Disease**
SVS	Impala[a]	11.3	0.0
S	Scepter[a]	8.7	0.0
MSS	Hammer CL Plus[a]	2.2	0.0
MS	LRPB Lancer[a]	1.7	0.0
MRMS	Orion[a]	1.1	0.0
MR	Sunlamb[a]	0.1	0.0

Varieties with the same letters are not significantly different.

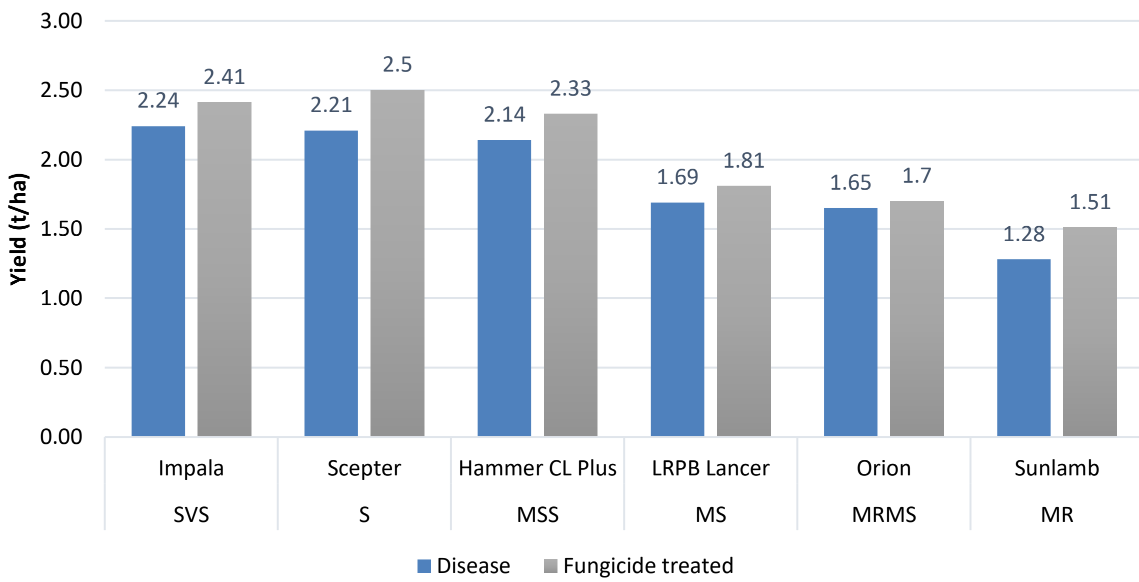


Figure 2. Average yield losses associated with STB at the Hart Field Site in 2021, no significant differences were detected.

Fungicide timing and grain yield loss

Disease severity in the fungicide timing trial was at a similar level to the variety trial with treatments varying from 1.6% in the foliar spray @ GS31 + GS39 and 9.5% in the nil treatment and foliar spray at GS39 (Table 3). Grain yields from the trial had no significant differences between treatments, indicating that in the 2021 growing season at Hart, fungicide timing was not critical for disease control.

Table 4. STB average disease severity of whole plants in fungicide timing trial at Hart 2021.

Treatment	**Average disease severity %**
Nil	9.5
Seed treatment	9.0
Foliar spray @ GS31	2.8
Foliar Spray @ GS39	9.5
Foliar spray @ GS31 + GS39	1.6
Seed treatment + foliar @ GS39	7.2

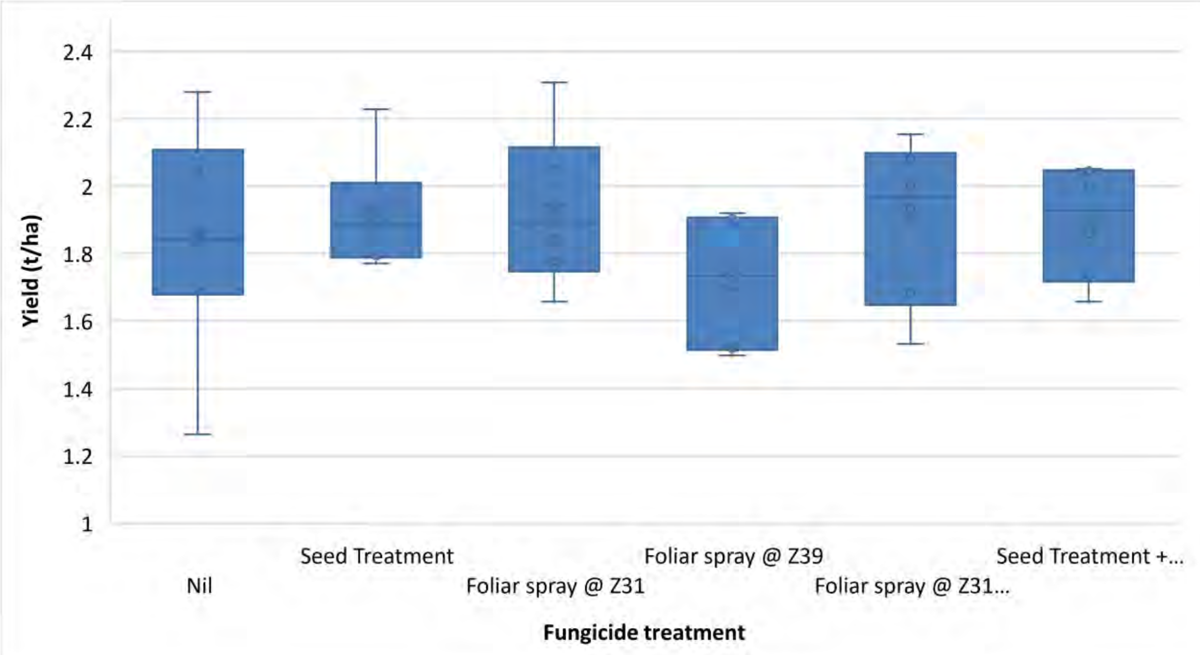


Figure 3: Grain yield of the STB fungicide timing trial at Hart 2021 yield data. No significant differences were detected.

Summary

Overall, the data from the 2021 trials at Hart illustrated that the growing season was not conducive for disease development and that fungicide applications were not an economical management strategy. These trials will continue for another two seasons at the Hart Field Site and provide insight into the economics of fungicide sprays over multiple seasons.

Acknowledgements

This research was undertaken as part of the GRDC funded project Epidemiology of Septoria Tritici Blotch in the low and medium rainfall zones of the southern region (DJP2104-004RTX).

References

CropLife Australia 2021, 'Fungicide resistance management strategies'

GRDC 2020, 'Septoria tritici blotch in wheat', Septoria Tritici Blotch Fact Sheet
Available online: https://grdc.com.au/septoria-tritici-blotch-in-wheat

GRDC 2014, 'Managing septoria tritici blotch disease in wheat', Septoria Tritici Blotch Fact Sheet
Available here: www.grdc.com.au/GRDC-FS-Septoria-Tritici-Blotch-Wheat

Milgate, A 2020, 'Septoria tritici blotch of wheat, management strategies for the medium and low rainfall zones of southeast Australia', GRDC Research Update Paper, Adelaide, South Australia.

Timing of septoria tritici blotch infection in wheat

Declan Anderson; Hart Field-Site Group

Key findings

- At Waite in 2021, drier spring conditions reduced the overall spread and infection (%) of septoria tritici blotch (STB), with wheat varieties yielding similarly, ranging between 4.33 – 5.16 t/ha.
- The selection of resistant varieties can significantly reduce STB infection, even in low disease pressure years.
- Early infection timings of STB within a growing season significantly increase disease infection (%) of wheat.

Why do the trial?

Septoria tritici blotch (STB) is a foliar disease in wheat that is often associated within high rainfall cropping environments, however, it is becoming increasingly common across the low and medium rainfall regions. Septoria tritici blotch is known for causing yield loss in crops with losses of up to 60% (GRDC 2020).

Recent spore trapping data completed across recent seasons has shown that there may be multiple infection events during a given growing season, particularly when significant rainfall events occur.

The aim of this trial is to evaluate the implications of infection timing (through inoculation) in wheat and determine if variety selection can reduce disease severity and impact on grain yield.

How was it done?

Plot size	0.5 m x 2.0 m	**Inoculation timings**	June 18 – GS14 (seedling) inoculation
Seeding date	May 14, 2021		July 28 – GS30 (stem elongation) inoculation
Location	Urrbrae, SA		September 1 – GS45 (mid-booting) inoculation
Harvest date	December 3, 2021		

The trial was a randomised split plot design with three replicates, six wheat varieties and four infection timings. All plots were assessed for grain yield (t/ha), crop establishment (plants/m^2) and disease infection (%).

Plots were sown by hand, and varieties were grouped for spray inoculation treatments. Each of the six wheat varieties trialed had different resistance ratings to STB (Table 1).

Three inoculation timings were selected based on results collected through spore trapping data from Port Germein in SA, indicating the key timings that infection events may be occurring within a growing season. The first inoculation timing was applied at four-leaf crop stage (GS14) to demonstrate impacts of early infection. Some plots were also inoculated at stem elongation (GS30) and mid-booting (GS45). Inoculation is the process of applying septoria spores as a spray solution.

Septoria tritici blotch was applied as a spore solution with a backpack sprayer.

Septoria tritici blotch prefers continual wet conditions for development and spread, which occurred from late May to early August (GRDC 2020) at Waite in 2021. From August onwards, rainfall conditions were below average which limited disease development for the remainder of the season.

Harvest cuts were conducted by hand (1 m x 2 rows) with scythes to measure wheat grain yield (t/ha). The heads were thrashed in a laboratory thresher and the grain sample was cleaned using a dockage tester. Disease assessments were also conducted on three plants per plot with STB infection (%) measured across leaf area, from flag leaf and every other leaf that had not senesced.

Table 1. Varieties trialed at Waite in 2021, showing maturity and resistance ratings for STB.

Variety	Maturity	STB Resistance Rating
Impala	Mid Spring	Very susceptible
Razor CL Plus	Quick-Mid Spring	Susceptible – Very susceptible
Scout	Mid Spring	Susceptible
Illabo	Quick Winter	Moderately susceptible – Susceptible
Denison	Slow Spring	Moderately susceptible
Orion	Mid-Slow Spring	Moderately resistant – Moderately susceptible

Results and discussion

Infection levels

Variety selection was shown to influence infection levels across the trial at Waite in 2021.

Impala and Razor CL Plus, two varieties that have poor genetic resistance to septoria tritici blotch, had the highest level of disease infection, as expected (Table 2). Illabo, Denison and Orion have improved genetic resistance to STB and this was demonstrated through the low levels of infected leaf area, ranging from only 6 – 13.2%. This enforces the fact that varieties selected with an increased resistance to disease will have significantly lower infection levels, reducing levels of STB inoculum in following years.

At Waite in 2021, varieties with disease resistance ratings of moderately susceptible - susceptible (MSS) were effective in controlling STB infection (< 10.6%).

Table 2. Average leaf area infection (LAI%) for each variety at Waite. Disease assessments were completed October 7, 2021.

Variety	Average infected leaf area (%)
Impala	40.5^{d}
Razor CL Plus	38.7^{d}
Scout	19.6^{c}
Illabo	6.0^{a}
Denison	13.2^{bc}
Orion	10.6^{ab}
LSD (P≤0.05)	**6.63**

The use of variety selection to reduce disease levels in a wheat crop is highlighted in Figure 1. The nil treatment also displayed higher LAI% than expected (Table 3). This was likely due to the trial having smaller plots that were close proximity, resulting in the spread of STB from treated plots.

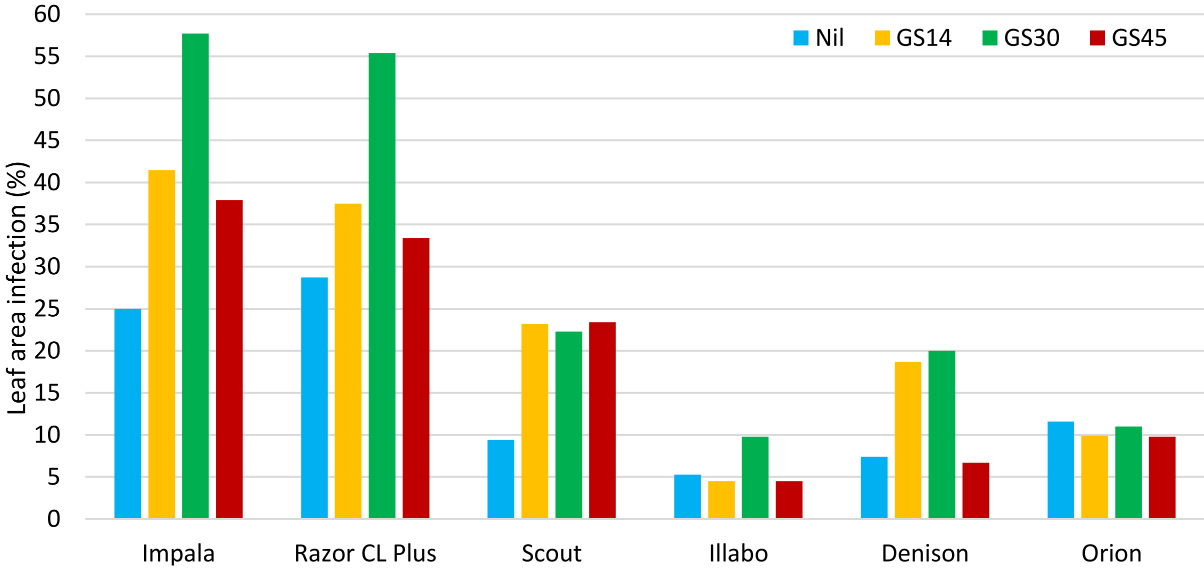


Figure 1. Leaf area infection (%) of varieties for each inoculation timing, assessed on October 7, 2021. Varieties are ordered from least to most resistant. Relationship between variety and infection timing is not significant.

The timing of STB inoculation influenced infection levels within the trial (Table 3). The seedling (GS14) and stem elongation (GS30) application timings showed the highest infected leaf area across all treatments. The early application at GS14 shows that STB had time to develop and spread during the season, increasing infection levels to 22.5%. While applications of inoculum at GS30 did not have the same amount of time to develop, there was more leaf area present to intercept the inoculation spray, providing a larger area for initial crop infection (29.4%).

The mid-booting (GS45) application had similar levels of STB to the nil treatment, which was not anticipated, due to low levels of infection expected.

At mid-booting, there was an abundance of leaf area to intercept the inoculation spray, however, penetration through the canopy to infect lower leaves is difficult due to canopy closure. At this timing, inoculant was intercepted by the upper canopy, resulting in high infection, but this was not observed lower down on the plant.

Table 3. Average leaf area infection (%) for each infection timing at Waite. Disease assessments conducted October 7, 2021.

Infection timing	**Average infected leaf area (%)**
Nil	14.6[a]
Seedling (GS14)	22.5[ab]
Stem Elongation (GS30)	29.4[b]
Mid-booting (GS45)	19.3[a]
LSD (P≤0.05)	**9.85**

Figure 2. (L-R) Flag leaf of Orion (MRMS) and Impala (VS) 36 days after GS45 application at Waite.

Yield loss

No differences were observed for wheat grain yields across all treatments trialed. Varieties yielded similarly ranging between 4.33 – 5.16 t/ha.

Although leaf area infection varied significantly across varieties and infection timings, grain yield was not affected. This is likely a result of negligible upper canopy infection in most treatments due to the lack of rainfall events occurring after mid-August, which would normally spread spores across the plant to the flag leaf.

The upper leaves of a cereal plant canopy are the most important when it comes to achieving grain yield. The flag leaf alone provides approximately 45% of the grain yield in wheat (Poole 2005). When the flag leaf and upper canopy are unaffected by disease, large yield losses would not be expected to occur.

Acknowledgements

The Hart Field-Site Group would like to thank the SARDI pathology group, Longreach Plant Breeding and AGT for providing seed.

We would also like to thank the SARDI pathology group for the use of their facilities, resources and their support of the Regional Internship program.

References

Grains Research & Development Corporation 2020, ‘Septoria tritici blotch in wheat’, *Septoria Tritici Blotch Fact Sheet*

Poole N 2005, ‘Cereal Growth Stages’, *Grains Research & Development Corporation*

Spalding lime trial – early results

Andrew Harding[1], Brian Hughes[1], Nigel Fleming[1], Bonnie Armour[1], Dr Nigel Wilhelm[1], Hugh Drum[1], Dr Sean Mason[2], Ruby Hume[3]

[1]PIRSA-SARDI; [2]APAL; [3]University of Adelaide

Key findings

- Lime significantly improved soil pH 19 months after application.
- Lime is more effective if it is incorporated rather than broadcast on the surface.
- It is important to sample soils at 0 – 5 and 5 – 10 cm as sampling 0 – 10 can mask results at 5 – 10 cm.
- Maintain soil pH above pH 5.5. If the pH falls below that level, aluminium levels start to increase and can become toxic, some nutrients like molybdenum also become less available and *Rhizobia* populations (important for nodulation of legumes) sharply decline.
- As the soil pH starts to fall below pH 5.5 ($CaCl_2$) biomass production can decline. When soil pH falls to pH 4.3 ($CaCl_2$) this can result in a 50% biomass loss of vetch.

Why do the trial?

Soil acidity is an increasing and significant issue. It is estimated that more than 2.4 million hectares are currently prone to soil acidity in SA, and that this is likely to increase to about 4 million hectares by 2050. Increasing soil acidity is a natural process but is accelerated with the use of high amount of ammonium-based nitrogen fertilisers, with higher yielding crops and more intensive cropping systems. Yields of crops and pastures start to fall when the soil pH falls below a pH 5.5 ($CaCl_2$).

How was it done?

In May 2020, as part of a GRDC project 'New knowledge and practices to address top-soil and sub-surface acidity under minimum tillage cropping systems of SA' a lime trial (one of 11 sites in SA) was established at Spalding to compare and evaluate lime sources, to assess broadcasting versus incorporation and investigate the effectiveness of compost and lime.

The lime sources included Clare Quarry and Angaston Penlime®. Lime was either applied to the surface or incorporated with a rotary hoe at a normal rate of 3 – 4 t/ha and a higher rate of 6 – 8 t/ha. The compost (cow manure) was sourced from Princess Royal Station feed lot and applied at 5 t/ha. The lime and compost were applied by hand on May 11, 2020.

A control and tillage treatment was included as a benchmark while a sulphur treatment (elemental sulphur broadcast onto the surface at 1 t/ha and incorporated) was added to determine the effects of increased acidification. The treatments were replicated four times and plots were sown with a small plot seeder. The site was identified as having a low soil pH from soil pH mapping. The soil is a light sandy clay loam over a medium clay (red-brown earth). The surface (0 – 10 cm) pH was 4.4 ($CaCl_2$) and the extractable aluminium (0 – 10 cm) was 4.7 mg/kg.

The trial was sown to Spartacus CL barley in 2020. During the year, incorporated lime with or without compost the crop appeared more vigorous. However, by harvest there were no differences in grain yield between treatments. The trial was badly frosted in October 2020.

In 2021, the trial site was sown by the landowner with Timok vetch at 50 kg/ha and with 60 kg/ha DAP on May 22. The seed was inoculated.

Greenseeker NDVI, biomass cuts and plant tissue sampling of the vetch was undertaken on August 24, 2021. Extensive soil sampling for soil pH and nutrients was carried out on all plots at depths of 0 – 5, 5 – 10 and 0 – 10 cm on December 6. Soil samples (0 – 1 cm) were also tested for *Rhizobia* populations.

Results and discussion

Biomass

Visual differences were present in the vetch in August 2021. The sulphur, control and tillage treatment were generally light green to yellow and approximately half the height of the lime treatments (Figure 1). Greenseeker NDVI and biomass cuts showed that the lime incorporated treatments had nearly twice the amount of dry matter (t/ha) compared to the control.

Soil test results

There has been a significant change in soil pH over the last 19 months (Figure 2). Soil pH in the 0 – 10 cm layer was at or above a target level of pH 5.5 ($CaCl_2$) for all lime treatments however, sampling the 0 – 5 and 5 – 10 cm layers separately showed that broadcasting lime only slightly increased pH in the 5 – 10 cm layer. Broadcasting lime has resulted in the 0 – 5 cm layer having a pH 1.8 units higher than the 5 – 10 cm layer. This shows the importance of sampling 0 – 5 and 5 – 10 cm layers separately.

The increase in soil pH due to liming has decreased toxic levels of soil aluminium and manganese. The increase in soil pH has also resulted in higher exchangeable calcium and lower exchangeable cations of magnesium, potassium, sodium and hydrogen. Adding sulphur decreased soil pH and increased toxic levels of extractable aluminium and manganese compared to the control. Adding compost had no effect on soil pH.

Figure 1. L-R: Penrice lime (6 t/ha) incorporated; control; Clare Quarry (8.4 t/ha) + compost incorporated; sulphur incorporated; Clare Quarry (4.2 t/ha) incorporated.

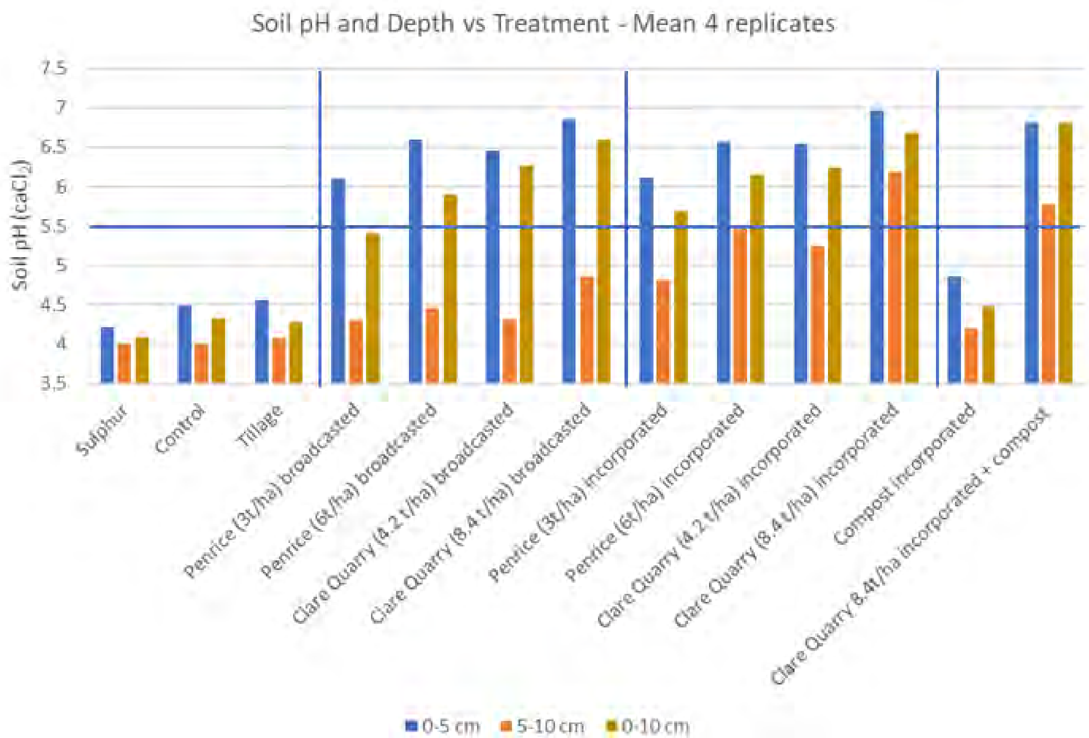


Figure 2. Effect of sampling depth and lime strategies on soil pH at Spalding 19 months after application. The horizontal blue bar is the target soil pH to avoid acidity issues.

Tissue test results

Tissue tests taken in August 2021 showed that the control and tillage treatments had high levels of aluminium and manganese with marginal levels of calcium, nitrogen, copper, boron and very low levels for molybdenum.

Molybdenum is important for nitrogen fixation and internal utilisation of nitrate. Symptoms of insufficient molybdenum in legumes include a general stunting and yellowing, as a result of insufficient nitrogen supply and green and small root nodules (Norton, 2015).

Adding lime particularly when incorporated, increased plant uptake of calcium, molybdenum and nitrogen.

Rhizobia

Rhizobia (root nodule bacteria) are responsible for nodulation and nitrogen fixation in legumes. When soil pH was below pH 5.3 ($CaCl_2$) *Rhizobia* levels in the soil were almost zero (Figure 3). As pH increased, so did *Rhizobia* levels. With improved *Rhizobia* populations and molybdenum status, the number and size of plant nodules increased which in turn, increased nitrogen nutrition.

Soil pH and biomass

The trial results showed that when the soil pH starts to fall there can be an increasing biomass loss. When the soil pH falls to 4.3 ($CaCl_2$) this can result in a 50% biomass loss of vetch (Figure 4).

Liming is important to improve and maintain soil pH. The trial has shown that lime is more effective when incorporated to at least 10 cm rather than leaving it on the surface after broadcasting. It is anticipated that this trial will continue for another two years.

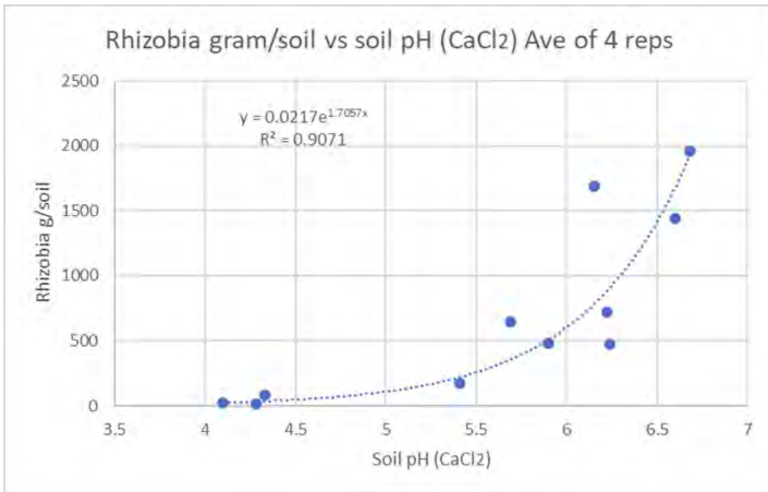


Figure 3. Soil pH ($CaCl_2$) and estimated E/F Rhizobia (per gram soil) (Compost treatments not included).

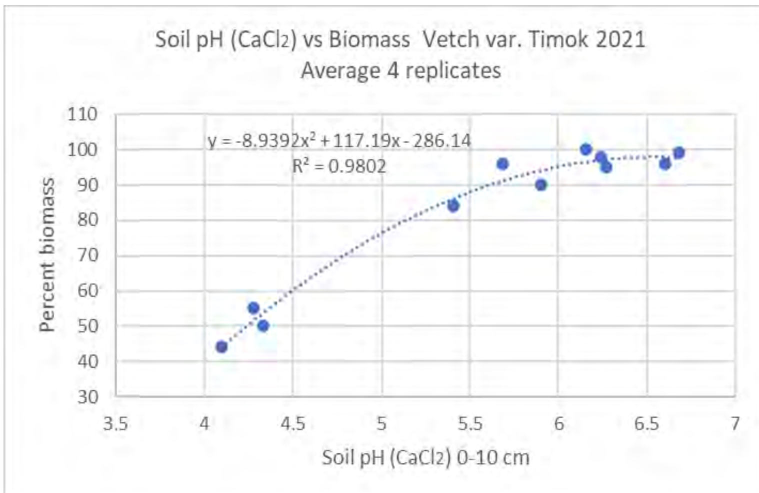


Figure 4. Soil pH (CaCl2) and percent biomass (Compost treatments not included).

References

Norton R. (2015) Molybdenum and its role in crops and pastures. *SANTFA The Cutting Edge Winter 2015.*

Acknowledgments

Dane and Natalie Sommerville are kindly acknowledged for allowing the trial on their property.

Ross Ballard (SARDI Plant and Soil Health) for *Rhizobia* testing, Penrice Quarry and Mineral (Angaston) and Clare Quarry for supplying the lime products and Princess Royal Station feedlot for the cow manure compost.

An informed approach to phosphorus (P) management in 2022

Sam Trengove[1], Stuart Sherriff[1], Jordan Bruce[1] and Sean Mason[2]

[1]Trengove Consulting, [2]Agronomy Solutions

Key Findings

- Opportunities are available for reformed phosphorus (P) rates under high fertiliser prices, but background knowledge is key.
- Gross margin analysis with phosphorus application rates is sensitive to soil available P, yield potential, fertiliser, and grain prices.
- On phosphorus responsive soil types, return from fertiliser (P) investment is normally greatest and most stable with cereal phases.

Why do the trial?

Fertiliser prices for phosphorus (P) inputs have more than doubled since those used at the start of the 2021 season and for a three-year rolling price average. Currently these high fertiliser prices are coupled with high grain prices which offsets potential decreases in partial gross margins but in the current global scenario there is high uncertainty if grain prices will hold until the end of 2022.

Higher inputs costs will naturally generate a mindset of simply reducing these input rates, but it is important to have background knowledge supporting these decisions so yield returns aren't compromised. Combined with high fertiliser prices there have been the observations that P replacement programs have been inadequate in meeting phosphorus demand in some soil types. This paper aims to outline gross margin scenarios under a range of fertiliser and grain prices which could be vastly different to those set up in previous seasons. Importantly the gross margin analysis will be performed using a range of different background P levels, soil type characteristics and yield potentials. Identification of likely paddock responsiveness and the variability in that response across the paddock is important. Several tools are available to assist with this determination which will be explained.

How was it done?

Through various research projects across the last 10 years both Agronomy Solutions and Trengove Consulting have managed over 50 replicated field trials across the broadacre regions of South Australia, with most of them being within the last 5 years (> 40). Most of these trials have assessed wheat and barley responses to P applications across a range of soil types. This dataset is highly valuable to assess gross margin scenarios under a range of conditions and the accuracy of various data layers in predicting P requirements.

In this article, we have used the P rate which is associated with the greatest partial gross margin (PGM) return when factoring in fertiliser prices and returns from grain yields. This is calculated by fitting grain yield response curves derived from the P rate trials. We have used this dataset to test the accuracy of various data layers in predicting PGM under current conditions and from the most accurate data layers looked at the effect of changing fertiliser to grain price ratios for expected 2022 scenarios. Determination of PGM has used recent price trends of MAP at $1250, Wheat (APW) at $400 and Barley (F1) at $295. This dataset is concentrated in the Yorke Peninsula and Mid-North regions of South Australia but is applicable to wider regions where soil types vary in alkalinity within paddocks driven by the presence of carbonates.

Results and discussion

Current soil P levels

Reviewing the large soil test database from project PROC9176604 reveals the overall P status of the broadacre cropping regions of SA and VIC. Over 1300 surface samples were collected in 2019 and 2020 with both Colwell P and DGT P levels placed in deficient, marginal, and sufficient categories (Table 1) based on published data (Moody 2007, Mason et al 2010). The PBI value for each site was used to determine a critical Colwell P position. Over half (52%) of sites were above critical DGT levels and as many as 73% of sites were sufficient in P using Colwell P. Using these soil test results to make a P recommendation for the sites sampled, shows that there are between 73% and 83% of sites that require < 10 kg P/ha to maximise yields. This proportion of sites is similar to what has been observed in the trial series associated with SAGIT project TC119 and TC221 discussed below.

Table 1: Soil P test results (Colwell P and DGT P) through the southern broadacre cropping region sampled in 2019 and 2020 placed in deficient, marginal, and sufficient categories with associated determinations of required P rates to maximise yields.

		Deficient		Marginal	Sufficient
		5 – 10 kg P/ha	> 10 kg P/ha	0 – 5 kg P ha	
Colwell P	Number of sites	72	218	68	970
	% Split	5	16	5	73
DGT P	Number of sites	163	367	113	685
	% Split	12	28	9	52

Site soil characteristics driving P responses

The intensive field trial dataset produced by Trengove Consulting from 2019 to 2021 (SAGIT projects TC119 and TC221), where 33 replicated field P response trials have been established on various soil type x NDVI/grain yield zones, is a powerful tool to test multiple data layers, including Colwell P and DGT P as discussed and other accessible data layers such as NDVI, pH and Yield. Of the 33 sites, 64% recorded non-significant ($P \leq 0.05$) responses to applied P (Table 1), leaving 12 with positive responses. Of these 12 responsive sites, at current prices the average P rate required to maximise PGM was 20 kg P/ha which highlights the continued importance of identification of P responsive soil types. Responsive soil types are characterised by soil pH ($CaCl_2$) between 7.5 – 7.8, higher PBI values (P retention) driven by the presence of soil carbonate and low comparative NDVI values (Table 2).

Table 2: Summary of soil characteristics averaged across the 12 responsive P sites compared to 21 non-responsive sites through Yorke Peninsula and Mid-North regions of SA. PGM was calculated based off MAP at $1250, Wheat (APW) at $400 and Barley (F1) at $295.

Response category	Number of sites	P rate at max PGM (kg/ha)	pH ($CaCl_2$)	Colwell P (mg/kg)	PBI	DGT P (ug/L)	Colwell P/PBI	pHnNDVI
Significant (0.05) (response to P)	12	20	7.56	28	91	26	0.42	9.3
Non-significant (0.05) (no response to P)	21	0.3	6.61	45	60	94	0.91	6.6

Relationships between the P rate at maximum PGM at each trial site and several data layers were used to find the layer(s) that most accurately predict P responsiveness at each site. Of the soil P tests, DGT P (R^2 = 0.72) was superior to Colwell P alone (R^2 = 0.44), at identifying sites where high P rates would produce high PGM's at current pricing and where reduction in P rates would not cause a decrease in PGM (data not presented). However, where Colwell P is combined with PBI (Colwell P divided by PBI) the Colwell P relationship improves to R^2 = 0.73, highlighting the importance of including PBI with Colwell P interpretation and measuring PBI at the same or similar intensity as Colwell P if that soil test is used for soil P mapping.

The most accurate combined data layer to provide a P rate requirement for max PGM was an index of the soil pH and NDVI at approximately GS30 (Figure 1). The index divides soil pH with the NDVI normalised to the paddock average. Areas that have high pH and low NDVI are typically highly P responsive, the level of response declines as pH decreases and historical NDVI at GS30 increases. The higher soil pH coupled with poor early vigour (low NDVI) occurs in the presence of soil carbonate, higher PBI values and lower residual P. The index is yet to be tested on soil types where high PBI is driven by other soil attributes such as Al or Fe, where there is a tendency of soil pH to be < 6 in these soils (e.g., Ferrosols on Kangaroo Island). For these areas a normalised NDVI index alone could be appropriate, or if pH is still an important factor, combining the data layers in a different index such as pH * nNDVI, where the lower values are more likely to be responsive to P however, this needs further investigation. A case study of a paddock associated with the SAGIT project TC221 using this method is presented later in this paper.

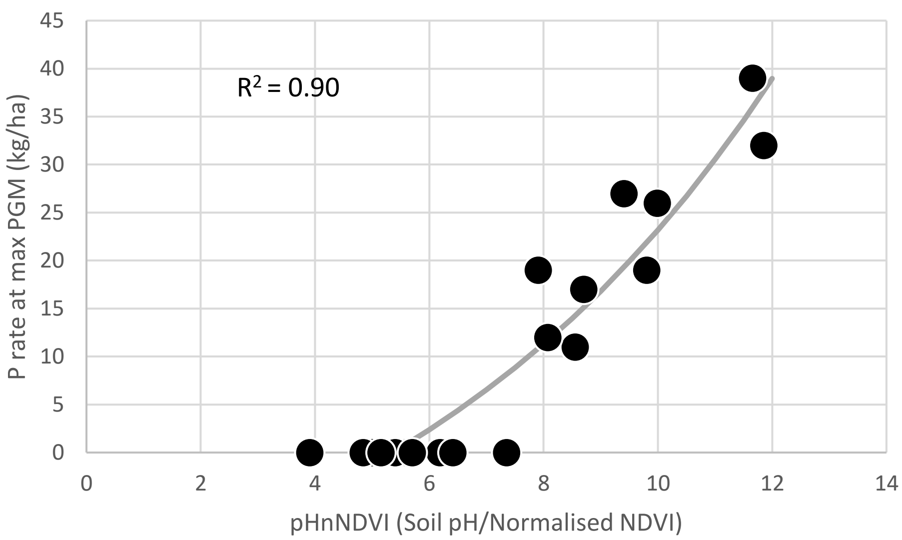


Figure 1: Relationship between the P rate associated with max PGM for P response trials (2019 – 2021) pHnNDVI.

Partial gross margin analysis for fluctuating fertiliser and grain prices

While there is some clarity with fertiliser prices for the 2022 season there is difficulty in predicting the grain price towards the end of 2022. At current grain prices the identification of P responsive sites still pays but what happens if grain prices fall? Using an accurate data layer (DGT P or pHnNDVI) we can present the influence of changing fertiliser and grain prices on optimal P rates for max PGM (Table 3). Based on 2021 fertiliser prices as a comparison and expected 2022 prices this analysis suggests economic P rates will be slightly less than half of that required in 2021.

Table 3: Sensitivity analysis of optimal P rates required for max PGM (kg/ha) for moving MAP prices at three decile grain prices (1, 5, 9) using either the pHnNDVI index or DGT P as a guide of deficiency (see figure 1). Grain price deciles from 2010 onwards, source: Mercado.

Decile 1 Grain prices: Wheat (APW1) - $214t, Barley (F1) - $165

MAP ($/t)	pHNNDVI					Soil DGT P				
	4	6	8	10	12	> 150	100	50	30	< 20
$500	0	3	11	19	28	0	4	16	28	40
$750	0	1	7	13	19	0	3	12	21	30
$1,000	0	1	5	10	14	0	2	9	16	24
$1,250	0	0	4	7	10	0	1	7	12	18
$1,500	0	0	3	5	7	0	1	5	9	13

Decile 5 Grain prices: Wheat (APW1) - $275t, Barley (F1) - $230

MAP ($/t)	pHNNDVI					Soil DGT P				
	4	6	8	10	12	> 150	100	50	30	< 20
$500	0	5	16	26	36	0	6	20	34	47
$750	0	2	10	18	25	0	4	15	26	38
$1,000	0	1	7	13	19	0	3	12	21	31
$1,250	0	1	6	10	15	0	2	10	18	25
$1,500	0	1	4	8	12	0	2	8	14	21

Decile 9 Grain prices: Wheat (APW1) - $332t, Barley (F1) - $293

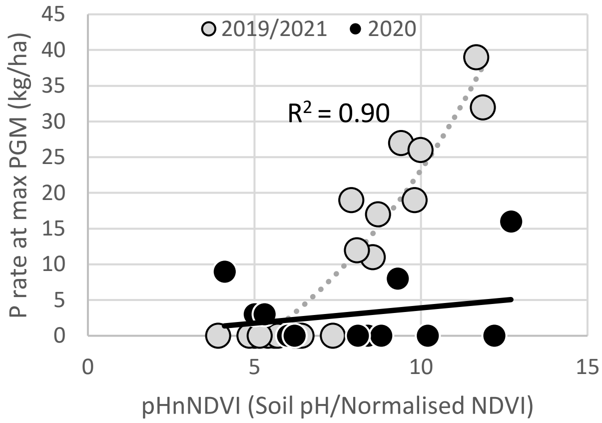
MAP ($/t)	pHNNDVI					Soil DGT P				
	4	6	8	10	12	> 150	100	50	30	< 20
$500	0	8	20	31	42	0	9	23	37	51
$750	0	3	12	21	31	0	5	18	31	44
$1,000	0	2	9	16	24	0	3	14	25	36
$1,250	0	1	7	13	19	0	3	12	22	31
$1,500	0	1	6	11	16	0	2	10	18	26

Opportunities for 2022 – time of sowing (TOS)

Recent SAGIT funded project (AS216) outlined the effect of TOS on P requirements through trials established on P responsive sites between 2017 and 2018 due to the prevalence of earlier sowing times. Results outlined that if adequate soil moisture was present in April for sowing, P rates can be reduced without any impact on yield.

This benefit reduced if there was either low moisture in April or sowing times moved to mid-May and beyond, with June sowing times producing linear but relatively flat uneconomic responses. Under high soil moisture and warm temperatures crop root systems develop effectively and therefore exploration of residual P is high, placing less reliance on fertiliser P inputs. Diffusion rates of P in these conditions are also optimised.

Data from Trengove Consulting supports this theory as the 2020 field trial data set, sown early May under good moisture revealed a lower pHnNDVI with optimal P rate relationship (Figure 2) compared to 2019 and 2021 with dryer conditions and later sowing (Table 4). This is a potential option for 2022 if wet conditions in April prevail.



Site	Year	Rainfall to May (mm)	Rainfall for April (mm)
Koolunga	2019	13	4.4
Bute	2019	9.1	3.2
Brinkworth	2020	180	64
Bute	2020	119	67
Kybunga	2020	154	78
Crystal Brook	2021	29	2.6
Spalding	2021	43	4.4
Hart	2021	42	10

Figure 2 (L) and Table 4 (R). Influence of high rainfall and high soil moisture at the 2020 sites compared to 2019 and 2021 and the impact of lower P requirements at P deficiency indices.

Case study

One paddock included in the trial series associated with the SAGIT project TC221 is located at Crystal Brook in the Mid-North of South Australia. This paddock was selected to evaluate the methodology of predicting P response using data layers and investigate a range of long-term P management strategies. Two data layers that are readily available were used to predict the P response at four sites in the paddock and P rate trials were established. The data layers used included, pH (calibrated to CaCl2) captured using a Veris pH mapping machine, taking approximately 8 samples per ha, and satellite imagery captured at approximately GS30 in a wheat crop in 2020 (Figure 3). These two data layers were used to calculate the pHNNDVI (as explained above) to identify four trial sites with different predicted P responsiveness. This process was repeated at a paddock at Hart and Spalding. A similar process was used in 2019 and 2020 to select sites to predict the P response across five paddocks.

At each of the four sites within each paddock, a P rate response trial was established with rates of P up to 90 kg/ha (409 kg MAP/ha). Very high rates of P are required to find the maximum yield on very high P demand sites. In the previous project the maximum rate was 50 kg P/ha, and some sites were still responding even at this level. At the site which was predicted to have the largest response a larger trial was established to investigate long-term (3 year) management strategies. This site included two treatments where 75 kg of P was broadcast in front of the seeder either as MAP or chicken litter, these treatments also had 15 kg P/ha as MAP applied in the furrow at seeding.

The grain yield response at each of the four sites in the paddock at Crystal Brook is shown in Table 5. The sites with low predicted P response (22 and 24) did not have any response to P fertiliser; the nil treatments produced the same amount of grain yield as the 90 kg P/ha treatments. At the site which was expected to have a moderate response there was also no response to P fertiliser. At this site there was significant variation in soil test results between replicates, with DGT-P soil test levels ranging from 38 in Replicate 1 up to 151 in Replicate 3. This level of variation explains why this site did not have a significant P response even though it was expected and highlights short scale variability that can be difficult to map and manage. At site 25, the most responsive site, significant yield responses were observed all the way up to 90 kg P/ha, indicating a highly P responsive soil. This is not to suggest that these rates were economic; for a current pricing scenario of $1,250/t for MAP and $295/t for barley, 32 kg P/ha (145 kg MAP) was required to maximise partial gross margin at site 25. The treatments that had 75 kg P/ha broadcast in front of the seeder followed by 15 kg P/ha below the seed, produced similar grain yield to the standard 90 kg P/ha applied below the seed. This suggests that the broadcast P was readily available. In previous trials this has not been the case, and this needs further investigation.

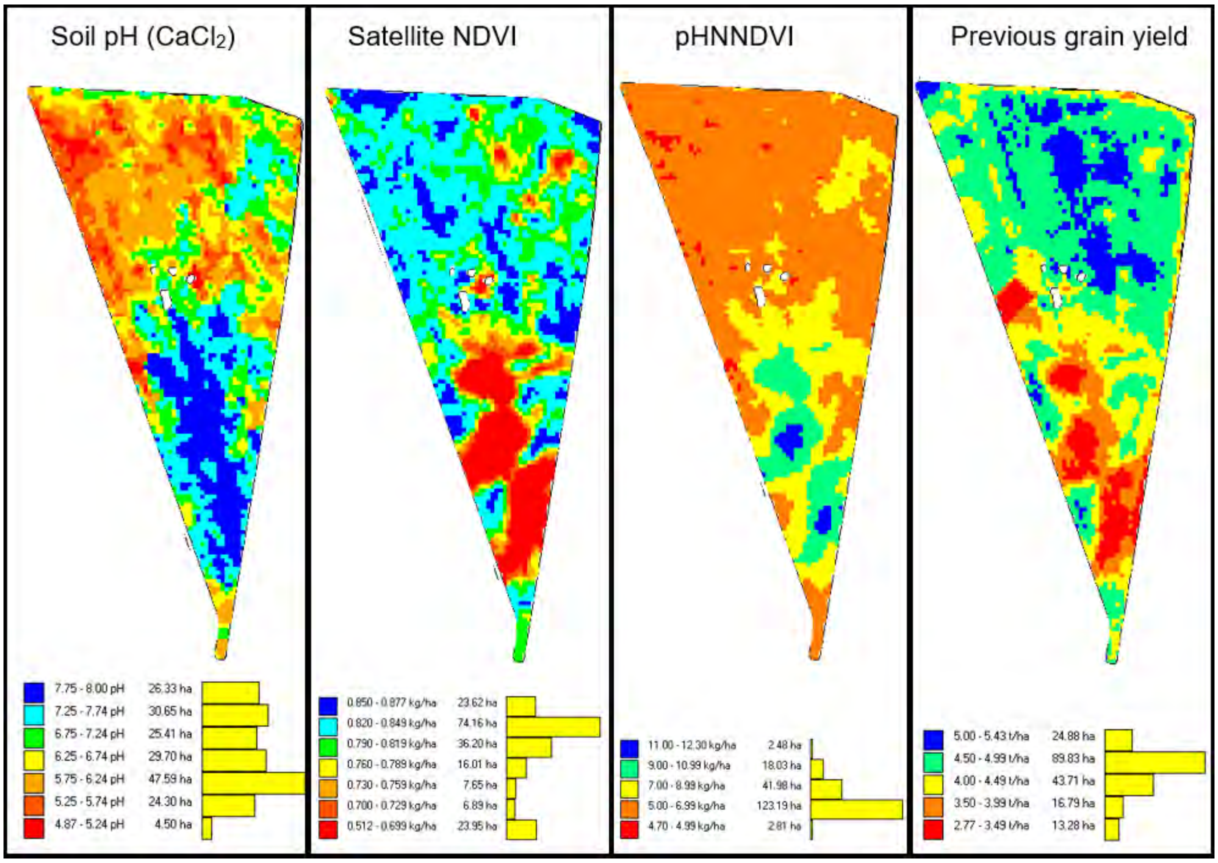


Figure 3. Soil pH, Satallite NDVI of wheat crop in 2020, approximately GS30, calculated pHNNDVI (pH / normalised NDVI) and historical grain yield for a paddock at Crystal Brook.

Table 5. Grain yield (t/ha) for the four P rate response trials at Crystal Brook in Compass barley in 2021, treatments with different letters are significantly different.

Site	22	23	24	25	
Expected response	Low	Moderate	Low	High	
P rate (kg/ha)					
0	2.70	4.32	3.98	2.71	f
7.5	2.47	4.36	3.83	3.41	e
15	2.77	4.44	3.78	3.84	d
22.5	2.51	4.38	3.58	4.10	c
30	2.56	4.35	3.64	4.22	c
50	2.94	4.44	3.65	4.54	b
90	2.73	4.31	3.54	4.74	a
CL				4.75	a
Spread MAP				4.75	a
P value	0.318	0.946	0.155	<0.001	

The yield data from the four trials in isolation is useful for measuring site specific responses within a paddock. But it becomes more powerful when a response curve is generated for each of the 33 sites, and these are put into a database to generate response curves based on the data layers used for site selection. From this database we can predict the P response based on pHNNDVI for each of the sites and use that data to generate partial gross margins. This can then be extrapolated to every point in a paddock to generate a P fertiliser application map.

The results from four modelled scenarios where high grain prices are coupled with a range in MAP prices and different fertiliser strategies are shown in Table 6. In Scenario 1 using MAP fertiliser price of $750/t, the optimum P rate ranges from 0 to 200 kg MAP/ha, averaging 44 kg/ha for the paddock. Increasing fertiliser price to $1,500/t in Scenario 2 reduces the average MAP rate to 24 kg/ha.

In some scenarios, we may prefer to ensure that all areas receive a minimum rate of starter fertiliser, rather than receiving nil in the areas that are predicted not to be P responsive. In Scenario 3 the minimum fertiliser rate is set to 20 kg MAP/ha, so that no zone receives less than this. This increases the average fertiliser rate for the paddock from 24 to 32 kg MAP/ha.

Scenario 4 is an example of a long-term strategy, where the minimum fertiliser rate for any given area is set by calculating P replacement based on the previous year's yield map. This strategy ensures P reserves are not being 'mined' on any soil, but being maintained on non-responsive soils, with higher rates still targeted to the P responsive soils. Each location receives whichever of the two rates is higher, the rate calculated from pHNNDVI or yield replacement. Scenario 4 increases the average rate to 90 kg MAP/ha, compared with 44 kg/ha in Scenario 1.

Given record high P fertiliser prices for 2022, Scenarios 2 and 3 provide an opportunity in this paddock for reducing average MAP fertiliser rates by 58 – 66 kg MAP/ha compared with Scenario 4, a saving of $87 – 99/ha.

Table 6. Results showing four modelled fertiliser strategies with a range of MAP prices.

Scenario	Grain price	MAP fertiliser price ($/t)	Min MAP fertiliser rate (kg/ha)	MAP fertiliser rate range (kg/ha)	Average MAP fertiliser rate calculated (kg/ha)
1	Decile 9	750	0	0 – 200	44
2	Decile 9	1500	0	0 – 130	24
3	Decile 9	1500	20	20 – 130	32
4	Decile 9	750	Replacement from previous yield	50 – 200	90

Conclusion

High P fertiliser price is currently slightly offset by high grain prices but with the uncertainty of these grain prices continuing into 2022, it is advised to revise P applications in 2022 due to significant impacts on optimal P rates required to maximise gross margins. Several data layers are available to assist with identifying areas where P rates can be safely cut back and those that will still return a profit with increased grain yields through adequate P applications.

Acknowledgements

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC and SAGIT, the author would like to thank them for their continued support.

We would like to acknowledge the growers involved in SAGIT funded project TC219 and TC221 and SAGIT for funding support for projects AS216, TC219 and TC221.

References

Moody PW (2007) Interpretation of a single-point P buffering index for adjusting critical levels of the Colwell soil P test. Soil Res. 45, 55-62.

Mason SD, McNeill A, McLaughlin MJ and Zhang H (2010) Prediction of wheat response to an application of phosphorus under field conditions using diffusive gradients in thin-films (DGT) and extraction methods. Plant Soil. 337, 243-258.

Photo. Soil testing rig.

Improved productivity on sandy soils - Kybunga case study 2021

Sam Trengove, Stuart Sherriff and Jordan Bruce; Trengove Consulting

Key Findings

- Deep ripping and/or spading treatments increased lentil yield in 2021 by 0.25 – 0.4 t/ha (37 – 59%).
- Over three seasons, deep ripping to 50 cm increased the cumulative partial gross margin (PGM) by $553/ha, generating a 426% return on investment.
- Treatments including spading and/or chicken litter produced high cumulative grain yield and cumulative PGM was equivalent to deep ripping to 50 cm but had lower return on investment due to their higher cost basis.
- All treatments have reduced penetrometer resistance, with the treatment effects detectable over two years after implementation. Treatments including deep ripping have had a greater impact to greater depth than the shallow rip or spading treatment.

How was it done?

Trial location:	Kybunga (Blyth BOM annual rainfall 365 mm, growing season 247 mm)
Plot size:	1.5m x 20.0m
Seeding date:	May 28, 2021
Variety:	PBA Highland XT
Fertiliser:	MAP @ 80 kg/ha
Previous crops:	2020 Spartacus barley 2019 Scepter wheat
Soil constraints:	Low organic carbon, low cation exchange capacity, mild water repellence and compaction

The trial was a randomised complete block design with seven treatments and four replicates. Chicken litter (CL) was applied to the surface of plots where applicable 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.

Treatments

1. District practice (control)
2. Shallow ripping (30 cm)
3. Deep ripping (50 cm)
4. Spading (30 cm)
5. Deep ripping + spading
6. Deep ripping + chicken litter @ 7.5 t/ha
7. Spading + chicken litter @7.5 t/ha

GreenSeeker NDVI data and grain yield was collected each season to measure crop performance. Crop measurements during the growing season included emergence, vigour and herbicide damage scores (data not presented), GreenSeeker NDVI on July 29 and grain yield. For specific details of dates in prior seasons see the previous trial reports.

Results and Discussion

Lentil performance in 2021

GreenSeeker NDVI was recorded early in the growing season with values only averaging 0.252. Bare earth NDVI values are generally about 0.16. There is little consistency with treatment or aggressiveness from this assessment.

Grain yield results for 2021 show that the untreated control produced the lowest grain yield in the trial (0.68 t/ha). Yield responses to ripping show a trend of increasing yield with increasing ripping depth, though Rip 30 was not significantly different to the untreated control (Table 1). Ripping to 50 cm and the more aggressive mixing treatment of spading increased lentil grain yields to an average of 0.99 t/ha. The addition of chicken litter did not provide any yield improvement in 2021, which is the third crop season since application.

Table 1. GreenSeeker NDVI recorded July 29 and grain yield (t/ha) for PBA Hurricane XT lentil at Kybunga 2021.

Treatment	GreenSeeker NDVI July 29		Grain yield (t/ha)	
Control	0.246	bc	0.68	c
Rip 30	0.257	ab	0.81	bc
Rip 50	0.242	c	0.95	ab
Spade 30	0.265	a	1.08	a
Rip50 + Spade	0.241	c	0.93	ab
Rip50 + Chick	0.260	a	0.97	ab
Spade + Chick	0.253	abc	0.99	ab
LSD (P≤0.05)	**0.014**		**0.23**	

Partial gross margin (PGM)

Despite significant costs of up to $460/ha associated with some of these treatments, all treatments had covered costs and generated a positive return on investment after the first season in 2019. Positive benefits have continued to accumulate in the following two seasons (Figure 1). The Rip 30 treatment has generated an additional $347/ha cumulative partial gross margin (PGM), whereas Rip50 has increased cumulative PGM by $553/ha over the untreated control.

Treatments including spading or chicken litter tended to have higher cumulative grain yields than the straight Rip50 treatment. However, cumulative PGM was not significantly higher due to the higher costs for these treatments. Due to the high cumulative PGM for Rip 50 and the lower (relative) cost basis this treatment had the highest return on investment of 426%.

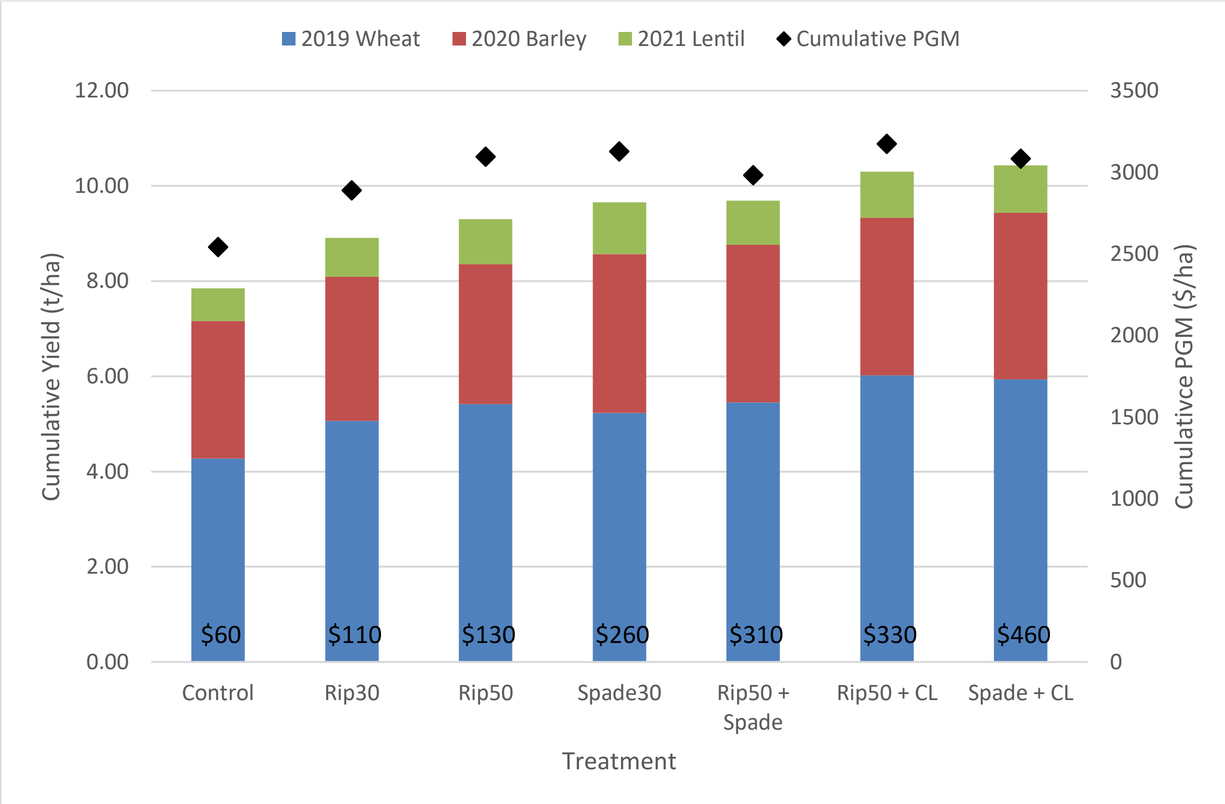


Figure 1. Cumulative grain yield and partial gross margin analysis for seasons 2019, 2020 and 2021 for the Kybunga low OM trial. Price assumptions include chicken litter $34.5/t, SoA $400/t, wheat ASW (2019) $310/t, wheat H2 (2019) $320/t, barley BAR1 (2020) $220/t, lentil NIP1 (2021) $1000/t. Estimated treatment costs are shown on each bar. Cost of spading in the deep rip plus spading treatment is reduced due to pre-ripping. Non-CL treatments received additional SoA ($60/ha) in 2019.

Penetrometer Resistance

Measurements of penetrometer resistance were made at this site in the winter of 2021 (Figure 2), which is greater than two years after treatments were implemented. Results show that compaction is likely to be a significant constraint, where penetrometer resistance exceeds 2500 kPa from 150 to 375 mm depth.

Treatment depth of intervention is clear, where the shallow rip and spade treatments that both target a depth of 30 cm only influence to this depth and do not address deeper compaction. The deep rip treatment targeting 50 cm depth has reduced penetrometer resistance deeper into the profile, such that no depth in the soil profile exceeds resistance of the 2500 kPa threshold.

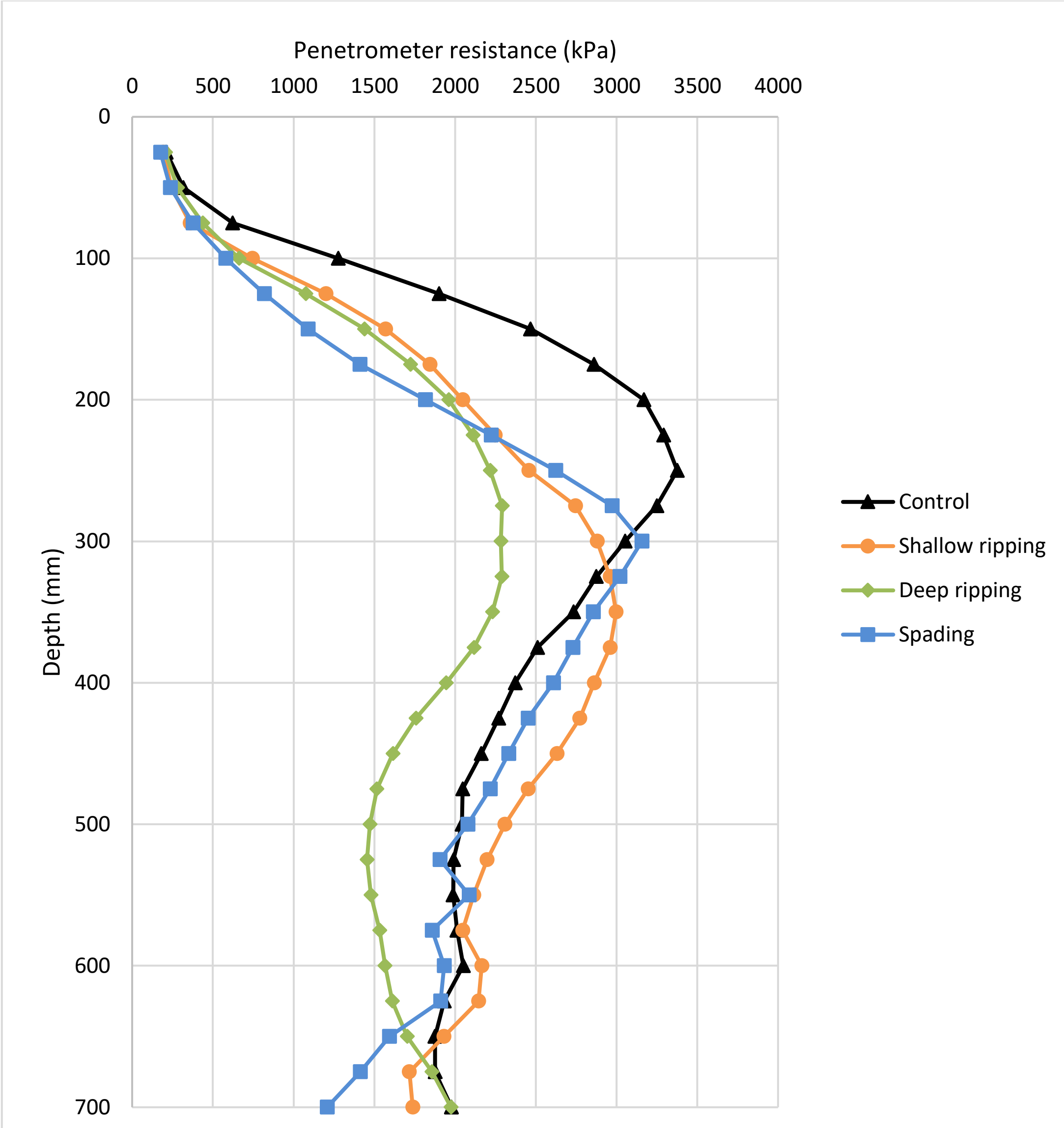


Figure 2. Penetrometer resistance measured using a cone penetrometer for selected treatments in winter 2021.

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 pesticide and fertiliser throughout the season.

Long-term comparison of seeding systems

Declan Anderson and Rebekah Allen; Hart Field-Site Group

Key findings

- Soil properties including organic carbon (SOC%), water infiltration (mm/h) and bulk density(g/cm^3) were similar for all cropping systems at Hart in 2021.
- Strategic and no-till treatments had the highest levels of available soil nitrogen (N) leading into the 2021 growing season, with 129.9 and 95.5 kg/ha, respectively.
- Over the past 21 years (2000 – 2020), no seeding system has provided consistently higher grain yield (t/ha) each season.

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 fertiliser regimes. 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 that no one seeding 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 nitrogen (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 quality.

How was it done?

Plot size	35.0 m x 13.0 m	**Fertiliser**	MAP (10:22) @ 50 kg/ha
Seeding date	May 28 – No-till June 2 – Strategic June 22 - Disc	**Medium Nutrition** **High Nutrition**	No extra fertiliser applied No extra fertiliser applied
Variety	PBA Butler field pea @ 100 kg/ha	**Harvest Date**	November 10 – No-till November 10 – Strategic December 1 - Disc
Location	Hart, SA		

The trial was a randomised complete block design with three replicates, three seeder treatments, and two nitrogen (N) treatments. This trial was also managed with the application of pesticides to ensure a weed, insect and disease-free canopy.

The disc, strategic, and no-till treatments were sown by local growers using their own equipment, Tom Robinson, Michael Jaeschke, and Matt Dare respectively.

Original 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.

In 2021, Scepter wheat stubble was managed uniformly across the trial area with the disc, strategic and no-till seeder systems sowing directly into standing stubble.

Nutrition treatments

In years with cereals or canola, a varying nutrition treatment is applied, where a high treatment receives two in-season applications of nitrogen on top of the basal rate of sown fertiliser, and a medium treatment where only one application of in-season nitrogen is applied on top of the starting fertiliser. As this year's trial consisted of field peas, no additional nitrogen was applied.

2021 assessments

Prior to seeding, soil available N was assessed on April 30, at depths of 0–20, 20–40, 40–60, and 60–80 cm. Plant establishment was also evaluated by counting the number of plants across 4 x 1 m sections of row in each plot. Water infiltration rate (mm/h) was conducted using a double ring infiltrometer, along with soil bulk density (g/cm3) for every treatment. Soil Organic Carbon (SOC%) was also measured from 0 – 10 cm in every plot. Grain yield and quality was not analysed in 2021.

Table 1. Crop history of the long-term cropping systems trial at Hart 2000 – 2021.

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	2020	2021
Scepter wheat	Scepter wheat	Wharton field pea	Sheriff CL wheat	Scepter wheat	PBA Butler field pea

Results and discussion

Plant establishment

This season, plant establishment was similar between the cropping systems, ranging from 31 to 40 plants/m^2. Target plant density was 55 plants/m^2, meaning final plant establishment was anywhere between 54% and 73% of the targeted establishment. In 2021, seeding systems had no effect on plant establishment, however, in previous years, some seeders had shown improved establishment. For example; in 2020, the disc treatment had a higher establishment of wheat seedlings when compared to the no-till and strategic treatments, although final yield was not affected (Noack *et al* 2021).

Nutrition level also had no effect on crop establishment in 2021. This has been a common observation across the duration of the trial (2000 – 2021).

Soil properties

Reducing the amount of soil disturbance from tillage is expected to help maintain higher carbon levels (Sanderman *et al* 2009). This means that the disc treatment was predicted to have higher soil organic carbon (SOC%) levels compared to the strategic treatment. This was not observed at Hart, with all cropping systems (disc, no-till and strategic) showing to have similar SOC% levels across three sampling years; 2007, 2014 and 2021 (Table 2).

Soil organic carbon was observed to be the highest in 2007 and 2014. This result is likely due to the crop type grown in the years prior to sampling, on both occasions, a legume. This is in contrast to 2021, where two cereal crops were grown in the two years prior to sampling (Table 1).

Table 2. Soil organic carbon levels (%) at Hart in 2007, 2014, 2021.

Seeding system	Nutrition	SOC % 2007	2014	2021
No-till	Medium	1.65	1.57	1.64
	High	1.78	1.89	1.67
Disc	Medium	1.70	1.97	1.61
	High	1.75	2.18	1.62
Strategic	Medium	1.69	1.98	1.59
	High	1.75	1.99	1.63
Average		**1.72**	**1.93**	**1.62**
LSD (P≤0.05)		**NS**	**NS**	**NS**

Soil available N was measured in autumn (prior to seeding) following a Scepter wheat crop in 2020, with values ranging from 54.2 kg N/ha to 132.7 kg N/ha (Table 3 and Figure 1).

Selection of seeder type influenced nitrogen levels in 2021, with the strategic and no-till treatment having the highest levels of available nitrogen, with 129.9 kg/ha and 95.5 kg/ha, respectively.

Table 3. Soil available N (kg N/ha) at Hart in 2021.

Seeding System	Nutrition	Soil available nitrogen (kg N/ha) 2019	2020	2021
Strategic	Medium	132	44	127
	High	146	116	133
No-till	Medium	95	58	72
	High	151	67	119
Disc	Medium	103	41	54
	High	118	89	100
LSD (P≤0.05)	Nutrition	**35**	**NS**	**NS**
	Seeder	**NS**	**NS**	**42**
	Seeder x Nutrition	**NS**	**NS**	**NS**

Water infiltration was assessed to measure the rate of water movement into a soil profile that is already wet, to achieve an accurate rate. Water infiltration rates for each seeding system were similar in 2021 with values ranging between 100 – 110 mm/h.

Soil bulk density is a measure of soil compaction; the mass of dry soil within a fixed volume (Brown and Wherrett 2021). Bulk density was similar across all treatments within the trial at Hart in 2021 (Table 4). Results show that continuous use of one particular cropping system including disc, no-till and strategic has not shown to improve or negatively affect measured soil characteristics.

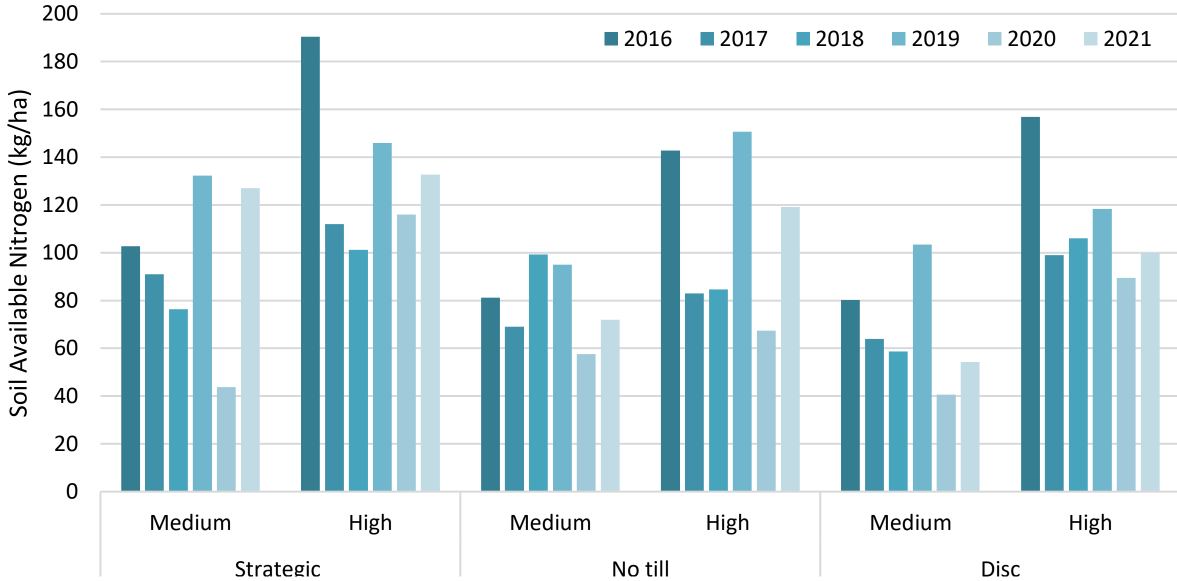


Figure 1. Five years of soil available N (kg N/ha) pre-seeding at Hart in 2016 – 2021.

Table 4. Soil bulk density (g/cm^3) at Hart in 2021.

Seeding System	Nutrition	Soil bulk density (g/cm^3)
No-till	Medium High	1.21 1.27
Disc	Medium High	1.23 1.18
Strategic	Medium High	1.20 1.19
LSD (P≤0.05)		NS

Grain yield

Over the past 21 years of this project (2000 – 2020), no seeding system has provided consistently higher grain yield (t/ha) each season. In 43% of years, small yield differences were observed between the disc, no-till and strategic cropping systems and in most cases, these higher yields were observed for disc and no-till treatments. Similarly, over a number of seasons, seeding systems used have had minimal impact on grain protein (%), screenings (%) and test weight (kg/hL).

Table 5. Grain yield (t/ha) for seeder and nutrition treatments at Hart from 2015 – 2020. Yield data for field peas in 2021 was removed from analysis.

Seeder type	Fertiliser strategy	2015 Canola	2016 Wheat	2017 Wheat	2018 Field pea	2019 Wheat	2020 Wheat
		Grain yield (t/ha)					
Strategic	Medium	0.6	4.8	3.5	0.8	1.3	2.6
	High	0.6	5.9	3.3	0.7	1.2	2.7
No Till	Medium	0.6	4.2	3.5	0.9	0.9	2.3
	High	0.5	5.8	3.5	1.0	1.1	2.4
Disc	Medium	0.5	5.0	4.1	0.7	1.3	3
	High	0.5	5.9	4.1	0.7	1.3	3
LSD nutrition (P≤0.05)		**ns**		**NS**	**NS**	**NS**	**NS**
LSD seeder (P≤0.05)		**ns**		**0.20**	**0.18**	**0.15**	**0.24**
LSD seeder x nutrition (P≤0.05)		**ns**	**0.3**	**NS**	**NS**	**NS**	**NS**

Acknowledgements

The Hart Field-Site Group would like to acknowledge the South Australian Grains Industry Trust (SAGIT) for funding to conduct this research (H119).

We would also like to thank all of the growers who participated in this project, from 2000 – 2021, contributing to its success by providing seeding equipment and the donation of both seed and fertiliser.

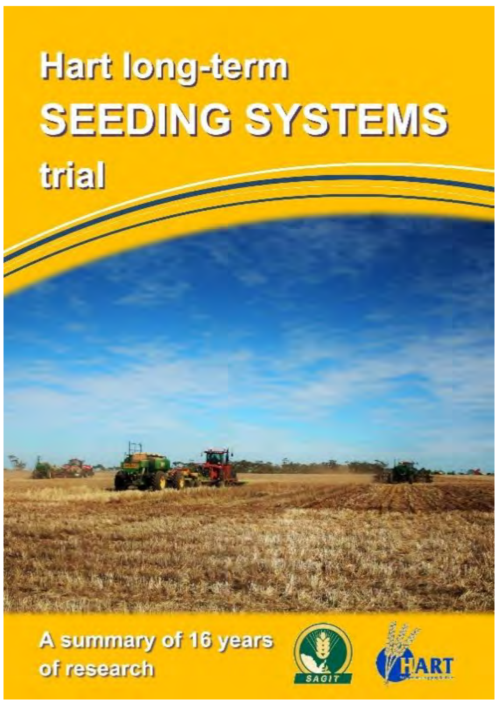
References

Brown K & Wherrett A (2021) Bulk density – on farm use. Fact Sheets – soilquality.org.au

Noack S, Allen R & Guidera B (2021) Long-term comparison of seeding systems. 2020 Hart Trial Results.

Sanderman J, Farquharson R and Baldock J (2009). Soil carbon sequestration potential: a review for Australian agriculture. CSIRO Land and Water.

Hart Field-Site Group (2016) Hart long-term seeding systems trial: A summary of 16 years of research, p 7-9.



Hart Grower Guides

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

You'll find other Grower Guides too:

- Ten tips for early sown wheat
- 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

www.hartfieldsite.org.au

Read the full 16 years summary of results on the Hart website:
https://www.hartfieldsite.org.au/media/Seeding_systems_a_long_term_trial_at_Hart_2016_web.pdf

Evaluation of the benefits of precision planting in canola at Hart

Glenn McDonald[1], Rebekah Allen[2], Jack Desbiolles[3] and Stefan Schmitt[4]

[1]School of Agriculture, Food and Wine, The University of Adelaide; [2]Hart Field Site Group; [3]Agricultural Machinery R&D Centre, The University of South Australia; [4]Agricultural Consulting and Research

Key findings

- Data collected across four years of trials suggest that precision planting of canola provided an average yield benefit of approximately 10% compared to conventional sowing.
- Yield benefits from precision planting tended to be greater at low plant populations.
- Precision planting significantly improved the uniformity of canola stands, although it was still well below the ideal uniformity of a perfect placement.
- Precision planting of canola could allow a reduction in plant density without a loss of grain yield, with potential savings on seed costs of $24/ha, confirming grower experiences to date.

Why do the trial?

Precision planting technologies are designed to place seeds at a consistent interplant distance and depth to promote uniform emergence and minimise interplant competition. In principle, minimising interplant competition allows each seedling to achieve its potential growth, thereby improving crop yield.

Precision planters were developed to improve yields of summer row crops where expensive hybrid seed is planted at relatively low densities. However, over the past decade there has been interest in using precision planting in small grain crops and especially in hybrid canola to reduce seed costs. This was prompted in part, by results of experiments in canola from Canada that found increases in grain yield of 20 – 30% at low plant densities in stands of equally-spaced plants, compared to unevenly-spaced plants. This has been supported by work from WA on plant arrangement that has shown equally-spaced plants can produce a higher yield than unequally-spaced plants at low densities.

Smart seeding technology is rapidly evolving with precision planter technology, allowing real-time monitoring of seed bed conditions and seeder performance. Machinery manufacturers are also showing increasing interest in developing precision planters suitable for winter grain crops, requiring adaptation for narrow row spacing, high population seed rate and bulk feeding of singulation row units. A small number of growers, particularly in Victoria and NSW, are using precision planters in their winter cropping programs and there have been reported benefits in canola and faba bean.

Over the last four years, trials have been conducted at the Hart field site to investigate the potential benefits of precision planting in canola and pulses, as part of a national program to examine the potential value of precision planting in winter crops. Trials compared the growth and yield of crops sown with a conventional cone seeder and a precision planter at a number of plant densities. In some experiments the effect of row spacing was also examined.

This article summarises the results of precision planting technologies at Hart for canola between 2018 and 2021.

How was it done?

The trials were sown with a purpose-built small plot disc seeder that had the ability to sow plots as a conventional disc seeder (with centralised cone metering) or as a precision planter (with singulation row metering). The seeder was built by Spot-on-Ag (Boort, Victoria) with Harvest International brand double disc openers, Precision Planting Inc. electric drive (vDrive) and vSet vacuum meters controlled by 20/20 SeedSense system.

In each year, a range of target plant densities were compared. In 2021 an experimental planter using Horsch Sprinter tynes was developed by UniSA with support from Muddy River Ag to operate as both a conventional air seeder (centralised metering) or precision planter (using Horsch Maestro singulation units controlled with E-Manager) and was included in the trial to allow a comparison between tyne and disc-based precision planters. A tyne precision planter was expected to combine the benefits of a fully tilled furrow and seed singulation. Treatments for each trial are listed in Table 1.

Trials were sown between early and mid-May following 20 – 50 mm of rainfall in the 2 weeks leading up to sowing (Table 2). Targeted seeding depth was in the range of 10 – 20 mm.

In 2021 some plots were sown at high densities with the tyne seeder and hand thinned to provide a treatment with consistently equal spacing between individual plants, and at equivalent established plant densities as the conventional and precision planted treatments. This represented an ideal arrangement of plants that minimised variation in interplant competition and provided a benchmark to assess the value of maximum stand uniformity.

Table 1. Precision planting experiments conducted at Hart between 2018 and 2021.

	2018		
Plot size	1.37 m or 1.52 x 12 m	**Seeder**	Cone tyne seeder and precision disc planter
Row Spacing	Narrow = 22.9 cm (9"), Wide = 30.5 cm (12")	**Variety**	Pioneer 44Y89 (CL)
Plant densities	15, 25, 35, 45, 55, 65 plants/m^2		
Seeding date	May 10, 2018 (May 17 for wide precision planter)		
	2019		
Plot size	1.37 m or 1.52 x 12 m	**Seeder**	Cone and precision disc planter
Row spacing	Narrow = 22.9 cm (9"), Wide = 30.5 cm (12")	**Variety**	Hyola 559TT
Plant densities	15, 25, 35, 45, 55, 65 plants/m^2		
Seeding date	May 14, 2018 (May 15 for wide precision planter)		
	2020		
Plot size	2.0 m x 12 m	**Seeder**	Cone and precision disc planter, plus perfect placement
Row spacing	25 cm (10")		
Plant densities	15, 25, 40 plants/m^2		
Seeding date	May 5, 2020	**Variety**	Hyola 350TT
	2021		
Plot size	2.20 m x 12 m	**Seeder**	Disc and tyne seeders; conventional and precision plus perfect placement
Row spacing	25 cm (10")		
Plant densities	15, 25, 35, 45 plants/m^2		
Seeding date	May 27, 2021	**Variety**	Hyola 350TT

Crop establishment (%) was estimated a number of times from first emergence by counting emerged seedlings along a three metre length of row, over two rows. The uniformity of stand establishment was assessed by measuring the interplant distance between 30 consecutive seedlings per row in two rows per plot at full establishment and calculating the coefficient of variation (CV%) for the interplant distance. Early crop cover was also measured using a hand-held Normalised Difference Vegetation Index (NDVI) sensor (Trimble GreenSeeker). Crop biomass at podding (t/ha), harvest index, calculated as the ratio of grain yield to total above-ground crop biomass at maturity, grain yield (t/ha) and grain quality (1000 grain weight) were also conducted.

Table 2. Summary of rainfall in canola trials 2018 – 2021.

Year	**Sowing date**	**Rainfall (mm)**		
		April-October	2 weeks before sowing	2 weeks after sowing
2018	May 10	219	20	18
2019	May 14	240	39	19
2020	May 5	324	53	8
2021	May 13	267	20	29

Results and Discussion

Sowing canola with a precision planter did not consistently affect the number of plants/m^2 achieved at sowing (Figure 1). Average crop establishment across the trials was lowest (50%) in 2020 which had the least rain post-seeding but reached up to 75 – 80% in more favourable years. No significant effect was observed on crop establishment as a result of precision or conventional planting when both technologies used the same disc row system (Table 3). This differed in 2018 when the tyned conventional seeder outperformed the precision disc.

Table 3. Summary of the main effects of sowing method on crop establishment, the uniformity of stand establishment and average grain yield. Asterisks after the values for the precision planter indicate the value is significantly different from conventional sowing (P≤0.05; *** P=0.001) and NS indicates the difference is not significant.*

Year	**Crop establishment (%)**		**Interplant distance CV (%)**		**Grain yield (t/ha)**	
	Conventional sowing	Precision planter	Conventional sowing	Precision planter	Conventional sowing	Precision planter
2018	90	65***	101	77***	1.38	1.39^{NS}
2019	67	64^{NS}	103	66***	0.54	0.61*
2020	48	52^{NS}	94	59*	1.01	1.06^{NS}
2021	72	82^{NS}	87	74^{NS}	0.79	0.84^{NS}

The uniformity of seed placement was increased substantially with the precision planter with the CV% for interplant distance significantly lower when compared to the conventional sowing treatment in three of the four trials (Table 3).

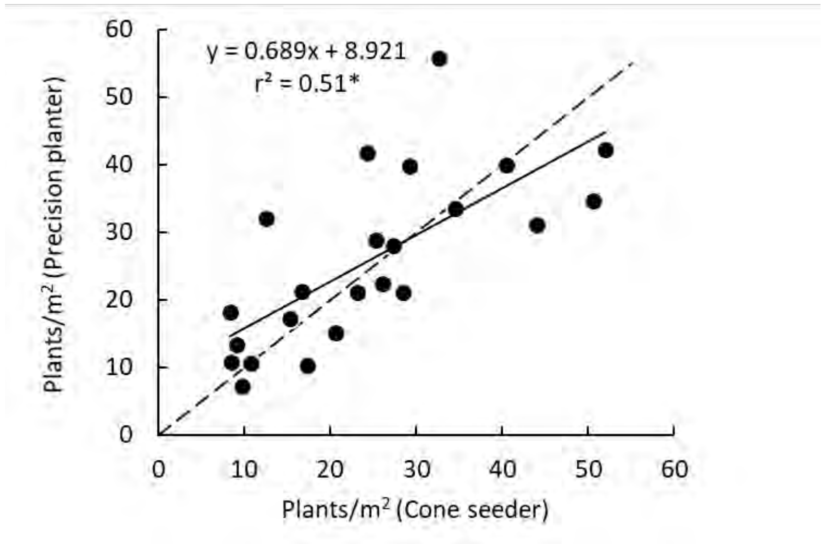


Figure 1. Established plant populations for canola sown with a cone seeder or precision planter. The data points represent different plant density treatments (n=23) across all trials. The dashed line is the 1:1 line which represents equivalent plant densities for respective cone seeder and the precision planter treatments.

Variation in plant density was the main cause of differences in NDVI among treatments. Where there was a significant effect of the sowing method on NDVI, this was associated with differences in plants/m^2. There was no consistent difference in biomass production at podding between the seeding methods and similar amounts of biomass (both from the NDVI measurements and the quadrat samples) were produced under both seeding systems (data not presented).

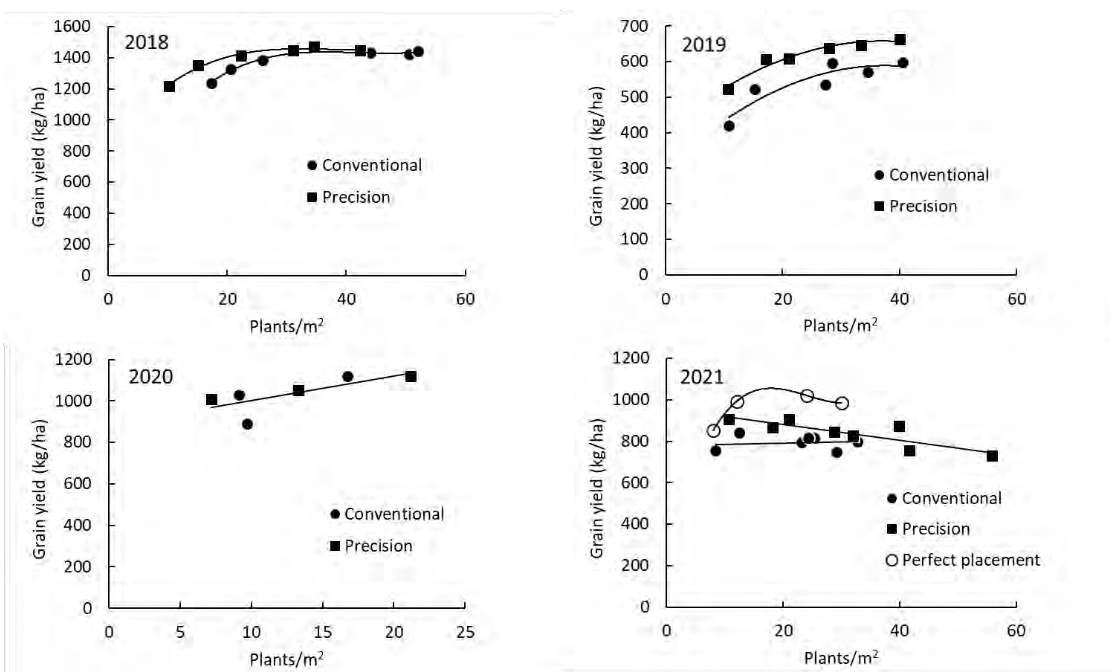


Figure 2. The yield responses to plant density in canola trials at Hart between 2018 and 2021. Plant number is the established plant population in each year. Data for precision planting in 2021 include the disc and tyne seeders.

The most consistent influence on grain yield was plant density, with significant effects measured in each year (Figure 2). Reductions in yield occurred below a plant density of about 20 – 30 plants/m^2, but precision planting was better able to maintain yields at these low densities compared to the conventional cone seeder. This was seen in 2018 and 2021 when yields with precision planting tended to be higher at low plant densities while in 2019 yields were consistently higher with precision planting over all plant densities. Within this range, reducing plant populations by about 10 plants/m^2 by precision planting had little effect on yield. In 2020 there was no difference in yield between the two methods of sowing.

The results suggest it may be feasible to reduce plant populations by about 10 plants/m^2 with a precision planter without an effect on yield. Assuming 70% field establishment and 95% germination, this is equivalent to a reduction in sowing rate of 0.8 kg/ha (assuming 180,000 seeds/kg). At a seed cost of $30/kg for hybrid seed, this is a potential saving of $24/ha.

There was an average yield benefit from precision planting of 10%, or 80 kg/ha, over the three years (2018, 2019 and 2021) where there was a difference in the response to plant density between seeding method (Figure 3). Including the 2020 results reduced the yield benefit to 6% or 26 kg/ha. There was a trend in each experiment for the benefit of precision planting to be greater at low plant densities.

The potential value of improving crop uniformity was demonstrated in 2021: the highest yields were achieved with the perfect placement treatment (Figure 2). Hand thinning established a highly uniform crop with each plant equally spaced (CV% for interplant distance = 0% compared to 60 – 75% typical value range for precision planter treatments and 90 – 100% value range for conventional seeder treatments, measured over the 4 years at Hart) which resulted in a further average yield benefit of 18%, or 150 kg/ha, over precision planting at 20 and 30 plants/m^2.

While these results are encouraging, the yield responses to precision planting varied considerably among the experiments and many of the yield differences (as kg/ha) were small. At the present time these effects may not be sufficient to warrant the use of precision planting technology.

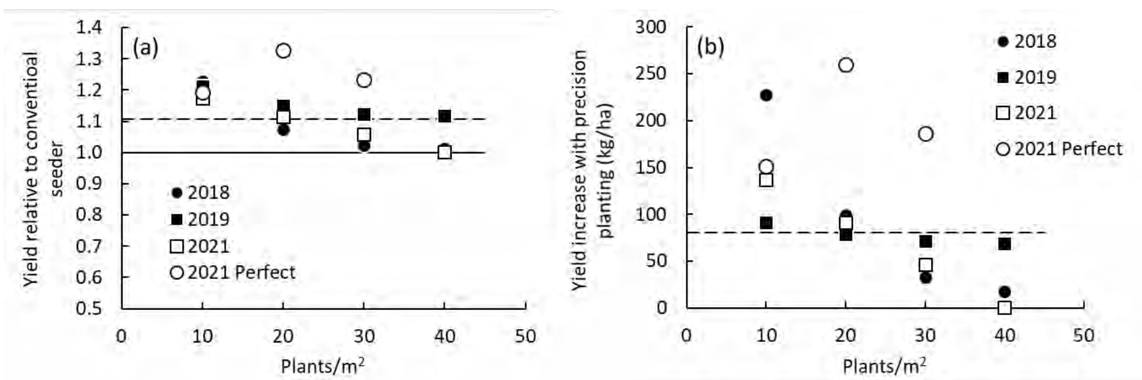


Figure 3. The yield advantage of precision planting over conventional sowing at four plant densities at Hart in 2018, 2019 and 2021 and the yield advantage of perfect placement in 2021 showing (a) the relative yield of precision planting or perfect placement over conventional sowing and (b) the yield increases from precision planting or perfect placement. To allow comparisons to be made at the same plant density, the yields are the predicted values at 10, 20, 30 and 40 plants/m2 from the response curves fitted to the data in Figure 2. Data from 2020 were not included because the responses to plant density with conventional sowing and precision planting were the same. The dashed lines are (a) the average relative yield and (b) the average yield increase.

There was a tendency for precision planting to increase the number of harvested seeds/m^2 by up to 15%. Average seed weight was similar for all seeding systems. These results suggest that the effect of improving crop stand uniformity occurred though improvements in podding and seed set rather than in seed filling. The perfect placement treatment also produced the highest number of harvested seeds/m^2 but average seed weight was slightly lower compared to the conventionally-sown treatments. High grain yields across the four years was most strongly associated with high rainfall during August, a period when canola biomass was increasing as it approached flowering and the yield potential of the crop was being set. Reducing the degree of interplant competition during this phase of growth may result in increased yields, but further work is required to verify this.

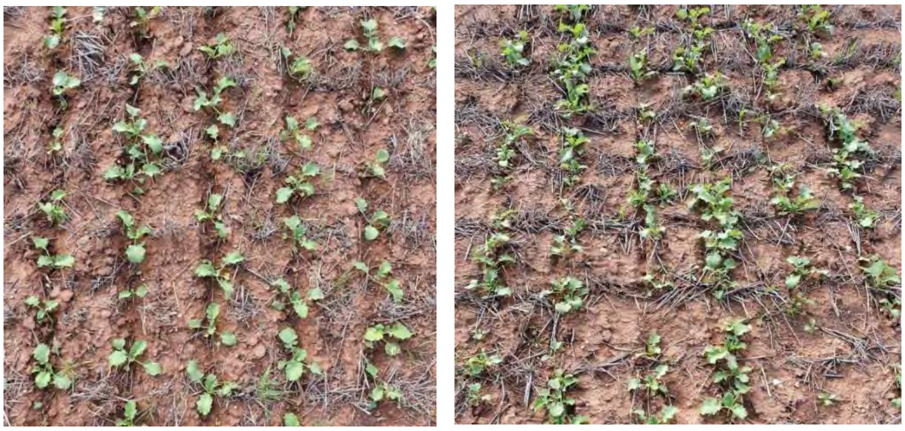


Figure 4. (L-R) Canola plot thinned to 30 plants/m^2 and canola sown with conventional disc seeder. (actual establishment of 30 plants/m^2) sown to target 45 plants/m^2 at Hart in 2021.

Currently, all commercial precision planters are disc seeders, however, having a tyned precision planter may be a more attractive option for many growers. A comparison of the tyned precision planter and the disc precision planter in 2021 found few differences between the two seeders. Plant establishment was higher with the tyned planter, but the uniformity of the plant stand was not improved when compared to the disc precision planter. Yields for the tyned seeder were not significantly different from those with the disc seeder.

Conclusions

Precision planting of canola did not consistently affect crop establishment relative to conventional seeding, but improved the uniformity of the crop stand. While there was considerable variation over the four years of the project, the project data suggested an average benefit in grain yield of 6 – 10% from precision planting over conventional seeding, although the benefits tended to be greater at low plant densities. Precision planting tended to maintain yields at low plant densities, which may allow a reduction in sowing rate and savings in seed inputs costs. This finding is consistent with reported grower experiences claiming significant canola seed cost savings achievable with precision planting.

The results from the perfect placement treatment also demonstrated that substantial improvements in grain yield are possible by maximising the uniformity of the crop stand under exact and consistent plant spacing. The project data indicate that the uniformity of inter-plant spacing of precision planters, while significantly better than that of conventional seeders, is still below the ideal perfect placement case and this is in part due to establishment being less than 100% even with precision planting, resulting in gaps along the row. While the results are encouraging, the economics of precision planting technology in canola cropping would need to integrate seed savings over sufficient area contracted per year and less reliance on grain yield responses alone.

Acknowledgements

The research undertaken was funded by the GRDC as part of the 'Optimising plant establishment, density and spacings to maximise crop yield and profit in the southern and western regions' project (9176134). Support from Muddy River Ag and Spot-on-Ag is gratefully acknowledged.

Establishing canola on marginal moisture

Genevieve Clarke[1] and Glenn McDonald[2]

[1]Birchip Cropping Group; [2]University of Adelaide

Key findings

- Marginal rainfall events result in false germination and patchy establishment.
- In marginal moisture conditions, it is better to sow shallow rather than deep.
- Hybrid varieties are less sensitive to sowing depth than open pollinated.
- Sowing too deep (> 30 mm) reduced yield.

Why do the trial?

Dry sowing is a common occurrence in Mallee and Wimmera cropping systems however, without a reliable forecast this can be a gamble for good establishment, particularly on a small seeded crop like canola. In 2021, the Mallee and Wimmera saw a lot of dry sowing and with little summer rain and unreliable forecasts, some growers made the decision to drop canola out of the rotation for the season. Where it remained in rotation, establishment quality around the region was varied.

A responsive trial was established at Watchupga to investigate the impacts of different factors on canola establishment under marginal moisture conditions.

The aim of this trial was to investigate the effect of variety selection, sowing rate and sowing depth on canola establishment in marginal soil moisture conditions in the Southern Mallee.

How was it done?

Location	Watchupga	**Fertiliser**	Granulock Z @ 60kg/ha at sowing (below seed), urea @ 100 kg/ha July 9 and urea @ 80 kg/ha August 11
Crop year rainfall (Nov-Oct)	234 mm		
GSR (Apr-Oct)	172 mm		
Soil type	Sandy clay	**Seed treatment**	Jockey® @ 2000 mL/100kg and imidacloprid @ 400 mL/100kg
Paddock history	Vetch hay		
Crop type	Canola		
Sowing date	April 19, 2021		
Harvest date	December 6, 2021		

A replicated field trial was established as a split plot design with sowing depth as the whole plot and variety and sowing rate as subplots. Four replicates were included. Assessments conducted were establishment counts, final establishment counts, seedling depth assessment, flowering biomass, grain yield and quality assessments.

Treatments and plant densities trialed are outlined in Table 1.

From November 2020 through to March 2021 the site received 44 mm of rain. There was very little stored moisture. In April, there was only one rainfall event of 1.2 mm received.

Table 1. Trial treatment outline.

Variety	Sowing depth target	Sowing rate (equivalent kg/ha rate ATR stingray/Hyola 350TT)
ATR Stingray (OP)	Shallow (~10 mm)	50 plants/m^2 (2.4 kg/5.1kg)
Hyola 350TT (hybrid)	Normal (~20 mm)	60 plants/m^2 (2.9 kg/6.1kg)
	Deep (~35 mm)	

Results and discussion

Seeding depth

Prior to sowing, three different seeding depths were set, targeting a shallow, normal and deep sowing for canola. Measurements were taken following emergence and found no statistical difference in the depth of shallow and normal seedlings however, deep sown treatments were significantly deeper (Table 2). While the measurements suggest limited differences between treatments, it is important to remember that measurements were taken on established seedlings and there may have been seeds at different depths (potentially very close to the surface) that did not establish.

Table 2. Average seedling depth (mm) achieved at different depth targets across the trial.

Sowing depth target	Established seedling depth (mm)
Shallow	21[a]
Normal	23[a]
Deep	35[b]
Sig. Diff.	**0.001**
LSD (P≤0.05)	**2.4**
CV%	**18.5**

Rainfall and establishment

Emergence did not begin to occur until a month following sowing, after the receival of a 4.6 mm rainfall event. Three previous rainfall events of 1 - 1.4 mm did not trigger germination. Not all treatments began to emerge at this time, however. The majority of plants emerging following this event were Hyola 350TT at the shallow and normal depth. Emergence rate data found that the hybrid was able to establish higher numbers at a faster rate on less rainfall and is less sensitive to sowing depth than the open pollinated, small seeded ATR Stingray (Figure 1).

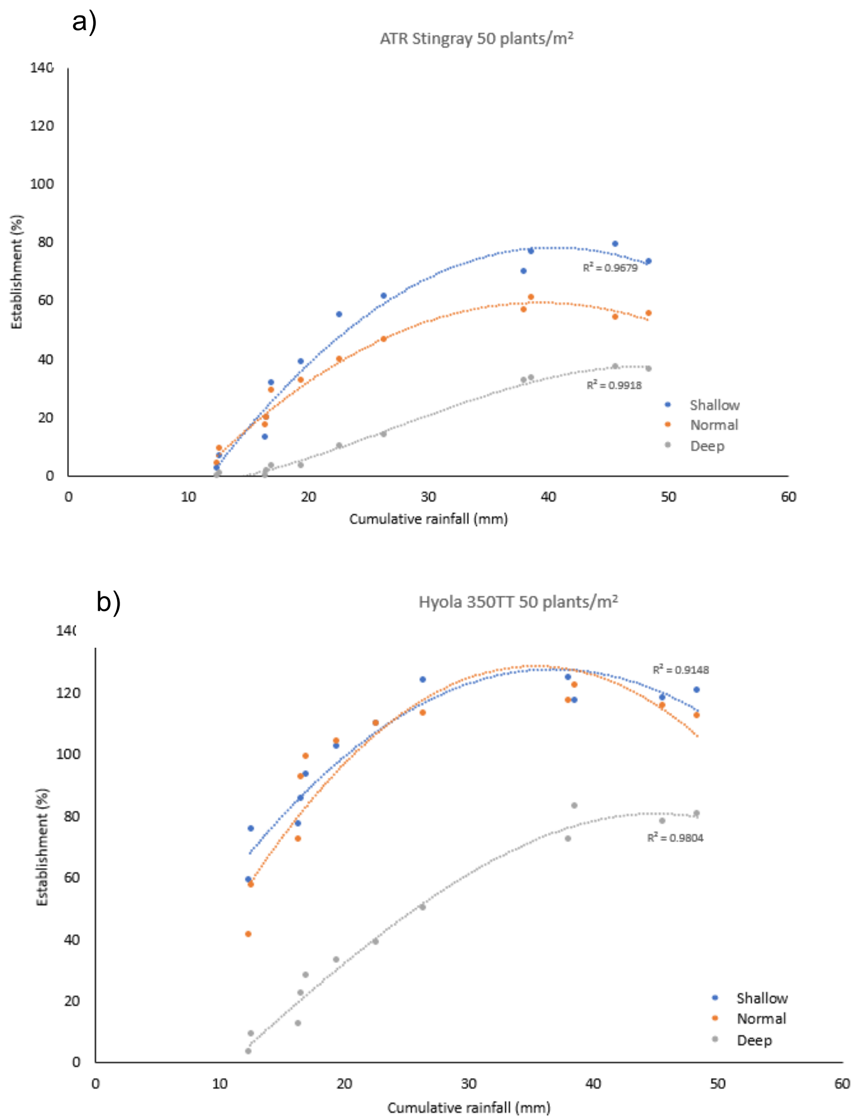


Figure 1. a) ATR Stingray establishment (%) at 50 plants/m^2 sowing rate and b) Hyola350TT establishment (%) at 50 plants/m^2 sowing rate, against cumulative rainfall (mm). Data collected between 29 and 79 days following sowing.

Final establishment was inconsistent and was not affected by sowing rate but was reduced by sowing deep (Figure 2). Hyola 350TT established more plants than ATR stingray however neither reached full targeted establishment (Table 3).

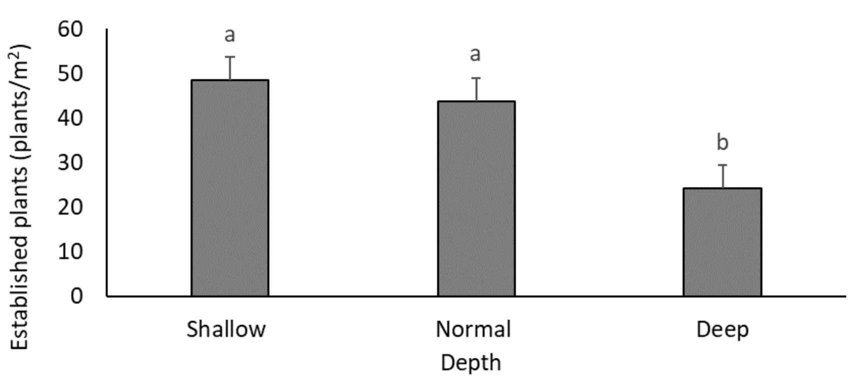


Figure 2. Average establishment (plants/m2) across sowing depths. P=0.001, LSD= 5 plants, CV= 25.2%

Table. 3 Average establishment (plants/m2 and %) of varieties.

Variety	Average established plants (plants/m^2)	Average establishment (%)
Hyola_350TT	46.4^{a}	85
ATR Stingray	31.5^{b}	58
CV%	25.02	
LSD (P≤0.05)	**5.8**	

Biomass

Hyola 350TT had higher biomass at flowering when compared to ATR Stingray with an average of 2.2 t/ha and 1.0 t/ha respectively (P=0.001).

In both varieties, biomass at flowering was reduced by placing seed too deep which was reflected in final yield (Figure 3).

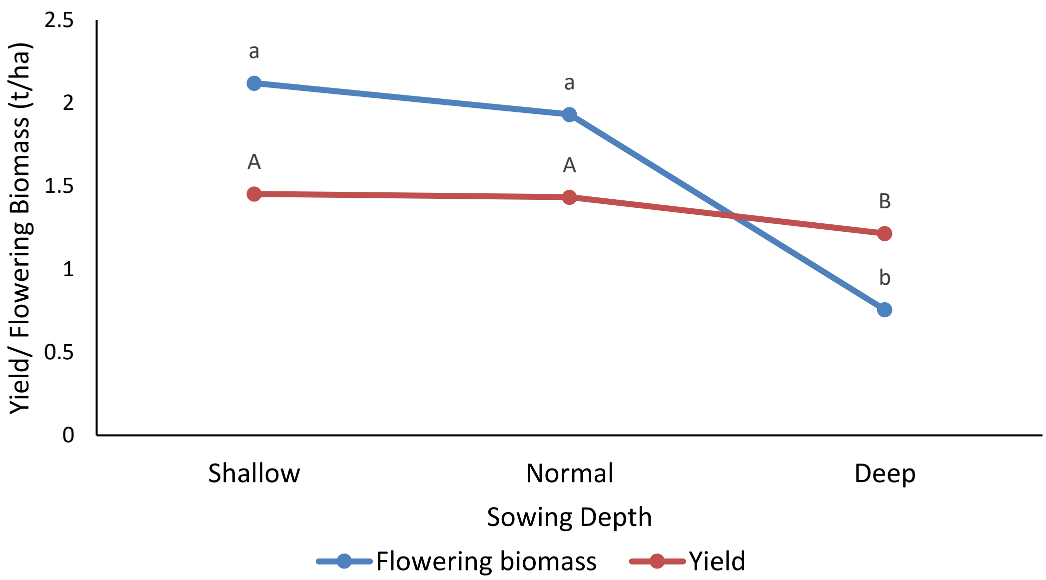


Figure 3. Average flowering biomass (t/ha) and yield (t/ha) for different sowing depths. Biomass: P=0.001, LSD = 0.47 t/ha, CV% 37.8 Yield: P=0.005, LSD = 0.12 t/ha, CV% 7.4.

Yield

Sowing depth and variety both had an impact on yield. There was an interaction between variety and sowing depth. Hyola 350TT yielded higher than ATR Stingray however at depth yields were lower for both varieties (Table 4).

Table 4. Average yield (t/ha) of varieties at different sowing depths.

Sowing depth	Variety yield (t/ha)	
	Hyola 350TT	ATR Stingray
Shallow	1.46^{ab}	1.45^{ab}
Normal	1.49^{a}	1.38^{bc}
Deep	1.32^{c}	1.11^{d}
LSD (P≤0.05)	**0.13**	
CV%	**7.3**	

A trend showing lower yield with deeper sowing was observed, however, when comparing the two varieties, Hyola 350TT yield was less sensitive to depth (Figure 4). The effect of sowing depth reflects the influence of depth on established plant numbers (Figure 5).

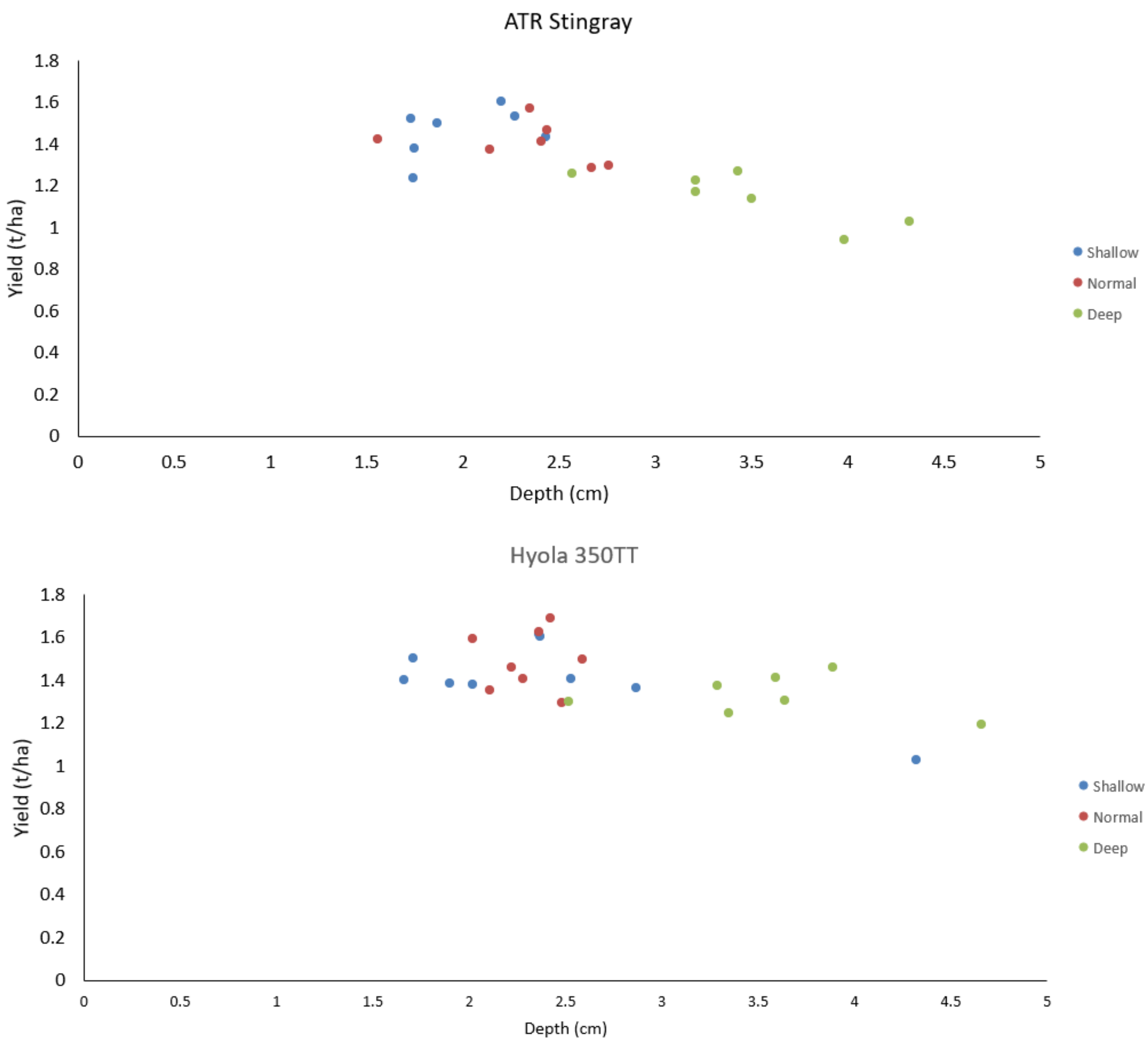
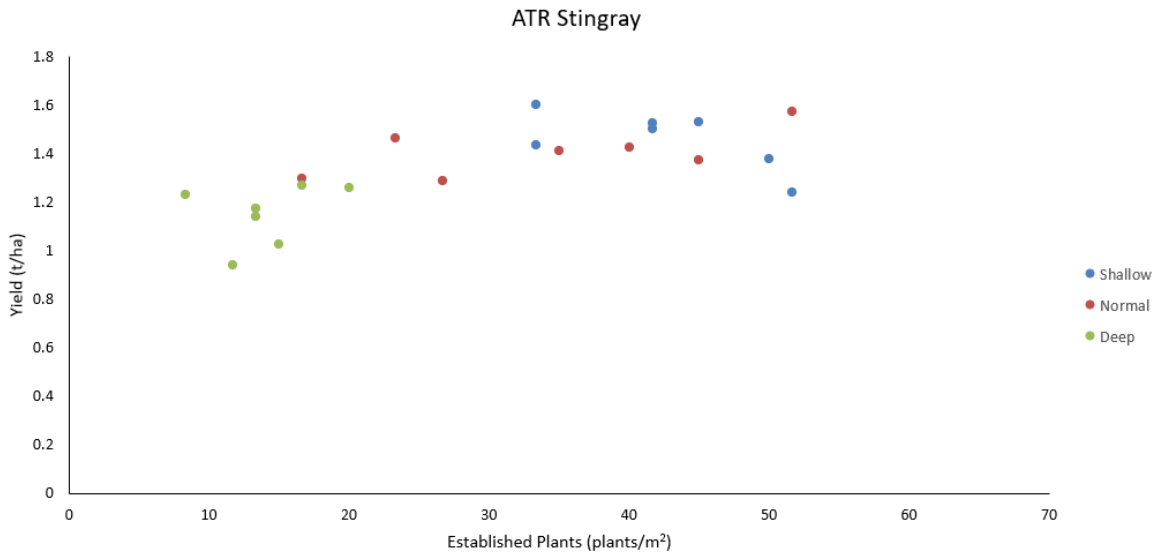


Figure 4. Yield (t/ha) for different seedling depths (cm) for ATR Stingray (top) and Hyola 350TT (bottom).

Table 5. Average yield (t/ha) of different sowing rates (plants/m^2).

Sowing rate (plants/m^2 target)	Yield (t/ha)
50	1.3^a
60	1.4^b
LSD (P≤0.05)	**0.06**
CV%	**7.4**



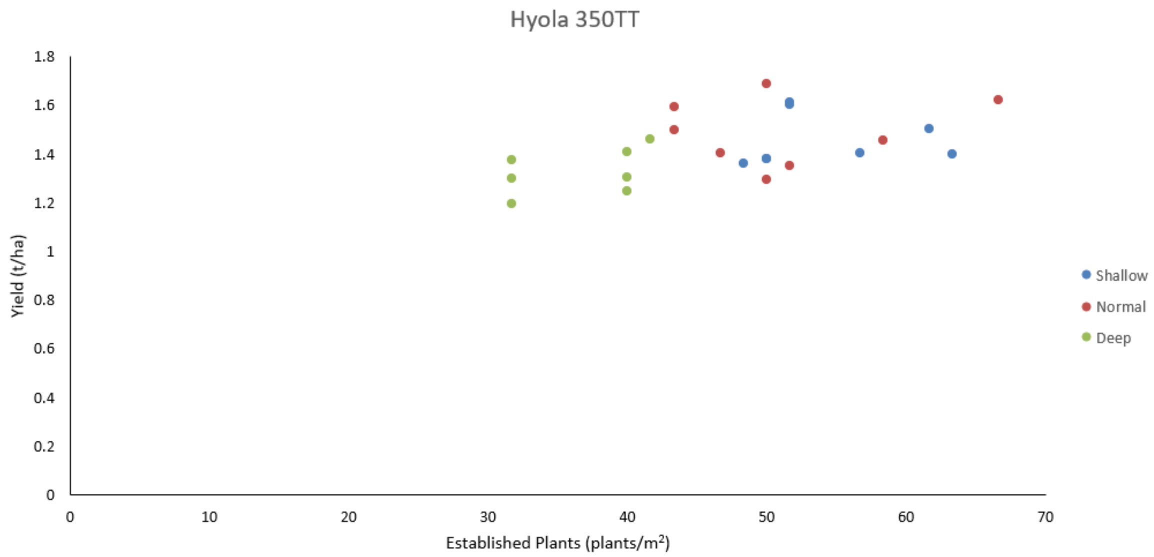


Figure 5. Yield (t/ha) for number of established plants (plants/m2) at different sowing depths for ATR Stingray (top) and Hyola 350TT (bottom).

Commercial practice and on-farm profitability

Canola can be successfully sown into dry soil and establish well. However, a few key factors need to come into play for this to occur. The soil must be dry enough to avoid premature germination and sufficient germinating rains; ~10 mm of cumulative rainfall within a week depending on soil type and variety must fall for even establishment to occur.

Research undertaken as part of the broader plant establishment project investigated how soil moisture can affect canola germination over time.

Seed germination and emergence is sensitive to the availability of soil moisture. At low soil moisture, germination rates decline and the time to establishment is delayed. An example is given in Figure 6 for a sandy loam soil. Seed of hybrid canola was sown at 15 mm depth in soil at different moisture contents. Emergence after three weeks fell from 100% in soil near field capacity (10 – 12% moisture content) to 20% in soil at 7% moisture content. There was no establishment in soil at 5% moisture content.

The effect of moisture content on final emergence in canola and wheat after three weeks is shown in Figure 7 and shows how quickly emergence can decline in dry soil.

In canola, emergence declined from approximately 100% to 70% by a 2% decline in the soil moisture and a further decline of 1 – 2% in soil moisture reduced emergence to approximately 30%.

Wheat showed a greater tolerance and its emergence did not start to decline until about 7%. Similar trends will be seen in other soils although the actual soil moisture values will be different depending on soil texture.

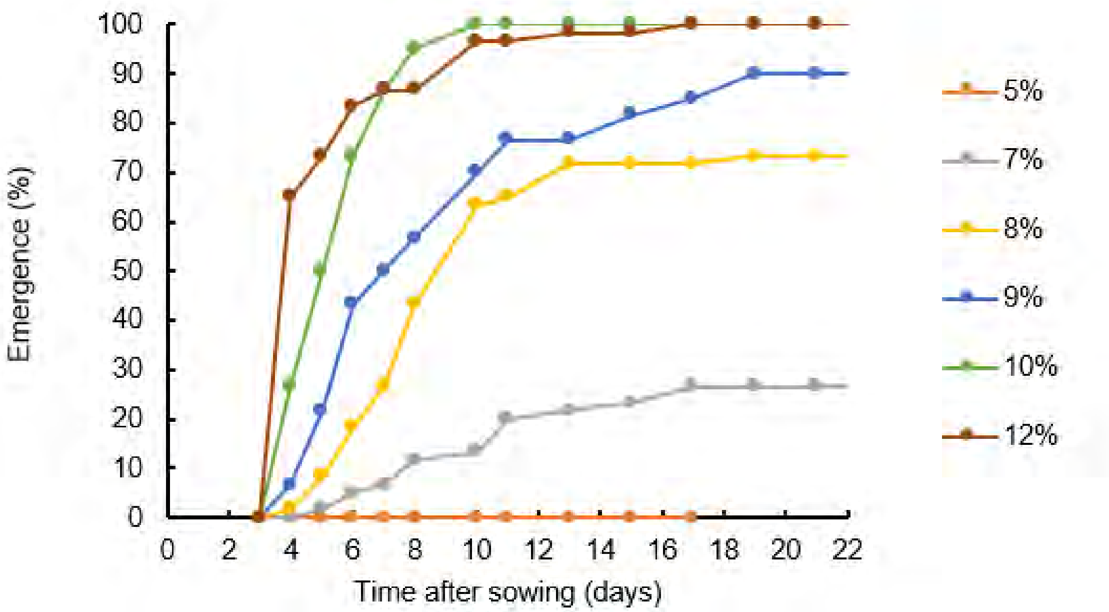


Figure 6. Changes in emergence time of canola sown into soil at moisture contents between 5% and 12%.

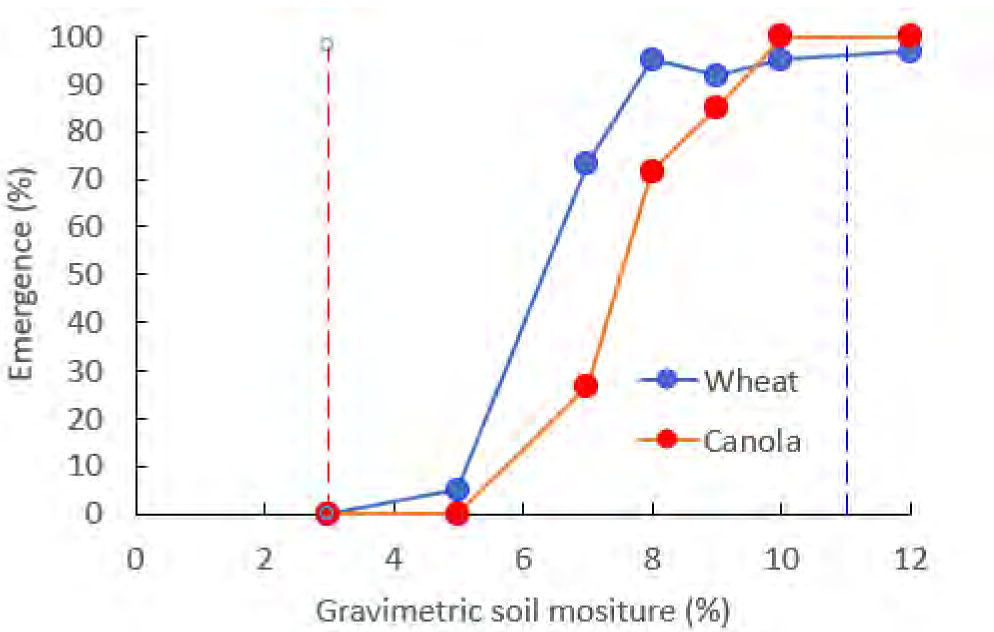


Figure 7. The effect of different soil moisture contents on the emergence of hybrid canola (●) and wheat (●). The vertical dotted lines represent the soil water content at field capacity (blue) and permanent wilting (red).

Patchy establishment was found across this trial with small rainfall events following sowing, resulting in established plant numbers significantly below targets, particularly deep sown ATR Stingray.

Variety selection, with factors such as large seed size and hybrid vigour contributed to faster and better plant establishment on small rainfall events. Selecting a hybrid variety over an open pollinated will provide a stronger choice for establishment due to the significantly greater early vigour of these varieties.

Canola has the ability to branch, compensating for low plant numbers to some degree. If a crop has achieved patchy establishment, it is important to assess established plant numbers and consider the potential of lower plant numbers compared to a better established but later sown crop. Research by BCG in the last few years as part of this project has shown that yield can be optimised in canola with plant numbers as low as 23 plants/m^2 (Clarke and McDonald 2020).

Traditionally, the recommended sowing depth for canola is between 1.5 cm and 3 cm however in some seasons seed can be placed deeper (5 cm) and successfully establish with access to moisture further down the soil profile (GRDC 2018).

Results from this research, and others consistently suggest that the risk of low emergence when sowing at a depth greater than 30 mm is high and targeting a depth < 30 mm is recommended (GRDC 2019). Unless you are sowing into moist soil, targeting a deep sowing depth with canola will result in no advantage. Targeting a shallower depth will take advantage of smaller rain events for germination and will be more successful across most seasons in the Mallee environment. Sowing deeper, particularly on heavier soils when dry, can bring up clods and reduced seed to soil contact required for good establishment. Soil type should be considered when selecting sowing depth.

Acknowledgements

This research was funded by the GRDC as part of the Optimising plant establishment, density and spacings to maximise crop yield and profit in the southern and western regions project (9176134) in collaboration with the University of Adelaide.

References

Clarke G, McDonald G, 2020, 2020 BCG Season Research Results, 'Sowing for Optimised Establishment' pp99-107. https://www.bcg.org.au/sowing-for-optimised-establishment/

Grains Research and Development Corporation (GRDC), 2018, GRDC Grownotes; Canola, 'Planting' pp 1-14. Available online at https://grdc.com.au/__data/assets/pdf_file/0028/369316/GrowNote-Canola-South-3-Planting.pdf

Grains Research and Development Corporation (GRDC), 2019, Maximising Crop Potential in a Drying Environment, Available online at https://grdc.com.au/__data/assets/pdf_file/0030/376761/Maximising-crop-potential-in-a-drying-environment-western.pdf

Hart 2021

Getting The Crop In seminar

Harvest

'Been Farming Long?' workshop; Balancing fertiliser rates and budgets

The Hart team

Notes