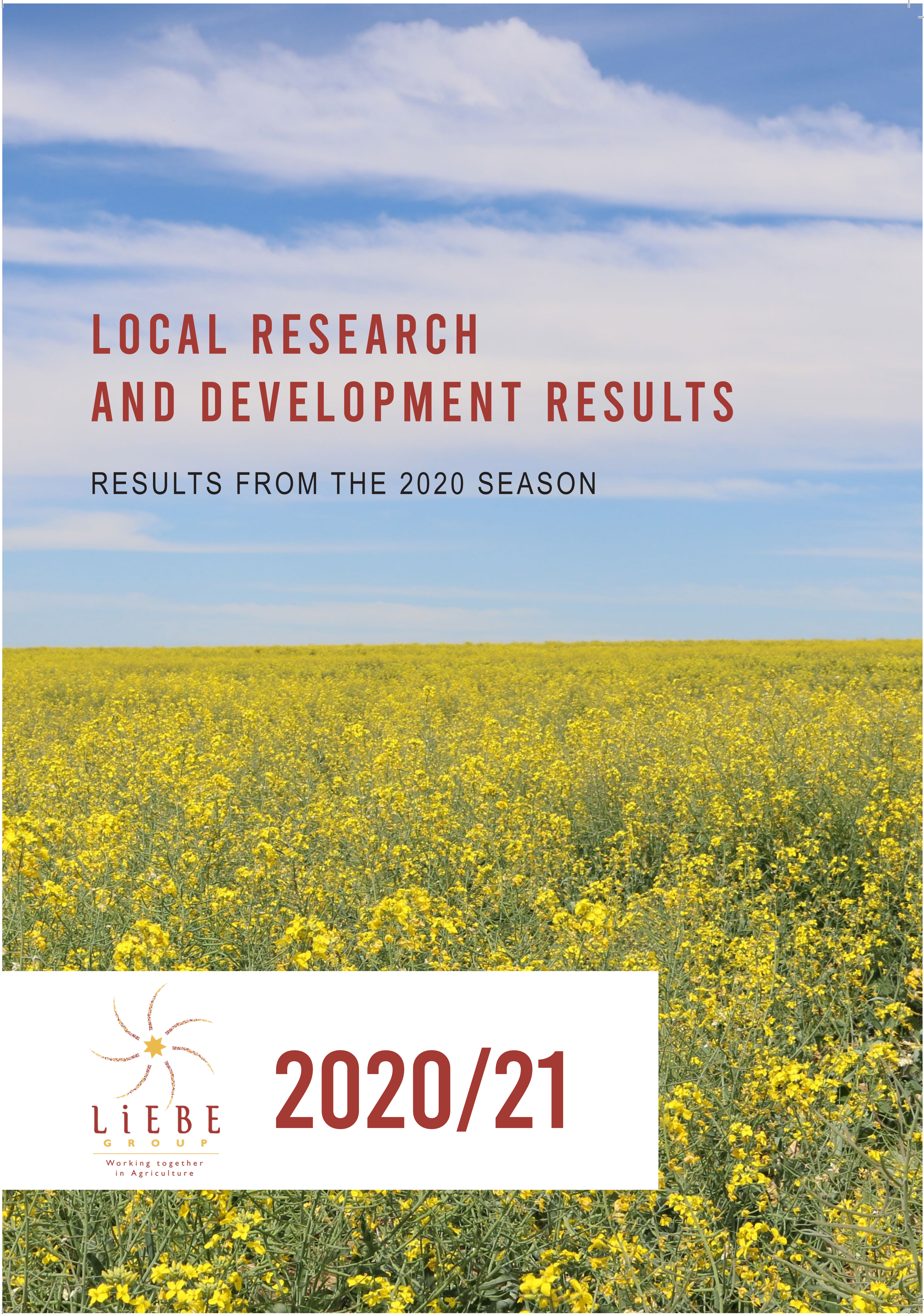

LOCAL RESEARCH AND DEVELOPMENT RESULTS

RESULTS FROM THE 2020 SEASON

LIEBE GROUP
Working together in Agriculture

2020/21

Dear Liebe Group Members and Supporters,

The Liebe Group team are proud to present the annual Local Research and Development Results Book for 2021. This publication contains the results from research trials and demonstrations conducted in the Liebe Group region from the 2020 season, as well as current projects across the district.

A year that will not be easily forgotten, 2020 delivered a variety of challenges for our farming community. From navigating the Covid-19 pandemic impacts on the delivery of regional events, research projects and overall community wellbeing, to managing disrupted market conditions and below-average seasonal rainfall, farming families and ag businesses have showcased resilience and strength.

I would like to sincerely thank the Liebe Group staff and committee members for their hard work and effort. It is with the contributions made by the team of dedicated staff and respected volunteers that keep this grower group pushing forward into the 24th year of research, development and extension activities.

Many thanks are also extended to Dylan and the Hirsch family for hosting the 2020 Main Trial Site and the Spring Field Day.

All partners and supporters play a vital role in ensuring the continued success of the Liebe Group. The Liebe Group acknowledges the invaluable support received from the Grains Research and Development Corporation (GRDC), the Department of Primary Industries and Regional Development (DPIRD), Farm Weekly, the Shire of Dalwallinu and the Grower Group Alliance. We would also like to thank our Diamond Partners Rabobank, RSM, CSBP and CBH Group, along with our valued gold and silver partners.

The Liebe Group team are anticipating a fantastic year ahead, with the Main Trial Site being hosted by Harry, Jane and son Matt Hyde's property in Dalwallinu.
Liebe Group's main events are scheduled for:

- Crop Updates and Trials Review Day on Wednesday 10th March
- Women's Field Day on Tuesday 15th June
- Post-Seeding Field Walk on Wednesday 21st July
- Spring Field Day on Thursday 9th September; and
- The monthly AgChats series, supported by Grain Growers

The majority of results presented in the book are from one season, and therefore should be interpreted with caution. Guidelines to understanding the results and statistics are included on page 15. Please contact the Liebe Group office if you have any further queries and we encourage you to get in touch with our research partners if you would like any further information on a given trial.

We wish you all the best for a successful 2021 season and look forward to working with you throughout the year.

Kind regards,

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LIEBE GROUP SPONSORS 2020

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The Liebe Group would like to recognise the support and contribution of the Liebe Group Committees throughout the 2020 season to the work outlined in this publication.

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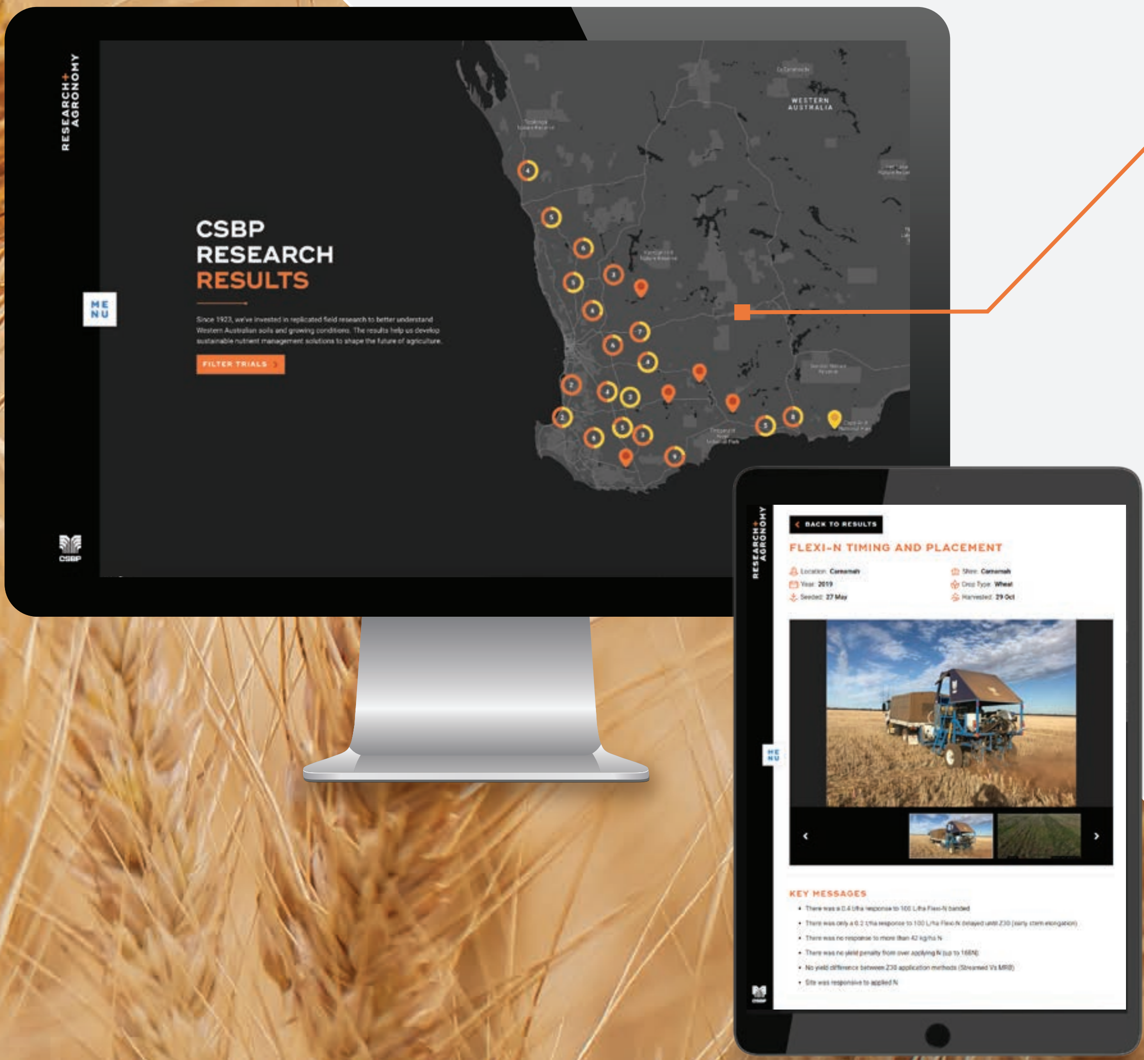

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UNDERSTANDING TRIAL RESULTS & STATISTICS

We have tried to present all trial results in one format throughout this results book. However, due to differences in trial designs, this isn't always possible. The following explanations and definitions should provide you with sufficient statistical understanding to get the most from the trial results.

Mean
The results of replicated trials are often presented as the average (or mean) of all replicates for each treatment. Statistics are used to determine if the difference between means is a result of treatment (e.g. different chemicals) or natural variability (e.g. soil type).

Significant Difference
In nearly all trial work there will be some difference between treatments, e.g. one rate of fertiliser will result in a higher yield than another. Statistics are used to determine if the difference is a result of treatment or some other factor (e.g. soil type). If there is a significant difference then there is a very strong chance the difference in yield is due to treatments, not some other factor. The level of significance can also play a role, this is denoted with a P value. If it says P<0.05% there is a greater than 95% probability that a difference is a result of treatment and not some other factor.

Standard Error
The standard error is a statistical term that measures the accuracy with which a sample distribution represents a population by using standard deviation. In statistics, a sample mean deviates from the actual mean of a population; this deviation is the standard error of the mean or the SE. The standard error tells us how confident we can be in the observed sample mean. A larger sample size usually results in a smaller standard error, and a more accurate sample mean.

The LSD Test
To determine if there is a significant difference between two or more treatments, a least significant difference (LSD) is often used. If there is a significant difference between two treatments, their difference will be greater than the LSD. For example when comparing the yield of five wheat varieties (Table 1), the difference in yield between variety 4 and 5 is greater than 0.6 t/ha (LSD), therefore it can be said there is a significant difference. This means its is 95% (P=0.05) certain that the difference in yield is a result of variety not soil type or some other factor. Whilst there is a difference in yield between variety 1 and 2, it is less than 0.6 t/ha, therefore the difference is unable to be determined as a result of variety; it may be due to subtle soil type change or other external factors.

Letters are often used to indicate which varieties are significantly different, using the LSD value (Table 1), so in this example, there is no significant different between varieties 1, 2 and 3, whereas varieties 4 and 5 are significantly different to each other and the rest of the varieties. Where the LSD result reads as 'NS' this represents that the values are not significantly different from each other.

Table 1: Yield of five wheat varieties

Treatment	Yield (t/ha)
Variety 1	2.1[a]
Variety 2	2.2[a]
Variety 3	2.0[a]
Variety 4	2.9[b]
Variety 5	1.3[c]
P value	<0.001
LSD (P=0.05)	0.6
CV (%)	9.4

The Coefficient of Variation (CV%)
The CV measures the amount of variation in the data. A low CV means less background noise or variations. Having less variation means there is more confidence in the trial results. Having high variation could mean that factors other than the one being tested are influencing the results (e.g. soil type), and if the same trial was recreated at your place, results may be different. Generally a CV of 5-10% (up to ~15%) is considered acceptable for wheat yields in field trials; some measurements would expect a higher CV, and some lower.

Non-replicated Demonstrations
This book presents the results from a range of non-replicated demonstrations. In this case we cannot say for certain if the difference in yield or quality is the result of treatment or some other factor e.g. soil type or old wheel tracks. Whilst the results from demonstrations are important, they need to be interpreted carefully as they are not statistical.

Nearest Neighbour Control
Some demonstrations will indicate a nearest neighbour control. In unreplicated research, often a control treatment will be included throughout the trial so a better decision can be made regarding treatment performance. This is helpful in situations where there may be a fertility gradient in the trial paddock hence it would be better to compare treatments against the nearest neighbour control rather than against other varieties. This would give a more accurate indication of treatment performance.

2020 Season Overview

Steve Sawyer, R&D Committee Chair

Welcome to the 2021 season! I hope that everyone will look back on 2020 as one we will never forget but also as a successful season despite all its challenges on numerous levels. I am debating with myself, that if I summed it up in one sentence, whether it would be “COVID-19” or "just one September rain please”.

When you take a moment to reflect on the last year you realise just how many challenges every business faced. Whether it was logistics of inputs, securing seasonal staff, or just the uncertainty of not knowing what was going to eventuate. It gives extra appreciation to how well Katrina, the Liebe Group staff and the Hirsch family have handled themselves in preparing and organising a successful Main Trial Site (MTS) full of interesting and relevant trials.

The group did impressively well in a year where it was a common story to have things cancelled or shelved for a year. We managed to have seven workshops, six AgChats, and a couple of Bitesize Learning sessions as well as a widely popular Post Seeding Field Walk in late July which was the first real community event since the end of March. Due to the large turnout, we decided to forgo our usual R&D meeting to allow everyone to network in an informal setting as a mental health initiative after what had been a tough few months for everybody. Earlier in the year, the Trials Review Day was a success with its annual sundowner, as was the cocktail night for the Liebe Annual Dinner held in October.

The annual Women’s Field Day, which has been very successful over previous years, was one event that did get cancelled but was substituted by a Ladies Landcare Luncheon later in the year.

Field walks were held for the legume demos and the Gen Y Paddock Challenge which was a great initiative that proved to be very successful. One of the Gen Y trials was also tied into our Main Trial Site.

The MTS was held on the Hirsch family property just west of Latham and was home to 20 trials. With another late start, the August rains really added a lot of potential to the season and the trials were looking good come Spring Field Day in September. Some of the popular trials on the day included FMC's Overwatch trial, Nutrien’s Canola Plant Density X Nitrogen trial, and there was a lot of interest surrounding the double break crops and pulses.

The marquee presentation by Neil Bennet from the Bureau of Meteorology on how weather cycles are predicted was well recieved before lunch. I would like to once again thank the Hirsch family, all our trial partners and sponsors that make our main calendar event so successful.

Looking forward, we received some great research ideas and feedback from our Spring Field Day R&D session which has assisted us in planning for the 2021 season where the Main Trial Site will be held at the Hyde family property just south of Dalwallinu. We have already laid down and planned a couple of trials including an IMI residue trial. Other interesting trial ideas include long coleoptile wheat, stripper front technology, and the potential to trial some new chemistry.

I would like to thank Katrina, Judy, Danielle, Sophie and Rebecca for their effort and contribution towards all the trials and events held last year, they have done an amazing job. I thank Chris O’Callaghan for his continued mentorship and support of the team. Many thanks to our sponsors, industry partners and researchers for their continued support for our trials, demonstrations, and events throughout a challenging 2020.

I look forward to seeing everyone back in 2021 and I hope some of the new faces from 2020 were impressed by what the Liebe Group has to offer and continue to be involved going forward as we have plenty of new ideas and trials lined up for what we hope is a successful and prosperous year ahead.

CEREAL RESEARCH RESULTS

Wheat National Variety Trial - Buntine

Anna Cornell, Graduate Research Scientist, Living Farm

Take Home Messages

- The top yielding varieties in this trial were Vixen, LRPB Havoc, Scepter, Sting and Devil (1.74 t/ha average for the top 5 varieties with 0.16 t/ha difference between the first & fifth variety).
- Season 2020 in this region had rainfall in May which provided moisture to sow into, an average winter followed by a dry spring.
- The dry finish favoured quicker maturity varieties.
- Grower decision on variety choice for 2021 should not purely be based on this data but include data from across the region and over a number of years.

Aim

The aim of the National Variety Trials (NVT) is to generate independent information for growers and industry about newly released varieties of field crops to the current commercial varieties grown in the area.

Background

The NVT program has been designed to identify the highest yielding varieties, free from the constraints of nutrition and disease. As a result, the nutrition and crop protection packages applied to NVT trials are typically higher than may be applied by the average grower. Management is the same for all plots with no differences in timing for crop protection or nutrition.

All trials have three replicates of each variety and all plots are sown (and subsequently harvested) on the same day. Timing of sowing is dependent upon the season, but is typically done within an average district “best practice” window and located on a typical soil type for the area.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	10m x 1.75m x 3 replications
Soil type	Sand
Paddock rotation	2017 Wheat, 2018 Wheat, 2019 Canola
Sowing date	27/05/2020
Sowing rate	Dependent upon grain weight for each variety
Fertiliser	27/05/20: Macro Pro extra 120 kg/ha, Uniform 0.3 L/ha (on the fertiliser) + Urea 50 kg/ha 10/07/20: Flexi-N 100 L/ha
Herbicides, Insecticides & Fungicides	27/5/20: Sakura 850 118 g/ha, Diuron 900 250 g/ha, Lontrel 750 80 g/ha, Treflan 2 L/ha, Avadex 1.5 L/ha, Chlorpyifos 500 1 L/ha, Bifenthrin 250 0.1 L/ha 10/06/20: Boxer Gold 2 L/ha + Velocity 0.8 L/ha 22/07/20: Prosaro 0.3 L/ha 28/08/20: FMC Trojan 2 mL/ha, BS1000 Bio-Degradable Surfactant 100 mL/100L
Growing season rainfall	143mm (May-Oct)

Soil Composition

Depth	Gravel %	Texture	NH_4 mg/kg	NO_3 mg/kg	P Colwell mg/kg	K Colwell mg/kg	Sulfur mg/kg	OC %	EC d S/m	pH ($CaCl_2$)	ESP %
0-10	0	1.0	2	8	21	96	3.8	0.59	0.028	5.6	0.73
10-30	5	1.5	<1	10			13.5		0.034	4.6	1.83

Treatments

1	BSWDH05-233	15	IGW6483	29	LPB17-6156	43	RockStar
2	Calingiri	16	IGW6496	30	LPB17-6157	44	Scepter
3	Catapult	17	IGW6563	31	LRPB Cobra	45	Sheriff CL Plus
4	Chief CL Plus	18	IGW6576	32	LRPB Havoc	46	Sting
5	Corack	19	IGW6636	33	LRPB Nyala	47	Supreme
6	Cutlass	20	IGW6637	34	LRPB Oryx	48	Tungsten
7	Denison	21	IGW7008	35	LRPB Trojan	49	Vixen
8	Devil	22	IGW8073	36	Mace	50	WAGT734
9	EDGE12W-011-04	23	IGW8139	37	Magenta	51	Wedin
10	EDGE19SA-1098	24	Kinsei	38	Ninja	52	Wyalkatchem
11	EDGE19WB-4112	25	LPB16-5783	39	OAGT0024	53	Yitpi
12	Emu Rock	26	LPB16-6150	40	RAC2721	54	Zen
13	Hammer CL Plus	27	LPB16-7401	41	RAC2736		
14	IGW4502	28	LPB17-6155	42	Razor CL Plus		

Results
MET Analysis of the 2020 data is not available at the time of publishing and will be available online at NVTonline.com.au from early February 2021.

Variety Descriptions
For variety descriptions and information on the best choice of variety to grow this season see the 2021 WA Crop Sowing Guide at https://grdc.com.au/2021-western-australian-crop-sowing-guide

Comments
The NVT wheat trial had an early advantage by being sown into moisture from the significant rainfall event on the 25th May, leading to even and vigorous emergence. The site then received reasonable rainfall in July and August. Unfortunately, the spring rainfall was well below average and the yield potential that had been set up from the good winter rainfall and high background nutrition did not materialise. The lack of rain during grain fill led to lower yields than expected and high screenings in some varieties. The dry finish tended to favour the quicker maturity varieties. There was also a hail event on the 5th of November in the area, but this had minimal damage to the trial.

For results of all NVT trials for 2020 please visit the National Variety Trials online www.nvtonline.com.au

Acknowledgements
Thanks to property owner, the Hirsch family for providing the site to the Liebe Group and Living Farm for the trial. Participating companies, GRDC and the NVT program coordinators.

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Note - This NVT was sown at the Liebe Group Latham Main Trial Site.

Barley National Variety Trial - Buntine

Anna Cornell, Graduate Research Scientist, Living Farm

Take Home Messages

- The top yielding varieties in this trial were Buff, Maximus CL, Fathom, Laperouse and Scope (1.45 t/ha average for the top 5 varieties) with 0.48 t/ha difference between the first & fifth varieties.
- Grower decision on variety choice for 2021 should not purely be based on this data but include data from across the region and over a number of years.

Aim

The aim of the National Variety Trials (NVT) is to generate independent information for growers and industry about newly released varieties of field crops to the current commercial varieties grown in the area.

Background

The NVT program has been designed to identify the highest yielding varieties, free from the constraints of nutrition and disease. As a result, the nutrition and crop protection packages applied to NVT trials are typically higher than may be applied by the average grower. Management is the same for all plots with no differences in timing for crop protection or nutrition.

All trials have three replicates of each variety and all plots are sown (and subsequently harvested) on the same day. Timing of sowing is dependent upon the season, but is typically done within an average district "best practice" window and located on a typical soil type for the area.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	10m x 1.75m x 3 replications
Soil type	Sand
Paddock rotation	2017 Wheat, 2018 Wheat, 2019 Canola
Sowing date	27/05/2020
Sowing rate	Dependent upon grain weight for each variety
Fertiliser	27/5/20: Macro Pro extra 120 kg/ha, Uniform 0.3 L/ha (on the fertilizer) + Urea 50 kg/ha 10/7/20: Flexi-N 100 L/ha
Herbicides, Insecticides & Fungicides	27/05/20: Diuron 900 250 g/ha, Lontrel 750 80 g/ha, Treflan 2 L/ha, Avadex 1.5 L/ha, Chlorpyifos 500 1 L/ha, Bifenthrin 250 0.1 L/ha 10/06/20: Boxer Gold 2 L/ha + Velocity 0.8 L/ha 22/07/20: Prosaro 0.3 L/ha 28/08/20: FMC Trojan 2 mL/ha, BS1000 Bio-Degradable Surfactant 100 mL/100 L
Growing season rainfall	143mm (May-Oct)

Treatments

1	AGTB0043	9	Beast	17	Flinders	25	Litmus
2	AGTB0188	10	Buff	18	IGB1825	26	Maximus CL
3	AGTB0197	11	Commanader	19	IGB1844	27	Mundah
4	AGTB0200	12	Compass	20	IGB1908	28	RGT Planet
5	AGTB0201	13	EDGE07-8120	21	IGB1967	29	Rosalind
6	AGTB0213	14	EDGE07-8424A	22	La Trobe	30	Scope
7	Alestar	15	EDGE17B-007-07	23	Laperouse	31	Spartacus CL
8	Bass	16	Fathom	24	Leabrook	32	Traveler

Results
MET Analysis of the 2020 data is not available at the time of publishing and will be available online at NVTonline.com.au from early February 2021.

Comments
The NVT barley trial had an early advantage by being sown into moisture from the significant rainfall event on the 25th May, leading to even and vigorous emergence. The site then received reasonable rainfall in July and August. Unfortunately, the spring rainfall was well below average and the yield potential that had been set up from the winter rainfall and high background nutrition did not materialise. The lack of rain during grain fill led to lower yields than expected and high screenings in some varieties. The dry finish tended to favour the quicker maturity varieties. There was also a hail event on the 5th of November in the area before harvest but this had minimal damage to the trial.

For results of all NVT trials for 2020 please visit the National Variety Trials online www.nvtonline.com.au

Acknowledgements
Thanks to property owner, the Hirsch family for providing the site to the Liebe Group and Living Farm for the trial. Participating companies, GRDC and the NVT program coordinators.

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Note - This NVT was sown at the Liebe Group Latham Main Trial Site.

CANOLA & PULSES RESEARCH RESULTS

Canola Early Glyphosate Tolerant National Variety Trial - Buntine

Anna Cornell, Graduate Research Scientist, Living Farm

Take Home Messages

- The top yielding varieties in this trial were Hyola 410XX, Hyola Garrison XC, Pioneer 44Y27 (RR), DG 408RR and Xseed Raptor (2.34 t/ha average for the top 5 varieties) with 0.21 t/ha difference between the first & fifth variety.
- Retained soil moisture from high rainfall events in February and May allowed canola crop to push through the drier winter and spring months. August also received good rainfall this year.
- Grower decision on variety choice for 2021 should not purely be based on this data but include data from across the region and over a number of years.

Aim

The aim of the National Variety Trials (NVT) is to generate independent information for growers and industry about newly released varieties of field crops to the current commercial varieties grown in the area.

Background

The NVT program has been designed to identify the highest yielding varieties, free from the constraints of nutrition and disease. As a result, the nutrition and crop protection packages applied to NVT trials are typically higher than may be applied by the average grower. Management is the same for all plots with no differences in timing for crop protection or nutrition.

All trials have 3 replicates of each variety and all plots are sown (and subsequently harvested) on the same day. Timing of sowing is dependent upon the season, but is typically done within an average district “best practice” window and located on a typical soil type for the area.

Trial Details

Trial location	Main Trial Site, Hirsch Property, Latham
Plot size & replication	10m x 1.75m x 3 replications
Soil type	Sand
Paddock rotation	2017 Fallow, 2018 Barley, 2019 Barley
Sowing date	20/04/2020
Sowing rate	Dependent upon grain weight for each variety
Fertiliser	27/05/20: Macro Pro extra 120 kg/ha, Urea 50 kg/ha 30/06/20: Sulphate of Ammonia 300 kg/ha 31/07/20: Flexi-N 70 L/ha
Herbicides, Insecticides & Fungicides	20/04/20 Roundup Ultra Max 1 L/ha, Propyzamide 1 L/ha, Lontrel 750 100 g/ha, Trifluralin 1.5 L/ha, Chlorpyifos 500 1 L/ha, Bifenthrin 100 0.1 L/ha 10/06/20 Clethodim 240 0.5 L/ha, Verdict 520 0.1 L/ha, Uptake 1 L/100L 02/07/20 Roundup Dry 1 kg/ha, Alpha-cypermethrin 100 0.2 L/ha, LI-700 1 L/100L 12/08/20 Transform WG 60 g/ha, Affirm 0.3 L/ha, Aviator Xpro 0.5 L/ha 07/10/20 Reglone 2 L/ha, BS1000 0.16 L/100L
Growing season rainfall	143mm (May-Oct)

Treatments

1	AA2465R	10	NCH18Q556
2	ADV-Robust	11	NCH18Q563
3	AN18Q4x1893RR2_O	12	NCH18Q567
4	DG 408RR	13	Pioneer 43Y29 RR
5	Hyola 410XX	14	Pioneer 44Y27 (RR)
6	Hyola Garrison XC	15	WW1751R
7	InVigor R 3520	16	WW1778R
8	InVigor R 4022P	17	Xseed Raptor
9	InVigor R 4520P		

Variety Descriptions

For variety descriptions and information on the best choice of variety to grow this season see the 2021 WA Crop Sowing Guide at https://grdc.com.au/2021-western-australian-crop-sowing-guide

Soil Composition

Depth	Gravel %	Texture	NH_4 mg/kg	NO_3 mg/kg	P Colwell mg/kg	K Colwell mg/kg	S mg/kg	OC %	EC d S/m	pH (CaCl2)	ESP %
0-10	0	1.0	2	9	27	32	13.0	0.43	0.041	5.5	1.53
10-30	5	1.5	< 1	4			6.1		0.023	5.3	1.73

Results

MET Analysis of the 2020 data is not available at the time of publishing and will be available online at NVTonline.com.au from early February 2021.

Comments

This NVT Early Glyphosate Tolerant Canola was dry sown on the 20th April, and germinated on a 6th May rainfall event with follow up rainfall on the 25th May. The site then received reasonable rainfall in July and August, and well below average spring rainfall. However, significant rainfall in February ensured there was enough soil moisture for the canola to push through these drier months and produce decent yields and high oil percentages. The trial was harvested on 21st October before the hail event on 5th November.

For results of all NVT trials for 2020 please visit the National Variety Trials online www.nvtonline.com.au

Acknowledgements

Thanks to property owner, the Hirsch family for providing the site to the Liebe Group and Living Farm for the trial. Participating companies, GRDC and the NVT program coordinators.

Peer review

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0400 123 596

Note - This NVT was sown at the Liebe Group Latham Main Trial Site.

Canola Early Triazine Tolerant National Variety Trial - Buntine

Anna Cornell, Graduate Research Scientist, Living Farm

Take Home Messages

- The top yielding varieties in this trial were HyTTec Trident, SF Dynatron TT, InVigor 4510, Hyola 350TT and SF Spark (2.29 t/ha average for the top 5 varieties) with 0.44 t/ha difference between the first & fifth variety.
- Retained soil moisture from high rainfall events in February and May allowed canola crop to push through the drier winter and spring months. August also received good rainfall this year.
- Grower decision on variety choice for 2021 should not purely be based on this data but include data from across the region and over a number of years.

Aim

The aim of the National Variety Trials (NVT) is to generate independent information for growers and industry about newly released varieties of field crops to the current commercial varieties grown in the area.

Background

The NVT program has been designed to identify the highest yielding varieties, free from the constraints of nutrition and disease. As a result, the nutrition and crop protection packages applied to NVT trials are typically higher than may be applied by the average grower. Management is the same for all plots with no differences in timing for crop protection or nutrition.

All trials have three replicates of each variety and all plots are sown (and subsequently harvested) on the same day. Timing of sowing is dependent upon the season, but is typically done within an average district "best practice" window and located on a typical soil type for the area.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	10m x 1.75m x 3 replications
Soil type	Sand
Paddock rotation	2017 Fallow, 2018 Barley, 2019 Barley
Sowing date	20/04/2020
Sowing rate	Dependent upon grain weight for each variety
Fertiliser	27/05/20: Macro Pro extra 120 kg/ha, Urea 50 kg/ha 30/06/20: Sulphate of Ammonia 300 kg/ha 31/07/20: Flexi-N 70 L/ha
Herbicides, Insecticides & Fungicides	20/04/20: Roundup Ultra Max 1 L/ha, Propyzamide 1 L/ha, Lontrel 750 100 g/ha, Trifluralin 1.5 L/ha, Chlorpyifos 500 1 L/ha, Bifenthrin 100 0.1 L/ha 10/06/20: Clethodim 240 0.5 L/ha, Verdict 520 0.1 L/ha, Uptake 1 L/100L 02/07/20: Atrazine 900 1.5 kg/ha, Alpha-cypermethrin 100 0.2 L/ha 12/08/20: Transform WG 60 g/ha, Affirm 0.3 L/ha, Aviator Xpro 0.5 L/ha 07/10/20: Reglone 2 L/ha, BS1000 0.16 L/100L
Growing season rainfall	143mm (May-Oct)

Treatments

1	ADV-Impressive	9	HyTTec Trident
2	AN18Q4x1893RR2_O	10	InVigor T 4510
3	AN20LT001	11	Monola H421TT
4	ATR Bonito	12	PHT-3860
5	DG1927TT	13	SF Dynatron TT
6	Hyola 350TT	14	SF Spark TT
7	Hyola Blazer TT	15	SFR65-028TT
8	Hyola Enforcer CT	16	SFR65-041TT

Variety Descriptions

For variety descriptions and information on the best choice of variety to grow this season see the 2021 WA Crop Sowing Guide at https://grdc.com.au/2021-western-australian-crop-sowing-guide

Soil Composition

Depth	Gravel %	Texture	NH_4 mg/kg	NO_3 mg/kg	P Colwell mg/kg	K Colwell mg/kg	S mg/kg	OC %	EC d S/m	pH (CaCl2)	ESP %
0-10	0	1.0	2	9	27	32	13.0	0.43	0.041	5.5	1.53
10-30	5	1.5	< 1	4			6.1		0.023	5.3	1.73

Results

MET Analysis of the 2020 data is not available at the time of publishing and will be available online at NVTonline.com.au from early February 2021.

Comments

This NVT Early Triazine Tolerant Canola was dry sown on the 20th April, and germinated on a 6th May rainfall event with follow up rainfall on the 25th May. The site then received reasonable rainfall in July and August, and well below average spring rainfall. However, significant rainfall in February ensured there was enough soil moisture for the canola to push through these drier months and produce decent yields and high oil percentages. The trial was harvested on 21st October before the hail event on 5th November.

For results of all NVT trials for 2020 please visit the National Variety Trials online www.nvtonline.com.au

Acknowledgements

Thanks to property owner, the Hirsch family for providing the site to the Liebe Group and Living Farm for the trial. Participating companies, GRDC and the NVT program coordinators.

Peer review

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Note - This NVT was sown at the Liebe Group Latham Main Trial Site.

National Vetch Breeding Trials - Latham, 2020

Stuart Nagel, Gregg Kirby and Angus Kennedy, National Vetch Breeding Program, SARDI

Take Home Messages

- Yields of both dry matter and grain were well below average due to low growing season rainfall, approx. 120mm.
- Initial emergence and growth showed good potential, however extremely low late winter-spring rainfall, receiving only 8.4mm after 18th Aug, prevented the trial reaching its potential.
- Common vetch can be grown successfully in the mid-west region of WA providing a legume option, particularly in mixed farming systems.

Aim

To demonstrate the potential opportunities for the use of vetches in Western Australian farming systems, particularly mixed farming enterprises looking for a short-term legume option that fits into their cropping rotation.

Background

The National Vetch Breeding Program has been looking for opportunities to demonstrate and test existing vetch varieties and potential new lines in diverse conditions including different soil types and environmental conditions. This includes areas outside of what has traditionally been seen as vetch growing areas, such as large regions of WA.

Traditionally vetch has been seen as a low rainfall (<375 mm/annum) legume best suited to Mallee environments with sandy, neutral to alkaline soils where other legumes struggle for consistency. Trials conducted in WA, SA and NSW at sites with lower (<5.0) pH soils have demonstrated that vetch can produce yields of at least 1.0 t/ha of grain and 3.0 t/ha dry matter in these soils, given adequate rainfall. It can also offer farmers in these areas all the benefits associated with a productive and reliable legume in their rotations.

WA farmers have identified opportunities for using vetch in their rotations in a number of ways. For example hay/fodder production, grazing, soil remediation and even grain. While providing these outputs vetch has the ability to offer substantial improvements in soil fertility (especially N input), soil structure and organic matter as well as offering a weed and disease break for cereals in a crop rotation.

The aim of this trial was to demonstrate the potential of vetch. The trial was inoculated with appropriate rhizobia (Group F E), a commercial inoculum. Research from Murdoch University and SARDI is looking to release new strains of rhizobia with improved tolerance to acid soils and better persistence in these hostile environments, these may improve nodulation in the future. No fertiliser was added as vetch can usually make the most of any residual nutrients left over from past cereal crops.

The intention with this regime is to demonstrate how the crop can grow with minimum inputs, as vetch is often used for hay, grazing or even brown manure, meaning growers may choose not to add extra inputs. If fertiliser is added, establishment and early growth can be improved, but there is no need for nitrogen to be added as, like all legumes, vetch fixes nitrogen in the soil when paired with the appropriate rhizobia.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	10m x 1.44m x 3 replications
Soil type	Reddish brown sandy loam
Paddock rotation	2017 Fallow, 2018 Barley, 2019 Barley
Sowing date	29/05/2020
Seeding rate	Approximately 40 kg/ha (60 plants/m²)
Fertiliser	No fertiliser was used
Innoculum	Alosca, F E @20 kg/ha
Herbicides, Insecticides & Fungicides	29/05/2020: Trifluralin 2.0 L/ha, Chlorpyrifos 500 ml/ha, Alpha-cypermethrin 400 ml/ha, Diuron 550 gm/ha, PSPE 07/07/2020: Metribuzin 150 gm/ha, Grass control As needed - Factor 180 gm/ha, Clethodim 500 ml/ha, Supercharge Elite 1% Chlorpyrifos 500 ml/ha, Alpha-cypermethrin 400 ml/ha

Soil Composition

Sample Depth		0-10	10-30
MIR - Aus Soil Texture		Sandy loam	Sandy loam
Gravel % Visual Assessment	%	50	5
Colour		Reddish brown	Reddish brown
Nitrate - N (2M KCl)	mg/kg	23	6.2
Ammonium - N (2M KCl)	mg/kg	1.6	1.1
Colwell Phosphorus	mg/kg	30	17
Colwell Potassium	mg/kg	150	55
KCl Sulfur (S)	mg/kg	12	24
Boron	mg/kg	0.61	0.57
Organic Carbon (W&B)	%	1.01	0.94
Exchangeable Al	mg/kg	<1.8	<1.8
Calcium (Ca) - AmmAc	mg/kg	914	443
Copper (Cu)	mg/kg	0.18	0.23
Zinc (Zn)	mg/kg	0.28	0.27
Manganese (Mn)	mg/kg	3	1.9
Magnesium (Mg) - AmmAc	mg/kg	52	41
Iron (Fe)	mg/kg	10	26
Salinity EC 1:5	dS/m	0.12	0.07
pH 1:5 water	pH units	7.15	5.7
pH CaCl2 (following 4A1)	pH units	6.61	4.94
Calcium (Ca) - AmmAc	cmol/kg	4.56	2.21
Magnesium (Mg) - AmmAc	cmol/kg	0.43	0.34
Potassium (K) - AmmAc	cmol/kg	0.393	0.146
Sodium (Na) - AmmAc	cmol/kg	0.063	0.059
Exchangeable aluminium	cmol/kg	<0.02	<0.02
Manganese (Mn)	cmol/kg	0.011	0.007
MIR - Sand (+20 micron)	%	86	80
MIR - Silt (2-20 micron)	%	5	6.9
MIR -– Clay	%	9.4	13
Organic matter	%	2	1.9
PBI + Col P		41	56

Results
The trial at Latham in 2020 emerged well and initially portrayed good development, however a lack of growing season rainfall effected plant development and growth. A total of 120mm growing season rainfall was recorded, with only 8.4mm recorded after the 18th August. This severely affected results of both dry matter/hay and grain.

The trial had a 1m^2 fodder cut on 9th September and plots were harvested for grain on 4th November. Analysis indicated no significant difference in both dry matter and grain production across the lines trialled. With a site mean for dry matter of 747 kg/ha and a grain yield mean of 150 kg/ha.

Comments
The results achieved were disappointing but reflective of the season at Latham. The trial was sown at an ideal time with moisture and emerged well. The lack of subsequent rainfall, particularly in the peak growing season in late winter and spring, slowed growth and impeded fodder production. Resulting in well below average yields of both dry matter and grain. The initial emergence and growth demonstrated vetches potential in the mid-west region, requiring further investigation.

Vetches have the ability and potential to fit into modern farming rotations in WA, particularly in mixed farming systems where farmers are looking for a versatile break option that still allows for strategic action against specific cropping problems. Unlike pulses and other break crops, the focus is not solely on grain production. Vetch can be used as a tool against herbicide resistant grass weeds, by spray topping or cutting before grass weed seeds set, and still produce a return with hay, grazing or grain and have an impact on subsequent cereals with increased levels of soil nitrogen.

The key to a successful crop and achieving the maximum benefits from vetch is to treat it as a crop, not as a set and forget break option. Inoculate with appropriate rhizobia, control weeds where possible and monitor for insects and disease. This can be difficult in a season like 2020, but it will still have provided the opportunity to deplete the grass weed seed bank.

Acknowledgements
The research undertaken as part of this project is only made possible by the significant contributions of growers, through trial cooperation, ongoing engagement and GRDC investment; the authors would like to thank them for their continued support. As well as the opportunity to conduct trials with research organisations and farmer groups like the Liebe Group.
GRDC Project Number: DAS1711-015RTX

Peer Review
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Evaluation of Spray Timing on the Control of *Ascochyta Rabiei* in Chickpeas

Stacey Power, Andrew Blake, Mark Seymour, Geoff Thomas & Salzar Rahman, Department of Primary Industries and Regional Development

Take Home Messages

- At Dalwallinu there was no yield response to foliar fungicide compared to seed dressing only.
- Yields increased by 500 kg/ha when Ascochyta was adequately supressed in Neelam at Mingenew.
- Management of Ascochyta remains critical to growing successful chickpea crops and application of an appropriate seed dressing is an essential first step.

Aim

These trials aim to evaluate the effectiveness of different fungicide timing options on the control of *Ascochyta Rabiei* in the moderately susceptible chickpea variety Neelam.

Background

Since the late 1990's, disease issues in chickpeas means growers remain cautious about this crop. Now varieties with better disease resistance along with new fungicide options are supporting a re-emergence of the chickpea industry. Growers and their advisors are seeking localised information about how to achieve stable yields whilst managing diseases.

Trial Details

Trial Location	Corner Courtlea Road & Great Northern Highway, Pithara
Soil type	Red clay loam
Sowing date	19/05/2020
Soil pH ($CaCl_2$)	0-10cm: 7.6, 10-20cm: 7.9
Sowing rate	Target density of 45 plants/m². 137 kg/ha Neelam + Group N ALOSCA 10 kg/ha
Fertiliser	19/05/20: 100 kg/ha superphosphate
Herbicides, Insecticides & Fungicides	19/05/20 - Pre-seeding: 2 L/ha Sprayseed® (135 g/L paraquat + 115 g/L diquat) + 1.5 L/ha Rustler®, (500 g/L propyzamide) + 1.2 L/ha Terbyne Xtreme® (875 g/kg terbuthylazine) 19/05/20 - Post-seeding: 200 mL/ha Chlorpyrifos 500EC® (500 g/L chlorpyrifos) + 200 mL/ha Alpha Scud® (100 g/L alpha-cypermethrin) + 100 g/ha Balance® (750 g/kg isoxaflutole) 15/07/20 - 500 mL/ha Select® (240 g/L clethodim) + 180 g/ha Factor® (250 g/kg butroxydim) + 1% Liberate® 07/08/20 - 200 mL/ha Alpha Scud® (100 g/L alpha-cypermethrin) 10/09/20 - 200 mL/ha Alpha Scud® (100 g/L alpha-cypermethrin)
Growing season rainfall	126mm (May - Oct) Pithara

Treatments

1	Fungicide seed dressing only
2	Fungicide seed dressing + 2 x programmed sprays (early spray at 5 weeks after seeding & podding spray at 16 weeks after seeding)
3	Fungicide seed dressing + 1 x programmed spray (podding spray at 16 weeks after seeding)
4	Fungicide seed dressing + 1 x spray after detection of disease spread (11 weeks after seeding)

All seed was treated with 200 mL/100kg seed of P-Pickle T® (360 g/L thiram + 200 g/L thiabendazole). Foliar fungicide treatments were 875 mL/ha Veritas® (200 g/L tebuconazole + 120 g/L azoxystrobin).

All plots were inoculated with infected chickpea stubble 38 days after seeding to ensure an even distribution of disease. Disease assessments were taken every three weeks.

Results

Table 1: Yield at Dalwallinu chickpea fungicide timing trial in 2020.

Fungicide treatment and timing	Yield (t/ha)
Fungicide seed dressing only	1.1
Fungicide seed dressing plus 2 x programmed sprays	1.1
Fungicide seed dressing plus 1 x programmed sprays	1.0
Fungicide seed dressing plus 1 spray after disease detection	1.1

Fungicide timing *P = not significant*

Table 2: Yield at Mingenew chickpea fungicide timing trial in 2020.

Fungicide treatment and timing	Yield (t/ha)
Fungicide seed dressing only	2.3
Fungicide seed dressing plus 2 x programmed sprays	2.8
Fungicide seed dressing plus 1 x programmed sprays	2.7
Fungicide seed dressing plus 1 spray after disease detection	2.3

Fungicide timing *P = 0.09, LSD = 0.34*

Comments

Chickpea Ascochyta can be introduced to a crop from both infected seed and stubble from previous year's crops and is then spread further within the crop by rain splash. At Dalwallinu in 2020 we saw no yield increase from application of foliar fungicide compared to a seed dressing only (Table 1), likely due to below average seasonal rainfall. Although there was not a yield response, when assessed on 14th September we did see significantly more plants infected with Ascochyta in seed dressing only plots. There was very little rainfall in the following six weeks after that assessment, meaning that although the disease was present it was unable to develop further and impact on final yield. Despite only 126mm of growing season rainfall in 2020, yields were still respectable, particularly at current prices around $540/t.

Even with these results, management of Ascochyta remains critical to growing successful chickpea crops. This was demonstrated by the 500 kg/ha yield benefit achieved with seed dressing plus two fungicide spray strategy in the same trial at Mingenew (Table 2). In 2020 Mingenew had lower than average rainfall (GSR 240mm compared to average 322mm), making it similar to an average year in the Dalwallinu area. A single fungicide applied at detection of the disease was ineffective at managing the disease in Mingenew. This suggests that the disease had already progressed by the time visual symptoms were evident. Though a single spray at disease detection didn't increase yield, a single spray at early podding did increase yield. Protecting the crop during podding safeguards the yield potential that has accrued in the vegetative stage of growth and may also result in cleaner seed which is beneficial if used as crop seed the following year.

The optimal spray strategy will vary between seasons and locations depending on many factors, however all crop seed should receive fungicide seed dressing as a critical first step towards Ascochyta management. Seed dressing alone without foliar fungicide did not hold the disease adequately at Mingenew in 2020. In wet situations that are conducive to disease development the application of seed dressing followed by two fungicide sprays remains ideal. Suppressing the development of Ascochyta with fungicide may also play a role in protecting varietal resistance that has been developed through crop breeding programs. Different strains of Ascochyta with varying virulence exist around Australia. Over-reliance on genetic resistance may accelerate the break-down of the limited varietal resistance to these strains.

Acknowledgements

These trials are part of the DPIRD/GRDC co-investment "High Value Pulses - Raising awareness, optimising yield and expanding the area of lentil, chickpea and faba bean in Western Australia". Thanks to the Wongan Hills TSU for trial management, Liebe Group for their support in providing trial sites, and Harry Hyde for hosting the trial.

Peer review

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GOVERNMENT OF WESTERN AUSTRALIA Department of Primary Industries and Regional Development

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

Pre-emergent Herbicide Options for Chickpeas

Stacey Power, Mark Seymour & Harmohinder Dhammu, Research Scientists, Department of Primary Industries and Regional Development

Take Home Messages

- A low-weed burden paddock and good pre-emergent weed control are very important when growing chickpeas.
- The pre-emergent herbicide options tested did not cause any crop damage or impact yield of PBA Striker or CBA Captain

Aim

To demonstrate pre-emergent herbicide options for chickpeas and tolerance of two varieties.

Background

Growers understand the positive impact that grain legumes can have on following cereal crops, as well being a cash crop in their own right. Of the available legume options, chickpeas are well suited to the Dalwallinu region and many growers are interested in trying them again after many years, or in some cases growing them for the first time. PBA Striker is one of the most commonly grown chickpea varieties in Western Australia, whilst CBA Captain (trialled as CICA1521) is a new variety that was released in October 2020. These two varieties were included in this trial as they have been the highest yielding in National Variety Trials in the Dalwallinu area over the last three years. Limited in-crop weed control options and lack of herbicide tolerant chickpea varieties mean that growers are cautious about the impact that introducing chickpeas in to their rotation can have on weed numbers. In order to support these growers, a range of the registered pre-emergent herbicide options for chickpeas, and the tolerance of two varieties that are suited to the Dalwallinu region are being demonstrated.

Trial Details

Trial location	Corner Courtlea Road & Great Northern Highway, Pithara
Plot size & replication	1.54m x 10m x 3 replications
Soil type	Red clay loam
Sowing date	19/05/2020
Soil pH ($CaCl_2$)	0-10cm: 7.6, 10-20cm: 7.9
Sowing rate	Target density of 45 plants per m^2. 122 kg/ha PBA Striker, 137 kg/ha CBA Captain
Fertiliser	At seeding: 100 kg/ha superphosphate
Herbicides, Insecticides & Fungicides	19/05/2020: 200 mL/ha (500 g/L chlorpyrifos) 15/07/2020: 500 mL/ha Select (240 g/L clethodim) + 180 g/ha Factor (250 g/kg butroxydim) 07/08/2020: 200mL/ha Alpha Scud (100 g/L alpha-cypermethrin) 10/09/2020: 1.5L/ha Bravo (720 g/L chlorothalonil) + 200mL/ha Alpha Scud (100 g/L alpha-cypermethrin)
Growing season rainfall	126mm

Treatments

	All treatments were applied immediately before seeding on 19/05/2020
1	1 kg/ha Palmero TX (750 g/kg terbuthylazine& 75 g/kg Isoxaflutole) + 1500 mL/ha Reflex (240 g/L fomasafen)
2	1 kg/ha Palmero TX (750 g/kg terbuthylazine& 75 g/kg Isoxaflutole) + 180 g/ha Terrain
3	1 kg/ha Palmero TX (750 g/kg terbuthylazine& 75 g/kg Isoxaflutole)
4	1500 mL/ha Reflex (240 g/L fomasafen)
5	835 g/ha Simazine (900 g/kg simazine) + 100 g/ha Balance (750 g/kg Isoxaflutole)
6	835 g/ha Simazine (900 g/kg simazine)
7	1.2 kg/ha Terbyne Xtreme (875 g/kg terbuthylazine) + 1500 mL/ha Reflex (240 g/L fomasafen)
8	1.2 kg/ha Terbyne Xtreme (875 g/kg terbuthylazine) + 180 g/ha Terrain (500 g/kg flumioxazin)
9	1.2 kg/ha Terbyne Xtreme (875 g/kg terbuthylazine)
10	Untreated control

N.B. Reflex is expected to be registered for use on chickpeas before the start of the 2021 season.

Results

None of the products that were tested in this trial had an impact on establishment of either PBA Striker or CBA Captain. Overall trial establishment of 47 plant/m^2 slightly exceeded the target of 45 plant/m^2

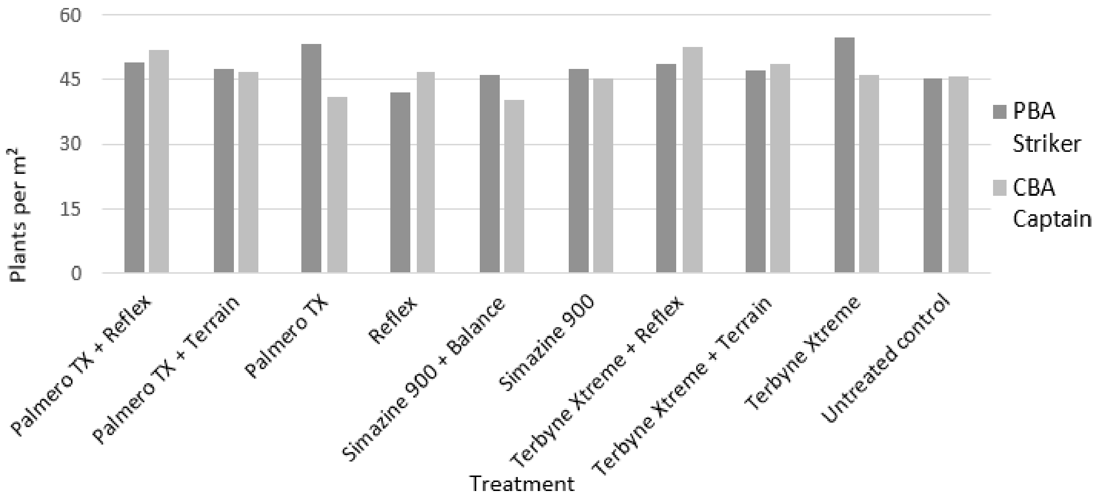

Figure 1: Plant establishment of two chickpea varieties after 10 different herbicide treatments at Dalwallinu in 2020. *Product P= not significant, Variety P= not significant, Product.Variety P= not significant.*

All treatments that were tested had less than 2 weeds per plot (plot size 15.4m^2), except the untreated control which had an average of 7 weeds per plot. The main weed species at the site was mustard.

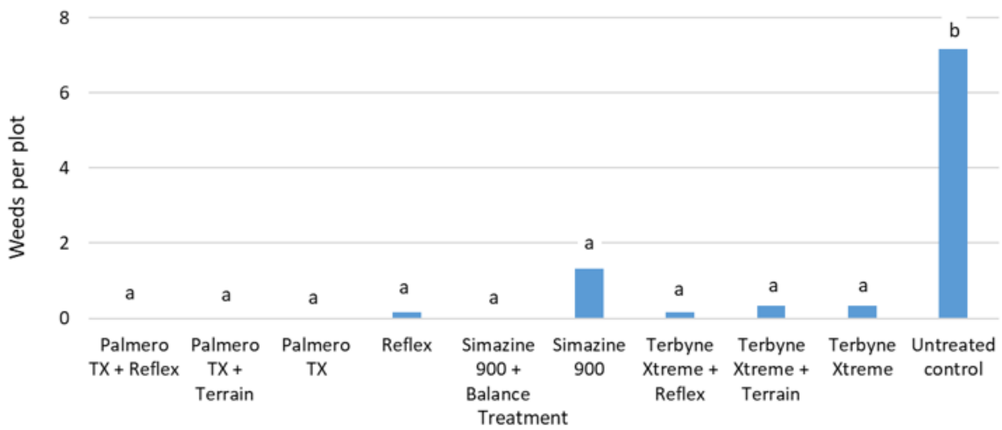

Figure 2: Weeds per plot on 27th July 2020 after 10 herbicide treatments. Sharing a common letter indicates that treatments are not significantly different.

None of the products tested in this trial had an impact on final grain yield. PBA Striker slightly out yielded CBA Captain by a very small amount (~50 kg/Ha).

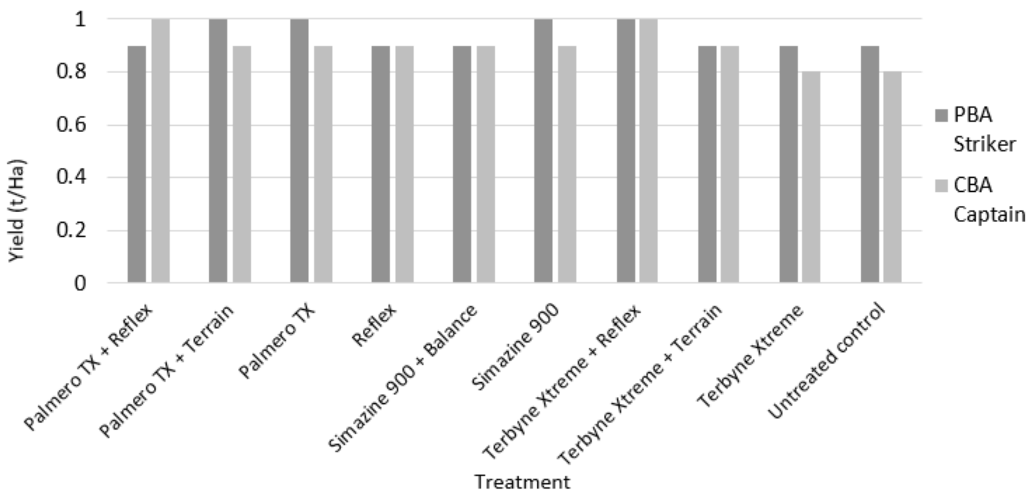

Figure 3: Grain yield (t/ha) of 2 chickpea varieties after 10 different herbicide treatments. *Product P=not significant, Variety P=0.009, Product.Variety P= not significant.*

Comments

There are many pre-emergent broadleaf herbicides registered for use on chickpeas. This trial demonstrated a range of those products from industry standard practice of Simazine 900 and Balance, through to newer products, such as Palmero TX and Reflex. All of the products included in this trial achieved very good weed control compared to the untreated control and none impacted on plant establishment, crop biomass or final yield. This demonstrates that, despite limitations in post-emergent herbicide options, good weed control can be achieved in chickpea crops when a low weed burden paddock is chosen and a robust pre-emergent herbicide regime employed.

Acknowledgements

This experiment was conducted as part of the DPIRD/GRDC co-investment “High Value Pulses - Raising awareness, optimising yield and expanding the area of lentil, chickpea and faba bean in Western Australia” (DAW1903-004RTX). Thanks to the Wongan Hills TSU for trial management, the Liebe Group for their continued support in providing trial sites, and for the Hyde family for hostin the trial. Salzar Rahman provided excellent technical assistance.

Peer review

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Increasing the Profitability of the Double Break Rotation in the MRZ of WA Wheatbelt through Incorporation of an Early Sown High Value Pulse

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages
- Grain yield was low across all high value legume treatments due to a combination of factors
- Attention to detail and good planning are essential to grow high value legumes in the region

Aim
1. Demonstrate that growing canola (with effective weed control options) followed by a high value legume (with higher economic value) can lead to an effective and profitable double break crop sequence. The contribution of an early sowing date versus a traditional sowing date to increase the profitability of these crops will also be evaluated.
2. Determine the economic value of growing canola followed by a high value legume, and the impact of this rotation on the grain yield and profitability of a cereal crop in the first year following the double break crop sequence.

Background
One of the constraints in the use of a single or double break crop sequence is that the gross margin of the most commonly used break crops are generally less than growing a cereal crop. As a result, break crops are used sparingly by growers in crop rotations with the aim of maintaining the most profitable sequence of crops while maintaining reasonable control of weeds and diseases. The short term decrease in economic return from growing a break crop is offset by the longer term benefits of decreased production costs and increase the productivity of cereal crops for many years following.

The most desired traits of a break crop are to be effective in controlling weeds and disease while also being profitable. Current highly effective break crop options of canola and lupin are rated as moderate to low profitability (respectively) by growers, while pasture phases or fallow period generally result in a low or negative gross margin. The integration of high value legumes such as chickpea or lentil have been successful in medium to low rainfall environments of Eastern Australia to improve crop rotation profitability while maintaining effective weed control.

Recent studies in WA found that profitable grain yields of both chickpea and lentil are achievable in the medium rainfall zone (MRZ) of the WA Wheatbelt. The impact of earlier sowing of these pulses has also been demonstrated to significantly increase the profitability of these high value legumes. The downside of high value legumes is that potentially these break crop options have less developed (and therefore less effective) weed management packages for the WA environment.

This project will deliver innovation to growers by demonstrating a double break crop sequence of canola followed by chickpea or lentil that increases both the effectiveness and profitability of break crop phases to increase the overall productivity and profitability of crop rotations in the MRZ of WA.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	200m x 18.3m x 1 replication
Soil type	Red Gravely Loam
Paddock rotation	2017 Wheat, 2018 Wheat, 2019 TruFlex Canola
Sowing date	Treatment 1 - 07/04/2020 Treatment 2 - 07/04/2020 Treatment 3 - 28/05/2020 Treatment 4 - 28/05/2020 Treatment 5 - 28/05/2020
Sowing rate	Treatment 1 - 60 kg/ha, Sceptre wheat Treatment 2 - 110 kg/ha, Twilight chickpeas Treatment 3 - 110 kg/ha, Twilight chickpeas Treatment 4 - 12 kg/ha, Volga vetch Treatment 5 - 40 kg/ha, Kelpie lentil
Fertiliser	07/04/2020: 40 Kg/ha MAP
Herbicides, Insecticides & Fungicides	Treatment 1: 07/04/2020: 500 g/ha Propyzamide Treatments 2 - 5: 07/04/2020: 500 g/ha Propyzamide, 800 ml/ha Trifluralin, 250 ml/ha Chlorpyrifos, 23/07/2020: 250 g/ha Factor, 240 g/ha Clethodim
Growing season rainfall	149mm

Treatments

	Treatment
1	Control, wheat sown using growers best practice
2	Early sown Chickpeas
3	Late sown Chickpeas
4	Late sown Vetch
5	Late sown Lentils

Soil Composition

Depth (cm)	pH($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	6.0	25	222	35.2	5	5	0.140	1.08
10-20	5.5	9	130	30.5	2	2	0.150	0.81
20-30	5.4	6	136	25.1	2	1	0.084	0.56

Results

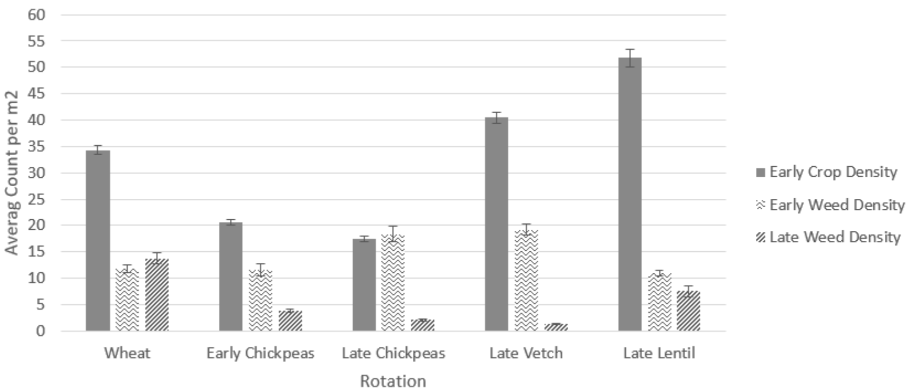

Figure 1: Average early (17/06/2020 or 23/06/2020) and late (19/08/2020) crop and weed density (per m²) in various rotation options in the double break trial at Latham 2020. Error bars are ± 1 S.E.

Early sown treatments (Figure 1) were counted on the 17/06/2020, and late treatments were counted on the 23/06/2020 with the aim of comparing them while they were at comparative growth stage. Secondary weed counts were then taken across the site on the 19/08/2020.

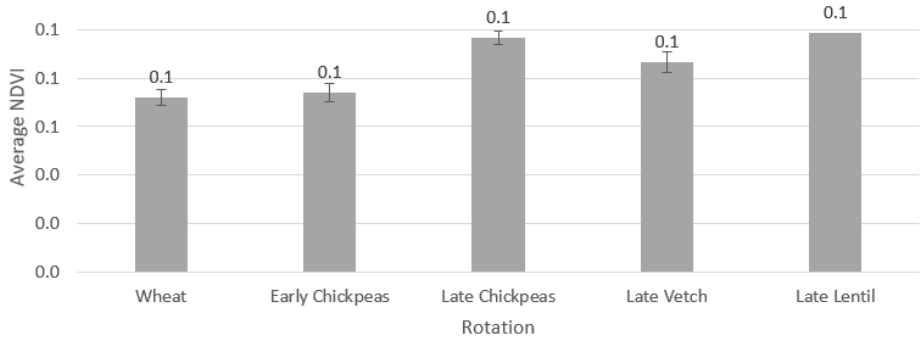

Figure 2: Average early (17/06/2020 or 23/06/2020) and late (19/08/2020) Average Normalized Difference Vegetation Index (NDVI) reading in various rotation options in the double break trial at Latham 2020. Error bars are ± 1 S.E.

The NDVI readings were taken at two different times, with the aim of measuring them at comparable growth stages. Early sown treatments (Figure 2) were measured on the 17/06/2020, and late treatments were measured on the 23/06/2020.

Comments

Both chickpeas were at the third node stage when early establishment counts occurred. Optimal plant density for Desi Chickpeas is considered 40-50 plants per square meter, but counts are well below that in both plots (14-22 plants/m^2) (Figure 1). The wheat was closer to the targeted plant population (50 plants/m^2) however also did not meet expectations. The vetch and lentils had a target density of 40-60 plants/m^2, but actual plant densities where just below at 34-56 plants/m^2. It is thought that wind damage from a major wind erosion event post seeding in early June and the subsequent row fill may be contributing factors, and that some seeding rates may not have been ideal leading to the lower than targeted plant densities across the trial.

Weed control was adequate across the site at the initial early observation, with weed numbers between 7 and 24 weeds/m^2 (Figure 1). There was some variation in number across the site and the weeds present predominantly comprised of rye grass and self-sown canola. Weed numbers had decreased in all legume rotations by the second, late, observation however weed numbers remained consistent in the wheat rotation.

Disease pressure was low at the site and no significant disease was recorded. Nodulation was not successful at the site, with all legume plots averaging a nodulation score below two. This may have significantly influenced the performance of the legumes overall, and will inhibit their value to the following years crop. Issues with inoculant delivery and soil pH have been highlighted as the cause of the lack of nodulation at the site.

Yield data has not been presented, as there was not significant grain mass to harvest in any of the legume treatments. Yields were initially expected to be low (less than 300 kg/ha) due to poor rainfall patterns in the area. The site was effected by a hail event on the 05/11/2020, which is estimated to have caused yield losses of between 80 and 100 percent. When harvest was attempted on the 18/12/2020, averages were below 10 kg/ha, which could not be accurately measured at that density, and were not representative of the trial performance.

Overall, the performance of all legumes onto the canola stubble was poor. They were not suited well enough to the seasonal conditions or paaddock to be able to present a potentially profitable crop this year. The Liebe Group will repeat the trial in 2021 with amendments to the site chosen and the methodology. The aim is to determine if any of the legume rotation options presented could potentially be profitable at a more suitable site.

Acknowledgements

This is a GRDC funded project, code WMG2003-001SAX, led by the West Midlands Group, and managed by the Liebe Group. Thanks to the Hirsch family for their assistance, hosting, implementing and managing the trial.

Peer review

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Very Early Sowing of Canola – Wongan Hills

Stacey Power, Jackie Bucat, Andrew Blake, Imma Farre and Martin Harries, Department of Primary Industries and Regional Development

Take Home Messages
- Acceptable plant density is difficult to achieve when sowing prior to April.
- Sowing in early-mid April is likely to be a sound package, with good establishment and yields, if there is a sowing opportunity at that time.
- It is unlikely that yields are penalised with very early sowing, provided there is enough follow-up rain. Awaiting 2020 yield data to confirm this.

Aim
To investigate how early farmers can plant a profitable canola crop, with very early sowing opportunities from mid-March onwards.

Background
There is considerable interest in sowing canola early to maximise yield and minimise the risk of missing a sowing opportunity. Traditionally ANZAC day (25th April) marked the date on which growers would start dry seeding, however growers are now routinely sowing in mid-April and are prepared to sow around the first week of April if there is rain at that time.

It seems logical that long season varieties are likely to be more profitable at early sowing and short season varieties at later sowing times, however there is little data to support this claim. This work aims to investigate whether canola sown from mid-March onwards can be profitable and if long season varieties are more suited to this early sowing time.

Trial Details

Trial location	Wongan Hills Research Station, Wongan Hills
Plot size & replication	10m x 2m x 4 replications
Soil type	Sandy loam duplex
Paddock rotation	2019 Lupins
Sowing rate	Differs by variety. Target plant density of 40 plants/m^2
Fertiliser	At sowing: 100 kg/ha Agstar Extra + 50 kg/ha urea. 4 weeks after sowing (WAS): 75 L/ha UAN 8 WAS: 75 L/ha UAN
Herbicides, Insecticides & Fungicides	All TOS: Pre seeding: 2 L/ha Sprayseed (135 g/L paraquat + 115 g/L diquat) + 1.5 L/ha Trifluralin (480 g/L trifluralin) + 1.1 kg/ha Atrazine (900 g/kg atrazine) All TOS: Post seeding pre-emergent: 200 mL/ha chlorpyrifos (500 g/L chlorpyrifos) + 200 mL/ha Alpha Scud (alpha-cypermethrin) All TOS: 6WAS: 1.1 kg/ha Atrazine (900 g/kg atrazine) + 1% MSO All TOS: 5-7WAS: 400 mL/ha Alpha Scud (alpha-cypermethrin) TOS 1 & 2: 11/5: 450 mL/ha Prosaro (210 g/L prothioconazole) All TOS: 24/6: 450 mL/ha Prosaro (210 g/L prothioconazole) All TOS: 25/9: 300 mL/ha Affirm (17 g/L emamectin) + 1% wetter TOS 1 & 2: 23/10: 3 L/ha Reglone (200 g/L diquat)
Growing season rainfall	209mm

Soil Composition

Depth	NH_4 mg/kg	NO_3 mg/kg	P Colwell mg/kg	K Colwell mg/kg	S mg/kg	OC %	pH ($CaCl_2$)	PBI
0-10	1	30	24	82	8.8	0.79	5.7	14.0
10-20	<1	10	23	68	5.4	0.32	4.7	10.4
20-30	1	7	21	69	8.4	0.24	4.3	25.0

Treatments

	Time of sowing (TOS)
1	17 March
2	7 April
3	28 April
4	26 May

	Variety	Maturity type
1	Hyola350TT	Early
2	ATR Bonito	Early-mid
3	InVigorT4510	Early-mid
4	SF Ignite	Mid
5	ATR Wahoo	Mid-late

Method

Times of sowing 1, 2 and 3 had 40mm applied via overhead irrigation in the week prior to seeding. This aimed to replicate the soil moisture that occurs in the wettest 25% of years at this site. TOS2 also received post-sowing irrigation via soaker hose, due to air temperature exceeding 35° for several days after seeding. TOS4 did not have any pre or post-sowing irrigation applied as it was sown with the season break.

TOS1, 2 and 3 were covered with netting from the first appearance of flowers until the day of harvest to protect flowers from bird damage. Flowering assessments were completed weekly on each plot from first flower until all flowers had fallen. Crop maturity, yield, and seed quality were also collected, however data is not yet available to be published.

Season rainfall data can be found in the rainfall tables at the back of the book.

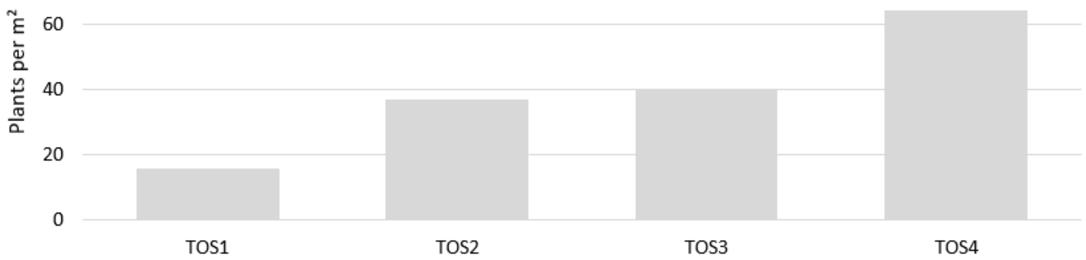

Figure 1: Plant establishment at Wongan Hills in 2020. Sowing rate for each variety was adjusted for seed size and germination to target establishment of 40 plants/m^2. Crop establishment counts were done three weeks after sowing.

Results

In this trial, variety did not significantly impact on plant establishment (*P=not significant*), but TOS did (*P=0.002*). Across all varieties, TOS1 had much poorer plant establishment, despite receiving the same amount of pre-sowing irrigation and rain as other TOS. A similar result was seen at Wongan Hills in 2019 and other sites in both 2019 and 2020. This is possibly due to higher soil temperatures with mid-March sowing.

When farmers plan to sow a canola crop in March, they may need to increase their seeding rate to achieve acceptable plant density. Early April sowing appears to be the earliest that growers can have confidence in achieving good crop density at standard sowing rates.

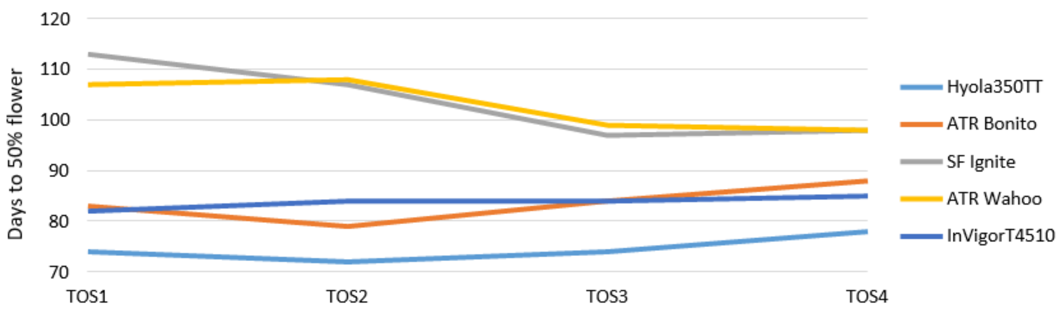

Figure 2: Days to peak flower for each variety and TOS. TOS *P=0.047*, Variety *P=<0.001*, TOS.Variety *P=<0.001*.

The varieties in this trial reached 50% flower in three groupings (Figure 2), with the early maturity Hyola350TT reaching 50% flower first, followed by the early-mid maturity ATR Bonito and InVigorT4510, then mid maturity SF Ignite and mid-late maturity ATR Wahoo last. These groupings were expected, as they follow the maturity types of the varieties trialled.

Late maturing varieties flowered more quickly when sown later, showing a vernalisation response. When sown early, they took much longer to reach their required cold accumulation and therefore remained in the vegetative stage longer. This vernalisation is met more quickly with later sowing into cooler conditions and flowering begins more quickly.

Early maturing varieties do not have a vernalisation requirement and simply respond to temperature. They are quicker to flower with earlier sowing due to warmer temperatures allowing them to accumulate thermal time more quickly. As conditions are cooler with later sowing, this accumulation and development slows down.

There was more variation in the time to the peak flowering for the mid and mid-late maturing varieties, compared with the early and early-mid varieties. For example, ATR Wahoo had a decrease of 15 days from TOS1 to TOS4, whilst there was less than a week difference in the time to 50% flower over all TOS for InVigorT4510.

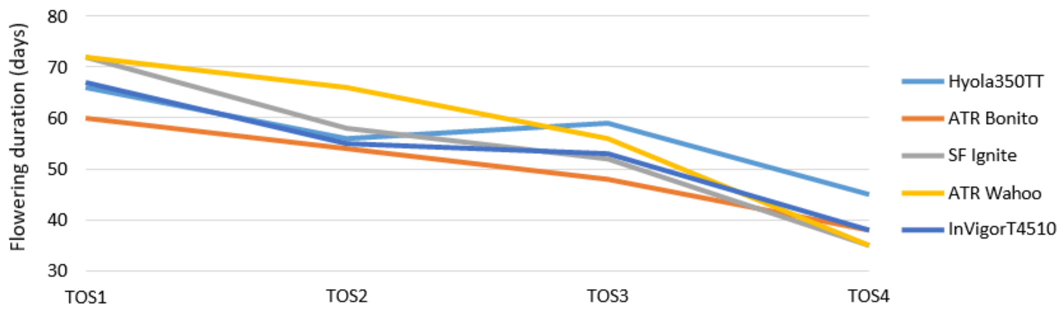

Figure 3: Flowering duration of each variety and TOS. TOS *P=<0.001,* Variety *P=<0.001,* TOS.Variety *P=<0.001*.

The duration of flowering decreased with later sowing. (Figure 3). Varieties with maturity at either extreme (Hyola350TT and ATR Wahoo) responded the most strongly to delaying sowing date. ATR Wahoo had the longest flowering duration of all varieties at mid-March sowing (72 days) and the shortest at late May sowing (35 days). Hyola350TT had a longer flowering duration than all other varieties when sown in late April or late May (59 and 45 days). It started flowering 7-10 days before the next variety, but held on and had a slow flower decline.

With early April sowing, Hyola350TT flowered from mid-June to early August and peaked around early July. Comparatively, when sown at the same time ATR Wahoo and SF Ignite flowered from mid-July to mid-September, with a peak at mid-August. A similar trend in the flowering response of different maturity types to TOS was seen in 2019, with a more consistent days to peak flower and more consistent flowering duration for early-mid and mid maturity types across sowing dates, however at earlier sowing the flowering of these varieties peaked too soon in the season when the temperature is still too cold.

Therefore, farmers growing early and early-mid maturing varieties would be better able to predict when their peak flower will occur and how long flowering will last based on whenever their sowing opportunity occurred, but if that opportunity did occur in early April, a longer maturity type should flower closer to the ideal flowering window than early and mid-maturity types.

Comments

Plant establishment in this trial was well below target at TOS1, however without yield data we cannot say whether plants have been able to compensate for the lower density. We can say from both 2019 and 2020 data that the first week of April appears to be the earliest that growers can have confidence in achieving good crop density at standard sowing rates.

The flowering data collected in this trial suggests that variety choice and maturity will be more important when looking to take advantage of very early sowing opportunities than it is for later sowing. It appears from this data that longer season varieties flower closer to the ideal flowering window than shorter maturing types when sown early, however, without yield and seed quality data we cannot yet confirm that they are also more profitable when sown earlier than ANZAC day.

This report discusses the phenological response of different canola maturity types to sowing time and should be interpreted with caution until yield and quality data is available. Harvest samples will be weighed and analysed for oil, moisture and protein and a further report will be provided to Liebe Group.

Acknowledgements

This experiment was conducted as part of the DPIRD/GRDC co-investment “Expanding the sowing window for canola and lupins – what works in WA?” (DAW1901-005RTX). Thanks to the Wongan Hills TSU for trial management. Salzar Rahman provided excellent technical assistance.

Peer review

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Demonstration of Legumes for Reliable Profitability in the Western Region - Field Peas, Dalwallinu

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- Minimal levels of fungus affected the crop.
- There was no difference in yield response between the two fungicide regimes implemented.
- In the dryer than average season the use of fungicide was not economical.

Aim

To address the issue of adequate disease control that impacted the profitability of field pea crops grown in medium rainfall zones.

Background

The Liebe Group have identified a need to continue to demonstrate alternate legume crops throughout the region and build on the existing momentum developed through this project. The aim of establishing new demonstration sites in 2020 is to further explore the constraints to adoption, as well as demonstrate the agronomy packages available to growers to determine if particular legumes are profitable in their farming system within a different season. Disease control was a significant constraint on field pea crop performance in the 2018/2019 trials. This demonstration aims to explore the agronomic options for disease control through the use of a variety of fungicides to address this constraint.

Trial Details

Trial location	Harry Hyde's Property, Dalwallinu
Plot size & replication	36m x 500m x 3 replications
Soil type	Heavy red loam
Paddock rotation	2017 Wheat, 2018 Wheat, 2019 Barley
Sowing date	29/05/2020
Sowing rate	120 kg/ha Twilight Field Peas
Fertiliser	26/05/2020: 60 kg/ha Map Zn (11.2%N, 22.4%P, 1.9%S, 0.5%Zn)
Herbicides, Insecticides & Fungicides	See treatment list 26/05/2020: 960 g/ha trifluralin, 990 g/ha Diuron 05/07/2020: 240 g/ha Clethodim, 100 g/ha Diflufenican, 3 g/ha Gamma-Cyhalothrin

Treatments

	Treatment
1	Nil Control
2	Azoxystrobin 150 ml/ha & Propiconazole 500 ml/ha (2 x timings: 10/07/2020 and 02/09/2020)
3	Tebuconazole 150 g/ha & Azoxystrobin 90 g/ha on 10/07/2020. Bixafen 45 g/ha & Prothioconazole 90 g/ha on 02/09/2020.

Chemical	Active
Azoxystrobin	250 g/L Azoxystrobin
Propiconazole	250 g/L Propiconazole
Veritas	200 g/L Tebuconazole & 120 g/L Azoxystrobin
Aviator Xpro	75 g/L Bixafen & 150 g/L Prothioconazole

Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	6.8	51	793	4	19	7	0.12	0.9
10-20	7.5	13	547	11	13	<1	0.14	0.7
20-30	7.7	5	380	18	5	<1	0.17	0.5
30-40	7.9	6	384	21	6	<1	0.23	0.4
40-50	8.2	4	435	14	4	<1	0.28	0.2

Results

The year had below average rainfall that came through in storms and dried quickly afterwards. These conditions were not favourable for fungus growth and the crop only had very minor evidence of black spot and powdery mildew. Due to the low disease pressure present, there were no clear visual effects from any of the fungicide treatments and the data collected was not significantly different between treatments.

Experience in WA and South Australia indicate responses to foliar applied fungicide in field pea only reliably occurs in crops set to yield above 1.5 t/ha. In 2020 at Dalwallinu yields were well below this (average 800 kg/ha) and fungicide treatments were not economic.

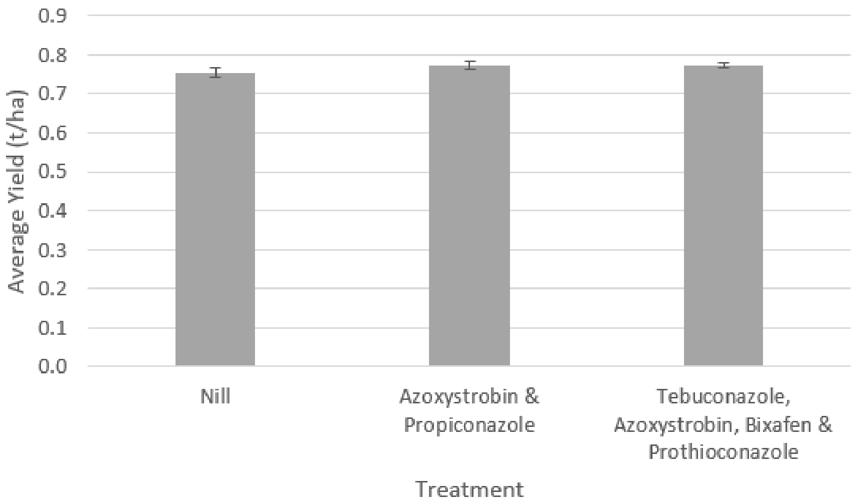

Figure 1: Seed yield of field pea in fungicide trials at Dalwallinu in 2020. Error bars are ± 1 S.E.

There were no significant differences between the average yields of the treatments.

Acknowledgements

This is a GRDC investment LIE1802-003SAX, led and managed by the Liebe Group. Thanks to Harry and Matthew Hyde for hosting and implementing the trial. Thanks to Elders Scholz Rural for their collaboration, providing advice for treatments and for supplying the chemical used in the trial.

Peer review

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Demonstration of Legumes for Reliable Profitability in the Western Region - Chickpeas, Dalwallinu

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- The combined Simazine and Isoxaflutole (Treatment 1) resulted in the lowest early weed counts, with less than 30 weeds per m² at four weeks post emergence.
- Simazine and Isoxaflutole (Treatment 1) had a profound impact on inhibiting Medic growth relative to other treatment styles.
- Application of Isoxaflutole & Terbuthylazine (Treatment 2) completely mitigated all weed species except the medic.

Aim

1. To identify the optimal agronomy for chickpeas, grown in medium to low rainfall zones of northern Western Australia.
2. To address the issue of adequate weed control that impacted the profitability of chickpea crops grown in medium rainfall zones in earlier trials in this project.

Background

The Liebe Group have identified a need to continue to demonstrate legume crops throughout the region and build on the existing momentum developed through this project. The aim of establishing new demonstration sites in 2020 explored the constraints to adoption, as well as demonstrate the agronomy packages available to growers to determine if particular legumes are profitable in their farming system within a different season. Weed control was a significant constraint on chickpea crop performance in 2018/2019. This demonstration aims to explore the agronomic options for weed control through the use of a variety of herbicides treatments.

Trial Details

Trial location	Ian Hyde's Property, Dalwallinu
Plot size & replications	36.6m x 500m x 2 replications
Soil type	Heavy red-brown clay
Paddock rotation	2017 Wheat, 2018 Fallow, 2019 Wheat
Sowing date	15/05/2020
Sowing rate	85 kg/ha Striker Chickpeas
Fertiliser	15/05/2020: 7.05 kg/ha N, 7.2 kg/ha P, 4.6 kg/ha S, 0.05 kg/ha Cu, 0.1 kg/ha Zn 20/07/2020: 1.786 kg/ha $(NH_4)_2SO_3$
Herbicides Insecticides & Fungicides	See treatment list, plus 24/06/2020: 200 g/ha mecoprop-P, 200 g/ha MCPA, 25 g/ha dicamba, 34 g/ha clopyralid, 90 g/ha bromoxynil 20/07/2020: 45 g/ha haloxyfop, 129 g/ha clethodim 24/06/2020: 79 g/ha chlorpyrifos 29/08/2020: 200 g/ha azoxystrobin, 80 g/ha cyproconazole

Treatments

	Treatment
1	Simazine 1.1 kg/ha + Isoxaflutole 75 g/ha PSPE (Control)
2	Isoxaflutole 75 g/ha + Terbuthylazine 750 g/ha pre-emergent
3	Terbuthylazine 1.05 kg/ha + Flumioxazin 90 g/ha pre-emergent
4	Terbuthylazine 1.05 kg/ha + Metribuzin 150 g/ha pre-emergent + Imazethapyr 35 g/ha PSPE

Chemical	Active
Simazine	900 g/kg Simazine
Balance	150 g/kg Isoxaflutole
Palmero TX	75 g/kg Isoxaflutole, 750 g/kg Terbuthylazine
Terbyne Xtreme	875 g/kg Terbuthylazine
Terrain	500 g/kg Flumioxazin
Metribuzin	750 g/kg Metribuzin
Spinnaker	700 g/kg Imazethapyr

Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	7.6	28	625	18	23	8	0.20	0.8
10-20	8.1	11	554	31	26	2	0.31	0.7
20-30	8.1	4	449	53	19	<1	0.53	0.4
30-40	8.3	4	413	72	7	<1	0.63	0.3
40-50	8.5	3	405	54	5	<1	0.62	0.2

Results

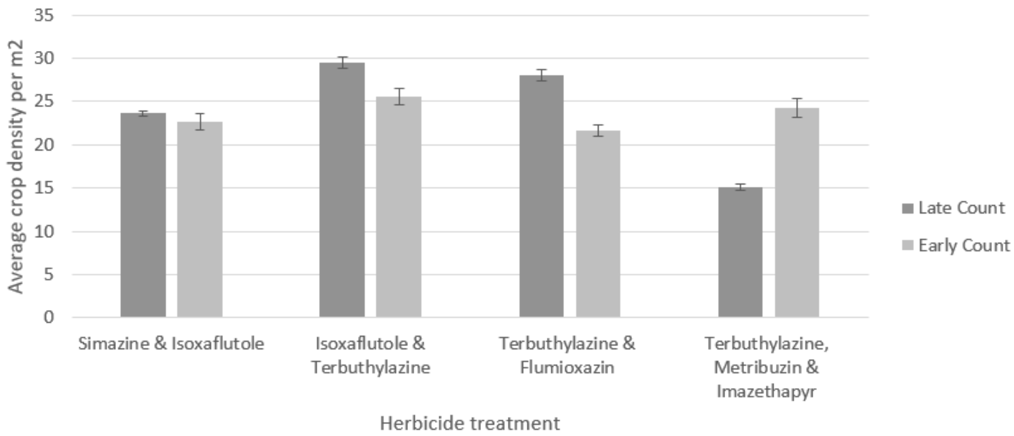

Figure 1: Early (25/06/2020) and late (20/08/2020) crop density (per m²) of PBA Striker Chickpeas in herbicide trial at Dalwallinu in 2020. Error bars are ± 1 S.E.

There was no significant difference in mean Striker Chickpea plant emergence (per m^2) between the four herbicide treatment compositions (Figure 1). Large variation was observed within plots. Inconsistencies in seedling emergence frequencies were common amongst the treatment levels. This may be due to the large irregular clods that were observed over the trial plots and the irregular structure of the seedbed.

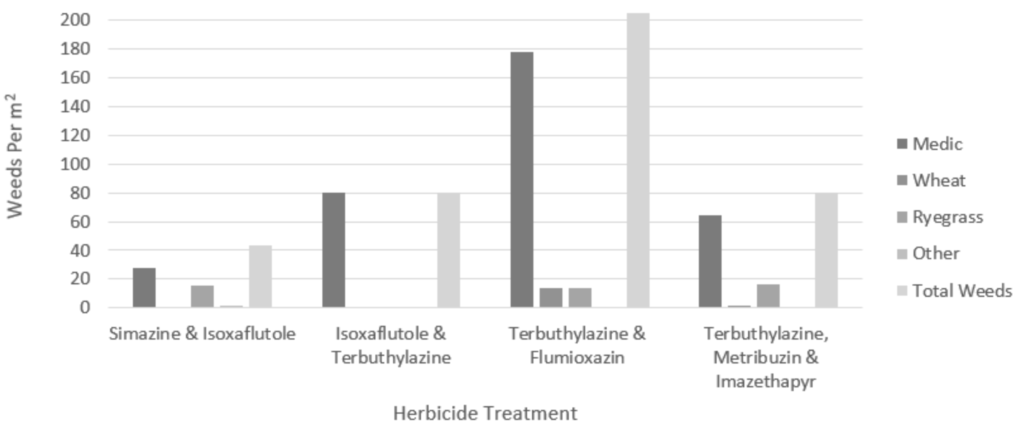

Figure 2: Average weed density (per m^2), by weed type, taken on 25/06/2020 and 20/08/2020, relative to each herbicide treatment type.

Weed development was not the same in all treatment types, with average weed count (per m^2) significantly higher when treated with the Terbuthylazine and Flumioxazin combination herbicide. Contrastingly, the application of the Simazine and Isoxaflutole (Treatment 1) resulted in a weed growth frequency of <30 plants/m^2 (Figure 2).

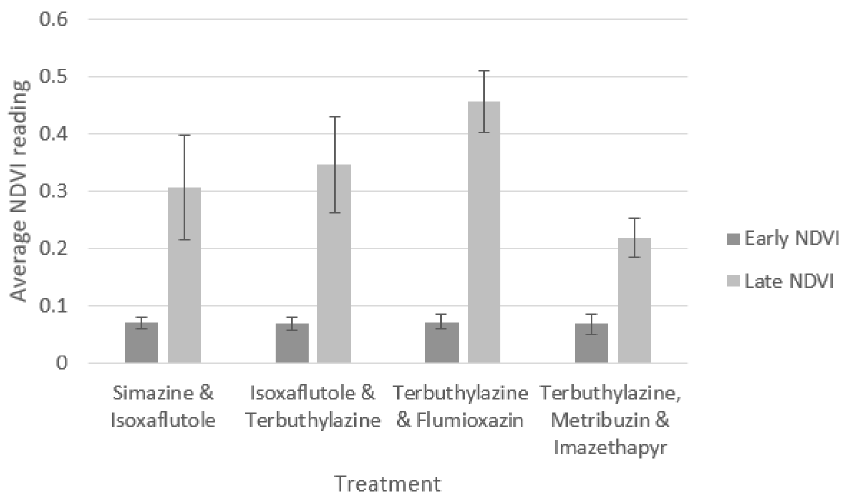

Figure 3: Average Normalized Difference Vegetation Index (NDVI) reading, taken on 25/06/2020, relative to each herbicide treatment type.

Mean NDVI readings (per m^2) were not significantly different between herbicide treatments (Figure 3). All Striker Chickpea plots displayed an average NDVI reading range within 0.003 (0.069-0.072).

Comments

Medic was the most prevalent weed found in all trial plots, regardless of treatment (Figure 2). Application of the Isoxaflutole & Terbuthylazine treatment (2) completely mitigated all weed species except the medic in the observed areas of the Chickpea trial zone. The Terbuthylazine, Metrabuzin & Imazethapyr treatment (4) had a substantial impact on inhibiting Medic growth relative to other treatments.

Differences in crop density and NDVI were not relevant to treatments.

Yield data is not available at time of publication. An update with analysis of yield and a cost-benefit analysis will be published when it becomes available.

Acknowledgements

This is a GRDC investment, LIE1802-003SAX, led and managed by the Liebe Group. Thanks to Ian Hyde for hosting and implementing the trial. Thanks to Elders Scholz Rural for their collaboration, providing advice for treatments and for supplying the chemical used in the trial.

Peer review

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Demonstration of Legumes for Reliable Profitability in the Western Region - Chickpeas, Beacon

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- There were no significant differences between herbicide treatments due to the low weed burden.
- Attention to detail and good planning is essential when growing high-value legumes in the region.

Aim

To explore the agronomic options for weed control through the use of a variety of herbicides to address this constraint.

Background

The Liebe Group have identified a need to continue to demonstrate legume crops throughout the region and build on the existing momentum developed through this project. The aim of establishing new demonstration sites in 2020 was to further explore the constraints to adoption, as well as demonstrate the agronomy packages available to growers to determine if particular legumes are profitable in their farming system within a different season. Weed control was a significant constraint on chickpea crop performance in 2018/2019.

Trial Details

Trial location	Kirby Property, Beacon
Plot size & replication	36.6m x 500m x 2 replications
Soil type	Heavy red clay
Paddock rotation	2017 Barley, 2018 Barley, 2019 Fallow
Sowing date	28/04/2020
Sowing rate	100 kg/ha PBA Striker Chickpeas
Fertiliser	28/04/2020: 40 kg/ha Crop builder 14, 30 kg/ha Urea 27/06/2020: 700 g/ha SOA
Herbicides, Insecticides & Fungicides	See treatment list and 27/06/2020: 180 g/ha Clethodim, 23.4 g/ha Haloxfop, 01/08/2020: 25 g/ha Alpha-Cypermethrin

Treatments

	Treatment
1	Simazine 1.1 kg/ha + Isoxaflutole 75 g/ha PSPE (Control)
2	Isoxaflutole 75 g/ha + Terbuthylazine 750 g/ha pre-emergent
3	Terbuthylazine 1.05 kg/ha + Flumioxazin 90 g/ha pre-emergent
4	Terbuthylazine 1.05 kg/ha + Metribuzin 150 g/ha pre-emergent + Imazethapyr 35 g/ha PSPE

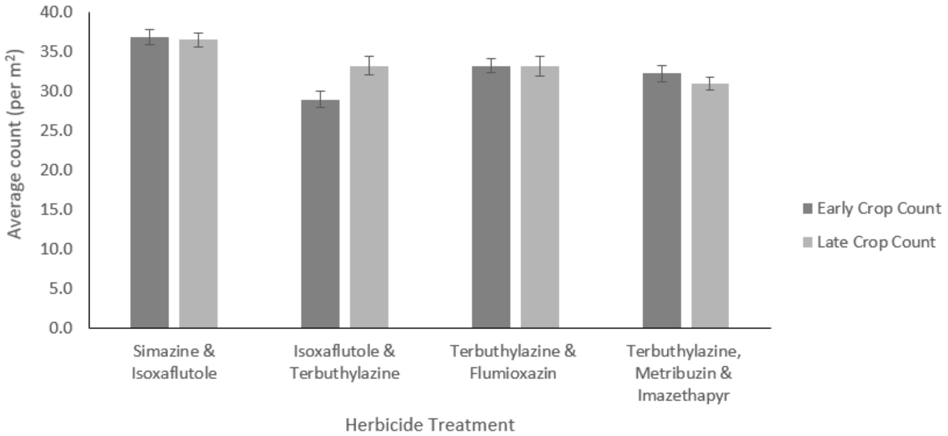
Chemical	**Active**
Simazine	900 g/kg Simazine
Balance	150 g/kg Isoxaflutole
Palmero TX	75 g/kg Isoxaflutole, 750 g/kg Terbuthylazine
Terbyne Xtreme	875 g/kg Terbuthylazine
Terrain	500 g/kg Flumioxazin
Metribuzin	750 g/kg Metribuzin
Spinnaker	700 g/kg Imazethapyr

Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	5.4	19	177	12	16	3.3	0.09	0.4
10-20	5.4	10	139	7	11	<1	0.06	0.4
20-30	5.5	3	132	6	3	<1	0.04	0.3
30-40	5.9	<2	147	7	2	<1	0.05	0.1
40-50	6.7	<2	356	10	3	<1	0.08	0.1

Results

Figure 1: Early (22/06/2020) and late (07/08/2020) crop density (per m²) of PBA Striker Chickpeas in herbicide trial at



Beacon in 2020. Error bars are ± 1 S.E.

Chickpea density was not significantly different between each treatment type. It was observed that crop density was inconsistent, with a variation of more than ten plants (per m²) within plots that were treated the same. The maximum average density rate was observed from the Simazine & Isoxaflutole treatmenmt (2) applied at sowing (Figure 1), however this difference was not significant.

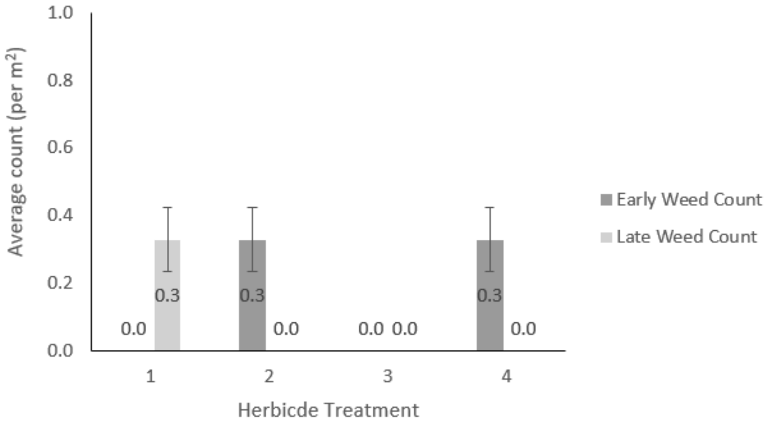


Figure 2: Early (22/06/2020) and late (07/08/2020) weed density (per m²) in PBA Striker Chickpeas in herbicide trial at Beacon in 2020. Error bars are ± 1 S.E.

Average weed density showed little variation. Weed control was observed to be extremely effective throughout the trial area, including at the fence lines. The weeds observed were summer weeds (*Argemone ochroleuca*) that were not actively growing. The low weed burden demonstrates that effective weed management in the year before a chickpea crop is possible – reducing the reliance on herbicides in the chickpea season.

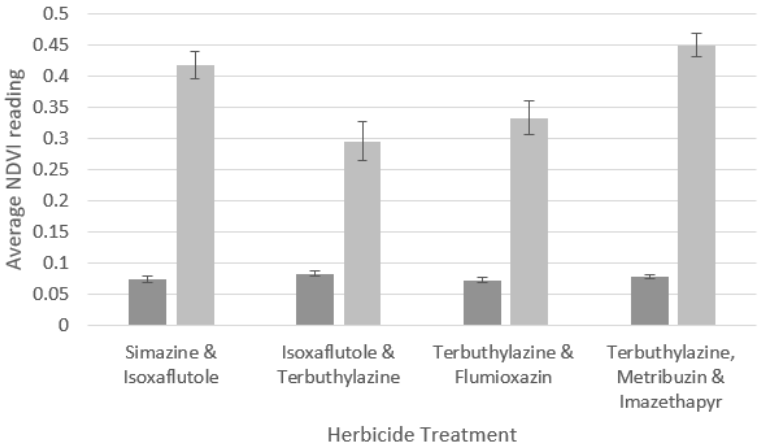


Figure 3: Early (22/06/2020) and late (07/08/2020) Normalized Difference Vegetation Index (NDVI) readings taking in PBA Striker Chickpeas in herbicide trial at Beacon in 2020. Error bars are ± 1 S.E.

The average NDVI reading across each treatment type was not significantly different (Figure 3).

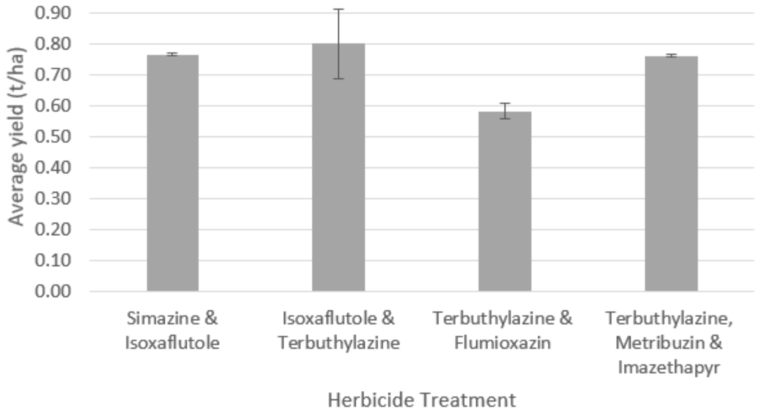


Figure 4: Average yield (t/ha) of PBA Striker chickpea in herbicide trial at Beacon in 2020. Error bars are ± 1 S.E.

The average yield of chickpea at Beacon was 730 kg/ha whilst herbicide treatments were not significantly different (Figure 4).

Comments

It appears that weed control in the previous year was highly effective in controlling weeds present, as such there were no significant differences between the weed control treatments in 2020. It should also be noted that there was a blockage at seeding, so the trial did not receive any inoculant and did not nodulate. The urea was added to ameliorate any lack of nitrogen brought about by this lack of nodulation.

In all treatments, costs exceeded income (Table 2). Differences in yield were not attributed to the herbicide treatments applied, so the slightly lower losses that arise from treatment 4 (Terbuthylazine, Metribuzin & Imazethapyr) are not seen as significant.

Acknowledgements

This is a GRDC investment, LIE1802-003SAX, led and managed by the Liebe Group. Thanks to Chris Kirby for hosting and implementing the trial. Thanks to Elders Scholz Rural for their collaboration, providing advice for treatments and for supplying the chemical used in the trial.

Peer review

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Contact

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Demonstrating the Effects of Reduced Lupin Seed Integrity on Crop Establishment

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- Mechanical handling in general led to a decline in germination.
- Manganese (Mn) did not seem to be a factor influencing germination rate in this data set.

Aim

The aim of this project is to undertake seed integrity testing and evaluate crop establishment to assess the impact that multiple handling practices have on lupin seeds.

Background

In recent seasons, growers have been experiencing issues with poor germination of lupin crops from retained seed and as such want to better understand the contributing factors behind this. Manganese (Mn) deficiency, variety, harvester settings and moisture at harvest have all been identified as contributing factors behind poor establishment, however there is limited information available to growers and advisors as to the most important and controllable factors in our modern farming systems (limited research was conducted in the 1970's but farming practices have changed drastically since then) that could be managed differently, to improve lupin germination percentages.

The issue has been raised in the Geraldton Port Zone RCSN meeting in June 2019 after issues in 2018 with retained seed from the previous season. Whilst it is widely accepted that Mn deficiency is a contributing factor to poor germination due to its expression in Lupins as split seed, it is unclear under what circumstances Mn deficiency is most prevalent, and what other factors contribute to this issue. Harvest operations are considered the other likely contributing factor as the threshing mechanisms within the header can damage the seed coating, an effect possibly exacerbated by grain moisture, harvesting conditions and variety.

Methodology

Liebe Group staff monitored 27 seed sources from participating growers in the region, which included six different varieties (Barlock, Coramup, Gunyidi, Jurien, Mandelup, and Coyote) and seed with foliar, compound and no Mn applied.

Each seed source was tracked through harvest 2019 and seeding 2020. Four samples were collected for each seed source and the management practices used were recorded. Samples were collected pre and post-harvest, and pre and post-seeding, and conditions and treatment of the seed were recorded as it was harvested, stored, cleaned and seeded.

Each of the samples collected were tested for Mn levels and germination rate (%) in a lab setting using the internationally recognised method. All germination tests were done using only whole seed, so the samples tested would have had no visual damage even when germination rates where as low as 50%, emphasising the need to test seed sources for germination percentage even if they appear visually ideal.

Each set of samples were subject to the handling practices preferred by the individual growers, with little congruity between sample sets, and as such, a large number of outside factors affected each set of results. Determination of specific factors behind the variation recorded in results was very difficult, however a few conjectures have been made based on the data collected.

Results

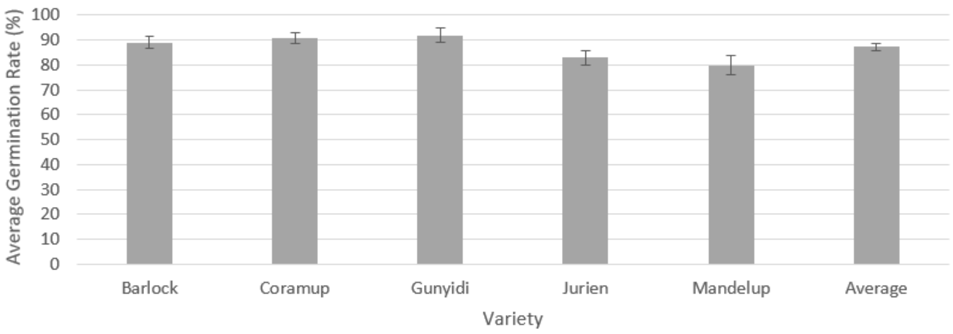

Figure 1: Germination rate (%) of lupins, by variety, as taken from 27 seed sources, each tested four times, pre-and post-harvest 2019, and pre and post-seeding. Error bars are ± 1 S.E.

Samples were taken from six different varieties, with five focus varieties that each have a minimum of three seed sources sampled. This variety selection aims to highlight any differences between variety performances. There were additional Jurien seed sources sampled to target differences observed between samples that are +/- application of Mn fertiliser. Each seed source was handled with best grower practice by each participant so there are no two sites with identical trial conditions. However, there did appear to be a variety effect, with Mandelup and Jurien being the numerically worst performing varieties, which would warrant further investigation.

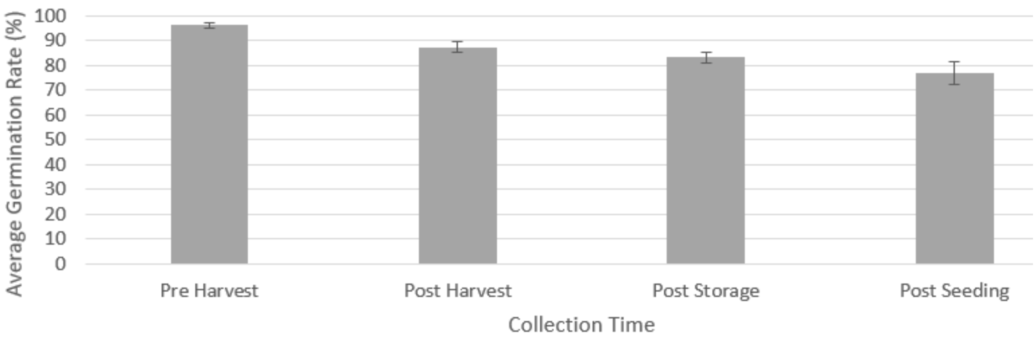

Figure 2: Average germination rate (%) of lupins, by sample time, as taken from 27 seed sources, each tested four times; pre-and post-harvest 2019, and pre and post-seeding 2020. Error bars are ± 1 S.E.

There does seem to be a correlation between mechanical handling of the lupin seed and germination rate. All seed sources started with an initial germination rate above 96% (excluding three outliers). At each successive sample time the average germination rate was lower across the seed sources, and there was a larger range of germination rates.

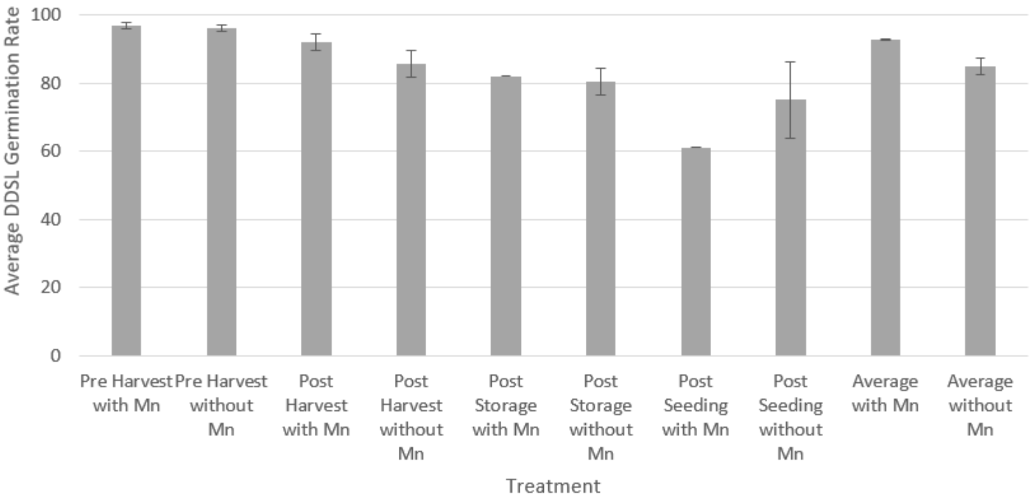

Figure 3: Average germination rate (%) of lupins, by sample time and Mn fertiliser application, as taken from 27 seed sources, each tested at four times; pre-and post-harvest 2019, and pre and post-seeding 2020. Error bars are ± 1 S.E.

There seems to be minimal impact caused by Mn content in this sample set, with all seed sources testing above 15 mg/kg, noting that it is common that Mn influences lupin performance when levels drop below 15 mg/kg. There is no significant correlation between Mn levels and germination rate, or Mn fertiliser use and germination rate (Figure 3).

Comments

Although Mn percentage was initially hypothesised to be a contributing factor for a decline in germination, the samples collected showed minimal variation in the Mn content of the seed. All samples had adequate Mn above the standard minimum threshold, despite variation in Mn application. This leads to the supposition that seed Mn did not seem to have any significant influence on germination rates within the sample set. 2019 received below average rainfall and it would be worth testing this hypothesis in a higher rainfall and yielding situation.

The main conclusion that can be drawn from the samples is that mechanical handling in general led to a decline in germination. On average across all the samples, there was a 19% decline from pre-harvest to post-seeding. However there was a wide range of losses, and some seed sources maintained germination rates of above 90% throughout, whilst others dropped by more than 40%. This indicates there are methods to mitigate mechanical damage to the seed.

As such Liebe Group has continued the investigation through a variation to the project. Further targeted trial work was conducted during the 2020 harvest season and additional experiments will be conducted focusing on reducing damage caused by the harvesting process and transport using an auger, as these are the processes most easily managed and varied by a grower. Case studies will be produced following six growers throughout their seasons and their corresponding germination results.

Acknowledgements

This is a GRDC investment, LIE1910-001SAX , led and managed by the Liebe Group. We would like to thank the Isbister, Tonkin, Helliwell, Hyde, O'Callaghan, Stone, Reynolds, Whyte, Birch, Pearse, Hirsch, Keamy, Nankivell, Northover, Seymour, Mincherton, Manuel, Metcalf, Marrone, Fitzsimons and Carter families for their assistance with the trial, helping with the collection of samples and supporting the research.

Peer review

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WEEDS RESEARCH RESULTS

Evaluation of Reflex® Herbicide for the Control of Broadleaf Weeds in Narrow-leaf Lupins

Owen Langley, Territory Sales Manager, Syngenta

Take Home Messages

- Broadleaf weed control in pulse crops is becoming increasingly difficult, with current herbicide options being challenged by herbicide resistance and various other influencing factors at time of application.
- Reflex® herbicide (currently pending registration from the APVMA) is a long residual Group G herbicide for the control and suppression of broadleaf weeds in narrow-leaf lupins, chickpeas, field peas, faba beans, lentils and vetch.
- Reflex® is registered for use IBS (incorporated by sowing) and PSPE (post-sowing pre-emergent), providing excellent residual weed control to assist in maximising yield and reducing pressure on post-emergent herbicide applications.
- Across multiple trials and demonstrations in 2020, the use of Reflex® as part of an integrated weed management strategy provided a high level of control compared to other treatments.

Aim

1. To demonstrate the efficacy of Reflex® on wild radish (*Raphanus raphanistrum*) and capeweed (*Arctotheca calendula*) compared to current industry standard control strategies.
2. To demonstrate a complete broadleaf weed control program using Reflex® pre-emergent followed by an application of post emergent herbicide options that allows for superior efficacy and resistance management compared to existing industry standard approaches.

Trial Details

Trial location	Latham	York	Geraldton
Rotation	2018 - Barley 2019 - Barley	2018 - Barley 2019 - Barley	2018 - Fallow 2019 - Fallow
Plot size & replication	12m x 2.5m x 3 reps	10m x 2.3m x 4 reps	12m x 2m x 4 reps
Soil type	Yellow sand	Sandy loam	Red loamy sand
Stubble cover	Low (<10%)	Low (<10%)	Low (<10%)
Variety		Jurien Lupins	
Seeding rate	80 kg/ha	100 kg/ha	100 kg/ha
Treatment application technique	90 L/ha, Handboom @ 6 km/hr, 2.1bar	100 L/ha, Handboom @ 6 km/hr, Lechler IDK 120-015 A.I. @ 2.1bar	100 L/ha, Handboom @ 6 km/hr, Billeracy 015 @ 2.5bar
Sowing date	21/04/2020	25/04/2020	28/05/2020
Time to incorporation	18-24 hours	<1hr	<1hr
Seeder type	Grower Sown, John Deere, KPPS system	Depth: 3cm, plot seeder knife point with presswheels at 4 km/hr	Depth: 3cm, plot seeder knife point with presswheels at 4 km/hr
Rainfall notes	Please refer to rainfall table at end of this book.	Sown dry, 22mm received 5th May, further 35mm 25th to 30th May. 55mm in June, 41mm in July and 54mm in Aug	Sown into good moisture, 5mm of rain 24hrs after sowing. 48mm in June, 44mm in July and 88mm in August
Herbicides : Knockdowns and Pre-Emergent Treatments	No knockdown, Propyzamide basal applied for grass control	No knockdown, grass pre-em of either Rustler or Ultro applied as per protocol	No knockdown, grass pre-em of either Rustler or Ultro applied as per protocol
Date of Post-Emergent Herbicide Applications	Reflex applied 27th April Clethodim applied 30th June. PSPE	PSPE treatments applied 30th April. Post-em treatments applied 19th June	PSPE applied 28th May. Post-em applied 30th June

Results

Table 1: Wild radish weed control (%) ratings at late timings by treatment at two locations in WA in 2020.

Location	York	Geraldton	Average Wild Radish Control
Untreated Wild Radish per m²	6.4	11	
Assessment date	21/07/2020	03/09/2020	Late (12 to 14 weeks after sowing)
Assessment timing	89DAS	98DAS	
Treatments			
Untreated	0e	0	
Gesatop 900WG 1000 ml/ha + Metribuzin 300 g/ha IBS	24d	52.5e	38.25
Reflex 1000 ml/ha IBS	90ab	82.5bc	86.25
Reflex 1500 ml/ha IBS	97a	88.8ab	92.9
Reflex 900 ml/ha PSPE	69c		78.2
Reflex 1250 ml/ha PSPE		87.5ab	
Reflex 1500 ml/ha + Gesatop 900WG 1000 ml/ha IBS	92ab	90ab	91
Reflex 1500 ml/ha + Metribuzin 300 g/ha IBS	92ab	90ab	91
Reflex 1500 ml/ha + Gesatop 900WG 1000 ml/ha IBS f/b Brodal 200 ml/ha + Metribuzin 80 g/ha	95ab	94.3a	94.65
Gesatop 900WG 1000 ml/ha + Metribuzin 300 g/ha IBS f/b Brodal 200 ml/ha + Metribuzin 80 g/ha	75bc	66.3d	70.65
L.S.D P=0.05	20.9	11.07	
C.V	18.6	10.17	

Wild Radish Weed Control Comments

Wild radish was only present at two of the mentioned trials, York and Geraldton. Both those trials had dense populations of naturally occurring wild radish, with an average of 6.4 plants per m² at York and 11 per m² at Geraldton. Current industry standards of Gesatop (simazine) plus Metribuzin provided poor levels of control when assessments were completed 12 weeks after application at York and 14 weeks after application at Geraldton. These treatments achieved 24% and 52.5% control respectively. Whilst the addition of a post-emergent application of Brodal and Metribuzin provided a significantly improved level of control, it was still less than that provided by Reflex® treatments.

One of the main strengths of Reflex® is the long residual activity, as demonstrated at these trials considering the assessment timings. Reflex® applied at 1 L/ha IBS provided 90% and 82.5% control. When the rate was increased to 1.5 L/ha IBS, the control at each trial increased to 97% and 88.5%. When applied PSPE the results showed a good rate response, with the York site achieving 69% control from 900 ml/ha PSPE and the Geraldton site 87.5% from 1.25 L/ha PSPE.

An integrated approach to weed management, incorporating high rates of robust pre-emergent herbicides with post-emergent strategies provided the best results at both sites. The combination of Reflex® at 1.5 L/ha IBS with either Gesatop or Metribuzin provided improved levels of control at both sites. The higher rate of Reflex (1.5 L/ha) provides a higher level of overall weed control, especially important when targeting weeds to which Reflex® only has suppression levels of activity. The higher rate is also important where longer residual control is required or when targeting a known high-pressure population.

The best results occurred when Reflex® was applied IBS at 1.5 L/ha in combination with Gesatop and was followed by an application of Brodal and Metribuzin post-emergent. This provided the highest level of control at both sites of 95% and 94.3%.

Table 2: Capeweed weed control (%) ratings at late timings by treatment at two locations in WA in 2020.

Location	York	Latham
Untreated Capeweed per m²	23	11
Assessment timing	107DAS	128DAS
Treatments		
Untreated	0	0
Gesatop 900WG 1000 ml/ha + Metribuzin 300 g/ha IBS	81[a]	95.61[b]
Reflex 1000 ml/ha IBS	28[de]	92.98[b]
Reflex 1500 ml/ha IBS	58[abc]	78.85[ab]
Reflex 900 ml/ha PSPE	68[ab]	
Reflex 1250 ml/ha PSPE		85.73[b]
Reflex 1500 ml/ha + Gesatop 900WG 1000 ml/ha IBS	81[a]	
Reflex 1000 ml/ha + Gesatop 900WG 1000 ml/ha IBS		94.04[b]
Reflex 1500 ml/ha + Metribuzin 300 g/ha IBS	69[ab]	
Reflex 1000 ml/ha + Metribuzin 300 g/ha IBS		91.18[b]
Reflex 1500 ml/ha + Gesatop 900WG 1000 ml/ha IBS f/b Brodal 200 ml/ha + Metribuzin 80 g/ha	81[a]	
Gesatop 900WG 1000 ml/ha + Metribuzin 300 g/ha IBS f/b Brodal 200 ml/ha + Metribuzin 80 g/ha	86[a]	
Gesatop 900WG 1000 ml/ha + Metribuzin 300 g/ha IBS f/b Brodal 200 ml/ha		92.02[b]
L.S.D P=0.05	29.5	18.39-80.71
C.V	33.6	86.27

Capeweed Weed Control Comments

Reflex® will provide suppression levels of activity on Capeweed and Doublegee. Capeweed was present at the York and Latham sites in good populations, with an average of 23 plants per m² at York and 11 plants per m² at Latham. Difficult seasonal conditions around and following seeding at the Latham trial caused a high level of variability across the site, as shown in the statistics. However, it does demonstrate the performance of Reflex® on capeweed and the benefit of an integrated weed management strategy for this weed.

At York, Reflex® achieved 28% suppression at 1L IBS and up to 58% at 1.5L IBS when assessments were completed 15 weeks after application. PSPE Reflex® at the York site was again an improvement, achieving 68%. Due to the high levels of variation at the Latham site, the individual stats cannot be commented on with much confidence. However, at the site Reflex® did provide a high level of activity of capeweed up to 18 weeks after application. In addition, this level of control was improved when a tank mix partner was added. In summary, whilst on occasions Reflex® standalone can provide a high level of activity on capeweed, the addition of a tank mix partner will result in more consistent results.

At both trials the addition of Gesatop to Reflex®1.5L IBS improved control, this was by as much as 23% at York. The addition of Metribuzin had a lesser effect. At York when combined with Reflex® at 1.5L it increased by 11%. In both these trials, an application of Brodal (Latham) and Brodal + Metribuzin (York) was applied over these treatments provided another increase in control. At Latham, this produced the highest level of control and at York, 81% was achieved.

Yield Results

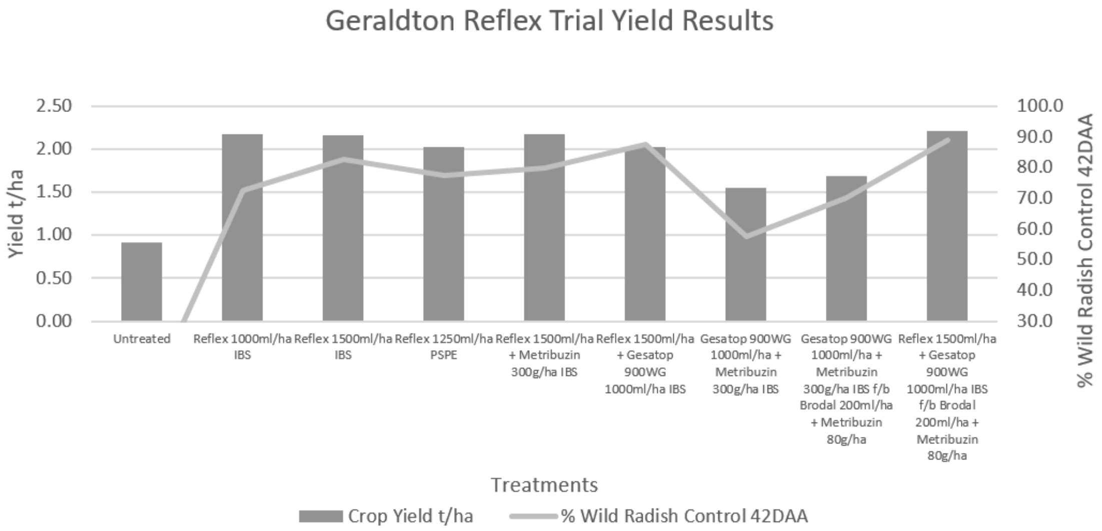
Early weed control can provide a number of benefits for a crop, all of these allowing the crop to reach its full yield potential. Robust pre-emergent control of weeds not only reduces the pressure on subsequent post-emergent sprays, but also reduces competition for resources for the crop. This is partciualry important for pulse crops such as lupins which have demonstrated a lack of early vigour and competitiveness.

At the Geraldton Reflex® trial, this benefit was demonstrated in the yield results (Graph 1). In the case of the current grower standard, Gesatop and Metribuzin IBS, where early weed control at 42DAA (days after application) was low as shown by the secondary axis, the subsequent yield was the lowest of all treatments recording 1.55 t/ha.

It also shows the importance of early weed control for the benefit of post-emergent sprays. When this treatment had an application of Brodal plus Metribuzin applied post-em, it increased overall weed control however the yield did not recover due the low early weed control (1.69 t/ha).

Where control in the first six weeks was vastly improved by the addition of Reflex®, so was the yield, increasing from 1.55 t/ha for Gesatop plus Metribuzin to 2.18 t/ha for Reflex®1 L/ha IBS standalone.

Graph 1: Crop yield results at the Geraldton Reflex®trial.



Conclusions

Whilst pulses form a smaller part of overall cropping hectares in Western Australia, the value they offer to the broader cropping system is critical. One of the major limitations of pulse production in Western Australia is robust weed control options to ensure cleanliness in the current crop, plus a reduced weed seed set for future crops in the rotation. Reflex® herbicide has been demonstrated to have powerful activity on key weeds challenging pulse production in WA. A combination of long residual activity, a new mode of action for resistance management, excellent crop safety across a range of pulses and good combability will make it a flexible and valuable weed management tool for growers.

Standalone, Reflex® has shown itself to be a step change in weed control for wild radish vs current standards. But more importantly, it has proved to be a valuable and robust partner for protecting and extending the life of existing chemistries. Reflex® tank mixed with a Group C offers improved levels of weed control compared to existing options and offers a cost-effective IBS option for broad spectrum weed control. Additionally, it has improved the performance of Group F and C applications post-emergent by reducing the early weed pressure and improving coverage of post-em sprays through reduced shading and numbers.

In summary, these trials have shown that the addition of Reflex® into pulse herbicide programs will offers growers a new option for robust, residual control of wild radish in a range of pulse crops.

Acknowledgements

Thanks to all the collaborators/managers of the various trial sites. Shannon Meyer from Elders Coorow and Bevan Addison from Adama for their assistance at the Latham site, Crop Circle Consulting for their management at Geraldton and Living Farm at York. Also a big thankyou to all who provided the sites, particularly Dylan Hirsch and family at the Latham site.

Peer Review

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Ultro®900 WG, a Novel Pre-emergent Herbicide for Grass Weed Control in Grain Legumes

Bevan Addison, Market Development Manager, ADAMA Australia

Take Home Messages

- Ultro®900 WG (900 g/kg Carbetamide) is new pre-emergence herbicide for use on grass weeds in grain legume crops including lupins, field peas, faba beans, chickpeas and lentils.
- Ultro is a novel Group E product for the control of brome grass, barley grass and annual ryegrass with a different mode of action to other grass herbicides on the market.
- Ultro is highly soluble for rapid uptake and offers residual in crop weed control.
- Ultro is registered and will be available in a 900 g/kg granular formulation for 2021 season.

Aim

To assess the efficacy of Ultro compared to other common herbicides and mixtures used for pre-sowing annual ryegrass control in lupins.

Background

Ultro 900 WG was trialled last year at the Liebe Group Main Trial Site with very good control of annual ryegrass. This site was a follow up trial to showcase the effects of Ultro versus commonly used pre sowing herbicides on a sandier soil type in a drier environment than in 2019. The product has been extensively tested across a range of environments and weed pressure situations over the past five-six years and this site was a final demonstration prior to registration in October 2020 and commercial release in the 2021 season.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	10m x 1.44m x 3 replications
Soil type	Sandy loam
Paddock rotation	2017 Fallow, 2018 Barley, 2019 Barley
Sowing date	21/05/2020
Sowing rate	80 kg/ha
Fertiliser	No fertiliser was used
Herbicides, Insecticides & Fungicides	As per treatment list, applied 21/05/2020

Treatments

	Treatment
1	UTC
2	Simazine 900 1.1kg + Mentor 200g
3	Propyzamide 900 550g
4	Ultro 900 1.1kg
5	Ultro 900 1.7kg
6	Propyzamide 900 550g + Simazine 900 1.1kg + Mentor 200g
7	Ultro 900 1.1kg + Simazine 900 1.1kg + Mentor 200g
8	Ultro 900 1.7kg + Simazine 900 1.1kg + Mentor 200g

**Ultro 900 = Carbetamide 900g/kg (Group E), *Mentor = Metribuzin 750g/kg (Group C), Propyzamide 900 WG (Group D), Simazine 900WG (Group C)*

Results

The trial was sprayed onto a dry, ripped paddock on 17th April using a 3m hand boom. It was dry sown on 20th April. Seeding was undertaken perpendicular to the spray treatments by the grower using commercial equipment. Following seeding the trial was badly affected by the severe wind blow event which covered much of the area.

The trial had establishment problems which, at the time of assessment on 11th June, did not appear to be correlated to any specific treatments. The patchy establishment of the lupins was likely due to the dry start and subsequent wind erosion. By the second assessment, lupins had recovered in many of the treated plots and despite some reduction in plant density, were looking healthy and vigorous where ryegrass pressure had been reduced. In the treatments with poor ryegrass control, the lupins had been severely out competed and were almost non-existent in the untreated control plots.

Despite the difficult start, visual assessments showed there were large treatment differences in the control of annual ryegrass when assessed using biomass observations.

As shown in figure 1, when assessed on 11th June, the Ultro treatments had a higher level of weed control compared to the alternatives. All Ultro treatments, either stand alone or mixed with simazine and Mentor provided significantly greater level of weed control than propyzamide-based treatments which in turn were significantly better than the simazine + mentor treatments.

As well as being a robust grass control herbicide, Ultro is more soluble than propyzamide, which can result in superior performance in situations, such as in this trial, where there were low levels of patchy rainfall at the start of the season.

There was no significant difference in the 1.7 kg/ha rate of Ultro compared to 1.1 kg/ha when used stand alone or in mixtures.

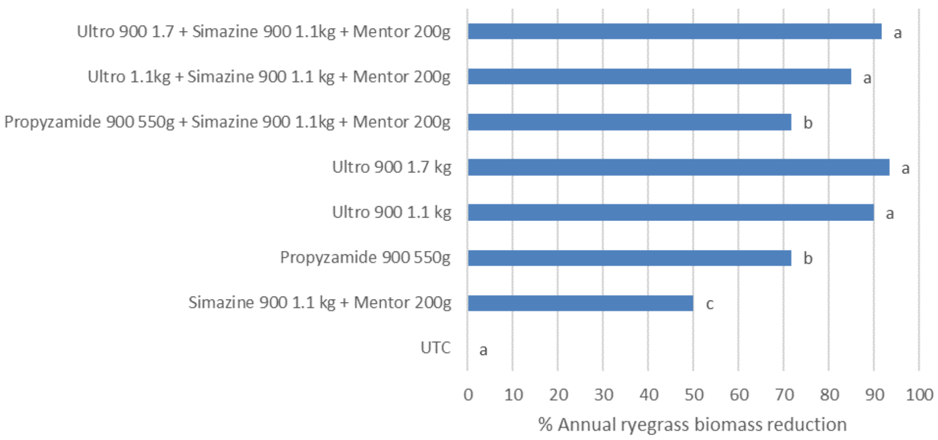

Figure 1: % biomass reduction of annual ryegrass on 11th June 2020.

Follow up assessments on 21st August showed the same trends continued, although in all cases surviving ryegrass and potentially some late germinations meant that overall biomass reduction compared to earlier assessment was slightly reduced across all treatments. This is common in many trials such as this and differences between treatments at each timing of weed assessment is more relevant.

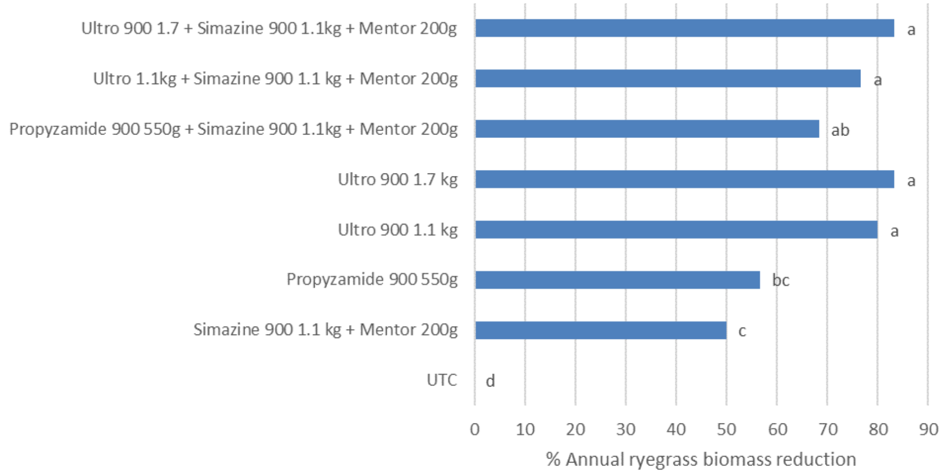

Figure 2: % biomass reduction of Annual ryegrass on 21st August 2020.

In the assessment made on 21st August, Ultro treatments still delivered the highest level of ryegrass control, although this was not significantly different to the propyzamide + simazine + metribuzin treatment.

All Ultro treatments provided significantly better ryegrass control than propyzamide stand-alone. By this time, propyzamide stand-alone, was not significantly different to the simazine + metribuzin treatment.

The trial was not harvested and was sprayed out to avoid excessive seed set and contamination of the site. As can be seen in image 1, the response to Ultro controlling grasses in this site meant the difference between a failed crop and an acceptable crop given the poor season.

Image 1: Foreground contains the Ultro treatments showing clear improvements in crop vigour and weed control compared to plots behind with high levels of annual ryegrass. Photo 21st August 2020.

Achieving a high level of ryegrass control using products such as Ultro has multiple benefits:

- Lupin performance is greatly improved due to lack of competition from annual ryegrass, particularly in seasons where poor starting rains mean other products with lower solubility may struggle.
- Post-em grass herbicides such as clethodim or butroxydim have greatly reduced weed numbers to control, hence better overall efficacy.
- Resistance management is improved by utilising an alternative Group of chemistry (Group E) which is not used in any other part of our broadacre cropping system.

Acknowledgements
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ADAMA

Overwatch® Herbicide – A new Group Q Pre-emergent Herbicide for the Control of Annual Ryegrass and Other Weeds in Wheat, Barley and Canola

Stephen Pettenon, Technical Extension Specialist WA & SA, FMC Australia

Take Home Messages

- Overwatch® herbicide is a Group Q pre-emergent herbicide that was granted registration approval for use in wheat, barley and canola in April 2020.
- Control of ARG, silver grass, wireweed, sow thistle and other weeds plus suppression of wild radish, capeweed, barley and bromegrass, wild oats and other species can be expected from an application of Overwatch at the 1.25 L/ha label rate.
- Effective pre-emergent herbicides are critical for getting crops established and growing quickly in weedy paddocks so understanding how new products work and perform is important.
- Good crop establishment and a solid stand of Annual ryegrass at this site allowed crop safety and initial, then residual weed control of products tested to be assessed.
- WeedSmart's integrated weed management guidelines include product rotation based on MOA, tank-mixing and use at label rates as a key part of a successful long term weed control strategy.

Aim

To demonstrate the crop safety and weed efficacy of Overwatch herbicide when applied alone and in certain tank-mix combinations alongside other pre-emergent products in wheat.

Background

FMC Australia has taken seven years to obtain the registration of Overwatch herbicide for use in wheat, barley and canola. In 2019, the WA state program focused on demonstrating crop safety in trials established using farm-scale machinery. This work was important as grower equipment can result in variable seed placement and soil throw under both dry and moist situations across many soil types. The 2020 program is a continuation of this work which is also looking at how Overwatch performs when applied in combination with a companion tank-mix partner.

This localised extension program across Western Australia has revealed new learnings well ahead of Overwatch being made available commercially. Although work has previously been undertaken in the Northern cropping zone, involvement in the 2020 Liebe Group program allowed FMC to demonstrate how Overwatch performs in sandplain country. This trial is specifically aimed at demonstrating crop safety, yield and ARG control.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	12m x 3m x 3 replications
Soil type	Medium yellow sand
Paddock rotation	2017 Wheat, 2018 Wheat, 2019 Barley
Sowing date	15/05/2020 (dry sown)
Sowing rate	Scepter wheat @ 60 kg/ha, 25mm depth @ 9.5 kph DUSTY
Fertiliser	15/05/2020: 40kg MAP and 60L UAN at seeding only.
Herbicides, Insecticides & Fungicides	As per trial protocol

Results

This trial was inspected at three weeks after application (WAA) and assessed at seven, ten and 18 WAA. Grain yield data presented through the site was affected by light hail damage and some glyphosate drift across one replicate.

Despite strong wind events and some light furrow fill, there was no noticeable visual differences in wheat plant numbers and crop vigour at 24 DAS between the herbicide treatments and the UTC. Wheat plant numbers and surviving ARG plant data were collected seven WAA. In a difficult start to the season, wheat plant establishment was excellent (164 to 196 plants/m² – data not presented).

This was somewhat surprising given the sandy soil type and lack of moisture at seeding, though rainfall received post-seeding fell lightly. Even though the site was deep ripped with closer plates in 2019, excellent seed placement was achieved, and warm soil temperatures contributed to rapid plant growth.

All herbicides when applied alone resulted in a very high level of weed control – 85 to 89% reduction in ARG plant numbers at seven WAA (Table 1). This suggests that the ARG population is susceptible to all herbicides tested. Overwatch applied at 1250 mL/ha resulted in 85% ARG control when compared to the untreated control.

In most cases, applying Overwatch in a tank mix with a companion herbicide resulted in a numerically higher level of weed control of 91 to 95 % though none of the improvements were statistically significant.

Table 1: Summary of Results - Annual ryegrass control and grain yield.

Treatment & Rate/ha	ARG 7 WAA		ARG 18 WAA		Yield t/ha	Variation (kg) vs Trifluralin
	plants/m²	% control	spikes/m²	% control		
Overwatch (OW) 1250 mL	41[ab]	82	99[a]	81	1.209[abc]	157
Sakura 118 g	43[ab]	81	42[a]	92	1.324[abc]	272
BoxerGold 2500 mL	30[ab]	87	102[a]	80	1.175[abc]	123
Lumixmax 500 mL	40[ab]	82	226[a]	56	1.055[c]	3
Trifluralin 2500 mL	38[ab]	83	131[a]	74	1.052[c]	0
OW 1250 mL + Trifluralin 2000 mL	39[ab]	83	87[a]	83	1.427[ab]	375
OW 1250 mL + Fighter 2500 mL	24[b]	89	117[a]	77	1.29[abc]	238
OW 1250 mL + Triallate 2000 mL	13[ab]	94	261[a]	49	1.256[abc]	204
OW 1250 mL + Sakura 118 g	26[b]	88	78[a]	85	1.25[abc]	198
OW 1250 mL + S-MET 150 mL	17[ab]	93	154[a]	70	1.093[bc]	41
OW 1250 mL + Callisto 150 mL	24[a]	89	264[a]	48	1.073[c]	21
Coded Low	56[b]	75	107[a]	79	1.49[a]	438
Coded Low x 2	22[b]	90	76[a]	85	1.48[a]	428
UTC	225		509		0.522[d]	-530
LSD P=0.05	20.30		ns		350.1	
Std Dev.	12.00				208.6	
CV	40.90				3.875	
P Value	<0.005				0.0001	
F	3.5				4.102	

Establishment details – Treatments applied and incorporated by seeding on the afternoon of Friday the 15th of May. Applied using an application volume of 100 L/ha – TeeJet AI 110015, 3 Bar @ 7kph Coarse droplet quality.

ARG spike numbers were assessed at 18 WAA. Due to variation across the site which included high bromegrass numbers in rep three, variation at the site was high. No herbicide differences were statistically significant though large numerical differences in the means across three reps existed.

All herbicides improved grain yield significantly when compared to the untreated control. Trifluralin applied alone resulted in a 530kg yield improvement. Overwatch, Sakura and BoxerGold improved yield over trifluralin applied alone by 157, 272 and 123 kg/ha respectively. A tank mix of Overwatch and trifluralin improved grain yield significantly by 375kg when compared to applying trifluralin alone.

Acknowledgements
Thanks to Dylan Hirsch and the Liebe Group team for their involvement and important contribution towards the establishment and delivery of this trial.

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FMC An Agricultural Sciences Company

Demonstration of the Agronomics of Various Prosulfocarb Strategies for ARG Control in Cereals

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Take Home Messages

- Pre-emergent herbicides are crucial to establishing a vigorous crop.
- Prosulfocarb in combination with Trifluralin (Bolta Duo) has proved useful for annual ryegrass and brome grass.
- Early post-emergent Prosulfocarb (1-3lf annual ryegrass) provided around 60% control as a stand-alone treatment, however the crop lost early vigour from the initial weed burden.
- Trifluralin pre followed by Prosulfocarb post (1-3lf annual ryegrass) provided useful, though not complete control.
- There was a slight numerical increase in control of annual ryegrass between 3 or 5 L/ha post emergent prosulfocarb rates in this situation.
- No evidence of crop damage from any treatment. Early loss of vigour/biomass due to weed competition continued through to trial completion regardless of final weed control.

Aim

The aim of the trial is to give growers some key data that can help them make informed decisions about their Prosulfocarb use in the Liebe Group area. The trial investigates key timings to the crop and grass weeds, rates and combinations.

Background

Liebe Group members have consistently indicated that they would like to see some locally generated data on Prosulfocarb. The experience with Prosulfocarb has seen mixed results, especially when it has been used post-emergent in salvage/clean-up situations. Prosulfocarb as a stand-alone molecule has uses both pre and post emergence in cereals, however the post-emergent uses have been known to be touchy in relation to environmental conditions and weed growth stage. This trial is designed to explore the different timings of use, combinations and rates so that some conclusions on the best use practice for this molecule can be determined for the Liebe area.

Trial Details

Trial location	Main Trial Site, Hirsch Property, Latham
Plot size & replication	11 x 2m with 3 replications
Soil type	Yellow Sand
Paddock rotation	2019 Barley 2018 Barley
Sowing date	18/05/2020
Sowing rate	Wheat cv. Chief, 55 kg/ha
Fertiliser	40kg MAP and 65L UAN seeding
Herbicides, Insecticides & Fungicides	2L Glyphosate 540 Pre

Treatments

No	Treatment	Pre-em (L/ha)	Post (1-3 leaf ARG) (L/ha)	Post (tillering ARG) (L/ha)
1	Untreated Control	0	-	-
2	Nil Pre + Prosulfocarb post	0	3	-
3	Nil Pre + Prosulfocarb post	0	-	3
4	Nil Pre + Prosulfocarb post	0	5	-
5	Nil Pre + Prosulfocarb post	0	-	5
6	Trifluralin	2	-	-
7	Prosulfocarb	3	-	-
8	Trifluralin pre + Prosulfocarb post	2	3	-
9	Bolta Duo (Prosulfocarb + Trifluralin)	3	-	-
10	Diablo Duo (Prosulfocarb + Triallate)	3	-	-
11	Trifluralin + Prosulfocarb + Prosulfocarb post	2	1.5	1.5

Results

Table 1: Comparison of treatment means. Mean number of annual ryegrass panicles per m^2.

No.	Treatment	Application rate (L/ha)	115 DAT 9/09/2020
1	Untreated Control	0	195 [b]
2	Nill Pre + Prosulfocarb 1-3lf	0 + 5 + 0	139[ab]
3	Nill Pre + Prosulfocarb tiller	0 + 0 + 3	196 [b]
4	Nill Pre + Prosulfocarb 1-3lf	0 + 5 + 0	116 [ab]
5	Nill Pre + Prosulfocarb tiller	0 + 0 + 5	78 [ab]
6	Trifluralin Pre	2 + 0 + 0	79 [ab]
7	Prosulfocarb Pre	3 + 0 +0	50 [ab]
8	Trifluralin pre + Prosulfocarb 1-3lf	2 + 3 + 0	44 [ab]
9	Bolta Duo Pre	3 + 0 + 0	33 [a]
10	Diablo Duo Pre	3 + 0 + 0	38 [ab]
11	Trif Pre + Pro 1-3lf + Pro tiller	2 + 1.5 + 1.5	67 [ab]
		P value	0.059
		LSD	160.1*

ns - no statistical significance at $p < 0.05$

Means within the same cell with a letter in common are not significantly different (P>0.1).
* 90% confidence LSD is used, no significant difference at 95%

Table 2: Comparison of treatment means. Mean number of Brome panicles per m^2

No.	Treatment	Application rate (L/ha)	115 DAT - 09/09/2020
1	Untreated Control	0	176
2	Nill Pre + Prosulfocarb 1-3lf	0 + 5 + 0	54
3	Nill Pre + Prosulfocarb tiller	0 + 0 + 3	159
4	Nill Pre + Prosulfocarb 1-3lf	0 + 5 + 0	83
5	Nill Pre + Prosulfocarb tiller	0 + 0 + 5	120
6	Trifluralin Pre	2 + 0 + 0	59
7	Prosulfocarb Pre	3 + 0 +0	85
8	Trifluralin pre + Prosulfocarb 1-3lf	2 + 3 + 0	46
9	Bolta Duo Pre	3 + 0 + 0	71
10	Diablo Duo Pre	3 + 0 + 0	82
11	Trif Pre + Pro 1-3lf + Pro tiller	2 + 1.5 + 1.5	35
		P value	0.763
		LSD	ns

Comments

Panicle counts of annual ryegrass and brome grass were conducted in early September to determine the potential for seed-set at the completion of the season under alternative in-crop prosulfocarb strategies. Some sand-blast and furrow-fill was experienced with the first front that passed over in early June 2020, this had some effect on plant establishment in some areas of the site.

The weed pressure was very high in the trial site, with a significant amount of brome grass present in large patches throughout. The high and uneven brome grass pressure significantly influenced the evenness of annual ryegrass at the site, outcompeting both the wheat and the annual ryegrass. This has led to some large variations between and within replicates, reflected in the low significance level (90% confidence instead of the preferred 95%). There were still some numerical trends in the data that warrant discussion, though the results should be viewed with a degree of caution.

Any treatment that had a pre-emergent application of any type clearly reduced weed numbers. The plots with a pre-emergent treatment visibly presented with better crop biomass/vigour throughout the season. Combining prosulfocarb with a mix partner pre-emergent appears to have improved control over the stand-alone actives. Pre trifluralin and post prosulfocarb performed in a similar manner to both actives applied up-front. Post emergent prosulfocarb provided some suppression of seed set in this situation, however it was at the lower end of the suppression spectrum. Post emergent prosulfocarb at 5 L/ha provided a slight increase in suppression. Timing of application was variable for control of annual ryegrass, with the 1-3 leaf being better than tillering for the 3L rate, but the opposite for the 5L rate. The latter is likely an anomaly due to the variability in weed density across the site.

There was no noticeable effect of any herbicide treatment to the host crop. The noticeable crop effect was from the high weed density present at the site, which germinated in conjunction with the crop. Any plot that did not receive a pre-emergent treatment demonstrated reduced early vigour due to competing weeds.

Acknowledgements

Thanks to Dylan Hirsch for seeding the site.

Peer Review

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Summer Weed Survey of WA Cropping Districts

Andrew Storrie, AGRONOMO

Take Home Messages

- Across the WA cropping zone broadleaf weed species out-number grass weeds by 3.5 to 1 which is similarly reflected across the Dalwallinu district which was 3:1.
- The most widespread and common summer broadleaved weeds at Dalwallinu were paddy melon, Afghan melon, mintweed, caltrop, wild radish, and mallow.
- The most common summer grass weeds were small burrgrass, button grass and stink grass.

Aim

1. Conduct 197 in-paddock surveys in both 2019-20 and 2020-21 to identify the composition of summer weed species present across the GRDC Western region.
2. Expand the understanding of WA's current in-paddock summer weed flora and better inform possible future initiatives on identification and management of summer weeds.

Background

Summer weeds continue to be highly prevalent and reported as an issue by multiple Regional Cropping Solutions Networks. Summer weeds are given a generic label when the reality is that they are extremely diverse both over area and time. Anecdotal reports suggest the summer weed spectrum is changing with many species emerging that are not well understood by growers. Species identification is critical to achieving successful management outcomes. While previous summer weed surveys have concentrated on roadside weed composition, actual in-paddock weed flora is not well understood.

Method

Between January and April 2020 197 paddocks were surveyed across the state for relative abundance and distribution. Surveys covered all 6 agricultural zones (Figure 1).

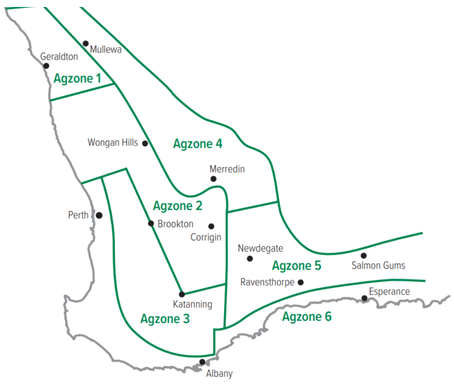


Figure 1: Map of WA Agzones.

Physical surveys were conducted from late January to early April 2020. Contact details of grower cooperators were obtained from grower groups and consultants. AGRONOMO organised the location of two or more survey paddocks per grower.

Paddock surveys consisted of relative weed abundance recorded along a transect within each paddock with 52 data points. Photos were taken along each transect. Unknown weeds were collected and grown out in pots to facilitate correct identification.

The Dalwallinu district is split between Agzones 2 and 4. Four cooperators and eight survey paddocks were from Agzone 2 and three cooperators and eight paddocks were from Agzone 4.

Paddock histories are being obtained from cooperators to look for correlations between management, soil type and rainfall. These paddocks will be surveyed again in the 2020-21 summer.

Results

Across the cropping belt there were 49 broadleaf and 14 grass species, excluding volunteer crop and pasture species. The number of summer broadleaf species for each Agzone ranged from 19 to 31 species while grasses ranged from two to nine species. Agzones 2, 4, and 5 have the highest number of species.

Dalwallinu had 16 broadleaf species including two perennials. There were five summer grass species, plus annual ryegrass and nine volunteer and pasture species.

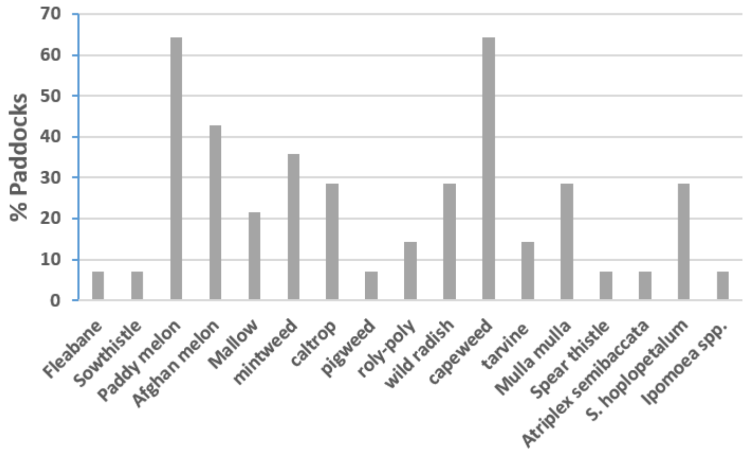


Table 1: Relative abundance of broadleaf weeds as percentage of paddocks surveyed – Dalwallinu paddocks.

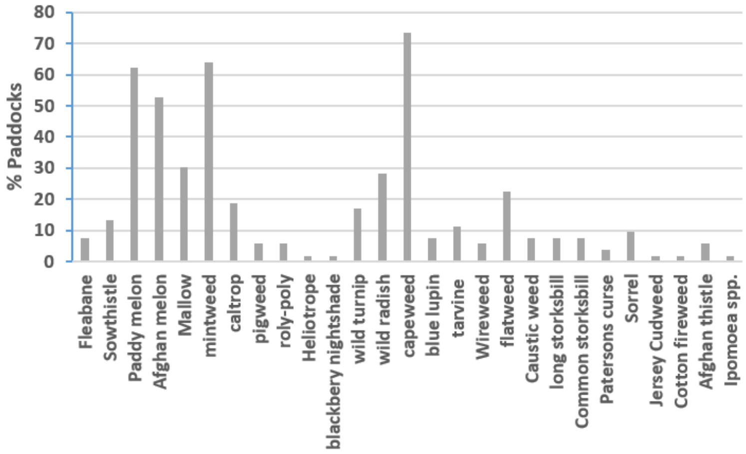


Table 2: Relative abundance of broadleaf weeds as percentage of paddocks surveyed – Agzone 2.

Over the whole of Agzone 2 there were 27 broadleaf species compared with 29 species in Agzone 4.

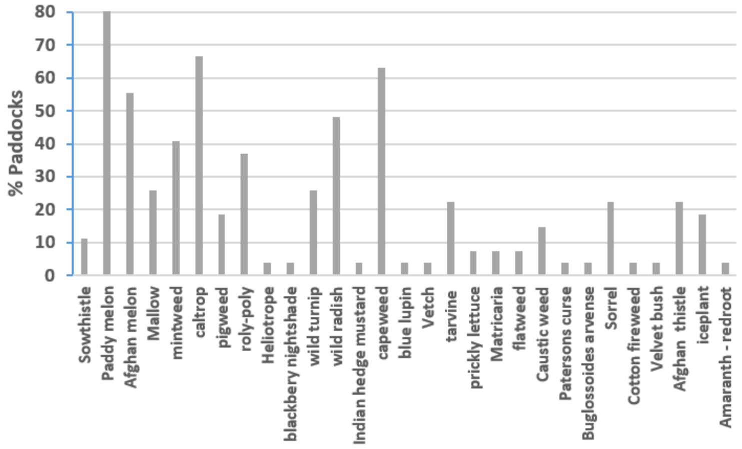
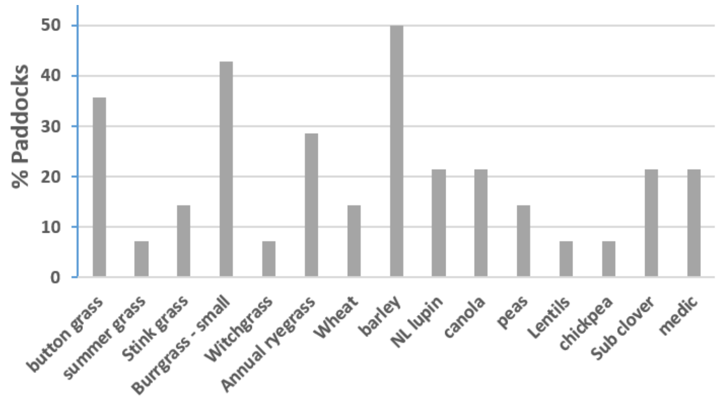


Table 3: Relative abundance of broadleaf weeds as percentage of paddocks surveyed – Agzone 4.

In Agzone 4 paddy melon jumps to 80% of paddocks and caltrop over 65% while wild turnip jumps to one in four paddocks.

Table 4: Relative abundance of grass weeds & volunteers as percentage of paddocks surveyed – Dalwallinu paddocks.



Small burr grass and button grass were the main grass species observed around Dalwallinu. Grasses were very minor in the whole of Agzone 2 while the drier Agzone 4 had more grass weeds with small burrgrass followed by stink grass and button grass.

Table 5: Relative abundance of grass weeds & volunteers as percentage of paddocks surveyed – Agzone 2.

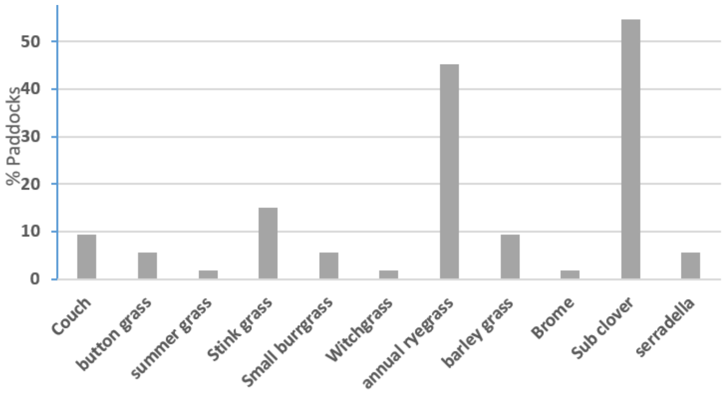
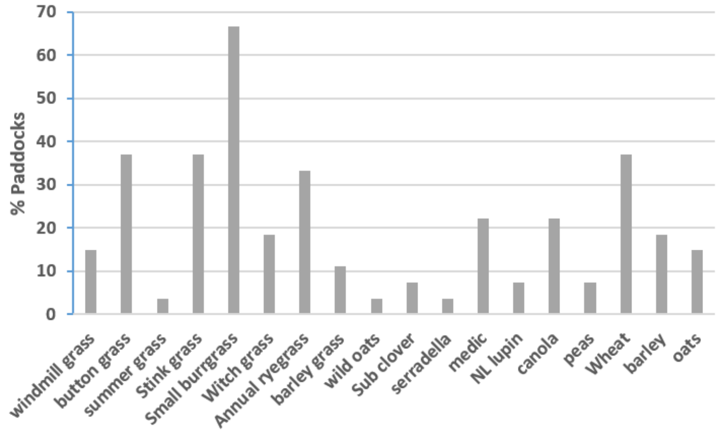


Table 6: Relative abundance of grass weeds & volunteers as percentage of paddocks surveyed – Agzone 4.



Comments

Above average temperatures and low humidity combined with dry soil profile meant that establishment of summer weeds was delayed due to difficult conditions. Surface germinating species such as fleabane, sowthistle and grasses are probably under-represented in this data due to these conditions. Weeds such as wireweed, windmill grass and melons had germinated prior to the 2019 harvest and were often present as larger established plants.

Discussions with co-operators in the northern region highlighted the fact that fleabane has only been an issue in that area for probably the last three years and was unknown prior to that time.

While button grass is common in the northern part of the cropping belt it was found along a survey paddock fence line in the Ravensthorpe area. This is a new record for the distribution of this species.

Agzone 2 had 26 broadleaf and nine grass weed species (excluding crop and pasture volunteers) and also had higher densities of weeds than Agzone 1. Mintweed had the highest densities and was found in more paddocks than any other summer species, followed by paddy melon and Afghan melon. Capeweed had the highest density and most widespread weed overall.

Stink grass was found in double the number of paddocks compared with button grass. While couch was found in 9% of paddocks, it potentially underestimates the importance of this weed as it is a hardy, mat-forming perennial which spreads readily with seeding machinery. Annual ryegrass had the highest weed densities and infested the greatest number of paddocks.

Agzone 4 covers a significant range in latitude from North to South and had 29 broadleaf and nine grass weed species. Caltrop had the highest densities followed by paddy melon, Afghan melon, mintweed, wild radish and pigweed. Paddy melon was the most widespread summer weed followed by caltrop and small burrgrass. Roly-poly is also a significant weed, found in nearly 40% of paddocks with many plants being large and well-established. Button grass, stink grass and small burrgrass were found in significant densities.

Acknowledgements
Thanks to the GRDC for funding this project and Liebe Group for supplying contact details for cooperators.

References

Storrie, A.M. (2019) Identifying Western Australian summer weeds manual https://grdc.com.au/resources-and-publications/all-publications/publications/2019/identifying-western-australian-summer-weeds-manual

Cameron, J. & Storrie, A. (2014) Summer fallow management – a reference manual for grain growers and advisers in the Southern and Western grain regions of Australia. GRDC.

Michael PJ, Borger CP, MacLeod WJ, Payne PL (2010) Occurrence of summer fallow weeds within the grain belt region of southwestern Australia. Weed Technology 24, 562-568.

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Group G Comparison Trial

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Take Home Messages

- Glyphosate and paraquat efficacy can be improved by the addition of Group G herbicides.
- A tank mixture of Terrad'or @ 40 g/ha and CRUCIAL provides higher levels of annual ryegrass control where populations have a low level of glyphosate resistance; compared to glyphosate standalone.
- It is useful to understand the strengths and weaknesses of each product.
- Terrad'or (tiafenacil) provides an increased speed of brownout and improved final control of weeds compared to other Group G herbicides.
- Terrad'or is a brand new active ingredient for the Australian knockdown and fallow management market, providing improved weed control, no residual and short plant back periods for primary crop species.

Aim

To compare the efficacy of Terrad'or (700 g/kg tiafenacil) to other Group G (PPO) herbicides applied at their common use rates.

Background

- Group G herbicides are extensively used as a tank mix partner with a knockdown herbicide to improve control of a greater weed spectrum and increase the speed of brownout.
- Group G herbicides differ in their selectivity depending on dose rate as well as their chemical nature and ability to penetrate plasma membranes of different plant species. At registered rates, some will be active on only broadleaf weeds, whilst others are active on both broad-leafed and grass weeds.
- Groups G's have limited translocation in plants and are often referred to as contact herbicides.
- Terrad'or can penetrate plasma membranes of a wide range of weeds and has activity on both broadleaf and grass weed species.
- There is a wide range of Group G products available on the market.
- The application was made in early July and weeds were well established. Annual ryegrass had several tillers and capeweed rosettes were 5 to 20cm in size

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	10m x 3m x 3 replications
Soil type	Sandy loam
Weed population	5-20cm Capeweed, 15cm wild radish, tillering bromegrass and annual ryegrass
Application date	09/07/2020

Treatments

	Treatment	
1	Untreated control	
2	CRUCIAL	1000mL
3	CRUCIAL + Terrad'or *	1000mL + 20g
4	CRUCIAL + Terrad'or *	1000mL + 40g
5	Terrad'or *	40g
6	CRUCIAL + Nail 600 *	1000mL + 20mL
7	CRUCIAL + B-Power *	1000mL + 100mL
8	CRUCIAL + Sledge *	1000mL + 80mL
9	CRUCIAL + Sharpen *	1000mL + 17g

*1.0% v/v Banjo adjuvant added to treatments 3 – 9

Results

Figure 1: Capeweed Control at 29 days after application measured as a percentage of the untreated control.

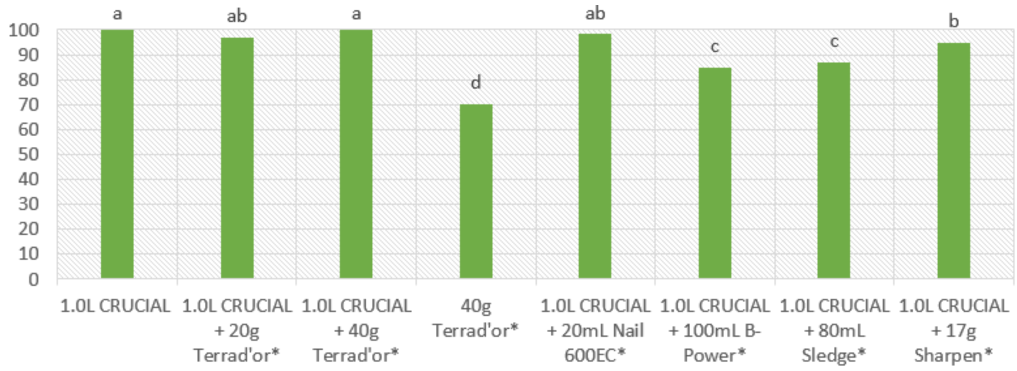

Table 1: Weed brownout and control as a % of the untreated control for Capeweed and Annual Ryegrass.

Location: West Latham, WA Year: 2020			Annual Ryegrass (Lolium rigidum)				Capeweed (Arctotheca calendula)			
			% Brownout		% Control		% Brownout		% Control	
Trt #	Treatment name	Product Rate	13 DAA %UNCK	EC	29 DAA %UNCK	EC	13 DAA %UNCK	AA EC	29 DAA %UNCK	AA EC
1	Untreated control	-	0		0		0		0	
2	CRUCIAL	1000 mL/ha	55	d	82	b	40	c	100	a
3	CRUCIAL Terrad'or	1000 mL/ha 20 g/ha	77	ab	97	a	77	ab	97	ab
4	CRUCIAL Terrad'or	1000 mL/ha 40 g/ha	88	a	98	a	93	a	100	a
5	Terrad'or	40 g/ha	33	e	37	c	73	b	70	d
6	CRUCIAL Nail 600EC	1000 mL/ha 20 mL/ha	63	bcd	95	a	52	c	98	ab
7	CRUCIAL B-Power	1000 mL/ha 100 mL/ha	72	bc	100	a	53	c	85	c
8	CRUCIAL Sledge	1000 mL/ha 80 mL/ha	63	bcd	100	a	52	c	87	c
9	CRUCIAL Sharpen	1000 mL/ha 17 g/ha	62	cd	98	a	77	ab	95	b
		LSD (P=0.5)		12.62	4.70 - 21.64		6.99		2.69 - 13.76	
		Standard Deviation		7.21	7.15t		3.99		5.39t	
		CV		11.23	9.3t		4.36		6.95t	
		Treatment Prob(F)		0.0001	0.0001		0.0001		0.0001	

*1.0% v/v Banjo adjuvant added to treatments 3 – 9
EC = Do not analyse untreated check, while still reporting treatment mean on AOV Means Table
AA = Automatic arcsine square root % transformation of means comparisons

Results

- CRUCIAL + 40g Terrad’or was the best performing treatment in general, with CRUCIAL + 20g Terrad’or not far behind in second place.
- CRUCIAL + 40g Terrad’or and CRUCIAL + 20g Terrad’or provided significantly higher early brownout of Capeweed at 13DAA compared to CRUCIAL + Nail 600EC, CRUCIAL + B-Power and CRUCIAL + Sledge.
- CRUCIAL + 40g Terrad’or provided significantly higher final control of capeweed at 29DAA compared to CRUCIAL + B-Power, CRUCIAL + Sledge and CRUCIAL + Sharpen.
- CRUCIAL + 20g Terrad’or provided significantly higher final control of capeweed at 29DAA compared to CRUCIAL + B-Power and CRUCIAL + Sledge.
- CRUCIAL + 40g Terrad’or and CRUCIAL + 20g Terrad’or provided significantly higher early brownout of annual ryegrass at 13DAA compared to CRUCIAL + Sharpen.
- All Group G herbicides tank-mixed with CRUCIAL provided equivalent final control of annual ryegrass.

Comments

The weed size and density on the trial site can present challenges for many Group G herbicides that are sensitive to coverage and may not be effective on larger weeds. Terrad'or (Tiafenacil) is not as sensitive to coverage and has more activity on larger weeds compared to most other PPO chemistry, mainly due to its ability to form highly reactive molecules that attack and destroy lipids and protein membranes. This activity helps to explain why it outperformed other Group G herbicides for final control of medium to large sized capeweed.

Acknowledgements

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Peer Review

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DISEASE & PEST RESEARCH RESULTS

Survey of the Summer/Autumn Brassica Refuges for Diamondback Moth in the Western Region to Predict Early Season Risk of Infestation

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Take Home Messages

- A late summer, early autumn green bridge may play a role in predicting diamondback moth (DBM) numbers, although initial results from 2020 suggest that there are likely other factors influencing winter DBM populations.
- It is important to monitor DBM populations by sweep netting as numbers can quickly increase above thresholds.
- Similarly, it is important to monitor DBM populations to avoid unnecessary spray applications.

Aim

To assess the role of Brassica green bridge on DBM presence and impact on winter / spring populations.

Background

Diamondback moth has unpredictable population dynamics with its timing and distribution difficult to determine. DBM has the ability to reproduce very fast (i.e. life cycle of about two weeks in warm spring temperatures), hence demonstrating explosive outbreak potential as has been seen in WA in some years. In order to improve timely and effective decision support for growers to manage DBM in canola crops, surveillance is being conducted throughout the five WA port zones to determine the Brassica hosts which may be present during summer and autumn and assess whether these hosts are providing a DBM reservoir bridging between growing seasons.

As part of a GRDC-funded project, staff from DPIRD, the Liebe Group, Mingenew Irwin Group and West Midlands Group found and identified DBM larvae in the March green bridge plants, including wild brassicas (e.g. wild radish) and volunteer canola. Pheromone moth traps were then set up at sites where we found brassica plants with moths and caterpillars monitored until late October to get a better idea of their spatial distribution.

Trial Details

Trial Location	WA Grainbelt (various locations) 42 Focus sites (Canola crop with a DBM trap) Geraldton (11) Kwinana West (10) Kwinana East (4) Albany (6) Esperance (12)
Start date	Green bridge survey – March/April Moth trapping July - October

March 2020 Green Bridge Survey

473 locations were inspected for the presence of brassica plants and DBM larvae throughout the five port zones, mostly from roadsides. Of the 473 sites, 61 sites (13%) had no live vegetation in the area. Most of these sites were in the Geraldton port zone (Figure 1). The South West part of the grainbelt received relatively less rainfall during February, and this area had fewer brassicas but was dominated mainly by the hardy summer weeds fleabane and stinkwort.

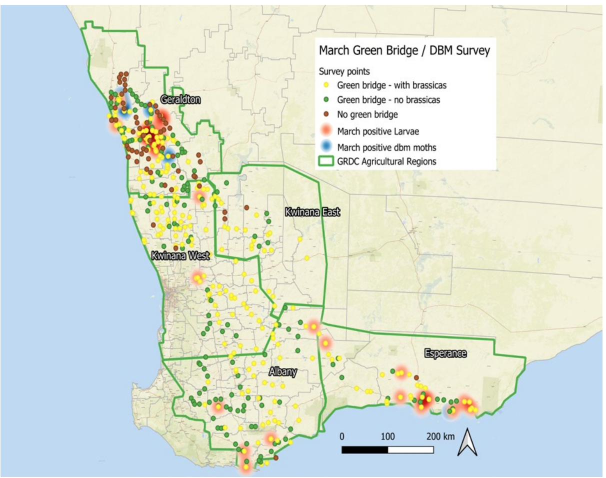

Figure 1: Map showing 473 locations inspected for brassica plants and DBM larvae during March 2020. Pheromone delta traps were set up for four weeks at each brassica location (yellow dots).

The team searched for DBM caterpillars and moths at each brassica location. DBM larvae were detected at 27 Brassica sites, ranging from 1-16 larvae found during 5-10 minute sampling events. We found moths at seven sites in the Geraldton region and one site near Esperance. It is evident that Geraldton and Esperance regions contained the highest number of positive sites and the fewest in Kwinana West and Kwinana East Port Zones. The DBM larvae were found on 4-leaf to flowering radish at 15 sites, 4-leaf to flowering canola at six sites, flowering sea rocket at 4 sites and flowering Lincoln weed at one site. The growth stage of brassicas at many sites were less than 4-leaf and little or no DBM larvae were found at these sites. We installed a DBM pheromone trap at each of the 180 brassica locations; four weeks later these were checked and removed.

Although it is not shown in Figure 1, it should be noted that a large portion of the March green bridge observed in the Geraldton region dried off in April and May. The break likely reduced or eliminated most DBM populations in the area.

April 2020 Green Bridge Survey

The team collected and counted moths caught in each of the March pheromone traps. Figure 2 shows the March and April moth and caterpillar collections. In order to investigate the influence of the green bridge and the subsequent DBM colonisation and population change in canola crops, 42 focus sites were chosen both near and far from DBM-positive green bridge sites in each Port Zone. Finding canola sites that were near green bridge positive DBM sites was at times difficult, although we did locate sixteen focus sites within 10km and three sites within 15km from a March/April positive DBM site.

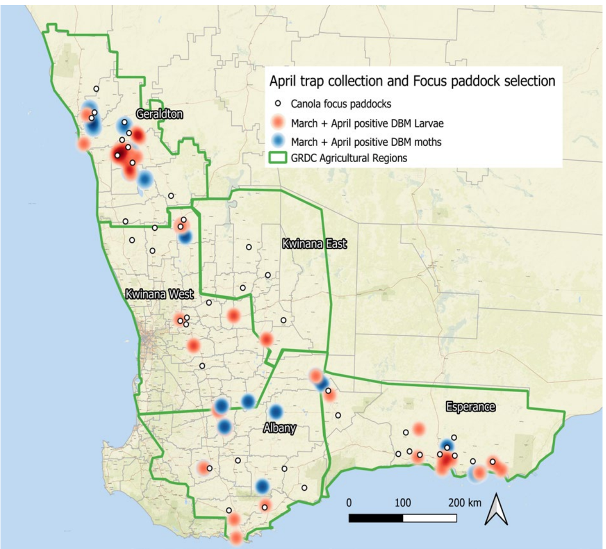

Figure 2: Map of DBM focus crops (white dots) in relation to DBM-positive March and April green bridge survey (red circles – caterpillars, blue circles – moths). Each red circle represents a 15km radius relative to a positive-DBM recording from the green bridge survey.

June - October focus crop results

Figure 3 shows the mean bimonthly DBM moth and caterpillar results for the 42 focus crops. The caterpillar populations increased through September and October, although not as rapidly as we would have expected considering the extensive pre seasonal rain and early moth detection. The project plans further investigation of growing seasonal conditions and insecticide use in the regions, which may have stifled potentially large populations of caterpillars at the focus sites.

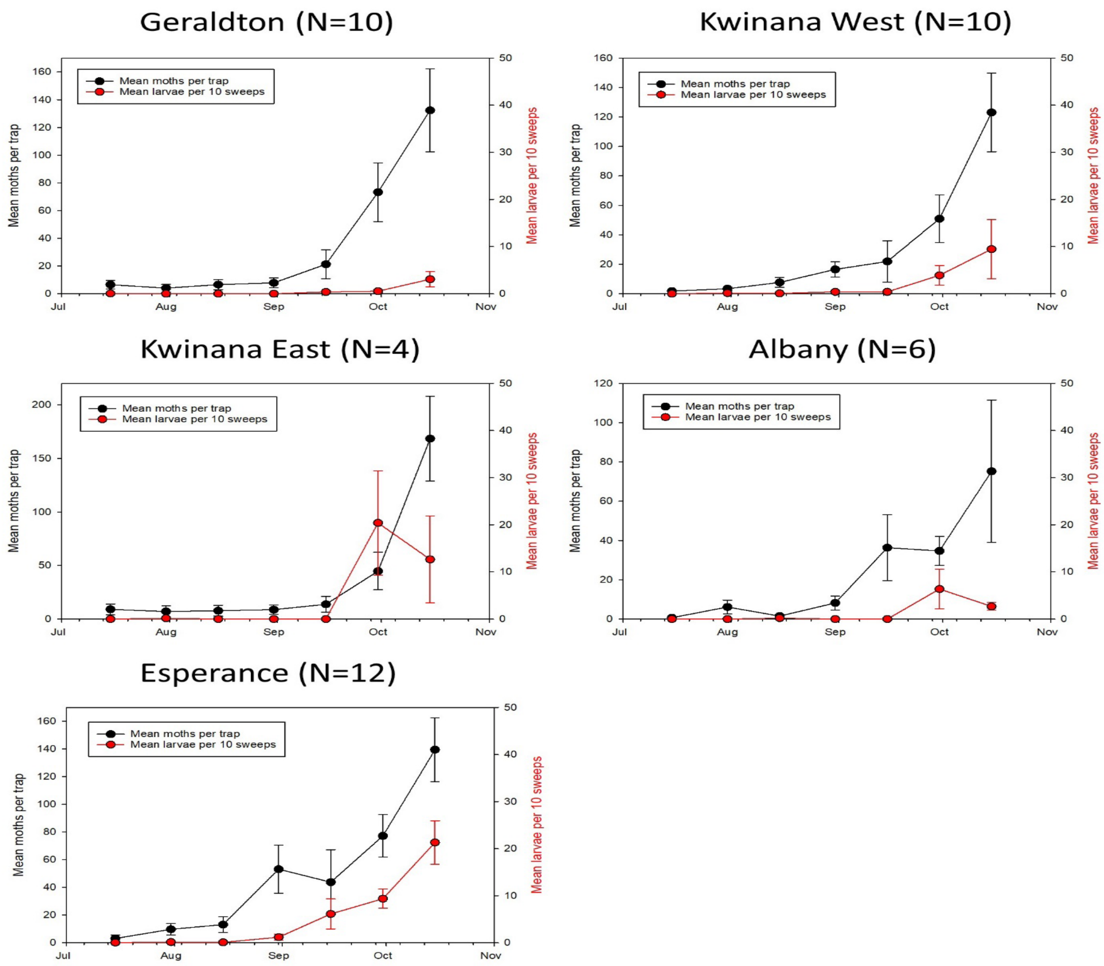

Figure 3: Mean DBM moth and caterpillars (+/- SEM) surveillance results for canola crops assessed from July to October 2020.

Detection of moths in the growing season began as far back as July. The running total (cumulative results) indicates the early August moth build up in Esperance may have set the region up for higher numbers in September and October.

Esperance experienced the highest populations of moths during the growing season, which corresponds to high numbers of caterpillars and moths found in the green bridge in the region in March. Interestingly high numbers of moths and caterpillars (relative to some other regions) developed towards the end of the season in the Kwinana East region, yet few caterpillars and moths were detected in March. Figures 4 and 5 spatially represents these numbers across the grainbelt.

The moth counts for each site and port zone are broken down into monthly mean moths in Figure 4 to see how moth populations changed over each month for each individual site. Similarly, Figure 5 shows DBM caterpillar distribution and numbers from July to October.

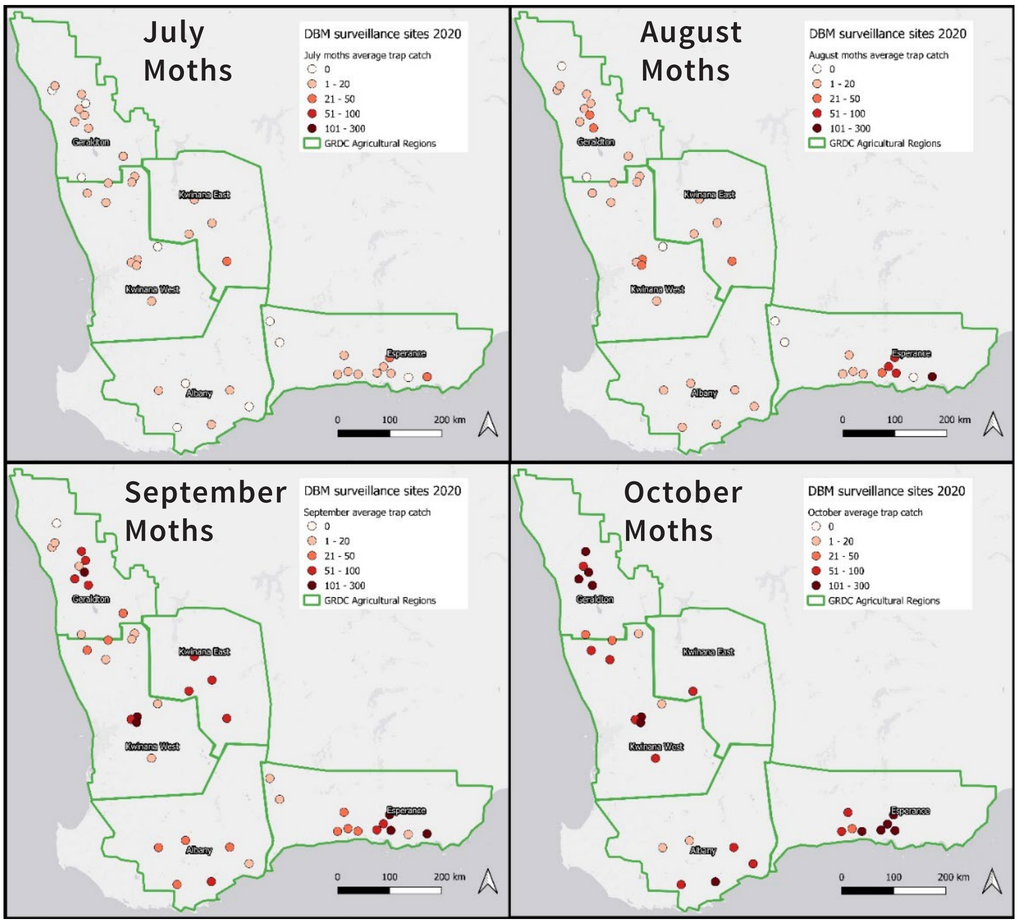

Figure 4: Monthly mean moth trap catch for focus sites

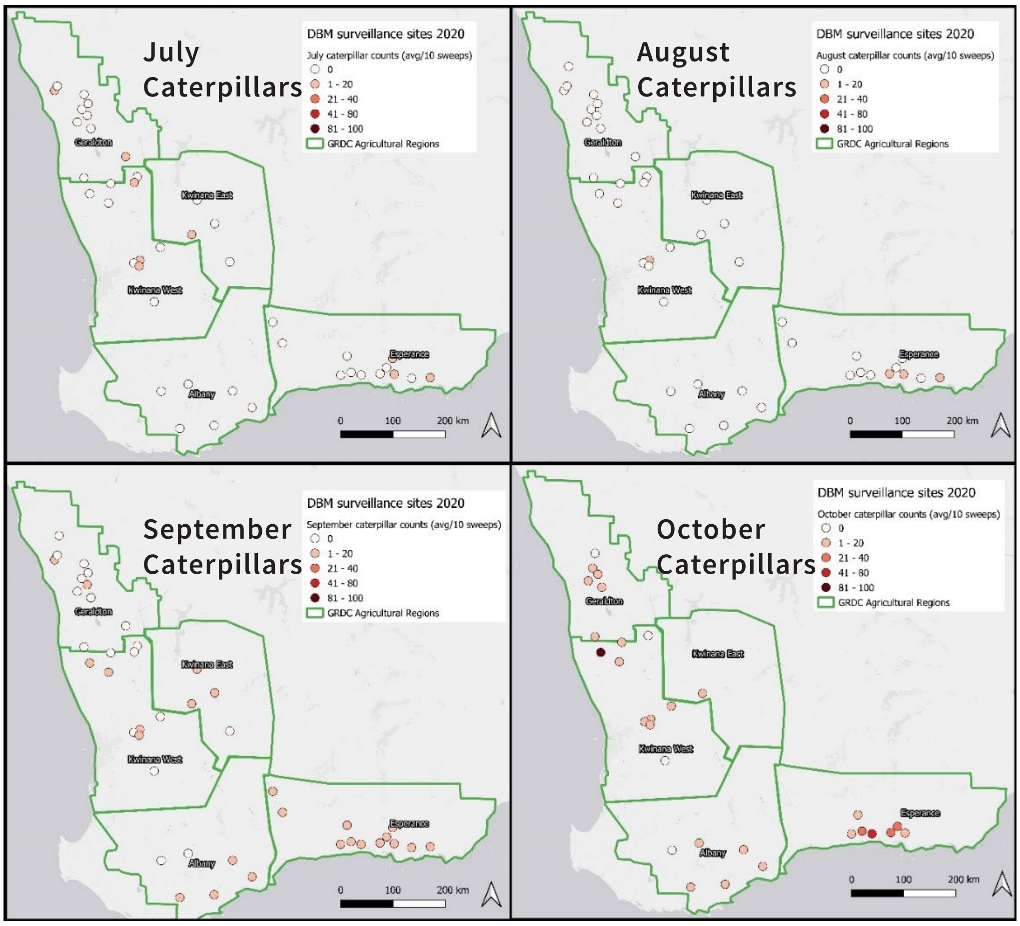

Figure 5: Monthly mean caterpillars per 10 sweeps for focus sites

Moth populations developed earlier in Esperance and Geraldton (Figure 4). Caterpillar numbers correlated well with high moth numbers in Esperance, although DBM caterpillars did not reach large numbers in Geraldton (Figure 5). We are currently collating grower insecticide data that may explain lower caterpillar numbers in some regions.

Discussion

It was important to follow DBM moth and caterpillar populations for all focus crops during 2020 given that none required insecticide application for DBM. This was regardless of whether sites were situated close or far from pre-season green bridge sites, which harbored DBM. This likely indicates that other factors, in addition to DBM in the green bridge, are influencing DBM populations. We will be continuing this project in 2021 to determine the roll of a green bridge, or its absence on DBM population and distribution.

Acknowledgements

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Peer review

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Impact of Soil Amelioration on Soilborne Pathogens, Nematode Pests and Weeds

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Take Home Messages

- Soil amelioration reduced the levels of *Pratylenchus neglectus* (RLN; root-lesion nematode), *Rhizoctonia solani* AG8 (Rhizoctonia bare patch), and *Heterodera avenae* (CCN; cereal cyst nematode) in the 0-10cm layer but increased levels at depth.
- Lime applied post amelioration on the soil surface without incorporation did not affect the distribution or the prevalence of the soilborne pathogen and nematode pests.
- Soil inversion was highly effective in reducing weed density and subsequent seed head production. Deep ripping stimulated weed emergence.
- Soil inversion out-yielded the control, deep ripping, and soil mixing treatments in both seasons. Soil inversion increased yield by 0.61 and 0.57 t/ha over the control in 2019 and 2020, respectively.

Aim

1. Compare the impact of three types of mechanical amelioration treatments and an un-ameliorated control on the prevalence and distribution of soilborne pathogens and nematode pests.
2. Determine if the addition of lime after mechanical amelioration influences the distribution and levels of soilborne pathogen inoculum and nematode pest levels.
3. Determine the effects of three types of mechanical amelioration on weed density, weed productivity, and crop yield.

Background

Growers in WA have widely adopted mechanical soil amelioration (deep ripping, soil mixing, and soil inversion) to manage sub-soil acidity, compaction, water repellence, and herbicide-resistant weeds. Mechanical soil amelioration methods lead to various degrees of soil mixing and can redistribute nematode pests, soilborne pathogens, and weed seeds throughout the soil profile. However, little is known about the changes in distribution and long-term survival of soilborne pathogens, nematodes, and weed seeds following soil amelioration in WA.

This investigation assesses changes and potential interactions in soil biology, chemistry, and the soil profile's physical properties for two growing seasons after soil amelioration. The three mechanical amelioration treatments and the control treatment were factorialised with post amelioration lime (+/- 2 t/ha). The types of mechanical amelioration were soil mixing (Imants 4m wide rotary spader), soil inversion (3-furrow Kverneland mouldboard plough), and deep ripping (2m wide Agroplow deep ripper capable of working to a depth of 45cm). All tillage implements worked to their maximum operating depth.

Trial Details

Trial location	Yerecoin	
Plot size & replication	20m x 2m x 6 replications	
Nematode pests	Root lesion nematode (RLN; *Pratylenchus neglectus*), cereal cyst nematode (CCN; *Heterodera avenae*)	
Soilborne pathogen	Rhizoctonia bare patch (*Rhizoctonia solani* AG8)	
Weeds	Great brome (*Bromus diandrus*), annual ryegrass (*Lolium rigidum*), barley grass (*Hordeum spp.*), and wild radish (*Raphanus raphanistrum*)	
Soil type	Yellow sandy earth	
Soil pH ($CaCl_2$)	0-10cm: 6.0 10-20cm: 4.8 20-30cm: 4.2 30-40cm: 4.2	
EC (dS/m)	0-10cm: 0.05 10-20cm: 0.03 20-30cm: 0.02 30-40cm: 0	
Soil Water Repellence	0-10cm: low	
Sub-soil compaction	15-50cm >2.5MPa	
Paddock rotation:	2016 Oats, 2017 Wheat, 2018 Wheaten hay	
	2019	**2020**
Sowing date	19/06/2019	28/05/2020
Sowing rate	La Trobe* barley (80 kg/ha) *Resistant (R) to CCN, moderately susceptible (MS) to *P. neglectus,* susceptible (S) to *R. solani*	Ninja* wheat (90 kg/ha) *Moderately susceptible (MS) to CCN, susceptible (S) to *P. neglectus*, susceptible to *R. solani*
Fertiliser	19/06/2019: K-start (100 kg/ha) banded & urea (30 kg/ha) topdressed 18/08/2019: Flexi N (60 L/ha)	28/05/2020: Agstar Extra (80 kg/ha) banded & urea (50 kg/ha) topdressed 14/07/2020: Flexi N (50 L/ha) 21/07/2020: Flexi N (50 L/ha) 06/08/2020: MOP (100 kg/ha)
Herbicides, Insecticides & Fungicides	18/06/2019: Spray.Seed® (2 L/ha) & Boxer Gold® (1.75 L/ha) 19/06/2019: Boxer Gold® (0.75 L/ha), Chlorpyrofos (0.2 L/ha) & Alpha-scud® (0.2 L/ha) PSPE 25/07/2019: Velocity® (0.8 L/ha) with 1% MSO 06/09/2019: Velocity® (0.8 L/ha) with 1% MSO	28/05/2020: Spray.Seed® (2 L/ha), Sakura (118 g/ha), Treflan® 480 (2 L/ha) 29/05/2020: Chlorpyrifos (0.2 L/ha) & Alpha-scud® (0.2 L/ha) 16/06/2020: Boxer Gold® (2.5 L/ha) 24/06/2020: Atlantis® (330 mL/ha) with 1% MSO 08/07/2020 Velocity® (0.8 L/ha) with 1% MSO 27/08/2020: Pirimor® (300 g/ha) with 1% spray oil
GSR	250mm	181mm

Results

Effect of mechanical amelioration on nematode pests and soilborne pathogens

At the beginning and end of each cropping season, we sampled soils at depths of 0-10, 10-20, 20-30, and 30-40cm, and the amount of pathogen DNA measured using PREDICTA®B (SARDI, SA). Due to COVID-19 restrictions, we only sampled the 0-10cm soil layer at the start of the 2020 cropping season. PREDICTA®B testing focused on *Pratylenchus neglectus* (RLN; root-lesion nematode), *Rhizoctonia solani* AG8 (Rhizoctonia bare patch), and *Heterodera avenae* (CCN; cereal cyst nematode) as these were the major nematode pests and soilborne pathogens present at the site.

Soil amelioration reduced pathogen levels in the 0-10cm layer but increased them at depth (Table 1). However, the redistribution differed by the type of amelioration, with the magnitude increasing with tillage intensity in the order: deep ripping < soil mixing < soil inversion (Table 1). These results indicate that soil amelioration significantly impacts the distribution of soilborne pathogens and nematode pests present in the soil. Soil inversion, which translocates soil but with limited mixing, buried the pathogen-laden topsoil and brought up pathogen-free subsoil to the surface.

Soil mixing (rotary spading) decreased pathogen levels in the topsoil while increasing them at depth.

Rotary spading mixes soil within the implement's working depth, although the different layers may, to some extent, remain segregated throughout the profile. This heterogeneity can be observed as patches of high organic matter content topsoil in a pattern that corresponds to each 'spade' action. Finally, we observed that deep ripping redistributed pathogens in the soil profile the least. Minimal soil mixing or soil translocation occurs with deep ripping, but some topsoil can fall into the slot behind the ripping tine and introduce pathogens at depth (Table 1).

Soil inversion and soil mixing treatments reduced *R. solani* inoculum in the topsoil, an effect that persisted over the two years. In contrast, at the end of the second year, *R. solani* levels were no different when comparing control plots and deep ripping treatment (Table 1). Rhizoctonia is a fungal pathogen that spreads through the soil matrix. Deep tillage before or at sowing is a traditional management strategy to disrupt the fungi's hyphal network so that the pathogen does not infect early root growth. These results suggest that soil movement created by inversion and mixing treatments successfully moved or mixed the Rhizoctonia inoculum deeper in the profile. Deep ripping, which has much less impact on the soil profile, did not create enough soil movement to redistribute the pathogen inoculum.

Both soil inversion and soil mixing reduced root-lesion nematode (RLN) in the topsoil by the end of the 2019 season compared to un-ameliorated plots. However, by the end of the 2020 season, there was no significant difference in topsoil RLN levels for mechanical amelioration treatments. Root lesion nematodes are vermiform (worm-like) and swim through the soil profile using soil pore spaces. This means that RLNs are relatively mobile over short distances and may have allowed the nematode population that had been physically displaced by inversion and mixing to re-establish in the topsoil over time.

Cereal cyst nematode (CCN) populations in the topsoil were unaffected by any amelioration treatment in the first season. CCN is a member of the *Heterodera* genus which are cyst nematodes. This genus is characterised by the hard covering that develops to protect its eggs making these nematodes very resistant to physical or chemical damage. So CCN would have been more protected from damage during the amelioration process. Differences between treatments may also have been masked by the resistant barley, which effectively reduced the CCN population. Differences in amelioration treatments became apparent by the finish of the second cereal crop after a more susceptible wheat variety was grown.

We also found that the pathogens investigated survived and persisted at depth (Table 1). Previous studies have shown that *Pratylenchus thornei*, a species of root-lesion nematodes can thrive in soils to a depth of 60 cm (Whish et al., 2017) but this is the first record of the three pathogens investigated here persisting and multiplying at depth in WA soils.

Management of soilborne disease and nematode pests is highly reliant on crop rotation and variety choice. Cereal crops are susceptible to all three dominant soilborne issues present in this paddock. To date, the trial area has had five consecutive cereal crops so it is unsurprising that *R. solani* and nematode pest populations in controls and some ameliorated treatments recorded levels that can cause significant yield loss (Table 2). *R. solani* is not influenced by cereal variety choice but nematode pests are, and results for this trial provide examples of this. For example, CCN numbers dropped to low levels in the topsoil for all treatments in 2019 when LaTrobe barley, a CCN resistant variety was grown. In 2020, CCN levels recovered as Ninja wheat, a variety moderately susceptible to CCN was grown (Table 2).

Table 1: DNA levels, as assessed by PREDICTA®B, of nematode pests and soilborne pathogens in ameliorated soil at Yerecoin to a depth of 40 cm at the start and end of 2019 and 2020 seasons. Red, green and yellow boxes indicate significant increases, decreases, or no difference, respectively when compared to the control (p<0.1).

			2019		2020	
Amelioration	Pathogen	Depth (cm)	Start of season	End of season	Start of season	End of season
Soil Inversion (Mould Board)	*P. neglectus*	0-10	▼	▼	◄►	◄►
		10-20	◄►	◄►		◄►
		20-30	▲	▲		▲
		30-40				◄►
	R. solani	0-10	▼	▼	▼	▼
		10-20	▲	▲		▲
		20-30	▲	▲		◄►
		30-40				◄►
	H. avenae	0-10	◄►	◄►	◄►	▼
		10-20	◄►	▲		◄►
		20-30	▲	▲		◄►
		30-40				◄►
Soil Mixing (Rotary Spade)	*P. neglectus*	0-10	◄►	▼	▲	◄►
		10-20	▲	▲		▲
		20-30	▲	▲		▲
		30-40				◄►
	R. solani	0-10	◄►	▼	▼	▼
		10-20	◄►	▲		▲
		20-30	▲	▲		▲
		30-40				◄►
	H. avenae	0-10	◄►	◄►	◄►	▼
		10-20	◄►	▲		▲
		20-30	▲	▲		▲
		30-40				▲
Deep Ripping	*P. neglectus*	0-10	◄►	◄►	◄►	◄►
		10-20	◄►	◄►		◄►
		20-30	▲	◄►		▲
		30-40				▲
	R. solani	0-10	◄►	▼	◄►	◄►
		10-20	▲	▲		▲
		20-30	◄►	◄►		◄►
		30-040				◄►
	H. avenae	0-10	◄►	◄►	◄►	◄►
		10-20	▲	◄►		▲
		20-30	▲	▲		◄►
		30-40				◄►

Key
- ◄► Same as control
- ▼ Lower than control
- ▲ Higher than control
- (blank) Not analysed

Table 2: Pathogen inoculum levels in the topsoil (0-10 cm) measured at Yerecoin using PREDICTA®B and their associated wheat yield loss risk categories over two seasons post amelioration.

		2019		2020	
		Start	End	Start	End
Soil Inversion	P. neglectus nem /g soil	3.36 (Low)	3.14 (Low)	1.79 (Low)	10.90 (Medium)
	R. solani AG8 log(pg DNA/g soil	1.16 (Low)	1.75 (Medium)	1.19 (Low)	1.69 (Medium)
	CCN eggs /g soil	10.38 (High)	1.16 (Low)	0.53 (Low)	1.59 (Low)
Soil Mixing	P. neglectus nem /g soil	4.71 (Low)	3.96 (Low)	3.73 (Low)	15.54 (Medium)
	R. solani AG8 log(pg DNA/g soil	1.51 (Medium)	1.99 (Medium)	1.53 (Medium)	2.14 (High)
	CCN eggs /g soil	10.38 (High)	1.25 (Low)	0.94 (Low)	3.25 (Low)
Deep Ripping	P. neglectus nem /g soil	5.49 (Low)	8.15 (Medium)	2.19 (Medium)	12.24 (Medium)
	R. solani AG8 log(pg DNA/g soil	1.40 (Low)	2.28 (High)	2.01 (High)	2.54 (High)
	CCN eggs /g soil	13.9 (High)	1.28 (Low)	1.15 (Low)	7.36 (Medium)
Control	P. neglectus nem /g soil	5.27 (Medium)	8.30 (Medium)	2.33 (Low)	10.98 (Medium)
	R. solani AG8 log(pg DNA/g soil	1.66 (Medium)	2.46 (High)	1.91 (Low)	2.35 (High)
	CCN eggs /g soil	13.34 (High)	1.35 (Low)	1.06 (Low)	5.79 (Medium)

* Disease Risk
- Low
- Medium
- High

Effect of surface-applied lime on nematode pests and soilborne pathogens

The topsoil (0-10 cm) at the trial site had a pH_{CaCl2} of six while the subsoil had a pH of 4.8 at 10-20 cm and 4.2 from 20-40 cm (see Trial Details). Deep mixing and inversion treatments incorporated the topsoil into the top 35 cm of the profile, decreasing the topsoil's pH and increasing it at depth (Figure 1). Lime applied after amelioration did not affect soil pH in the low-soil-disturbance treatments (deep ripping and control) but increased the topsoil pH in soil inversion and deep mixing treatments (Figure 1).

Lime applied post amelioration on the soil surface without incorporation had no significant effect on the distribution and prevalence of soilborne pathogens and nematode pests (data not shown). This is likely because the unincorporated lime did not substantially alter the pH of the soil profile (Figure 1).

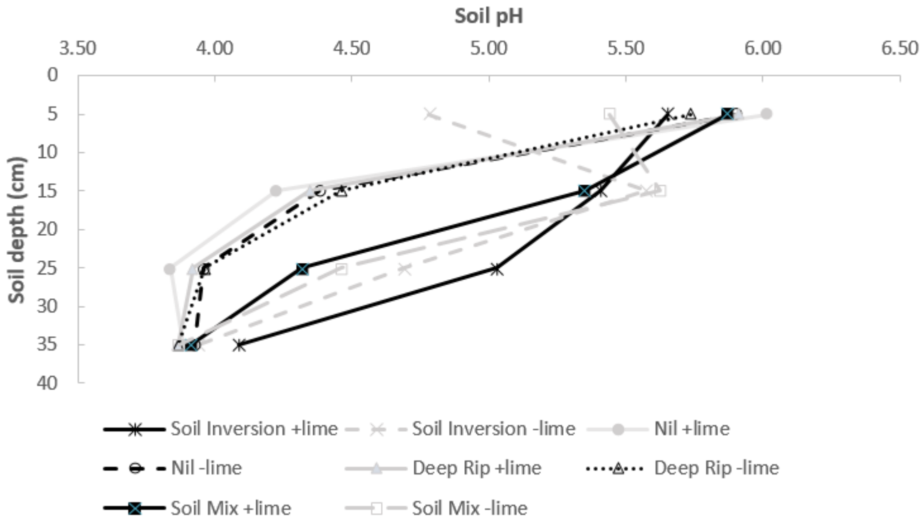

Figure 1: Soil pH_{CaCl2} at the Yerecoin trial site to a depth of 40cm in the second season (2020). The optimal pH for crop growth is 5.5 in the topsoil and 4.8 in the subsurface.

Effects of mechanical amelioration on weed density and productivity

Full soil inversion was highly effective in reducing weed density and subsequent seed head production of all weed species (Table 3). Soil inversion buried weed seed at a depth sufficient to prevent emergence. Deep ripping stimulated weed emergence (compared to deep mixing in 2019 and compared to all treatments in 2020) and had the highest seed head production in both years. In contrast, weed emergence and seed head production in the deep mixing treatment were not significantly different from the control in both years. The lime application did not affect weed growth.

Crop performance

Soil amelioration affected crop establishment with deep mixing and soil inversion having fewer plants per m^2 in both years than the control (Table 3). Lime did not significantly affect crop establishment or yield (data not shown). However, the amelioration technique influenced yield. Soil inversion was the highest yielding treatment in both years, increasing yield by an estimated 0.61 and 0.57 t/ha over the control in 2019 and 2020, respectively (Table 3).

Table 3: Effect of soil amelioration on weed density, seed head set, crop establishment, and yield at Yerecoin in 2019 and 2020. Letters indicate where means are significantly different (P<0.05).

Amelioration	Grass weed density (plants/m²)		Grass weed head (number/m²)		Plant establishment (plants/m²)		Yield (t/ha)	
	2019	2020	2019	2020	2019	2020	2019	2020
Control	88bc	115b	113b	202b	115b	117c	0.55a	2.49a
Deep ripping	120c	207c	163c	324c	115b	112bc	0.62a	2.63a
Deep mixing	32ab	57ab	97b	100ab	100a	102ab	0.66a	2.64ab
Soil inversion	0a	12a	5a	10a	96a	91a	1.16b	3.06b

Comments

Mechanical soil amelioration had a significant impact on the distribution of nematode pests and soilborne pathogens in soils. Generally, amelioration decreased pathogen levels in the topsoil and increased them deeper in the profile. The soil-borne pathogen and nematode pests we focused on in this study survived and persisted at depth over two years. The disease implications of their continued presence and multiplication at depth are unclear and need investigation.

Surface-applied lime did not affect the levels of *R. solani*, *P. neglectus,* and *H. avenae*. We did not incorporate the lime. Consequently, we did not observe substantial pH changes at a depth beyond that which occurs from incorporating higher pH topsoil with the mixing and inversion implements. We hypothesise that lime needs to be incorporated to significantly affect soil biology, though even in the top 10cm, where lime did slightly increase the soil pH of the inversion and mixing treatments there was no evidence of differences in pest or pathogen levels. Soil pH is a major driver of soil microbial diversity and further research is required to understand the interactions between soil pH and soilborne pathogens and nematode pests.

Soil inversion significantly reduced weeds at the site, indicating that this treatment buried weed seed at a depth sufficient to prevent emergence. Deep ripping stimulated weed emergence. Soil inversion provided the most significant benefit to crop yield in the first year, likely because it had benefits in reducing the impact of both the soil and biological constraints, especially weeds.

Acknowledgements

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Peer Review:

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References

Whish, J. P. M., Thompson, J. P., Clewett, T. G., Wood, J., & Rostad, H. E. (2017). Predicting the slow decline of root lesion nematodes (*Pratylenchus thornei*) during host-free fallows to improve farm management decisions. *European Journal of Agronomy*, 91, 44-53. doi:https://doi.org/10.1016/j.eja.2017.09.012

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EverGol® Energy: Comparing the Efficacy of Seed Treatments on Loose Smut in Barley When Applied at Different Slurry Volumes

Matt Willis, Market Development Agronomist (WA North), Bayer Crop Science

Take Home Messages

- Loose smut can cause large yield losses in barley crops when left uncontrolled.
- Seed treatments can be an effective form of controlling loose smut, however, due to the lifecycle of loose smut, it is crucial that good seed coverage is achieved at application.

Aim

1. To compare seed treatments for their efficacy on loose smut in barley.
2. To compare two different application volumes for each product to show the difference in seed treatment performance.

Background

Loose smut in barley is the hardest of the smut diseases to control. Barley crops infected with loose smut will have the characteristic dark spore filled heads within the crop, but this is actually the appearance of infection from the previous season which has been within the seed. These spores will infect other neighbouring crops at flowering time leaving the infected grain looking completely normal. Moist conditions at flowering combined with mild temperatures will favour infection. When the seed is sown and germination occurs the following season, the fungus will begin to grow within the plant with a mass of spores replacing the head and continuing the disease cycle.

Due to the lifecycle of loose smut, a fungicidal seed treatment that penetrates the seed at germination is required to control the disease. Most smut diseases can be controlled by a seed treatment that sterilises the surface of the seed but this is not the case for loose smut as the fungus is within the seed. Due to this, good coverage at application is particularly important when treated for loose smut.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	10m x 2m x 3 replications
Soil type	Yellow-grey loamy sand
Soil pH ($CaCl_2$)	0-10cm: 6.0 10-20cm: 4.7 20-30cm: 4.5
EC (dS/m)	0-10cm: 0.042 10-20cm: 0.025 20-30cm: 0.027
Paddock rotation	2019 TruFlex Canola, 2018 Wheat, 2017 Wheat
Sowing date	27/05/2020
Sowing rate	75 kg/ha Spartacus CL barley, treated as per treatment list + 240 mL/100kg Gaucho®.
Fertiliser	27/05/2020: 100 kg/ha Macro Pro + 80 kg/ha urea (drilled)
Herbicides, Insecticides & Fungicides	27/05/2020: 2.0 L/ha Roundup® UltraMax® + 250 g/ha diuron + 80 g/ha clopyralid + 2.0 L/ha trifluralin + 1.5 L/ha triallate + 1.0 L/ha chlorpyrifos + 100 mL/ha bifenthrin. 15/07/2020: 800 mL/ha Velocity® + 1% v/v Hasten® 01/08/2020: 500 mL/ha Aviator® Xpro + 50 g/ha Transform®.

Seed Treatments used

Baytan®-T: 150 g/L triadimenol + 4 g/L triflumuron
Rancona® Dimension: 25 g/L ipconazole + 20 g/L metalaxyl
EverGol® Energy: 76.8 g/L prothioconazole + 38.4 g/L penflufen + 61.4 g/L metalaxyl
Vibrance®: 66.2 g/L difenoconazole + 13.8 g/L sedaxane + 16.5 g/L metalaxyl-m
Systiva®: 333 g/L fluxapyroxad

Treatments

	Seed treatment	Application slurry volume	Variable Cost (70 kg/ha seeding rate)
1	Untreated		$0.00/ha
2	Baytan-T 1.5 L/tonne seed	6L per tonne seed	$2.30/ha
3	Rancona Dimension 0.8 L/tonne seed	3L per tonne seed	$2.38/ha
4	Rancona Dimension 0.8 L/tonne seed	6L per tonne seed	$2.38/ha
5	Vibrance 1.8 L/tonne seed	3L per tonne seed	$4.59/ha
6	Vibrance 1.8 L/tonne seed	6L per tonne seed	$4.59/ha
7	EverGol Energy 1.30 L/tonne seed	3L per tonne seed	$4.96/ha
8	EverGol Energy 1.30 L/tonne seed	6L per tonne seed	$4.96/ha
9	Systiva 1.5 L/tonne seed	3L per tonne seed	$20.90/ha
10	Systiva 1.5 L/tonne seed	6L per tonne seed	$20.90/ha
11	Coded Product 1	3L per tonne seed	N/A
12	Coded Product 1	6L per tonne seed	N/A
13	EverGol Energy 2.6 L/tonne seed	6L per tonne seed	$9.92/ha
14	Coded Product 2	6L per tonne seed	N/A

Results

Plant establishment counts were conducted on the 17th of July, 21 days after seeding. The untreated control had an establishment of 154.4 barley plants/m² (see Table 1). The 150 mL/100kg Baytan-T treatment had significantly lower ($P \leq 0.05$) establishment, with only 114.6 plants/m² (74.2% of the untreated), whilst all other treatments were not significantly ($P \leq 0.05$) different.

Crop safety was also assessed at this timing, looking for crop discolouration or a reduction in biomass relative to the untreated control (Table 1). There was no crop discolouration detectable in any of the treatments, however, there were some biomass reductions visible. Most notable was a 12% biomass reduction in the 150mL/100kg Baytan-T treatment. All other treatments had negligible or no reduction in biomass.

Whole plot loose smut counts were conducted on the 10th of September, 106 days after seeding, with the number of heads affected by smut being counted. From this, it was calculated that the untreated control had a loose smut infection of 1.1115% (Table 2). All treatments significantly ($P \leq 0.05$) reduced the level of loose smut present. The highest level of control was achieved by all EverGol Energy treatments, with 100% control at both rates and slurry volumes. Vibrance and Baytan-T were not statistically ($P \leq 0.05$) different to the EverGol Energy, nor was Systiva with the low slurry volume however there was a reduction in control at the higher slurry volume (only 88.1% control). Rancona Dimension provided the worst control of loose smut, with significantly ($P \leq 0.05$) lower levels of protection at both slurry volumes: 68.9% control with a 3 L/t slurry, and 78.7% control with a 6 L/t slurry.

The plots were harvested on the 1st of December to determine crop yield and grain quality. At this time of writing the grain quality data was not available, but there was no significant difference ($P \leq 0.05$) in yield for any of the treatments (Table 2). However, only the 150 mL/100 kg Baytan-T treatment yielded lower than the untreated, with a 4.1% reduction in yield. The highest yielding treatment was 260mL/100kg EverGol Energy, with a 13.0% increase in yield relative to the untreated.

Table 1: Barley plant establishment counts and crop phytotoxicity assessments (both plant discolouration and biomass reduction ratings) taken 21 days after seeding. Means followed by the same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

			Assessment date: 17-Jun-20				
			Crop growth stage: 21 DAS (Z13)				
	Seed Treatment	**Slurry Volume**	**Establish. (plants/ m²)**		**Establish. %**	**Phyto Discolour%**	**Phyto Biom Reduct%**
1	Untreated		154.4	a	100.0	0	0
2	150 mL/100 kg Baytan T	6 L/t	114.6	b	74.2	0	12
3	80 mL/100 kg Rancona Dimension	3 L/t	146.1	a	94.6	0	2
4	80 mL/100 kg Rancona Dimension	6 L/t	143.9	a	93.2	0	0
5	180 mL/100 kg Vibrance	3 L/t	156.6	a	101.4	0	3
6	180 mL/100 kg Vibrance	6 L/t	143.5	a	92.9	0	2
7	130 mL/100 kg EverGol Energy	3 L/t	145.2	a	94.1	0	2
8	130 mL/100 kg EverGol Energy	6 L/t	136.0	a	88.1	0	0
9	150 mL/100 kg Systiva	3 L/t	145.2	a	94.1	0	2
10	150 mL/100 kg Systiva	6 L/t	146.1	a	94.6	0	0
11	260 mL/100 kg EverGol Energy	6 L/t	138.7	a	89.8	0	2
		LSD P=.05	19.62				
		Std. Deviation	11.69				
		CV	8.10				

Table 2: Loose smut infection assessments (106 days after seeding) and final crop yield. Means followed by the same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

		Assessment date:	10-Sep-20			01-Dec-20		
		Crop growth stage:	106 DAS (Z71)			188 DAS (Z99)		
	Seed Treatment	**Slurry Volume**	**Loose smut infect%**		**% Loose smut control**	**Yield (t/ ha)**		**% UTC Yield**
1	Untreated		1.1115	a	0	0.924	-	100
2	150 mL/100 kg Baytan T	6 L/t	0.0738	d	95.1	0.885	-	95.9
3	80 mL/100 kg Rancona Dimension	3 L/t	0.3594	b	68.9	0.940	-	101.8
4	80 mL/100 kg Rancona Dimension	6 L/t	0.2515	bc	78.7	0.983	-	106.5
5	180 mL/100 kg Vibrance	3 L/t	0.0168	d	98.4	0.950	-	102.8
6	180 mL/100 kg Vibrance	6 L/t	0.0551	d	95.1	0.998	-	108.0
7	130 mL/100 kg EverGol Energy	3 L/t	0.0000	d	100	1.002	-	108.5
8	130 mL/100 kg EverGol Energy	6 L/t	0.0000	d	100	1.029	-	111.4
9	150 mL/100 kg Systiva	3 L/t	0.0176	d	98.4	0.938	-	101.6
10	150 mL/100 kg Systiva	6 L/t	0.1355	cd	88.5	0.957	-	103.6
11	260 mL/100 kg EverGol Energy	6 L/t	0.0000	d	100	1.043	-	113.0
		LSD P=.05	0.1249			0.111		
		Std. Deviation	0.0744			0.066		
		CV	51.5500			6.830		

Comments

The potential from early generation triazoles (i.e. Baytan-T) for shortening of the coleoptile was evident in the biomass reduction ratings and lower crop establishment values seen in this trial. Newer SDHI fungicide seed treatments such as EverGol Energy, Vibrance and Systiva are much safer on the crop, and this can be seen in these results, with no significant difference ($P \leq 0.05$) when compared to the untreated control.

The newer seed treatments containing SDHI active ingredients EverGol Energy, Vibrance and Systiva also all provided very high levels of loose smut control. EverGol Energy showed excellent control, with a 100% reduction in loose smut in all treatments. Rancona Dimension, which does not contain an SDHI active, only provided 68.9% and 78.7% control respectively at the low and high slurry volumes. An effective loose smut seed treatment strategy requires extremely high levels of control to keep smut infection in a seed source under control: each smutted head that is able to release spores whilst the crop is flowering can infect thousands of plants, contributing to an increased disease incidence the following season.

The difference in loose smut protection provided by higher and lower slurry application volumes in this trial was not clear. Both EverGol Energy and Vibrance provided such high levels of control that it was too difficult to separate the 3 L/t and 6 L/t treatments statistically, and the Systiva treatments had the inverse occur to what was expected: with the higher slurry volume resulting in lower levels of loose smut control. However, the poorer performing seed treatment Rancona Dimension was best able to demonstrate the benefits of applying the seed treatment in a higher slurry volume, with control increasing from 68.9 to 78.7% with just the addition of water to the slurry to improve coverage. It is suspected that these differences may have been clearer in more challenging conditions at establishment, with this trial being sown into moisture possibly resulting in good penetration of the seed treatment through the seed wall.
Previous work by Rick Horbury at Liebe Group in 2016 when there was a very dry start showed a much more significant reduction in control at lower slurry volumes.

Acknowledgements

Thanks to Dylan Hirsch and the Liebe Group for hosting the site, and to Living Farm for conducting the trial.

Peer review

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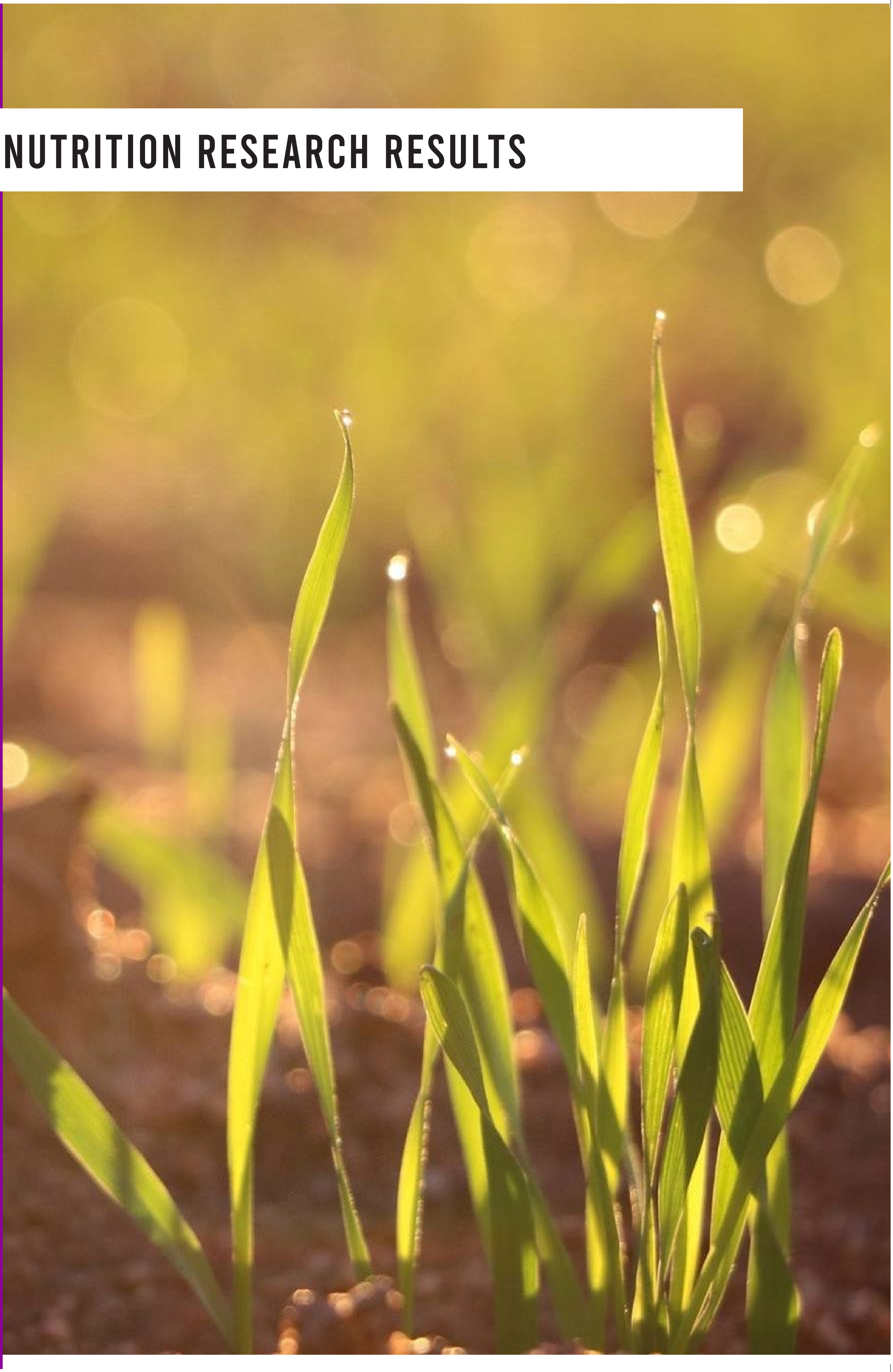
NUTRITION RESEARCH RESULTS



DKP: A High Analysis Liquid Fertiliser

Dr. Peter Keating, Managing Director, Bioscience Pty Ltd

Take Home Messages

- Liquid DKP significantly increased initial canopy cover (P < 0.001) compared to standard farmer practice.
- DKP and standard farmer practice produced comparable plant nutrition throughout the season.
- Lower fertiliser rates in DKP treatments had no significant effect on grain yield (P = 0.065).

Aim

To assess the effect of liquid DKP (di-potassium phosphate) on wheat emergence, in-season plant nutrition, and grain yield compared with standard farmer practice. Given that this a pilot trial, another aim was to inform optimisation of fertiliser application rates, timing, and placement for future trials.

Background

Farmers are increasingly using liquid fertilisers at seeding and as foliar top-up sprays. Liquid fertilisers allow higher use efficiency and flexibility than granular products. Some liquid products currently on the market can be expensive and are derived for horticultural industries where higher input costs are less of an issue. DKP was specifically designed for economical broadacre use.

The product is a central part of a new system under development, wherein farmers apply minimal amounts of fertiliser at seeding. Then, more P fertiliser can be applied via foliar sprays depending on how the season progresses. This can be done via boom spray alongside other products such as herbicides or nitrogen fertilisers. This is intended to give farmers much greater flexibility to respond to rainfall, and to base fertiliser decisions on crop nutrition in step with the season. It is further anticipated that applying most fertilisers to leaves rather than to soils will improve uptake efficiency and soil health by avoiding carbon rundown.

Trial Details

Trial location	Main Trial Site, Hirsch Property, Latham
Plot size & replication	10m x 2m x 6 replications
Soil type	Yellow sandy loam
Paddock rotation	2019 Canola, 2018 Wheat, 2017 Wheat
Sowing date	02/06/2020
Sowing rate	70 kg/ha Chief wheat
Fertiliser	See Treatment Table (Table 1 and 2)
Herbicides, Insecticides & Fungicides	02/06/2020 Glyphosate 2L, Trifluralin 2L, Sakura 118g, Ammonium Sulphate 750g (buffering agent)
Growing Season rainfall	162mm (April-October)

Soil Composition

Nine soil samples from within the trial area showed good soil pH but relatively low levels of soil carbon. Soil EC was conducive to plant growth and concentrations of N, P, and K were adequate.

Analyte	EC	$pH_{(CaCl2)}$	$pH_{(H2O)}$	NH_4-N	NO_3-N	PO_4-P	Ex K	Ex Ca	Ex Mg	Ex Na	C
Unit	mS/cm	-	-	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
Range	0.051 - 0.076	5.76 - 6.33	6.47 - 7.03	14.2 - 29.4	13 – 22	8.4 - 31	28.2 - 59.6	264 - 650	34 - 66.4	28.4 - 254	0.43 - 0.72

Treatments

Four different treatments were applied at seeding (Table 1) with four different foliar sprays (Table 2) applied twice in a fully factorial, randomised block design with six replicates per treatment. This resulted in 24 individual treatments replicated six times (96 plots, 10m x 2m).

Table 1: Treatments at seeding (2nd of June 2020).

	Seeding Treatments			Macronutrient inputs		
Treatment	**Banded UAN (L/ha)**	**Banded MAP (kg/ha)**	**Seed bed DKP (L/ha)**	**N (kg/ha)**	**P (kg/ha)**	**K (kg/ha)**
T1 (Farmer Practice)	70	35	0	26	8	0
T2	35	0	10	11	2	4
T3	35	0	20	11	4	8
T4	35	17	10	11	6	4

Table 2: Spray treatments.

	First spray (45 DAS, tillering)			Second spray (78 DAS, stem extension)		
	Flexi-N (L/ha)	**DKP (L/ha)**	**Bioprime Trace (L/ha)**	**Flexi-N (L/ha)**	**DKP (L/ha)**	**Bioprime Trace (L/ha)**
A (Farmer practice)	40	0	0	40	0	0
B	25	8	0	25	8	0
C	25	15	0	25	15	0
D	19	9	3	25	8	3

Results

Treatments that included DKP at seeding (T2 – T4) resulted in a significant increase in canopy cover 21 days later (Figure 1, $P < 0.001$). This effect was somewhat subdued in T4 where a combination of DKP and granular MAP (Table 1) was used.

Plant nutrition 45 days after seeding and before the first foliar spray showed that T1 (farmer practice) had significantly higher concentrations of leaf nitrogen ($P < 0.01$, Figure 2A) than the other three treatments. Leaf phosphate concentrations were significantly higher in T1 than in T2 ($P < 0.01$) but not T2 and T4 (Figure 2B). There were no significant differences in leaf K concentrations between treatments ($P = 0.067$). These results are unsurprising given that T1 received higher rates of N and P during seeding (Table 1).

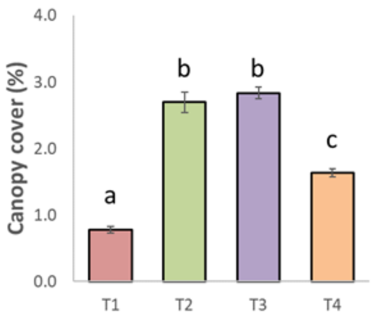


Figure 1: Canopy cover 21 days after seeding.

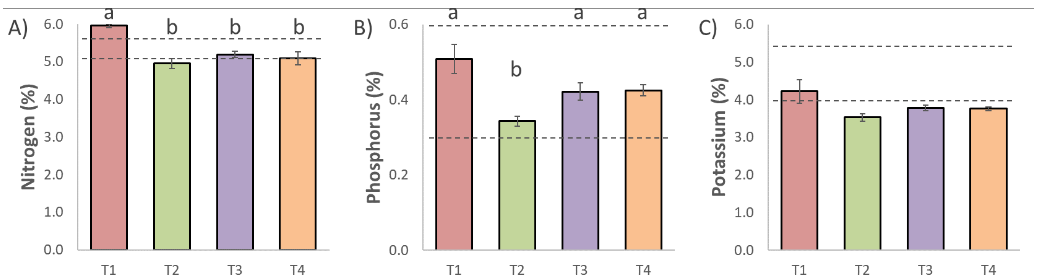


Figure 2: Leaf tissue analyses (45 DAS, tillering). A) Nitrogen, B) Phosphate, C) Potassium before first spray. Grey dotted lines indicate ideal ranges for each element for wheat at tillering.

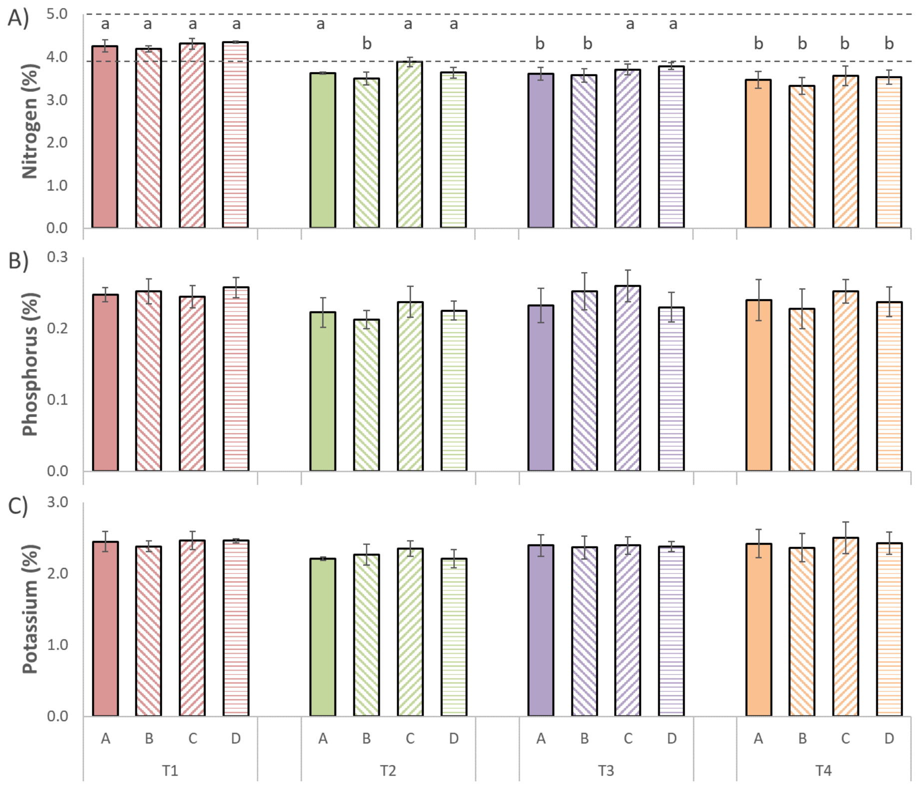


Figure 3: Leaf tissue analyses (78 DAS, stem extension). A) Nitrogen, B) Phosphate, C) Potassium. Before second spray. Grey dotted lines indicate ideal ranges for N. Ideal rages for P (0.3% - 0.6%) and K (3.5% -5.5%) are outside the value depicted.

The second round of leaf tissue analyses conducted 78 days after seeding and before the second foliar sprays showed significant differences in leaf N concentrations (P < 0.001, Figure 3A). However, there were no significant differences for P (P = 0.947) and K (P = 0.707) nutrition.

Yields ranged from 1.16 t/ha to 1.34 t/ha across all treatments. This is within the predicted rainfall yield potential of 0.85 t/ha for a dry finish and 1.70 t/ha for a normal finish for the 161 mm of seasonal rainfall received (www.soilquality.org.au, 2020) with very low rainfall during August and September. There were no significant differences in yields between the 16 treatments (Figure 4, Table 3, *P* = 0.065) despite marked differences in fertiliser inputs (Table 4). However, a trend of decreased yields was evident for T2 (on average -4.0% compared to farmer practice [T1A]), while there was a trend of yield increases for T3 (on average +3.6% compared to farmer practice [T1A]) and T4 (on average +2.4% compared to farmer practice [T1A]).

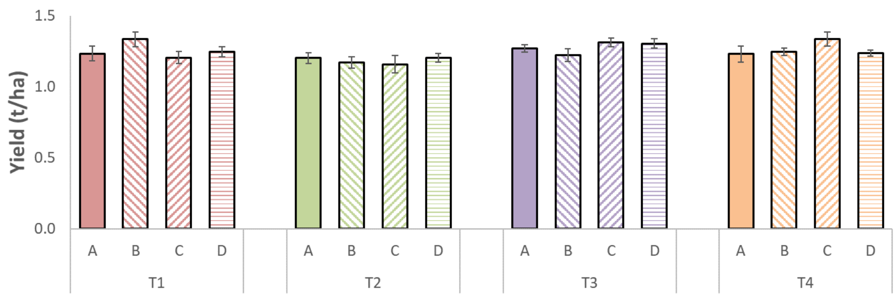


Figure 4: Grain yields for 16 treatments.

Table 3: Impact of Macro Nutrient input on wheat yield. *awaiting protein and screening data

	Total macronutrients applied (Sum of seeding and foliar treatments)			Grain yield				
	N (kg/ha)	P (kg/ha)	K (kg/ha)	Yield (t/ha)	Standard Deviation	Variance	Standard Error	% change to T1A
T1 A	52	8	0	1.23	0.13	0.02	0.05	0.0%
T1 B	42	10	6	1.33	0.13	0.02	0.05	8.1%
T1 C	42	12	11	1.21	0.10	0.01	0.04	-2.3%
T1 D	40	10	6	1.25	0.09	0.01	0.04	1.2%
T2 A	37	2	4	1.20	0.09	0.01	0.04	-2.5%
T2 B	27	4	10	1.17	0.10	0.01	0.04	-5.0%
T2 C	27	6	15	1.16	0.15	0.02	0.06	-6.2%
T2 D	25	4	10	1.20	0.07	0.01	0.03	-2.4%
T3 A	37	3	8	1.27	0.06	0.00	0.03	3.1%
T3 B	27	5	14	1.22	0.11	0.01	0.04	-0.9%
T3 C	27	8	19	1.31	0.08	0.01	0.03	6.5%
T3 D	25	5	14	1.30	0.08	0.01	0.03	5.7%
T4 A	37	5	4	1.23	0.14	0.02	0.06	-0.2%
T4 B	27	8	10	1.25	0.07	0.00	0.03	1.1%
T4 C	27	10	15	1.34	0.12	0.01	0.05	8.4%
T4 D	25	8	10	1.24	0.05	0.00	0.02	0.4%
			LSD	N/A				
			P Value	0.065				

Comments

The main findings of this trial are that liquid DKP fertiliser can be used in place of standard farmer practice to achieve comparable plant nutrition and grain yields. This is important for growers as it offers flexibility to vary fertiliser inputs according to the season.

During the Liebe Group Post Seeding Field Walk, farmers noted they had already applied UAN to their crops whereas this trial had not received any. Despite the above ideal ranges for leaf tissue N 45 days after seeding, the late application of the first foliar spray may have affected overall yields. This will be adjusted in future trials.

Trends for lower yields of T2 (10 L/ha DKP) and higher yields in T3 (20 L/ha DKP) inform the trial programme for the 2021 season, where we will trial different rates of DKP at seeding.

Acknowledgements

We thank COGGO for funding this work. We also thank Lamond & Co for expertly conducting the trial and the Hirsch family for hosting the trial.

References:

www.soilquality.org.au. (2020). *Yield Potential | Calculators | soilquality.org.au*. [online] Available at: http://www.soilquality.org.au/calculators/yield_potential.

Peer review

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Canola Systems x Plant Density x Nitrogen for LRZ

Phil Smyth, Director and Agronomist, Nutrien Coorow Ag

Take Home Messages

- Hybrid canola varieties have outperformed the OP variety.
- There were statistically significant yield gains by increasing plant densities.
- Nitrogen response was more profitable under higher plant populations however responses were relatively limited.

Aim

1. To determine if hybrid canola can produce higher profits over OP canola in the LRZ.
2. To determine which canola system produces the highest gross margin.
3. To determine if high applied nitrogen rates can drive higher yield and returns in each canola system in the LRZ.
4. To determine if low plant populations can compensate using early applied high nitrogen rates.

Trial Details

Trial location	Main Trial Site, Hirsch property, Latham
Plot size & replication	20m x 3m x 3 replications
Soil type	Deep yellow sand
Soil pH ($CaCl_2$)	0-10cm: 6.4 10-20cm: 5.4 20-30cm: 4.8
Paddock rotation	2019 Barley, 2019 Barley, 2018 Fallow
Sowing date	15/05/2020
Sowing rate	See trial treatments
Fertiliser	Compound 110kg K Start 10 (13.2N 14.4P 11K *3.3S 0.11Cu 0.22Zn)*
Herbicides, Insecticides & Fungicides	IBS: Propyzamide + Trifluralin, Chlorpyrifos + Bifenthrin, 1.1kg Atrazine on TT plots 6WAS: 1.3kg Plantshield on RR, 330ml Clethodim & 1.1kg Atrazine on TT. 06/08/2020: 300ml Affirm, 30ml Trojan

Treatments

Canola Variety	Target Plants/m²	Seeding N 15/05/2020	Top Up N 6WAS 25/06/2020	Total N/ha	Average P/m²	Total Seed Cost $/ha	Total Cost $/ha
410XX	15	23	17	40	7	27.55	93.40
		53	7	60	10		120.05
		53	47	100	7		173.65
	30	23	17	40	20	55.10	120.95
		53	7	60	10		147.60
		53	47	100	9		201.20
Bonito	15	23	17	40	12	1.38	75.81
		53	7	60	10		102.46
		53	47	100	5		156.06
	30	23	17	40	12	2.73	77.16
		53	7	60	8		103.81
		53	47	100	10		157.41
Trident	15	23	17	40	10	13.60	88.03
		53	7	60	7		114.68
		53	47	100	9		168.28
	30	23	17	40	14	27.20	101.63
		53	7	60	15		128.28
		53	47	100	10		181.88

Assumptions

- Total Cost = Seed + Nitrogen + Herbicide
- Varieties: 410XX $42.50/kg Bonito $3/kg Trident $20/kg
- Seed Cost includes TUA fee/ha
- Trident EPR $10/t
- UAN Price: $430/t
- Herbicide Costs: Plantshield $9.30/kg, Atrazine $7/kg, Clethodim $16/L. Other costs the same
- CAG: $630 CAN: $660 plus oil bonus

Soil Composition

Depth	Col P	Col K	KCl S	O C	pH Ca Cl2	PBI	NO3N	NH4N
0-10	46	65	3.2	0.54	6.4	25.7	9	1
10-20	12	52	11.6	0.30	5.4	28.8	4	1
20-30	4	30	24.8	0.20	4.8	32.1	2	< 1
30-40	2	31	30.7	0.16	5.1	28.9	2	< 1
40-50	< 2	19	23.1	0.14	5.2	30.2	2	< 1

Results

Increasing the sowing rate increased yields significantly in the Triazine Tolerant and Roundup Ready canola systems (Figure 1). Establishment percentages were close to half of the targeted populations after plant counts. Higher plant populations have multiple agronomic and production benefits. Not only does it drive yield as indicated in (Figure 1), it aids weed and insect competition, aids in reducing wind erosion and also drives greater harvestability and harvest efficiency.

The Trident TT hybrid significantly out yielded the open pollinated Bonito. If adequate weed control in this system can be achieved this system should still be considered across all rainfall zones.

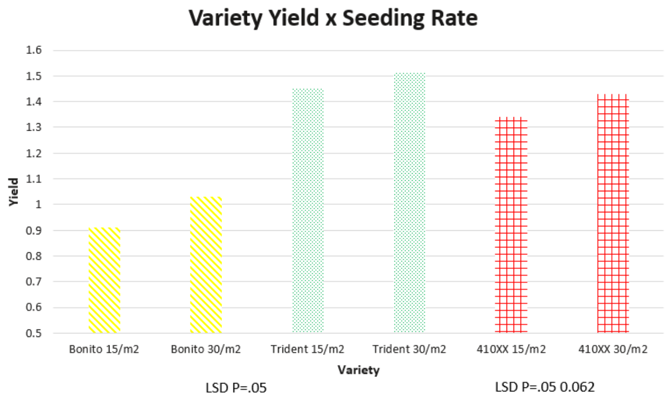

Figure 1: Variety Yield x Seeding Rate.

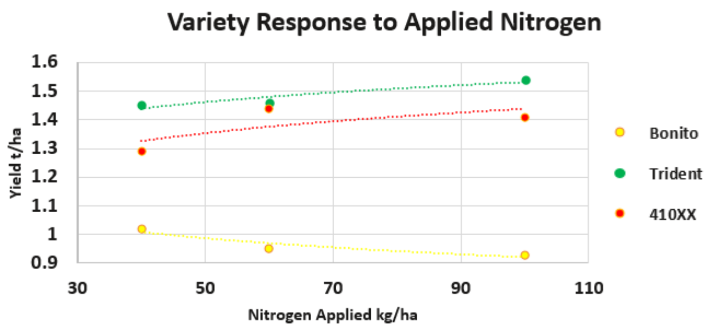

Figure 2: Variety Response to Applied Nitrogen.

Three rates of nitrogen were applied over the varieties. All nitrogen (Bulk N liquid) was applied by six weeks after sowing. The results indicate a positive trendline as evident in Figure 2 with applying increasing amounts of nitrogen to hybrid canola and a negative trendline to applied nitrogen with the OP canola.

There was also a trend that the higher plant populations of 410XX and Trident responded better to increasing nitrogen rates. The Bonito showed no response to applied nitrogen over 40 units of nitrogen, in fact each time in both seeding rates nitrogen was applied, a yield decrease occurred. This indicates that open pollinated canola may not compensate as well as hybrid canola lines when additional nitrogen is applied to overcome low densities and still increase yield.

The most profitable system in this trial was Hybrid Triazine Tolerant Canola with the top treatment being Trident canola at the higher seeding rates with 100 units of nitrogen applied as seen in Figure 3 yielding 1.61 t/ha. This was only marginally ahead of low plant density Trident with low applied nitrogen. Given the short growing season and low rainfall experienced, nitrogen management needs to be carefully considered in season. Consideration would be dependant on factors including the break of season, sub soil moisture, plant establishment, residual available nitrogen etc.

There were consistent yield increases in 410XX with the higher plant density and applied nitrogen although applying above 60N reduced gross margin return.

Bonito produced consistently lower returns and applying additional nitrogen had a negative impact on financial returns. Given the performance of Trident with low plant densities this presents an opportunity in the LRZ significantly over and above Bonito going forward.

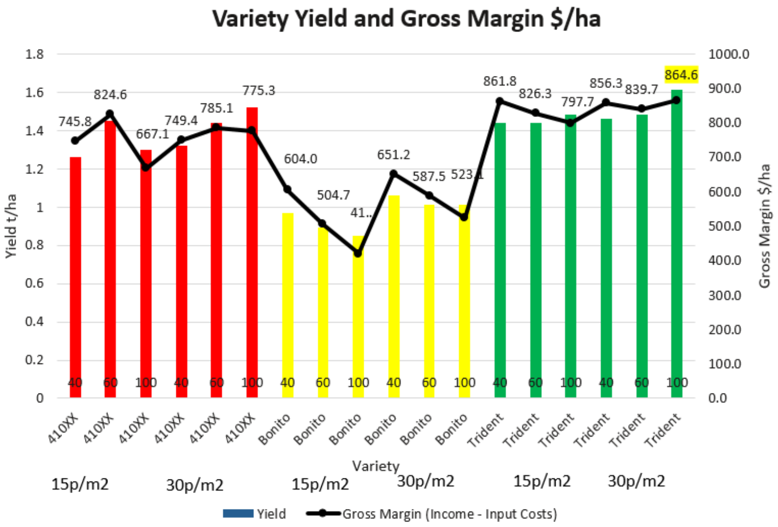

Figure 3: Variety Yield and Gross Margin.

Comments

Given a relatively late break and an establishment date of the 31st May, this trial indicates significant returns are possible in the LRZ with canola. Both the Roundup Ready Truflex and Triazine Tolerant Trident hybrid canola varieties have significantly out yielded and financially outperformed the open pollinated variety.

Increasing the seeding rates significantly increased yield in both RR and TT production systems. Responses to nitrogen were limited but showed a positive trend with hybrid canola and a negative trend in open pollinated canola in this trial site. Ensuring growers target above 15-20 plants/m^2 ensures maximum crop competition and improved harvestability along with leaving soils less prone to soil erosion, especially sandy soil types common in the NAR.

Peer Reviewed

Grant Thompson, Crop Circle Research.

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Nitrogen Management of High Protein Barley

Angus McAlpine, Midlands District Agronomist, CSBP

Take Home Messages

- Nitrogen (N) fertiliser increased crop yield from 3.6 to 5.8 t/ha and protein from 9.1 to 11.5%.
- Banding N at seeding was more efficient than splitting the application between seeding and at stem elongation.
- Water use efficiency increased with higher N rates and efficiency.

Aim

To investigate whether nitrogen (N) use efficiency on barley can be improved through a combination of different application methods of Flexi-N including: incorporating by sowing (IBS), banding at seeding (BAS) and in season streaming at stem elongation.

Background

Crop N requirements are increasing with increasing yield potential and declining soil reserves. Increasing the uptake efficiency of applied N can potentially increase grower returns. Understanding the impact of when and how the nitrogen is applied can help growers make better N decisions.

There is potential market demand for a high protein malting barley, and therefore interest in how we can achieve these grain specifications with better management of N.

Trial Details

Trial location	Victoria Plains, West Calingiri
Plot size & replication	15m x 2.5m x 3 replications
Soil type	Sand over gravel
Soil pH ($CaCl_2$)	See soil analysis below
EC (dS/m)	See soil analysis below
Paddock rotation:	2017 Wheat, 2018 Lupins, 2019 Barley
Sowing date	13/05/2020
Sowing rate	90 kg/ha Maximus barley
Fertiliser	Basal 150 kg/ha Sulphate of Potash IBS + 135 kg/ha Big Phos banded (0N, 18P, 62K) Nitrogen treatments in table below
Herbicides, Insecticides & Fungicides	13/05/2020: 2.5 L/ha Arcade, 2 L/ha Triflur X, 400 ml/ha Lorsban 7/07/2020: in season Flexi-N applications as per table below 4/08/2020: 300 ml/ha Aviator
Rainfall	Summer rain November 2019 - April 2020 170mm Growing season May - Oct 2020 171mm

Soil composition

Depth (cm)	pH ($CaCl_2$)	EC	OC	ECEC	Nit N	Amm N	P	PBI	K	S
0-10	5.4	0.07	0.8	5	20	2	11	12	36	6
10-20	5.3	0.02	0.4	4	5	<1	13	10	37	3
20-30	5.2	0.01	0.4	3	4	<1	13	19	46	4

Results

The effects of nitrogen treatment on barley yield, quality, nitrogen use and water use efficiency

Trt	IBS (L/ha)	Banded (L/ha)	Foliar Z31 (L/ha)	N	Yield (t/ha)	Protein (%)	Scrngs. (%)	NUE* (%)	WUE** (kg/mm)
1	-	-	-	0	3.55[e]	9.1[de]	9[a]	-	16
2	100 Flexi-N	-	-	42	4.48[d]	8.4[f]	9[a]	45	20
3	-	100 Flexi-N	-	42	4.59[d]	8.7[ef]	9[a]	53	21
4	200 Flexi-N	-	-	84	5.07[c]	9.2[de]	11[ab]	44	23
5	-	200 Flexi-N	-	84	5.71[ab]	10.0[c]	13[abc]	71	26
6	-	100 Flexi-N	100 Flexi-N	84	5.38[bc]	9.5[cd]	15[bc]	56	24
7		200 Flexi-N	100 Flexi-N	126	5.90[a]	10.7[b]	18[cd]	58	27
8		100 Flexi-N	200 Flexi-N	126	5.77[ab]	10.7[b]	21[de]	55	26
9		100 Flexi-N	300 Flexi-N	169	5.75[ab]	11.5[a]	24[e]	46	26
				Prob	<0.001	<0.001	<0.001		
				LSD	0.45	0.5	5		

* assumes 75% of N taken up is remobilised to grain.
**based on one third summer rainfall + GSR / grain yield.

- Nitrogen (N) fertiliser increased crop yield from 3.6 to 5.8 t/ha and protein from 9.1 to 11.5%.
- Water use efficiency increased from 16 to 27 kg/mm with higher N rates and efficiency.
- There was no significant yield increase above 84N banded at seeding, which produced 10% grain protein.
- Higher protein (11.5%) was achieved by increasing N rates up to 169N.
- Nitrogen use efficiency (NUE) varied from about 40 to 70% depending upon how the N was applied.
- Hectolitre weights (average 72 kg/hL) were not affected by N treatment.

Economics*

Trt	IBS (L/ha)	Banded (L/ha)	Foliar Z31 (L/ha)	N	Yield (t/ha)	Returns ($/ha)	Cost ($/ha)	N Profit ($/ha)
1	-	-	-	0	3.55[e]	-	-	-
2	100 Flexi-N	-	-	42	4.48[d]	233	67	156
3	-	100 Flexi-N	-	42	4.59[d]	250	60	189
4	200 Flexi-N	-	-	84	5.07[c]	365	131	234
5	-	200 Flexi-N	-	84	5.71[ab]	518	121	398
6	-	100 Flexi-N	100 Flexi-N	84	5.38[bc]	439	128	311
7		200 Flexi-N	100 Flexi-N	126	5.90[a]	564	188	376
8		100 Flexi-N	200 Flexi-N	126	5.77[ab]	533	191	342
9		100 Flexi-N	300 Flexi-N	169	5.75[ab]	528	254	275
				Prob	<0.001			
				LSD	0.45			

* assumes barley $240/t, Flexi-N $460/t plus applications costs.

Crop yield and profit from N was maximised by banding 200 L/ha Flexi-N at seeding – treatment 5 (a 400% ROI).

Comments
The trial demonstrated that N applications on barley can be very profitable. Banding N at seeding achieves higher N efficiency. Banding higher rates of N at seeding may be an opportunity to increase returns. N requirements are driven by soil supply and crop demand.

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SOIL HEALTH RESEARCH RESULTS

Combined Application of Lime and Gypsum Boosts Wheat, Canola and Barley Yield on Acidic Soil

Gaus Azam, Chris Gazey, & Craig Scanlan, Department of Primary Industries and Regional Development

Take Home Messages

- Liming significantly increased wheat (up to 16%), canola (up to 64%) and barley (up to 39%) grain yield from the first year of the trial compared to the control. Gypsum also improved grain yield but it was statistically significant for canola only. There was no significant improvement in yield from incorporation treatments, rather one-way plough had statistically significant negative effect last three-seasons.
- The application of lime and gypsum together had an additive effect to improve grain yield (for wheat and canola, but not for barley) by more than the application of either ameliorant individually, however, the interactions were not statistically significant.
- The most economically viable treatment (for the first four growing seasons) was the surface application of 2 t/ha lime that generated an extra net income of $AU158/ha in last four years.

Aim

The trial was conducted to evaluate the interactive effect of lime and gypsum application, with or without incorporation, on subsoil acidity, Al toxicity and grain yield. The trial was designed to address amelioration of acidic soil under low rainfall conditions; hence, we chose a paddock near Kalannie, Western Australia. We also grew three major grain crops, i.e., wheat, canola and barley.

Background

Subsurface soil acidity (low pH) is a widespread phenomenon in the Mediterranean-type climatic region of south Western Australia (Gazey et al., 2013). At low soil pH the toxic forms of aluminium (Al) increase and significantly limit root growth and crop yield. Incorporation of agricultural lime to an acidic soil can increase soil pH which reduces the level of the toxic forms of Al. However, lime is usually applied at the surface soil and it can take several years to increase subsurface soil pH (Azam and Gazey 2020).

Previous work suggests that physical incorporation of lime in the subsurface soil increases the rate of change of subsurface soil pH (Azam and Gazey 2020). However, physical incorporation using tillage equipment may make the liming process too expensive for many growers. Another suggested method for quick amelioration of acidic subsoil is the application of gypsum on the soil surface. Surface applied gypsum rapidly moves into the subsoil and may reduce toxic forms of Al, as well as supplying additional calcium (Ca) and sulphur (S) where it is deficient (Sumner et al.,1986). The addition of extra Ca may play a role in reducing Al activity by increasing electrical conductivity (EC) and ionic strength (Is) of the soil (McLay et al., 1994b). McLay et al. (1994a) reported an initial, large increase in wheat grain yield, due to gypsum application, in the eastern wheatbelt of Western Australia (WA). However, there was a negative effect of gypsum on grain yield after the second year of the trial. Treatment with gypsum alone produced inconsistent results in improving crop yield in acidic soil (Smith et al., 1994). Therefore, there is confusion amongst growers in adopting gypsum application as part of management strategies for acidic soil. There is also a large gap in understanding the underlying mechanism of how gypsum brings beneficial chemical changes in soil.

Trial Details

Trial location	Nixon property, Kalannie
Plot size & replication	20m x 1.8m x 3 replications
Soil type	Acidic (Wodjil) sand
Soil pH ($CaCl_2$)	0–10cm: 4.4 10–20cm: 3.9 20–30cm: 3.9
Paddock rotation:	2017 Mace wheat, 2018 Mace wheat, 2019 Bonito canola, 2020 Spartacus barley
Sowing date	01/05/2019 (dry sowing)
Sowing rate	60 kg/ha wheat, 2.2 kg/ha Bonito canola, 84 kg/ha barley
Fertiliser	MAP 37 kg/ha and Urea 57 kg/ha at sowing; SOP 100 kg/ha (at 2017 sowing)

Treatments

	Four rates of lime x four rates of gypsum x with/without cultivation		
Lime rates:	0, 2, 4 and 6 t/ha	Gypsum rates:	0, 1, 2 and 3 t/ha
Cultivation:	No cultivation or one-way ploughing to 20 cm depth (all plots deep ripped to 50cm depth to remove compaction constraint prior to the application of cultivation treatment)		

Results

Growing seasons:

The four growing seasons were contrasting in terms of rainfall for sowing and finishing the crop (Figure 1). Season 2017 had a dry start but finished with average rainfall for the district. In contrast, 2018 and 2020 started with greater than average rainfall but received well below average rainfall in the month of September. In 2017, the growing months (May–September) received only 124mm rainfall compared to 187mm and 148mm for the same months in 2018 and 2020, respectively. Season 2019 had a perfect start with nearly 90mm rainfall in June, but the crop growing months (July and August) had less than average rainfall and were followed by nil rain in September and October. This resulted in a growing season rainfall of 163mm, almost 60% of which occurred in June.

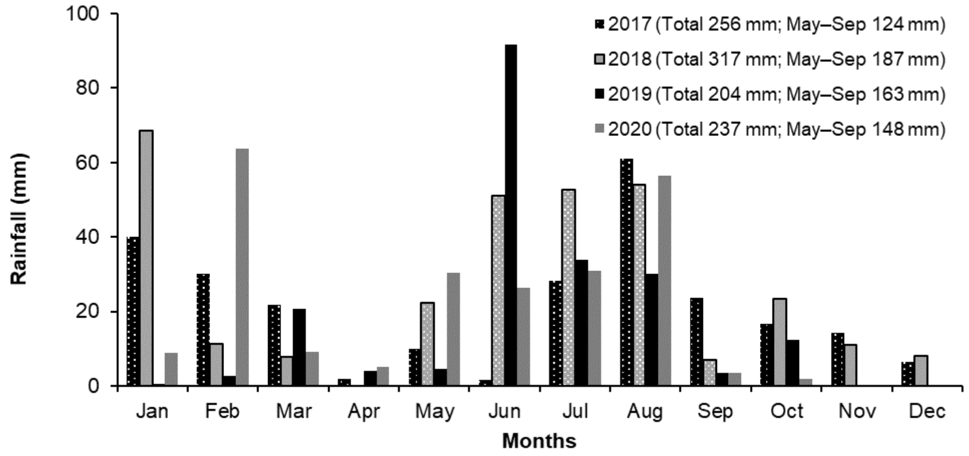

Figure 1: Monthly total rainfall at the trial site during 2017, 2018, 2019 and 2020.

Grain yield:

There was a large difference between the overall trial yield of wheat for 2017 (0.95 t/ha) and 2018 (1.85 t/ha) primarily due to the differences in rainfall during the crop growing months. An extra 64mm rainfall in 2018 produced an extra 0.9 t/ha wheat crop compared to 2017. Canola yield in season 2019 was very low. The trial averaged only 0.18 t/ha, mainly due to diminishing rainfall after July. In contrast, the yield of Spartacus barley in 2020 was as high as 1.99 t/ha (trial average 1.72 t/ha).

There was no significant interaction of tillage x lime rate x gypsum rate nor of lime rate x gypsum rate in any growing season (Table 1). The main effect of incorporation was not significant in 2017 but shallow incorporation using one-way plough significantly decreased yield of wheat, canola and barley in 2018–2020 respectively. The main effect of lime was significant in all four growing seasons. The main effect of gypsum was not significant for wheat in 2017 and 2018 and barley in 2020, but it had a significantly positive effect on canola yield in 2019.

In 2017, there was a 13% increase in wheat grain yield from lime treated plots over the control (Table 1). Gypsum increased wheat yield by 5% (surface applied gypsum only) over the control but it was not statistically significant (Table 1). In general (but statistically not significant), combined application of lime and gypsum increased wheat yield compared to the control more than either ameliorant alone. For example, application of 6 t/ha of lime with 3 t/ha of gypsum without incorporation produced 30% more wheat grain (1.04 t/ha) than the control (0.79 t/ha). Whereas 6 t/ha lime alone increased wheat yield to 0.99 t/ha and 3 t/ha gypsum increased wheat yield to 0.85 t/ha.

In 2018, there was an average 12% increase in wheat grain yield from lime treated plots over the control (Table 1). Overall application of gypsum had an 11% yield benefit over the control, but the effect of gypsum rates was not statistically significant. As in 2017, the combined application of lime and gypsum resulted in a non-significant increase in yield compared with the application of lime or gypsum individually. Incorporation of 6 t/ha lime plus 3 t/ha gypsum produced 23% more wheat grain (2.05 t/ha) than the control (1.66 t/ha). Whereas 6 t/ha lime alone increased wheat yield to 1.86 t/ha and 3 t/ha gypsum increased wheat yield to 1.82 t/ha.

In 2019, there was an average 80% increase in canola grain yield from lime treated plots over the control (Table 1). Overall application of gypsum had a 49% yield benefit over the control. As in 2017 and 2018, the combined application of lime and gypsum significantly increased canola yield by more than the application of lime or gypsum individually. Incorporation of 6 t/ha lime plus 3 t/ha gypsum produced 165% more canola grain (0.24 t/ha) than the control (0.09 t/ha). Whereas 6 t/ha lime alone increased canola yield to 0.18 t/ha and 3 t/ha gypsum increased canola yield to 0.14 t/ha.

In 2020, there was an average 26% increase in barley grain yield from lime treated plots over the control (Table 1). Overall application of gypsum had only 1%, non-significant yield benefit over the control. In 2020, the combined application of lime and gypsum did not increased barley yield by more than the application of lime alone.

The increase in grain yield was optimized with the surface application of 2 t/ha lime (with or without incorporation, Table 1). As the cost of treatments increased with increasing rates of lime and gypsum as well as the use of one-way plough for incorporation, treatments that had higher lime rates and/or additional gypsum rates (with lime above 2 t/ha), were economically less viable within the four seasons of this study (Figure 2). Almost all treatments involving incorporation of lime and gypsum produced a negative net income in first four years of trial.

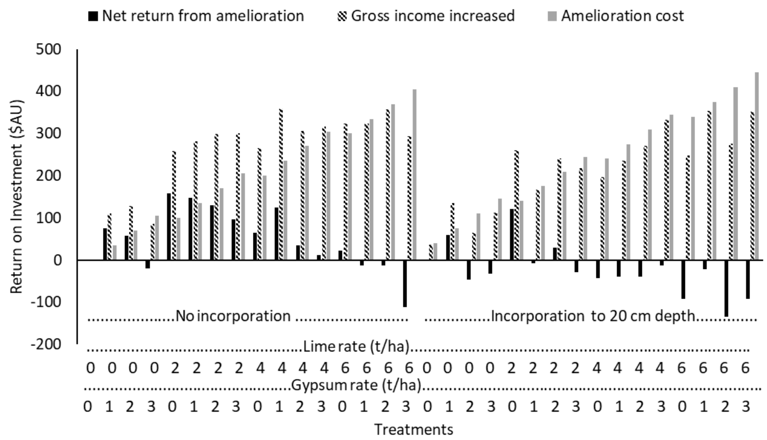

Figure 2: Amelioration treatment cost, gross income and net income under different amelioration treatments during first four years of trial establishment in Kalannie, WA.

Amelioration of acidity and Al toxicity with lime and gypsum

Lime application to the surface significantly increased soil pH in the 0-10cm depth, while incorporation increased it to 0–20cm depth (Table 2). However, sub-surface soil pH was raised over the target pH (4.80) only at 10–15cm and where 4 or 6 t/ha lime was incorporated. There was also an increase of 0.08 unit pH in the 20–30cm depth where 4 or 6 t/ha lime was incorporated. No changes were recorded in soil pH at deeper depths.

Table 1: Grain yield (t/ha) of wheat in 2017 and 2018, of canola in 2019 and barley in 2020.

Lime rate (t/ha)		Gypsum rate (t/ha)				LSD (5%)
		0	1	2	3	
Wheat (2017)						
0	No incorporation	0.79	0.92	0.88	0.85	Incorporation = 0.031 (NS)
2		1.01	0.91	0.94	0.96	Lime rate = 0.044 (P≤0.001)^
4		1.02	0.98	0.99	1.03	Gypsum = 0.044 (NS)
6		0.99	1.02	1.02	1.04	Lime x gypsum = 0.087 (NS)
0	Incorporation	0.82	0.95	0.89	0.86	
2		0.94	0.92	0.94	0.94	
4		0.89	0.95	1.03	1.02	
6		0.89	0.99	0.95	1.00	
Wheat (2018)						
0	No incorporation	1.66	1.71	1.82	1.69	Incorporation = 0.031 (P≤0.05)*
2		1.74	1.94	1.88	1.94	Lime rate = 0.082 (P≤0.001)^
4		1.76	1.98	1.78	1.83	Gypsum = 0.082 (NS)
6		1.88	1.82	1.95	1.77	Lime x gypsum = 0.165 (NS)
0	Incorporation	1.72	1.84	1.70	1.82	
2		1.96	1.78	1.86	1.98	
4		1.77	1.87	1.88	1.94	
6		1.86	1.98	2.04	2.05	
Canola (2019)						
0	No incorporation	0.09	0.12	0.15	0.17	Incorporation = 0.012 (P≤0.05)*
2		0.16	0.17	0.18	0.19	Lime rate = 0.017 (P≤0.001)^
4		0.18	0.21	0.24	0.25	Gypsum = 0.017 (P≤0.001)^
6		0.17	0.23	0.21	0.20	Lime x gypsum = 0.035 (NS)
0	Incorporation	0.09	0.12	0.15	0.17	
2		0.16	0.17	0.18	0.19	
4		0.18	0.21	0.24	0.25	
6		0.17	0.23	0.21	0.20	
Barley (2020)						
0	No incorporation	1.37	1.54	1.49	1.47	Incorporation = 0.060 (P≤0.001)*
2		1.89	1.86	1.94	1.83	Lime rate = 0.085 (P≤0.001)^
4		1.85	1.95	1.89	1.83	Gypsum = 0.085 (NS)
6		1.99	1.91	1.92	1.89	Lime x gypsum = 0.170 (NS)
0	Incorporation	1.37	1.45	1.37	1.52	
2		1.78	1.59	1.73	1.57	
4		1.73	1.69	1.73	1.88	
6		1.80	1.89	1.67	1.78	

*^means the effect on yield was positive *means the effect on yield was negative.*

Table 2: Soil pH and aluminium profiles after four seasons of lime application at different rates with and without incorporation by a one-way plough

Depth (cm)	Lime rate (t/ha)								
	0	2	4	6	0	2	4	6	LSD (5%)
					pHc				
0–5	5.50	5.92*	6.04*	6.03*	5.38	5.40	5.37	5.38	0.47
5–10	4.65	5.17*	5.32*	5.42*	4.46	5.12*	5.34*	5.23*	0.40
10–15	4.08	4.16	4.31	4.36	4.64*	4.67*	4.94*	4.93*	0.33
15–20	3.95	3.96	4.07	4.05	4.07	4.20*	4.33*	4.51*	0.18
20–30	3.87	3.88	3.91	3.90	3.85	3.88	3.94*	3.93*	0.05
30–40	3.84	3.85	3.88	3.85	3.82	3.82	3.84	3.88	0.06
40–50	3.81	3.81	3.84	3.83	3.81	3.82	3.81	3.79	0.05
50–60	3.78	3.78	3.79	3.81	3.76	3.78	3.77	3.77	0.06
					Al (mg/kg)				
0–5	0.3	0.2	0.3	0.2	0.4	0.2	0.2	0.2	0.30
5–10	2.6	1.1*	1.0*	0.8*	3.4	0.6*	0.5*	0.5*	1.25
10–15	11.7	9.5	5.7*	6.0*	4.3*	2.6*	0.9*	1.6*	3.29
15–20	16.0	17.5	11.6*	13.1*	10.7*	7.2*	6.9*	5.2*	4.48
20–30	21.5	19.7	20.7	19.4	23.0	21.3	18.4	21.6	3.63
30–40	25.4	25.3	24.9	25.0	27.1	27.6	26.0	23.9	3.11
40–50	26.0	26.2	26.6	24.4	26.3	25.1	25.6	26.8	2.34
50–60	24.9	24.8	24.3	22.9	26.7	26.1	26.3	26.7	2.46

Surface application of 4 or 6 t/ha lime had statistically insignificant effect on soil pH at any depths below 0-10cm layer compared to 0 and 2 t/ha lime treatment, however, a smaller improvement in subsoil pH significantly decreased aluminium in 10-15 and 15-20cm soil depths (Table 2). The differences in soil pH and aluminium within 2, 4 and 6 t/ha lime treatments (with or without incorporation) didn't differ in crop yield response. A minor but statistically significant increase in soil pH (around 0.08 unit) by 4 and 6 t/ha lime in 20–30cm soil depth did not improve aluminium concentration (Table 1).

Comments

It is clear from this field trial that liming can significantly increase grain yield. This effect was consistent across four contrasting seasons where three different crops were grown. This yield improvement was related to an increase in soil pH and hence decrease in Al toxicity. Increased soil pH also lead to improved uptake of major macronutrients as we reported for 2018 season.

It is also evident from this trial that gypsum can improve wheat and canola grain yield, which is similar to McLay et al. (1994a), but not by improving soil pH nor total aluminium concentration, as found by McLay and his colleagues (1994b). In our experiment, the result was consistent especially when gypsum was applied at the surface. Gypsum greatly improved the ionic strength of soil and this was observed at every depth (Azam et al. 2018). Gypsum provided extra S and Ca in the soil solution that led to their increased uptake by the crop as we reported in 2018 and 2019 seasons. Gypsum also increased plant uptake of some micronutrients such as B, Mn, and Zn reported in 2018.

The application of lime and gypsum together had an additive effect on grain yield of wheat and canola. This is a similar result to that reported by others (e.g. McLay et al., 1994a). This is likely due to the fact that lime increased soil pH and hence decreased the total amount of toxic Al in soil solution. Gypsum on the other hand supplied additional Ca and S as well as improving the uptake of micronutrients. In addition, gypsum probably helped by changing toxic Al into non-toxic forms and caused Al to leach deeper. The combined application of lime and gypsum also had an additive effect in improving uptake of the most macronutrients, especially total nitrogen (see 2019 report).

Lime incorporation using a one-way plough increased soil pH mainly within 0–20cm soil depth, but that did not improve yield over surface applied lime treatments. In general, in this trial root growth was restricted within the top 20–25cm due to low soil pH and high Al concentration below this layer. Therefore, shallow incorporation of lime was thought to be ineffective to manage subsoil acidity, especially in shorter term. In future work, deeper lime incorporation treatments to increase soil pH below the 0–20cm soil depth need to be considered.

References

Gazey C, Andrew J, Griffin E (2013) Soil acidity. In 'Report card on sustainable natural resource use in agriculture'. Department of Agriculture and Food, Western Australia. Available at https://www.agric.wa.gov.au.

Mclay CDA, Ritchie GSP, Porter WM (1994a) Amelioration of subsurface acidity in sandy soils in low rainfall regions .1. Responses of wheat and lupins to surface-applied gypsum and lime. Soil Research. 32, 835-846.

Mclay CDA, Ritchie GSP, Porter WM (1994b) Amelioration of subsurface acidity in sandy soils in low rainfall regions .2. Changes to soil solution composition following the surface application of gypsum and lime

Smith C, Peoples M, Keerthisinghe G, James T, Garden D, Tuomi S (1994). Effect of surface applications of lime, gypsum and phosphogypsum on the alleviating of surface and subsurface acidity in a soil under pasture. Soil Research 32, 995-1008.

Sumner ME, Shahandeh H, Bouton J, Hammel J (1986) Amelioration of an Acid Soil Profile through Deep Liming and Surface Application of Gypsum. Soil Science Society of America Journal 50, 1254-1258.

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GOVERNMENT OF WESTERN AUSTRALIA
Department of Primary Industries and Regional Development

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Deep Soil Re-engineering to Optimise Grain Yield Under Low Rainfall Conditions

Gaus Azam, Chris Gazey, Richard Bowles, Craig Scanlan, Department of Primary Industries and Regional Development

Take Home Messages

- Wheat and barley grain yield was at least doubled and water use efficiency (WUE) was as high as 27 and 26 kg/mm for wheat and barley, respectively, due to deep amelioration of soil compaction and acidity in the low rainfall region of WA. Grain yield of the control was only 52% (wheat) and 84% (barley) of the estimated water limited yield potential while deep amelioration increased the yield to 133% (wheat) and to 156% (barley) of the estimated water limited yield potential.
- Deep incorporation of lime increased soil pH near to the minimum target pH and decreased Al concentration to below toxic levels within two months of lime incorporation.
- Wheat plants produced root systems to 60–65cm depth with deep amelioration of either compaction or compaction and acidity together compared to 20–25cm depth for the untreated control. Deeper roots allowed plants to extract soil water from deeper soil horizons and avoid moisture stress, in absence of sufficient rainfall, during the grain filling stage in both 2018 and 2020 seasons.

Aim

The trial was conducted in a paddock near Kalannie, Western Australia, where a wheat crop was grown in small plots under no soil constraints (to an approximate depth of 45cm) to quantify the yield potential and WUE of wheat and barley on an ameliorated sandy soil.

Background

More than 70% of topsoil samples and almost 50% of subsurface (10–20 and 20–30cm) layer samples collected from the WA wheatbelt were below the minimum recommended pH targets of 5.5 and 4.8 (Gazey et al., 2013). These soils are acidic due to the historic contribution of the leguminous native plants and/or due to intensive use of ammonium based fertilisers and export of food and fibre from the farm. Conventional application of surface applied agricultural lime to treat acidic soil takes many years to improve soil pH deeper in the soil profile (Azam and Gazey 2020) and increase crop yield (Whitten, 2002). While grain yield increases occur, the number of years that elapse before yield improves, and economic benefit is realised, is a barrier for many growers. Therefore, growers are looking for more rapid methods to correct subsurface soil acidity.

A large proportion of acidic sandplain is also compacted (van Gool 2016). Literature suggests that physical incorporation of lime through tillage operations to an acidic soil could be the most effective way of improving soil pH while reducing soil compaction (Davies 2015). Scanlan et al (2014) suggested that if an efficient tillage operation is used mix to the depth where the soil pH constraint occurs then an immediate payback on lime and cultivation is possible. However, currently used soil amelioration practices (e.g. deep ripping, liming) are found to partially remediate soil acidity and compaction. Such soil renovation generates variable crop yield responses as observed from various long-term field trials (Davies 2015).

In paddocks where multiple soil constraints such as compaction and subsoil acidity are present, most crop roots are confined within 20–30cm of the surface (Azam and Gazey 2020). With such shallow roots a large proportion of growing season rainfall quickly drains away beyond the root zone. The aim of this field trial was to test whether ‘Re-engineering’ (deep tillage and lime incorporation) a soil profile with multiple constraints can significantly improve rooting depth of grain crop towards optimising water use efficiency (WUE), water limited yield potential and grain yield.

Trial Details

Trial location	Nixon property, Kalannie
Plot size & replication	3m x 2m x 2 replications
Soil type	Acidic (Wodjil) sand
Soil pH ($CaCl_2$)	0–10cm: 4.4 10–20cm: 3.9 20–30cm: 3.9
Paddock rotation:	2017 Wheat, 2018 Wheat, 2019 Canola, 2020 Barley
Sowing date	01/06/2018 (wheat), 28/05/2020 (barley)
Sowing rate	60 kg/ha Mace wheat, 84 kg/ha Spartacus barley
Fertiliser	MAP 37 kg/ha, Urea 57 kg/ha at sowing

Treatments

T0	Zero grading, zero lime
T1	Grade 10cm, then 10–30cm, keep soils from each layer separately, rotary hoe 30–45cm without spreading lime; back-fill the plots layer-by-layer without adding any lime.
T2	Grade 10cm, then 10–30cm, keep soils from each layer separately, rotary hoe 30–45cm without spreading lime; back-fill the plots without adding any lime to the 10–30cm subsoil; back-fill topsoil (0–10cm) and incorporate 1.5 t/ha lime with a manually operated rotary hoe.
T3	Grade 10cm, then 10–30cm, keep soils from each layer separately, rotary hoe 30–45cm without spreading lime; back-fill 10–30cm and incorporate 3.0 t/ha lime with a rotary hoe; back-fill topsoil (0–10cm) and incorporate 1.5 t/ha lime with a rotary hoe.
T4	Grade 10cm, then 10–30cm, keep soils from each layer separately, incorporate 1.5 t/ha lime with a rotary hoe to 30–45cm; back-fill 10–30cm and incorporate 3.0 t/ha lime with a rotary hoe and back-fill topsoil (0–10cm) and incorporate 1.5 t/ha lime with a rotary hoe.

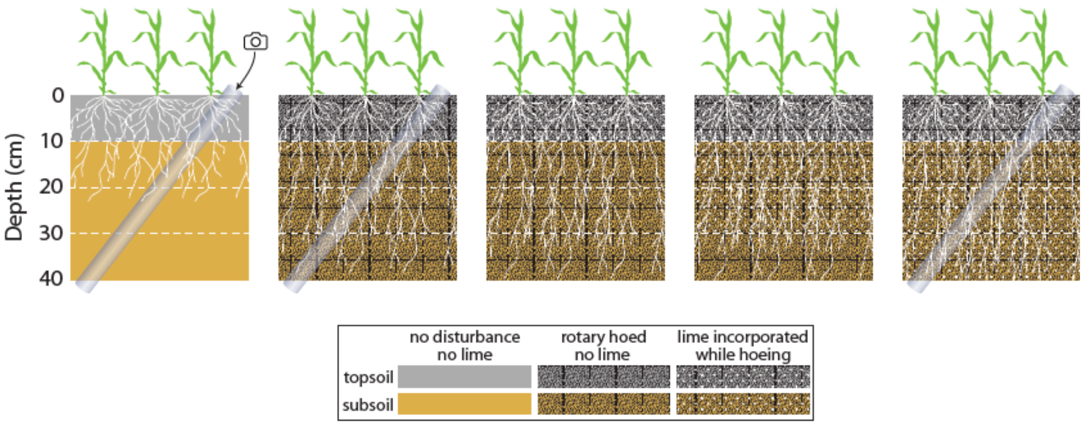

Figure 1: A schematic diagram of the four amelioration treatments and the control.

Results

Seasons:

Both seasons 2018 (Figure 2a) and 2020 (Figure 2b) began with average rainfall but the rainfall in spring, especially the month of September, was well below average. The total rainfall for the shortened growing seasons (May-September) was 187mm in 2018 and 148mm in 2020. In both seasons, the minimum temperatures were not low enough to cause crop damage by frost (Figure 2a & b).

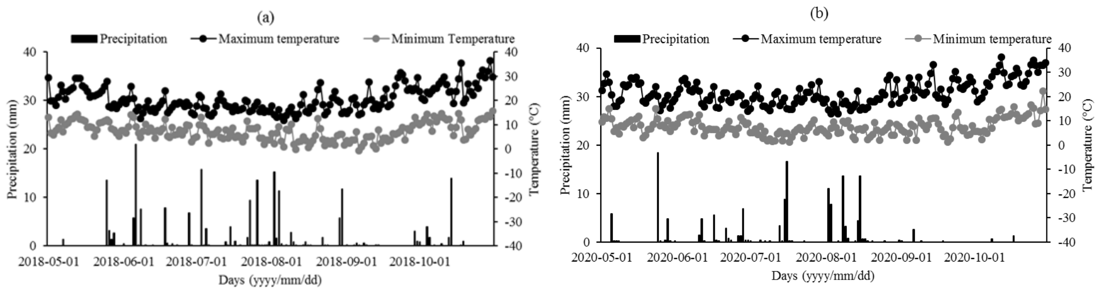

Figure 2: Daily rainfall and minimum and maximum temperatures at the trial site in (a) 2018 and (b) 2020.

Soil properties:

Soil excavation completely removed compaction to the depth of excavation and was maintained below the threshold level after three growing seasons (Figure 3e & f). Untreated control plots always had higher soil water content in the subsoil compared to soil amelioration treatments (Figure 3g & h). Lime incorporation raised soil pH of the treated soil horizons well above the minimum recommended pH_{Ca} of 5.5 in the surface and 4.8 in the subsurface within 2 months (Figure 3a) and maintained or further improved as the seasons progressed (Figure 3b). Liming also decreased total Al from a very toxic range (18–27 mg/kg in the control subsoil) and this was maintained at a non-toxic level of <5 mg/kg (Figure 3c & d).

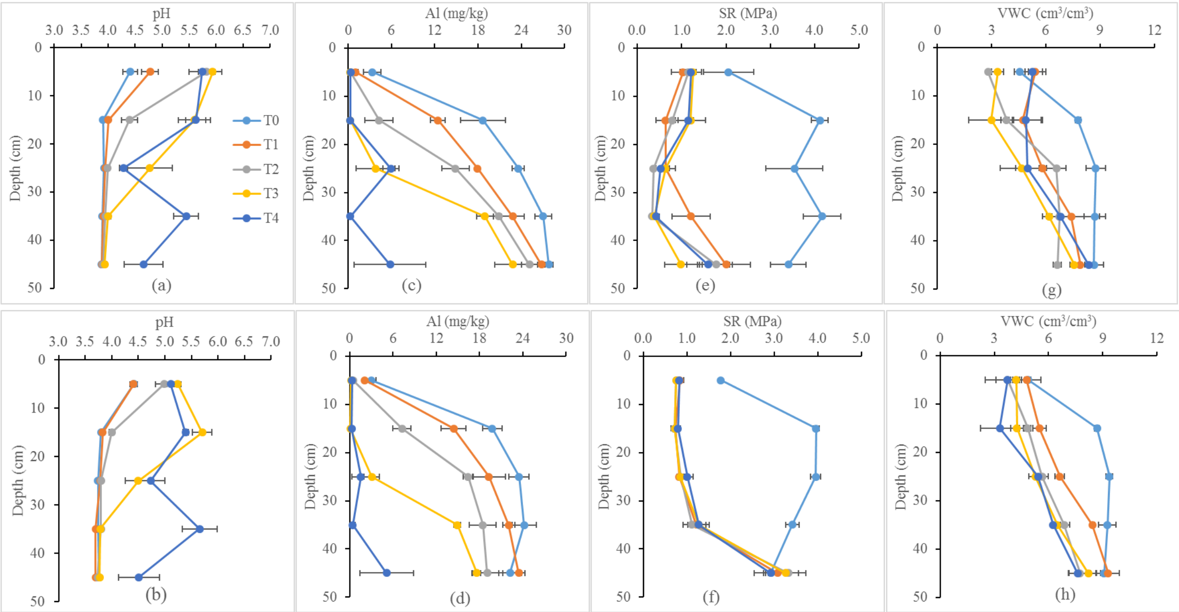

Figure 3: Effect of excavation and incorporation of lime on (a & b) soil pH, (c & d) aluminium, (e & f) soil resistance and (g & h) water content under different treatments at (a, c, e, & f) 2-months and (b, d, f & h) 26-months after lime incorporation. Horizontal error bars represent standard error of the mean values of the respective variables.

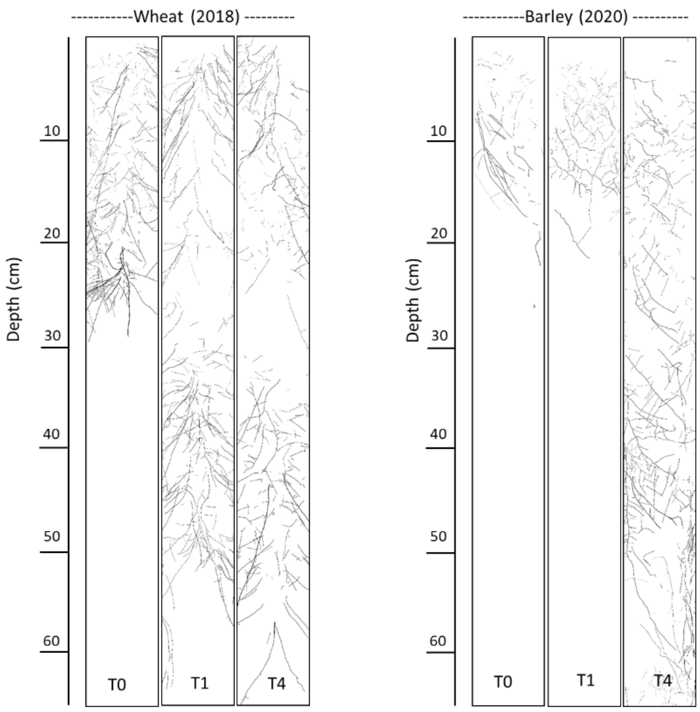

Figure 4: Wheat and barley root growth under different soil amelioration treatments.

Root growth and water uptake:
Due to the improvement in soil chemistry and physics, there was significant improvement in root growth. Wheat and barley root growth was restricted to within 20–25cm depth for the untreated control (T0, Figure 4). For treatments T1–T4 Mace wheat roots grew up to 60–65cm depth, where lime was incorporated at depths (T3 and T4), there were more fine roots and roots hairs in the deeper horizons. However, removal of compaction only (T1) did not improve growth of acid sensitive Spartacus barley crop. Barley roots grew in the soil where soil pH and Al were corrected by lime incorporation. The wheat and barley crop growing on ameliorated soil profiles was found to extract more water and in the untreated control plots a large proportion of the soil water remained unused (Figure 3g & h).

Yield and WUE:
In 2018 season, tiller count, biomass and grain yields of wheat were at least doubled in the ameliorated soil profiles compared to the control (Figure 5a, b & c). This improvement in biomass production did not affect the grain filling (i.e., harvest index was not different, Figure 5d) despite having a dry month of September (Figure 2a & b). For the wheat crop the yield was increased from 52% of the French and Schultz (1984) water limited yield potential in the control to 105% in T1 and 133% in T4. The improvement was also evident in WUE which increased from 11 kg/mm in the control to 21 kg/mm in T1 and 27 kg/mm in T4 treatment. In 2020 season, tiller count, biomass and grain yield of barley did not increase to significant level in T1 but increased significantly for all lime related treatments (T2–T4). Tiller count, biomass and yield of barley increased by 46%, 110%, 86%, respectively, in T4 treatment compared to the control. Similar improvements were also noticed in actual yield potential and WUE of barley due to improvement in soil pH and Al toxicity in T2–T4.

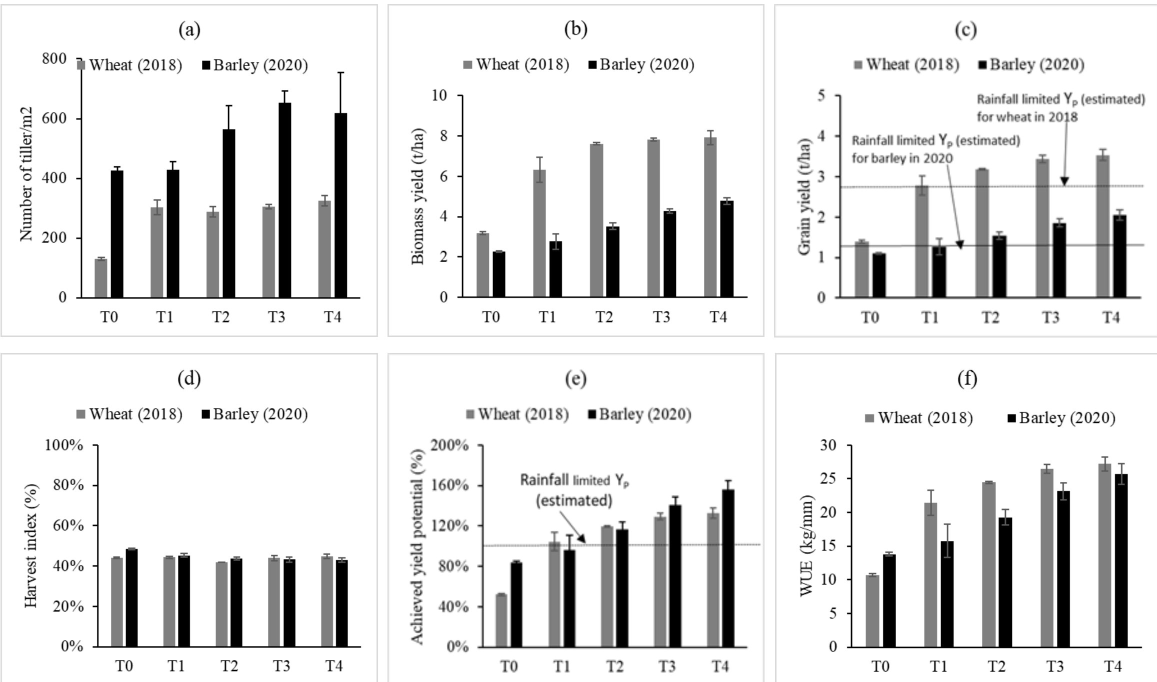

Figure 5: Improvement in (a) tiller count, (b) biomass yield, (c) grain yield, (d) harvest index and, (e) water limited yield potential (Y_p) and (f) water use efficiency (WUE) for wheat in 2018 and barley in 2020 due deep incorporation of lime. Vertical bars represent ± standard error of the mean values of the respected parameters. Scales on Y-axes are different due to differences in response of different parameters.

Comments
Our results show that deep incorporation of lime increased soil pH by more than a unit within two months of lime application. This improvement in soil pH also decreased Al concentration to a completely non-toxic level. Complete removal of compaction (by grading and back-filling) coupled with lime incorporation produced deep root systems for both wheat and barley (with fine roots and root hairs), which allowed plants to extract soil water and nutrients from deeper soil horizons (Scanlan et al., 2014). With the improvement in soil chemistry as well as water and nutrient uptake, plant growth was improved significantly. Furthermore, plants grown in ameliorated plots were not susceptible to the dry finish of the season in 2018 and 2020.

This trial demonstrated that deep amelioration of soil compaction and acidity can double wheat and barley grain yield exceeding the modelled yield potentials for the low rainfall region of WA. The WUE of the wheat and barley crops were 27 and 26 kg/mm, respectively, which surpassed the expectation of the local grower. Although it is currently difficult to replicate these soil amelioration treatments to a farmer's scale of practice, the findings from this trial set the benchmark to maximise yield potential at the site.

References

Azam G, Gazey c (2020) Slow movement of alkali from surface-applied lime warrants the introduction of strategic tillage for rapid amelioration of subsurface acidity in south-western Australia. Soil Research 59, 97-106. at https://www.agronomyaustraliaproceedings.org/index.php/special-publications

Davies S, Hagan J, Reynolds C, Smee V, Lefroy W, Andrew J, Newman P (2015) Long-term responses to soil amelioration – benefits will last more than 10 years! Agribusiness Crop Updates 2015.

Gazey C, Andrew J, Griffin E (2013) Soil acidity. In 'Report card on sustainable natural resource use in agriculture,' Department of Agriculture and Food, Western Australia. Available at https://www.agric.wa.gov.au

Scanlan C, Brennan R, Sarre G (2014) Shifting investment from nutrients to lime and cultivation on acid soils: is an immediate payback possible? GRDC Updates Papers available at https://grdc.com.au.

Whitten M (2002) Amelioration and prevention of agriculturally generated subsurface acidity in sandy soils in Western Australia, PhD Thesis, University of Western Australia, Crawley, Australia.

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Amelioration Options for Cropping Wodjil Sands

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Take Home Messages

- Identify possible constraints by soil testing to at least 30cm.
- Check for subsoil compaction and deep rip if required.
- The profitability of treatments was affected by poor seasonal conditions during the experimental period.
- Highest cumulative grain yields after four years was obtained using lime (and dolomite) at a rate of 2 t/ha with gypsum where deep ripping with inclusion plates removed the subsoil compaction limitation and provided incorporation of lime or dolomite.

Aim

To determine the benefits of applying lime, dolomite and gypsum to a wodjil loamy sand, with and without deep ripping (with inclusion plates) to 450mm.

Background

A long-term CSBP trial on an acidic high aluminium wodjil country at Bonnie Rock (2008-2018) showed increased wheat yields from applying gypsum in combination with lime or dolomite (Anderson et al 2020). Sub-surface soil compaction can also be a constraint to crops on deep wodjil sands.

This site at Latham is highly acidic. Subsoil pH levels were as low as 4.0 and extractable aluminium (Al) levels as high as 30 mg/kg ($CaCl_2$). Penetrometer measurements identified subsoil compaction as a likely constraint.

Amendments were topdressed onto small plots in April 2017 and the back half of the trial was deep ripped with inclusion plates. Wheat was planted in 2017, followed by wheat in 2018, and canola in 2019.

Low potassium reserves were a concern, so 100 kg/ha K-Till Extra was used as a basal fertiliser in 2017, 2018 and 2019.

In 2020, wheat was sown by the farmer across the trial plots.

Trial Details

Trial location	Hirsch property, Latham
Plot size & replication	10m x 2.1m x 3 replications
Soil type	Acidic red brown loamy sand
Paddock rotation	2017 Wheat, 2018 Wheat, 2019 Canola
Sowing date	09/05/2020
Sowing rate	75 kg/ha Chief CL wheat
Fertiliser	35 kg/ha MAP + 60 L/ha Flexi-N banded at seeding
Herbicides, Insecticides & Fungicides	09/05/2020 1.5 L/ha Trifluralin + 300 ml/ha Diuron

Treatments

	2017 (t/ha)
1	Control
2	2 lime sand[1] (2L)
3	4 lime sand[1] (4L)
4	1 gypsum (1G)
5	2 lime sand[1] + 1 gypsum[3] (2L 1G)
6	2 dolomite[2] (2D)
7	2 dolomite[2] + 1 gypsum[3] (2D 1 G)

[1]Yarra lime sand [2]Watheroo dolomite [3]Kalannie gypsum

Soil Composition

Depth (cm)	pH	Al	EC	OC	ECEC	Nit N	Amm N	P	PBI	K	S
0-10	4.6	2	0.05	0.7	2	16	5	19	30	36	10
10-20	4.1	20	0.03	0.5	1	3	3	3	49	18	24
20-30	4.0	24	0.03	0.2	1	3	1	2	57	15	41
30-40	4.0	28	0.03	0.2	1	4	1	2	80	15	61
40-50	4.0	30	0.03	0.2	1	3	1	2	97	15	70

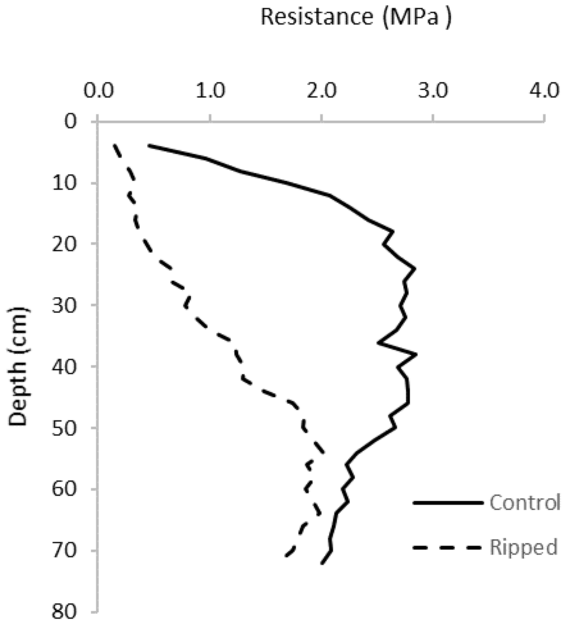

Figure 1. Penetrometer resistance (MPa) measured to a depth of 80cm (August 2018).

Results

In 2020, a severe wind event in late May resulted in patchy crop establishment and dry conditions limiting yields to 1.0 to 1.4 t/ha. Responses to the amendments applied in 2017 were variable, and care should be taken interpreting results.

Unfortunately, dry conditions also resulted in low yields in 2017 and 2018.

The combined application of lime or dolomite provides the greatest grain yield response while there has been no response when only gypsum was applied in all four years.

Small responses to deep ripping each year have added up to a 0.8 t/ha response over four years.

Table 1. Grain yield response to lime, dolomite, gypsum and lime or dolomite applied in combination with gypsum with or without deep ripping with inclusion plates.

	2017 Wheat (t/ha)		2018 Wheat (t/ha)		2019 Canola (t/ha)		2020 Wheat (t/ha)	
Treatments	Unripped	Ripped	Unripped	Ripped	Unripped	Ripped	Unripped	Ripped
Control	0.45	0.61	1.59	1.58	0.06	0.15	1.09	1.44
2L	0.52	0.53	1.32	1.89	0.09	0.28	1.05	1.19
4L	0.46	0.59	1.29	1.99	0.11	0.28	0.98	1.03
1G	0.45	0.59	1.62	1.78	0.10	0.16	1.01	1.03
2L 1G	0.44	0.60	1.48	2.03	0.20	0.18	1.15	1.33
2D	0.49	0.64	1.56	1.68	0.09	0.16	1.06	1.41
2D 1G	0.47	0.60	1.64	2.10	0.13	0.19	1.12	1.29
Prob	0.59	0.87	0.36	0.03	0.07	0.21	0.80	0.03
LSD	ns	ns	ns	0.33	0.08	ns	ns	0.37

After four years, poor seasonal conditions and low grain yields resulted in none of the treatments being profitable.

Table 2. Profitability (per hectare) after four years of lime, dolomite, gypsum and lime or dolomite applied in combination with gypsum with or without deep ripping with inclusion plates.

Treatments	Unripped	Ripped
2L	-$111	-$84
4L	-$205	-$144
1G	-$22	-$179
2L 1G	-$30	-$71
2D	-$49	-$117
2D 1G	-$24	-$57

*Economics assume wheat $280/t, canola $550/t, lime, dolomite and gypsum $30/t (including application), deep ripping $90/ha

Comments

Low yields in three of the four years highlight the challenge of recouping the costs of applying lime or dolomite or in combination with gypsum to soils in a dry environment.

Responses to gypsum on acidic soils is due to increased soil sulfate, calcium and electrical conductivity in the sub soil which reduces the toxicity of aluminium present.

Deep ripping with inclusion plates gave the most consistent response year on year. The results in 2018 indicated better responses to lime and dolomite or in combination with gypsum following deep ripping.

The responses to lime and dolomite and in combination with gypsum were poor without removing the subsoil compaction constraint and incorporating the amendments with inclusion plates.

References

Anderson, G.C.; Pathan, S.; Easton, J.; Hall, D.J.M.; Sharma, R. (2020) Short and long term effects of lime and gypsum application on acid soils in a water-limited environment: 1. Grain yield response and nutrient concentration. Agronomy 10(8), 1213; https://doi.org/10.3390/agronomy10081213.

Anderson, G.C.; Pathan, S.; Easton J.; Hall, D.J.M.; Sharma, R. (2020) Short and long term effects of lime and gypsum application on acid soils in a water-limited environment: 2. Soil chemical properties. Agronomy, 10(12), 1987; https://doi.org/10.3390/agronomy10121987

Anderson, G.C.; Pathan, S.; Easton J.; Hall, D.J.M.; Sharma, R. (2020) Short and long term effects of lime and gypsum application on acid soils in a water-limited environment: 3. Soil Solution Chemistry. 2020, status (unpublished; manuscript in preparation)

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Amelioration of Subsoil Aluminium Toxicity for Improved Productivity in the Northern Agricultural Region of WA – Dalwallinu

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages
- Soil sampling to depth identified that aluminium (Al) toxicity was present as a soil health and crop growth constraint.
- All amelioration techniques of subsoil al toxicity had a positive yield response.
- The ameliorant treatments did not show a net positive effect on the enterprise earnings in the first year.
- The biochar treatments had significantly higher plant numbers than the lime or gypsum treatments but significantly lower yields.
- The untreated control had higher crop and lower weed numbers than any other treatment but significantly lower yield.

Aim
1. To demonstrate the soil health and crop growth benefits of using soil ameliorants combined with cultivation to depth to address subsoil aluminium toxicity.
2. To increase awareness and support the adoption of tools and methods to identify and effectively manage aluminium toxicity.

Background
Aluminium (Al) toxicity in the subsoil is a major problem associated with acidic soils across the Western Australian Wheatbelt. In most Wheatbelt soils, where the subsoil pH is below 4.8, Al concentrations will reach levels that are considered toxic and yield limiting to crops. Current practices to ameliorate surface soil (0-20cm) acidity have been successful and farmers are now seeking validation on practices that ameliorate subsoil (below 20cm depth) acidity and Al toxicity.

Demonstration of practices to identify Al toxicity using existing tools such as soil sampling to depth and methods to ameliorate the constraint will provide farmers with the confidence to trial these practices in their own environments.

In the trial, three ameliorants (lime, gypsum & biochar) were applied to address the Al constraint. Lime application increases soil pH which subsequently converts toxic Al^{3+} to inert gibbsite (Anderson, Pathan, Sharma, Hall, & Easton, 2019). Application of gypsum increases the soil solution sulphate, which can bond with toxic Al to form inert non-toxic Al sulphate (Anderson, Pathan, Sharma, Hall, & Easton, 2019). The oxidising introduced carboxylic functional groups (- charge sites) on biochar surfaces can serve as binding sites for Al^{3+}, rendering it inert and non-toxic (Lin, et al., 2018). The Liebe Group are seeking to investigate these ameliorant options for reducing toxic Al in the soil, and which is most cost effective to implement on property.

Trial Details

Trial Location	Shannon and Jody Fry's property, East Dalwallinu
Plot size & replication	12m x 300m x 2 replications
Soil type	Acidic white sand
Paddock rotation	2017 Wheat, 2018 Wheat, 2019 Wheat
Sowing date	01/05/2020
Sowing rate	50 kg/ha Scepter wheat
Fertiliser	01/05/2020: 45 kg/ha Urea, 30 kg/ha (50%MAP 50%DAP) 25/06/2020: 20 L/ha UAN 19/06/2020: 30 kg/ha Urea
Herbicides, Insecticides & Fungicides	30/04/2020: 1.5 L/ha glyphosate 600, 1.6 L/ha Trifluralin, 2.4 L/ha Boxer, 400 ml/ha ester 680 25/06/2020: 1 L/ha Jaguar, 300 ml/ha LVE

Treatments

	Treatment
1	No ameliorant, no cultivation
2	Lime applied at 3 t/ha, cultivated
3	Gypsum applied at 3 t/ha, cultivated
4	Biochar applied at 2 t/ha, cultivated

Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)	Al $CaCl_2$ (mg/kg)
0-10	6.1	41	33	4	9	2	0.03	0.47	<1
10-20	4.4	20	19	12	16	<1	0.05	0.41	9
20-30	4.3	<2	<15	35	10	<1	0.04	0.19	17
30-40	4.1	<2	<15	49	8	<1	0.04	0.13	20
40-50	4.2	<2	<15	55	7	<1	0.04	0.09	20

Results

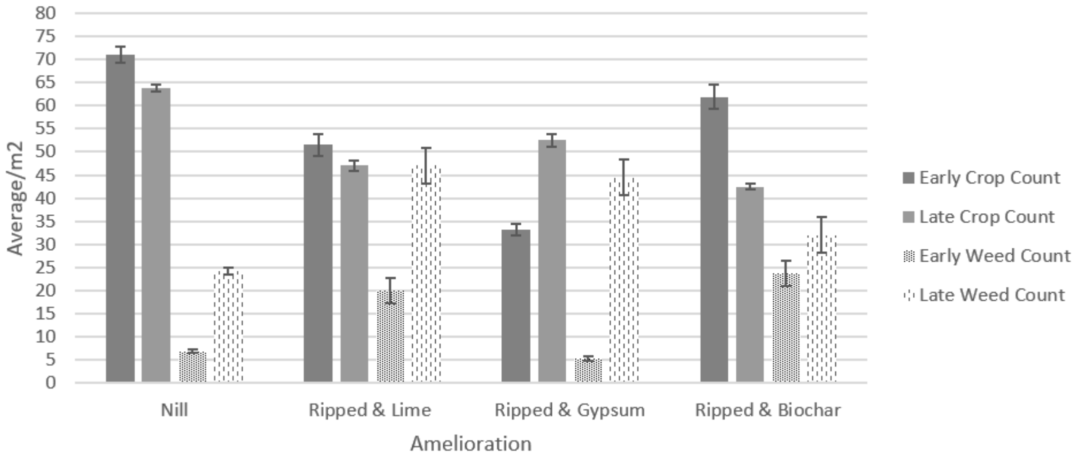

Figure 1: Average early (16/06/2020) and late (20/08/2020) crop and weed density (per m^2) in Scepter wheat in aluminum toxicity trial at Dalwallinu. Error bars are ± 1 S.E.

There was a significant weed burden across the site consisting primarily of ryegrass with some capeweed present. The weed burden increased between the two counts (Figure 1) and ripped treatments had a higher weed density. Crop establishment was staggered but even across each treatment by the second count. The untilled (control) plots had significantly higher establishment numbers, but there were no significant differences between establishment numbers in the other treatments.

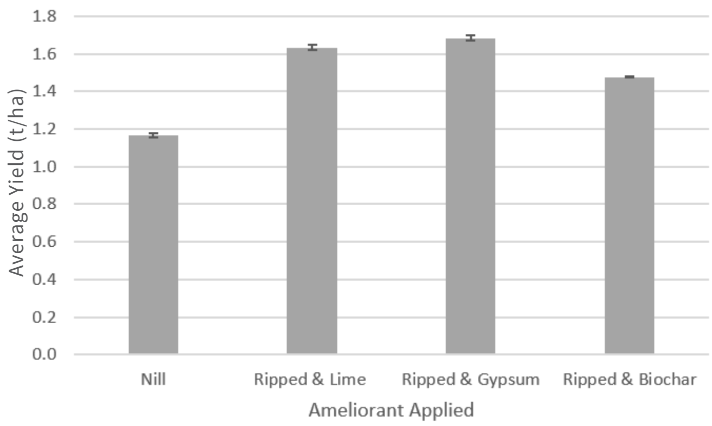

Figure 2: Yield (t/ha) of Scepter wheat in aluminum toxicity trial at Dalwallinu. Error bars are ± 1 S.E.

All ameliorants had a positive yield effect (Figure 2) despite the decreased establishment numbers on the ripped soils (Figure 1). The biochar treatments had significantly lower yields than the lime and gypsum treatments, but lime and gypsum were not significantly different (Figure 2).

Comments

Aluminium is considered to have a negative impact on the growth of susceptible plant species when it reaches concentrations above 5 mg/kg. At the site, prior to application of ameliorants, aluminium levels were above 5 mg/kg throughout the sub soil (10-50cm). Therefore, subsoil Al toxicity would be considered a significant constraint to crop performance.

Table 1: Cost benefit analysis of different ameliorants applied to acid soil with Al toxicity present in Dalwallinu.

Amelioration Treatment		**Nil**	**Lime**	**Gypsum**	**Biochar**
Yield	t/ha	1.17	1.63	1.68	1.48
Average Grain Price (APW1)	$/t	303	303	303	303
Income	$/ha	354	495	510	447
Variable Operating Costs	$/ha				
Seed, Treatment & EPR's		20	20	20	20
Grain Freight		29	41	42	37
Grain Handling Charges		10	14	15	13
Crop Contract		35	35	35	35
Other Crop Costs & Crop Ins		22	22	22	22
Wages Gross		28	28	28	28
R&M Mach./Plant/Vehicle		42	42	42	42
Fuel & Oil		27	27	27	27
Amelioration Including Ripping and Spreading Cost		0	175	160	685
Pesticide		30	30	30	30
Variable Operating Costs	$/ha	243	434	421	939
Operating Gross Margin	$/ha	111	61	89	-491
Fixed Operating Costs	$/ha	133	133	133	133
Total Operating Costs	$/ha	376	567	554	1,072
Operating Profit (BIT)	$/ha	-22	-72	-44	-624
Finance Costs		36	36	36	36
Earnings Before Tax (EBT)	$/ha	-58	-108	-80	-660

All ameliorants have demonstrated a positive effect on yield, however this has not translated to a positive effect on the ROI in the first year (Table 1). It has been shown in other research (Anderson, Pathan, Sharma, Hall, & Easton, 2019) that amelioration can have positive yield benefits over a number of years. As such, the Liebe Group are exploring the opportunity to extend the monitoring of this project into future seasons.

Tissue testing was also performed on each plot, but no significant differences were found between any of the nutrient levels of the treatments. However, it should be noted that the plant tissue testing identified potassium (K) as being deficient in all treatments. This would have limited the potential for any responses to the amelioration treatments. The soil test levels of potassium were also very low, indicating that K supply may have been one of the major constraints that reduced productivity at this site.

The results from this project have provided greater understanding of soil health characteristics and crop growth responses to Al toxicity, the identification of potential management practices, and support for local growers to improve their practices to contribute to positive soil health changes in the region. Validating the quantifiable economic benefits for growers is an important step in the adoption of long-term and sustainable land management practices.

Additionally the benefits of soil sampling to depth have been introduced as an effective tool to measure positive changes in soil health due to on-farm practices, which will be highlighted further with the second set of soil tests that will be taken post-harvest 2020. This second sampling activity will assist in determining the effect each ameliorant had on aluminium concentrations and pH in the soil profile.

Acknowledgements

This project is supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's National Landcare Program Smart Farms Small Grants. Thanks to the Shannon, Jodi and the Fry family for their assistance hosting, implementing and managing the trial as well as their involvement in our virtual field walk. Thanks to Kalannie Gypsum Supplies for the donation of the gypsum for the trial.

References

Anderson, G., Pathan, S., Sharma, R., Hall, D., & Easton, J. (2019). Soil solution concentrations and aluminium species of an eastern wheatbelt acidic soil of WA treated with lime and gypsum. Retrieved from Grains Research and Development Corporation: https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/02/soil-solution-concentrations-and-aluminium-species-of-an-eastern-wheatbelt-acidic-soil-of-wa-treated-with-lime-and-gypsum.

Lin, Q., Zhang, L., Riaz, M., Zhang, M., Xia, H., Lv, B., & Jiang, C. (2018, October 15). Assessing the potential of biochar and aged biochar to alleviate aluminium toxicity in an acid soil for achieving cabbage productivity. Ecotoxicology and Environmental Safety, pp. 290-295.

Peer review

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Amelioration of Subsoil Aluminium Toxicity for Improved Productivity in the Northern Agricultural Region of WA – Latham

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages
- Soil sampling to depth identified that aluminium (Al) toxicity was present as a soil health and crop growth constraint.
- Ripping had a negative yield effect due to wind erosion events at the site.
- The liming ameliorant appears to have had a positive yield effect, offsetting the impact of the ripping.
- The gypsum and biochar ameliorants did not increase yield.

Aim
1. To demonstrate the benefits of using soil ameliorants with deep cultivation to address subsoil aluminium toxicity.
2. To increase awareness and support the adoption of tools and methods to identify and effectively manage aluminium toxicity.

Background
Aluminium toxicity in the subsoil is a major problem associated with acidic soils across the WA Wheatbelt. In most Wheatbelt soils, where the subsoil pH is below 4.8, Al concentrations will reach levels that are considered toxic and yield limiting to crops. Current practices to ameliorate surface soil (0-20cm) acidity have been successful and farmers are now seeking validation on practices that ameliorate subsoil (below 20cm depth) acidity and Al toxicity.

In the trial, three ameliorants (lime, gypsum & biochar) were applied to address the Al constraint. Lime application increases soil pH which subsequently converts toxic Al^{3+} to inert gibbsite (Anderson, Pathan, Sharma, Hall, & Easton, 2019). Application of gypsum increases the soil solution sulphate, which can bond with toxic Al to form inert non-toxic Al sulphate (Anderson, Pathan, Sharma, Hall, & Easton, 2019). The oxidising introduced carboxylic functional groups (- charge sites) on biochar surfaces can serve as binding sites for Al^{3+}, rendering it inert and non-toxic (Lin, et al., 2018). The Liebe Group are seeking to investigate these ameliorant options for reducing toxic Al in the soil, and which is most cost effective to implement on property.

Trial Details

Trial location	Hirsch property, Latham
Plot size & replication	12m x 300m x 2 replications
Soil type	Acidic white sand
Paddock rotation	2017 Fallow, 2018 Wheat, 2019 Barley
Sowing date	26/07/2020
Sowing rate	60 kg/ha Buff Barley
Fertiliser	26/07/2020: 40 kg/ha MAP, 50 L/ha UAN
Herbicides, Insecticides & Fungicides	26/07/2020: 3 L/ha Trifluralin, 30 g/ha Diuron 01/07/2020: 1 L/ha Jaguar, 200 ml/ha LV Ester 680

Treatments

	Treatment
1	No ameliorant, no cultivation
2	No ameliorant, cultivated*
3	Lime applied at 3t/ha, cultivated*
4	Gypsum applied at 3t/ha, cultivated*
5	Biochar applied at 2t/ha, cultivated*

*The cultivation method used was deep ripping to 400mm with inclusion plates.

Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)	Al $CaCl_2$ (mg/kg)	PBI
0-10	5.2	16	81	33	10	6	0.07	0.5	<0.2	33
10-20	4.3	6	54	26	5	3	0.04	0.3	8	44
20-30	4.2	<2	52	31	4	2	0.04	0.2	19	56
30-40	4.2	<2	43	34	4	1	0.04	0.2	20	62
40-50	4.2	<2	27	37	5	1	0.03	0.2	22	72

Results

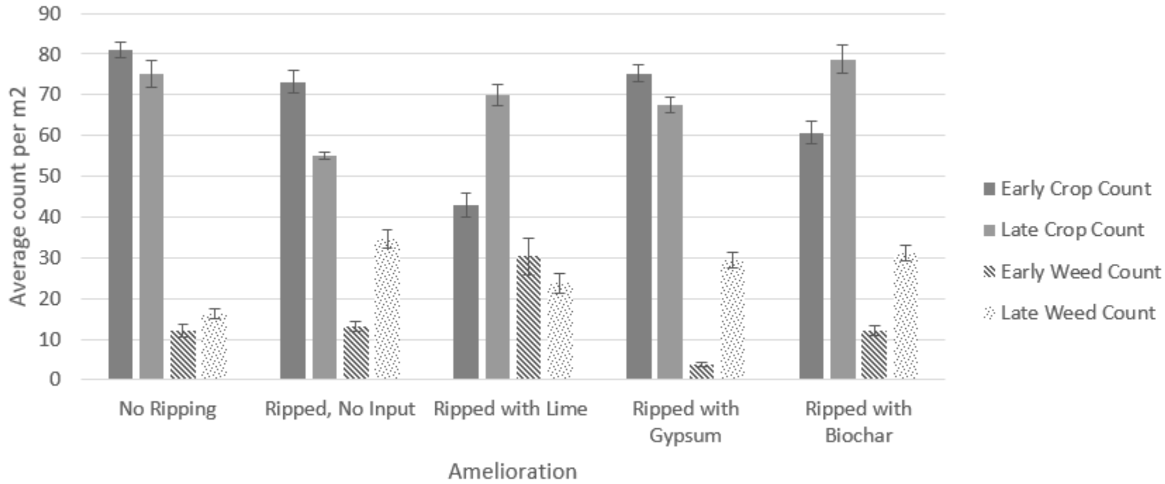

Figure 1: Average early (17/06/2020) and late (18/08/2020) crop and weed density (per m^2) in Buff barley in aluminum toxicity trial at Latham. Error bars are ± 1 S.E.

There was significant weed density across the site consisting primarily of ryegrass. The weed burden was varied across and between plots (Figure 1), however, overall the ripped treatments had a higher weed burden than the un-ripped. Crop establishment was staggered, and quite uneven within and between plots. The un-ripped (control) plots had higher crop establishment numbers, but there were no significant differences between establishment numbers in the other treatments.

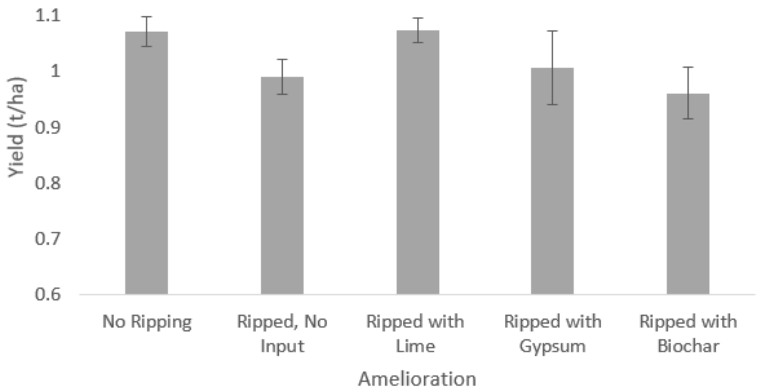

Figure 2: Yield (t/ha) of Buff barley in aluminum toxicity trial at Latham. Error bars are ± 1 S.E.

The ripping seems to have had a negative yield effect (Figure 2), while the lime appeared to have had a positive yield effect.

Comments

The host paddock received two significant wind events post sowing, which led to wind damage and row fill at the trial site.

Variation in plant and weed numbers seems to primarily be spatial due to wind damage and had little correlation to the treatments, with the exception of lower weed numbers being observed in un-ripped treatments (Figure 1).
The negative yield response to the ripping is likely due to wind damage and furrow fill moving the disturbed soil of ripped treatments more than the undisturbed soil of the un-ripped treatments.

The lime may have had a positive yield effect, mitigating some of the negative effects of the ripping treatment. The biochar and gypsum however do not appear to have had a positive effect on yield. The lack of response to gypsum was probably due to the high levels of sulphur present in the soil to render the Al non-toxic. The effectiveness of biochar is dependent on its exact makeup and what materials have been included in the product (Lin, et al., 2018). Exact understanding of when the product is most and least effective at ameliorating subsoil Al is not entirely clear.

Tissue testing was also performed on each plot, but no significant differences were found between any of the nutrient levels of the treatments. Given the impact of external factors on the performance of the treatments applied, an economic analysis was not conducted on the results.

The results from this project have provided greater understanding of soil health characteristics and crop growth responses to Al toxicity, the identification of potential management practices, and support for local growers to improve their practices to contribute to positive soil health changes in the region. Validating the quantifiable economic benefits for growers is an important step in the adoption of long-term and sustainable land management practices.

Additionally the benefits of soil sampling to depth have been introduced as an effective tool to measure positive changes in soil health due to on-farm practices, which will be highlighted further with the second set of soil tests that will be taken post-harvest 2020. This second sampling activity will assist in determining the effect each ameliorant had on Al concentrations and pH in the soil profile.

The Liebe Group would also like to quantify the long term costs and benefits of the different ameliorants used, and are looking into extending the monitoring of the project over following seasons.

Acknowledgements
This Project is supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's National Landcare Program Smart Farms Small Grants. Thanks to the Hirsch family for their assistance, hosting and implementing the trial as well as donating the lime and gypsum.

References
Anderson, G., Pathan, S., Sharma, R., Hall, D., & Easton, J. (2019, February 26). Soil solution concentrations and aluminium species of an eastern wheatbelt acidic soil of WA treated with lime and gypsum. Retrieved from Grains Research and Development Corporation: https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/02/soil-solution-concentrations-and-aluminium-species-of-an-eastern-wheatbelt-acidic-soil-of-wa-treated-with-lime-and-gypsum.

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Peer review
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Demonstrating the Benefits of Soil Amelioration (Ripper Gauge) - Dalwallinu

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages
- Compaction is a major soil constraint with approximately 75% of WA's cropping land susceptible to and impacted by, subsoil compaction.
- Penetrometer readings show that deep ripping and Horsch Tiger removed the compaction layer at the site, whilst other shallower, disc type treatments did not.
- The combined maximum tillage treatment consistently provided the highest average yield.

Aim
To evaluate the grain yield and economic benefit of soil amelioration and controlled traffic practices on a broader range of soil types across the grain growing region of WA.

Background
Approximately 75% of WA's cropping land is at risk of lost production due to subsoil compaction. Compaction is conservatively estimated to cost the industry around $833 million annually (DPIRD, 2018). Control options including cultivation practices and controlled traffic farming are costly and some growers are reluctant to implement soil amelioration because of this. In addition to this, multiple cultivation methods and machinery types add to the difficulty in the decision to adopt.

To assess the effectiveness of various cultivation methods and their ability to improve yield and economic return, the Liebe Group, with funding from GRDC, have implemented a large scale three year grower scale demonstration in the Kwinana East Port Zone, at two sites, one in Kalannie and the other in Dalwallinu. At the Dalwallinu site four cultivation methods were also investigated;
- Standard offset discs
- Deep ripping
- Combined maximum tillage
- And the combination of standard offset discs and deep ripping

Trial Details

Trial location	Carlshausen Property, Dalwallinu
Plot size & replication	36.6m x 400m x 1 replication
Soil type	Gravely sand
Paddock rotation	2017 Fallow, 2018 Wheat, 2019 Wheat
Sowing date	03/05/2020
Sowing rate	60 kg/ha Planet Barley
Fertiliser	03/05/2020 60 L/ha Flexi N, 70 Kg/ha Agflow 07/09/2020 50 L/ha Flexi N, 75 g/ha Zinc Sulphate foliar
Herbicides, Insecticides & Fungicides	03/05/2020 2 L/ha Treflan, 2 L/ha Prosulfocarb 07/09/2020 0.1 L/ha Chlorpirfos, 0.2 L/ha Brom MA, 0.4 L/ha Flight 07/09/2020 0.13 L/ha Azoxystrobin, 0.25 L/ha Tilt

Treatments

	Treatment
1	Control
2	Offset Disc
3	Deep Ripper
4	Deep Ripper + Offset Disc
5	Combined Maximum Tiller

Soil Composition

Depth	Col P	Col K	KCl S	O C	EC	pH $CaCl_2$	PBI	NO3N	NH4N	DTPA Cu	DTPA Zn	DTPA Mn	Ex Al	$CaCl_2$ Al
0-10	50	99	15.7	0.75	0.090	5.7	24.2	30	2	0.33	0.48	1.72	0.145	0.22
10-20	18	46	17.7	0.50	0.047	4.9	19.4	9	< 1	0.19	0.12	0.51	0.251	0.39
20-30	10	34	25.1	0.31	0.052	4.7	23.5	10	< 1	0.14	0.13	0.32	0.302	< 0.20
30-40	5	25			0.054	5.2		7	< 1					0.23
40-50	2	19			0.046	5.4		4	< 1					< 0.20

Results

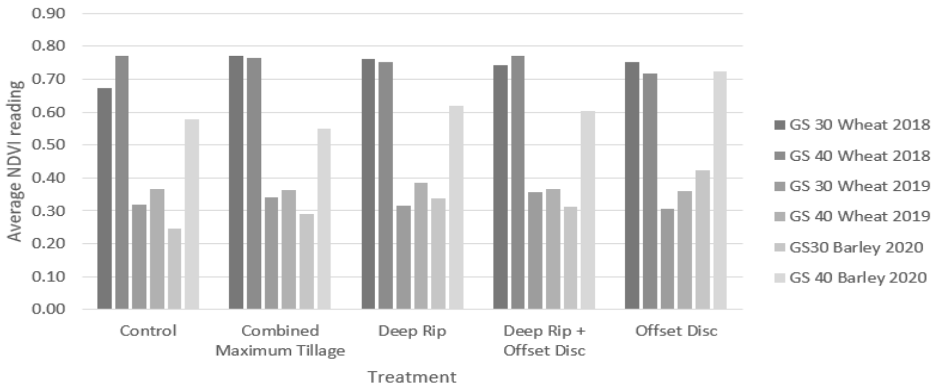


Figure 1: NDVI – Green seeker readings, at Emergence, Z30 and Z40 crop stages during 2018, 2019 and 2020.

Table 1: Observations as measured during the 2020 season at the Dalwallinu site.

Treatment	Emergence/ m^2		NDVI GS21		NDVI GS30		NDVI GS40		Weeds/m^2	
Ausplow Deep Rip	112	c	0.09	ns	0.62	ab	0.34	ab	12	a
Ausplow Deep Rip + Offset Disks	46	a	0.10	ns	0.60	ab	0.31	ab	11	a
Control	87	bc	0.12	ns	0.61	ab	0.13	a	2	a
Control 2	55	ab	0.11	ns	0.52	a	0.47	b	3	a
Horsch Tiger	89	bc	0.10	ns	0.55	a	0.29	ab	1	a
Offset Disks	48	a	0.10	ns	0.72	b	0.42	b	4	a
P Value	<0.001		0.7		0.02		0.01		0.028	

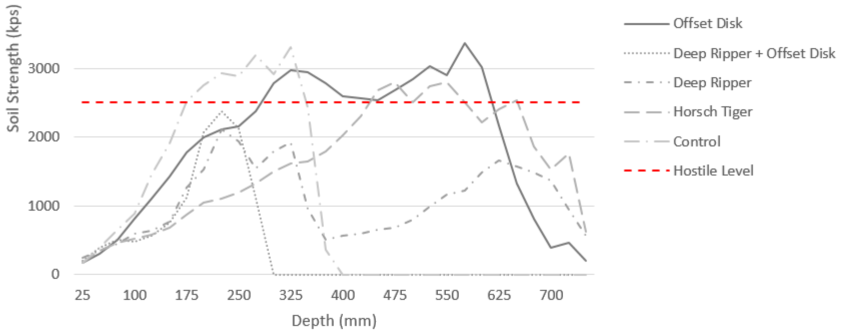


Figure 2: Penetrometer measurement of soil strength on the rip line as taken in 2018 (six months post cultivation). The dashed horizontal line indicates strength at which 90% of root growth stops.

These measurements were taken at the site in the first year of the project, in the winter six months post-treatment application (Figure 2). The control treatment shows the compaction levels pre-cultivation, the control soil was too hostile and compaction levels could not be measured past 400mm. There were also clear and significant differences between the different treatments.

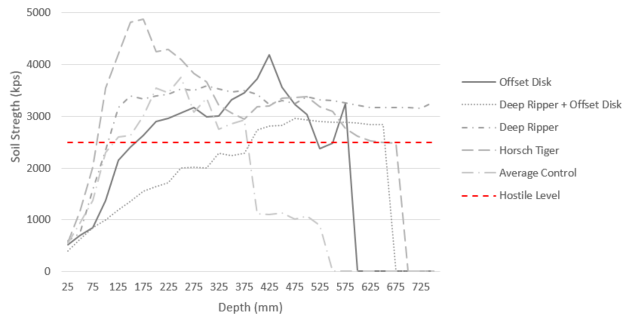
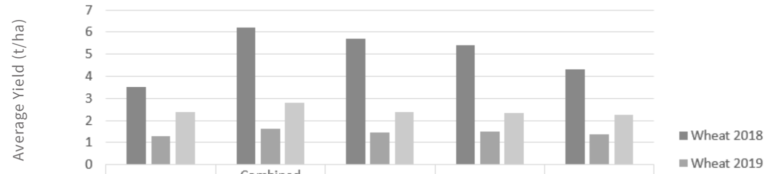


Figure 3: Penetrometer measurement of soil strength on the rip line as taken in 2020 (three years post cultivation). The dashed horizontal line indicates strength at which 90% of root growth stops.

These measurements were taken three years post cultivation (Figure 3), at which time compaction levels measured unexpectedly high across all treatments. This may indicate that the soil was not at capacity at the time of measurement which can exaggerate soil strength.



	Control	Combined Maximum Tillage	Deep Rip	Deep Rip + Offset Disc	Offset Disc
Wheat 2018	3.5	6.2	5.7	5.4	4.3
Wheat 2019	1.27	1.61	1.46	1.49	1.37
Barley 2020	2.38	2.82	2.39	2.34	2.27

Figure 4: Yield quantity, measured in t/ha during harvest 2018, 2019 and 2020.

There were some significant differences in yields in all years, but differences became less pronounced each year past initial cultivation.

Comments

Initial penetrometer readings, taken in July of 2018 (Figure 2), show the impact of each treatment on the shatter of the compaction from a depth of 170mm. Readings from the control strip indicate a high-level compaction strength, with soil remaining hostile until the penetrometer could not obtain a reading (375mm). Observations suggest soil strength seems to become hospitable to root growth below 650mm. This deep compaction has been attributed to a long history of stock and machinery movement on the land.

Due to the shallow starting level of the compaction, all cultivation techniques initially improved rooting depth. As the compaction reaches deep into the soils B horizon the deeper cultivation continues to improve the rooting depth and thus further increasing water and nutrient availability to the plants. Initially, both the deep ripped and deep ripped plus offset disc treatments appear to have alleviated the entire compaction layer present at the site.

Over the three years it appears that the compaction layer has begun to re-form, and although compaction is not as significant as the control under the treatments, soil strength had become hostile once more under most treatments by 2020 (Figure 3).

All treatments had a significant positive yield response in comparison to the untreated control in 2018 and 2019 (Figure 4). This was not as apparent in 2020, there were no significant differences in yield between the control and the deep ripping, offset disc and deep ripped combined with offset disc treatments. Only the combined maximum tillage treatment still showed significantly higher yield in 2020.

Table 2: Combined income, variable costs and earnings before tax (EBT) across three years of production at the Dalwallinu site.

Enterprise Analysis Crop Dalwallinu						
Combined Year on Year (2017-2020)						
Crop Enterprise		**Control**	**Offset Disk**	**Deep Ripper + Offset Disks**	**Deep ripper**	**Combined Maximum Tillage**
Income	$/ha	$2,268	$2,694	$3,005	$3,087	$3,299
Variable Operating Costs	$/ha	$958	$1,044	$1,098	$1,115	$1,135
Operating Gross Margin	$/ha	$1,310	$1,650	$1,906	$1,972	$2,164
Fixed Operating Costs	$/ha	$477	$477	$477	$477	$477
Total Operating Costs	$/ha	$1,435	$1,521	$1,575	$1,592	$1,612
Operating Profit (BIT)	$/ha	$833	$1,173	$1,429	$1,495	$1,687
Finance Costs	$	$45	$45	$45	$45	$45
Earnings Before Tax (EBT)	$/ha	$788	$1,128	$1,384	$1,450	$1,642

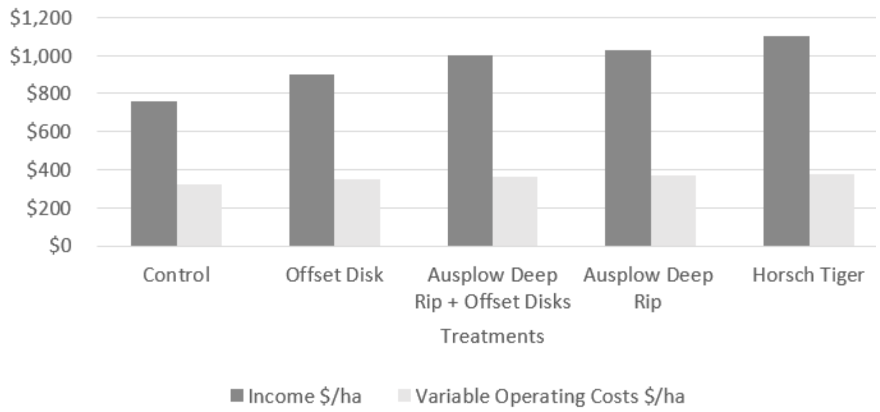


Figure 5: Average Income and variable costs across three years of production at the Dalwallinu site.

All treatments had a positive cumulative return on investment (ROI) after the three year period (Table 2). All amelioration techniques achieved a higher average three-year earnings before tax (EBT) than the untreated control. There where significant differences between each of the treatments, with the combined maximum tillage being the most effective over the three years (Figure 5). This combined maximum tillage treatment caused the most mixing and disturbance in the soil, which has been most effective at boosting yield in this heavier soil more prone to deep compaction.

Acknowledgements
Many thanks to the Carlshausen family for hosting this demonstration site and Travis Stanley and Bob Nixon, Kalannie, who provided their time and machinery to implement this demonstration. Thank you to Ty Henning of TekAg who developed the trial design for this grower scale demonstration and, AFGRI Equipment Dalwallinu for the supply of the Horsch Tiger MT and Horsch Joker RT as well as the Equaliser Seeding Bar for the seeding of the demonstration.

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Demonstrating the Benefits of Soil Amelioration (Ripper Gauge) - Kalannie

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages
- Compaction is a major soil constraint with approximately 75% of WA's cropping land susceptible to and impacted by, subsoil compaction.
- Penetrometer readings show that deep ripping and combined maximum tillage removed the compaction layer at this site, whilst the other shallower, disc type treatments did not.

Aim
To evaluate the grain yield and economic benefit of soil amelioration and controlled traffic practices on a broader range of soil types across the grain growing region of WA.

Background
Approximately 75% of WA's cropping land is at risk of lost production due to subsoil compaction. Compaction is conservatively estimated to cost the industry around $833 million annually. Control options including cultivation practices and controlled traffic farming are costly and some growers are reluctant to implement soil amelioration because of this. In addition to this, multiple cultivation methods and machinery types add to the difficulty in the decision to adopt.

To assess the effectiveness of various cultivation methods and their ability to improve yield and economic return, the Liebe Group, with funding from GRDC, have implemented a large scale three year grower scale demonstration in the Kwinana East Port Zone, at two sites, one in Kalannie and the other in Dalwallinu. At the Kalannie site, four cultivation methods are being investigated;
- Standard offset disc;
- Deep ripping;
- Combined maximum tillage; and
- Speed Disc tillage.

Trial Details

Trial location	McCreery Property, Kalannie
Plot size & replication	200m x 12m x 2 replications
Soil type	Loamy sand
Paddock rotation	2017 Fallow, 2018 Wheat, 2019 Chemical fallow
Sowing date	24/04/2020
Sowing rate	80 kg/ha Jurien Lupins
Fertiliser	24/02/2020: 37.5 kg/ha Sulphur, 6.75 kg/ha Phosphorus, 9 kg/ha Calcium 04/09/2020: 0.43 kg/ha Amino Acids, 0.215 kg/ha Nitrogen, 0.125 kg/ha Magnesium
Herbicides, Insecticides & Fungicides	24/04/2020: 300 g/ha Metribuzin 750 WG, 560 g/ha Propyzamide 900 WG, 350 g/ha Chlorpyifos 500 EC, 40 g/ha 11/06/2020: 62.5 g/ha Diflufenican, 375 g/ha Metribuzin 18/06/2020: 686 g/ha Ammonium sulphate, 20 g/ha Quizalofop, 108 g/ha Clethodim 24/04/2020: 0.8 kg/ha Iprodione 250, 40 g/ha Alpha-cypermethrin 03/09/2020: 25 g/ha Alpha-cypermethrin 04/09/2020: 25 g/ha Alpha-cypermethrin

Treatments

	Treatment
T1	Control
T2	Maximum Tiller (6m)
T3	Standard Offset Disc (12m wide with 28-inch offset discs)
T4	Deep Ripper (12m)
T5	Speed Disc Tiller (12m)

Soil Composition

Depth (cm)	Col P	Col K	KCl S	O C	EC	pH	PBI	NO3N	NH4N	DTPA Cu	DTPA Zn	DTPA Mn	Ex Al	Ca Cl2 Al
0-10	27	73	6.0	0.92	0.077	5.1	30.9	25	2	0.25	0.31	1.15	0.108	0.44
10-20	9	41	12.3	0.69	0.037	4.2	44.6	6	< 1	0.15	0.13	0.36	0.709	10.32
20-30	3	36	30.2	0.29	0.041	4.2	52.6	4	< 1	0.10	0.08	0.24	0.789	20.51
30-40	< 2	35			0.046	4.1		5	< 1					17.74
40-50	5	42			0.053	4.2		7	1					8.63

Results

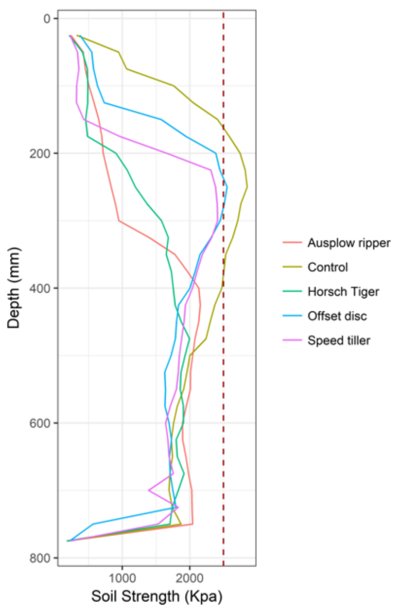


Figure 1: penetrometer measurement of soil strength on the rip line taken when the soil was at capacity in July 2018.

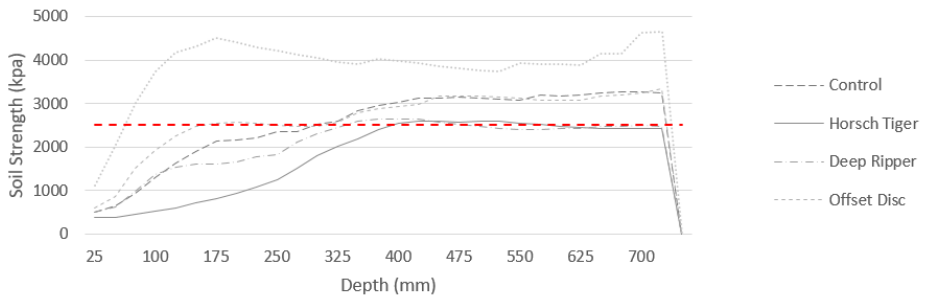


Figure 2: penetrometer measurement of soil strength on the rip line taken when the soil was at capacity in July 2020.

These measurements (Figure 1) were taken in July 2018. The control shows a compaction layer from 150mm to 450mm pre-cultivation. There were very clear differences between treatments, with the Horsch Tiger and deep ripper completely ameliorating the compaction layer whilst speed tiller and offset disc left the compaction layer partially intact from 200-300mm.

These measurements (Figure 2)were taken in July of the final year of the project, 2020. The soil did not show the expected characteristics under any of the plots.

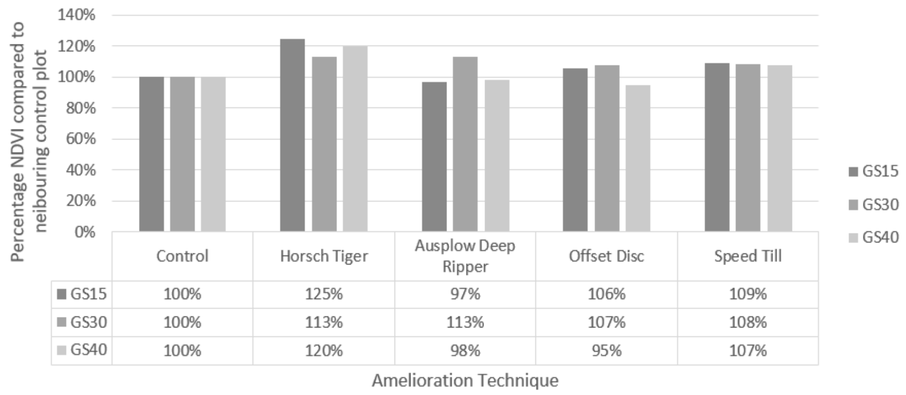


Figure 3: NDVI – Green seeker readings, at Growth Stages 15, 30 and 40, during 2018, 2019 and 2020. Each reading is expressed as a percentage of the neighbouring control plot.

Table 1: Observations as measured during the 2020 season at the Kalannie.

Treatment	Emergence/m²	NDVI GS15	NDVI GS30	NDVI GS40	Weeds/m²
Ausplow Deep Ripper	96 [ab]	0.23 ns	0.73 ns	0.61 ns	7 ns
Control	92 [a]	0.21 ns	0.66 ns	0.57 ns	10 ns
Horsch Tiger	126 [b]	0.23 ns	0.71 ns	0.59 ns	14 ns
Offset Disc	84 [a]	0.25 ns	0.69 ns	0.59 ns	5 ns
Speed Till	100 [ab]	0.21 ns	0.65 ns	0.65 ns	7 ns
P Value	0.16	0.3	0.81	0.85	0.25

Figure 4: Yield quantity, measured in tons per hectare during harvest 2018, 2019 and 2020. Each quantity is expressed as a percentage of the neighbouring control plot.*

**No yield data for the 2019 harvest has been included, the 2019 oat crop was sprayed out to control weed seed set.*

All cultivated land yielded higher than the uncultivated control. However, it should be noted that the controlled traffic tram lines ran through each of the control plots, which may have limited their yields.

Comments

Penetrometer readings taken during 2018, the year treatments were applied, show the impact of each treatment on the compaction layer that was present at the site between 200mm and 300mm. This shallow compaction has been attributed to the long history of livestock farmed on this property. The compaction layer under the control treatment does not go beyond a depth of 40cm; meaning, beyond 40cm soil compaction decreases providing good soil structure for roots to penetrate.

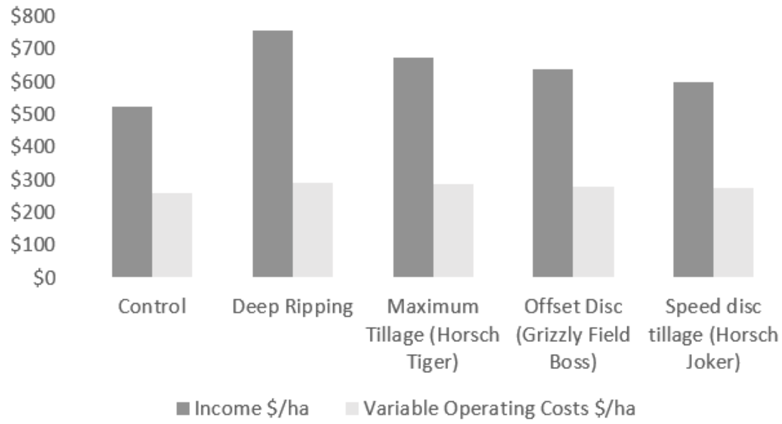
Given the working depth of the standard offset disc treatment (200mm), it appears to have only marginally reduced the level of compaction, leaving hostile levels of compaction from 200-250mm. The speed disc tiller also has a similar shallow working depth (200mm) to the offset disc, however, this machine is designed to cut and bury crop stubbles at the soil surface and was slightly more effective at alleviating compaction.

The deep ripper and maximum tiller both had a major impact on the removal of the compaction layer, due to their deep working depth (450mm+), with minimal resistance experienced on those plots post-treatment.

The 2020 soil strength testing does not show the expected results for any of the treatments, and there is a concern that the soil was not at capacity or there was another error that influenced the readings.

Table 2: Average Income, variable costs and EBT across three years of production at the Kalannie site.

Enterprise Analysis Crop Kalannie Combined Year on Year (2017-2020)						
Crop Enterprise		**Control**	**Deep Ripping**	**Maximum Tillage**	**Offset Disc**	**Speed disc tillage**
Income	$/ha	$1,567	$2,261	$2,008	$1,908	$1,784
Variable Operating Costs	$/ha	$774	$865	$860	$830	$821
Operating Gross Margin	$/ha	$793	$1,396	$1,148	$1,078	$963
Fixed Operating Costs	$/ha	$477	$477	$477	$477	$477
Total Operating Costs	$/ha	$464	$556	$551	$521	$512
Operating Profit (BIT)	$/ha	$316	$919	$671	$601	$486
Finance Costs	$	$45	$45	$45	$45	$45



Earnings Before Tax (EBT)	$/ha	$271	$874	$626	$556	$441

Figure 5: Average Income and variable costs across three years of production at the Kalannie site.

All treatments had a positive average return on investment (ROI) after the three year period (Table 2). All amelioration techniques achieved a higher average three-year earnings before tax (EBT) than the untreated control. This includes the costs and lack of income represented by spraying out the 2018 crop instead of allowing it to progress to harvest. The deep ripped treatment was the most profitable, despite having the largest average variable cost, it also significantly increased crop performance, outlaying the larger initial investment. Deep ripping was likely most effective at boosting yield on this soil type as it completely ameliorated the limited compaction band in the light sand.

Acknowledgements

Many thanks to the McCreery family for hosting this demonstration site and to Travis Stanley and Bob Nixon, Kalannie, who provided their time and machinery to implement this demonstration. Thank you to Ty Henning of TekAg who developed the trial design for this grower scale demonstration and, AFGRI Equipment Dalwallinu for the supply of the Horsch Tiger MT and Horsch Joker RT as well as the Equaliser Seeding Bar for the seeding of the demonstration.

This project is funded through the GRDC investment: Demonstrating the benefits of soil amelioration (Ripper-Gauge) which is led by the West Midlands Group.

Peer Review

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Gen Y Paddock Challenge -Tactical Employment of Fallow and Utilising Fertiliser Strategies to Optimise Rotation Performance on Heavy soils

Blair Stone, PR&CJ Stone, and Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages
- An increased fertiliser rate can help to optimise profits post fallow, taking full advantage of stored soil moisture from the fallow period.
- The fallow wheat rotation significantly improved EBT in comparison to the wheat, wheat rotation.

Aim
To investigate fertiliser rates on wheat post fallow to optimise the combined two-year EBT.

Background
Farmers are very good at trialling best practice soil management in the isolation of their environment, however, do not always effectively capture and analyse trial information beyond visual or yield assessments. Furthermore, they don't always have the opportunity to share the information they are gathering publicly, limiting their opportunities to gain valuable feedback from peers. By building the capacity of farmers to actively trial, capture and share their on-farm trials, with input from their peers and in a trusted environment, we aim to increase engagement and foster the adoption of best practice soil management methods.

Blair Stone has been investigating optimisation of returns on a usual heavy clay soil on his property. The soil has a high water-holding capacity and a high wilting point due to the higher clay content. This has resulted in the paddock performing especially poorly in low rainfall years but quite well in average and above-average rainfall years. Due to this, Blair has been investigating the use of fallows in years with poor outlooks. He has had very promising results and over the last four years, has implemented a wheat, fallow, wheat, fallow rotation with wheat strips seeded each year in the fallow rotation. In 2018 the single wheat harvest yield after a fallow was higher in tons per hectare than the combined yields off the two crops with a wheat, wheat rotation.

Blair is now looking to fine-tune the system by investigating fertiliser application strategies in the wheat rotation to optimise return on investment.

Additional natural resources management (NRM) benefits to this strategy include improved water use efficiency, and higher biomass resulting in a reduced risk of wind erosion.

Trial Details

Trial location	Stone Property, Marchagee
Plot size & replication	36m x 400m x 2 replications
Soil type	Red deep loam
Paddock rotation	2019 Fallow, 2018 Wheat, 2017 Fallow
Sowing date	15/05/2020
Sowing rate	55 kg/ha Scepter Wheat
Fertiliser	As per treatment list
Herbicides, Insecticides & Fungicides	15/05/2020 118 g/ha Sakura, 2 L/ha Treflan 15/07/2020 650 L/ha Trident, 10 g/ha Logran

Treatments

#	Treatment	
1	Low Rate Fertiliser	55kg Agstar Extra
2	Medium Rate Fertiliser	55kg Agstar Extra, 30kg Urea at seeding & 40L top up Flexi N
3	High Rate Fertiliser	55kg Agstar Extra, 30kg Urea at seeding & 80L top up Flexi N

Soil Composition

Depth (cm)	PH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (dS/m)	OC (%)
0-10	7.4	41	701	15.4	46	2	0.2	1.1
10-20	8.0	9	245	3.1	8	1	0.1	0.6
20-40	8.4	3	162	16.1	5	1	0.2	0.3
40-60	8.5	3	207	38.3	5	<1	0.5	0.3
60-80	8.6	<2	258	73.9	3	<1	0.8	0.2
80-100	8.6	<2	318	91.7	2	<1	0.8	0.2

Results

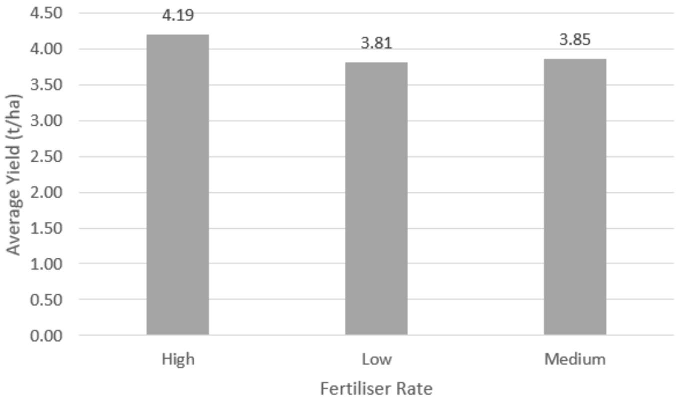

Figure 1: Average wheat yield (t/ha) by fertiliser rate as harvested on the 27/11/2020.

The crop was even and came off well at harvest. During harvest, there was a clear visual difference between the treatments that have been mirrored by the yield results.

Comments

There was a clear trend between the treatments and the yield, showing a positive yield effect to both the increased fertiliser rate (Figure 1). When analysing the economics (Table 1), this also correlated to an increased enterprise profit from the high fertiliser rate (highest EBT). However, there was also an increase in EBT from the lower fertiliser rate in comparison to the medium (standard practice fertiliser rate. This shows that there was another limiting factor in place, and the decreased cost associated with the low fertiliser rate also had the potential to increase enterprise performance. This clearly shows the diverse effect fertiliser rate can have on enterprise performance, and that optimising fertiliser application can be a valuable tool to optimise a fallow wheat rotation.

Table 1: Economic analysis of three fertiliser rates applied to wheat following fallow.

Fertiliser Rate		**High**	**Medium**	**Low**
Yield	t/ha	4.19	3.85	3.81
Grade		ASW1	ASW1	ASW1
Average Grain Price	$/t	$300	$300	$300
Income	**$/ha**	**$1,257**	**$1,155**	**$1,143**
Variable Operating Costs	**$/ha**	**$**	**$**	**$**
Seed, Treatment & EPR's		$12	$12	$12
Grain Freight		$21	$19	$19
Grain Handling Charges		$37	$34	$34
Crop Contract		$35	$35	$35
Other Crop Costs & Crop Ins		$22	$22	$22
Wages Gross		$28	$28	$28
R&M Mach./Plant/Vehicle		$42	$42	$42
Fuel & Oil		$27	$27	$27
Fertiliser		$76	$62	$33
Variable Operating Costs	**$/ha**	**$300**	**$281**	**$252**
Operating Gross Margin	**$/ha**	**$957**	**$874**	**$891**
Fixed Operating Costs	**$/ha**	**$73**	**$73**	**$73**
Total Operating Costs	**$/ha**	**$373**	**$354**	**$325**
Operating Profit (BIT)	**$/ha**	**$884**	**$801**	**$818**
Finance Costs	**$/ha**	**$24**	**$24**	**$24**
Earnings Before Tax (EBT)	**$/ha**	**$860**	**$777**	**$794**

Table 2: Economic analysis of two rotation options applied over 2017 & 2018 seasons.

		Fallow-Wheat Rotation		Wheat-Wheat Rotation	
		Wheat 2018	Fallow 2017	Wheat 2018	Wheat 2017
Yield	t/ha	4.8	0	3.2	1.2
Grade		ASW1		ASW1	ASW1
Average Grain Price	$/t	$300	$0	$300	$300
Income	$/ha	$1,440	$0	$960	$360
Variable Operating Costs	$/ha	$	$	$	$
Seed, Treatment & EPR's		$12	$11	$12	$12
Grain Freight		$24	$0	$16	$6
Grain Handling Charges		$42	$0	$28	$11
Crop Contract		$35	$0	$35	$35
Other Crop Costs & Crop Ins		$22	$0	$22	$22
Wages Gross		$28	$14	$28	$28
R&M Mach./Plant/Vehicle		$42	$21	$42	$42
Fuel & Oil		$27	$12	$27	$27
Fertiliser		$106	$0	$106	$106
Variable Operating Costs	$/ha	$338	$58	$316	$289
Operating Gross Margin	$/ha	$1,102	-$58	$644	$71
Fixed Operating Costs	$/ha	$73	$72	$73	$73
Total Operating Costs	$/ha	$411	$130	$389	$362
Operating Profit (BIT)	$/ha	$1,029	-$130	$571	-$2
Finance Costs	$/ha	$24	$23	$24	$24
Earnings Before Tax (EBT)	$/ha	$1,005	-$153	$547	-$26
Combined 2 Year EBT	$/ha	$852		$521	

The comparison of the two rotation options (Table 2) clearly shows the benefits of the tactical fallow Blair is looking to employ on these soils in his business. There was insufficient water available to grow a profitable crop in 2016, and the lack of that soil water in 2017 significantly limited the wheat yield.

Conversely, the additional soil water from the 2019 fallow boosted the yield achieved in the 2020 wheat, significantly increasing its profitability. Looking to the combined 2-year EBT the fallow wheat rotation is the clear standout, showing an above-average profit compared to the wheat, wheat rotation.

Please note that this is an un-replicated farmer demonstration and results should be interpreted with caution.

Acknowledgements
This Project is supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's National Landcare Program Smart Farms Small Grants.

The Liebe Group would like to thank Blair Stone for the extensive time and effort he invested into implementing and managing the trial, and for his continued participation in the Gen Y Paddock Challenge.

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The Gen Y Paddock Challenge – Compost to Aleviate Saline, Non-Wetting Soils

Casey Shaw, Jindarra Cropping Co, and Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- There was no positive return on investment to any rate of compost or deep ripping at the site this season.
- Observation will continue to assess impacts in successive years

Aim

To improve consistency of crop performance by alleviating salinity and non-wetting issues on an unproductive salt-affected paddock.

Background

Farmers are very good at trialling best practice soil management in the isolation of their own environment, however do not always effectively capture and analyse trial information beyond visual or yield assessments. They don’t always have the opportunity to share the information they are gathering publicly, limiting their opportunities to gain valuable feedback from peers. By building the capacity of farmers to actively trial, capture and share their on-farm trials, with input from their peers and in a trusted environment, the Liebe Group aims to increase engagement and foster the adoption of best practice soil management methods.

The trial presented has been conducted by Casey Shaw who returned to his family farm in 2019. He is seeking to bring salt land back into cropping after it has been left as grazing for many years. The trial is hosted in the paddocks fourth year of cropping, as the business no longer produces livestock in their enterprise mix. Compost has been employed in an effort to help boost soil OC and reduce evaporation over summer to limit the salt that rises to the soil surface over summer and improve crop germination and overall performance.

Trial Details

Trial location	Shaw Property, Buntine
Plot size & replication	20m x 100m x 1 replication
Soil type	Sandy loam
Paddock rotation	2019 Barley, 2018 Canola, 2017 Barley
Sowing date	12/05/2020
Sowing rate	60 kg/ha Spartacus Barley

Treatments

	Treatment
1	Untreated Control
2	3 t/ha compost, unripped
3	3 t/ha compost, deep ripped
4	5 t/ha compost, deep ripped

Soil Composition

Depth (cm)	PH ($CaCl_2$)	Col P	Col K	S	N (NO_3)	N (NH_4)	EC	OC
0-10	6.4	31	82	23	32	13	0.14	1.09
10-20	5.8	17	55	26	5	1	0.04	0.71
20-40	6.1	2	35	16	2	<1	0.03	0.24
40-60	6.5	<2	24	19	1	<1	0.03	0.13
60-80	6.6	<2	21	22	1	<1	0.05	0.13

Results

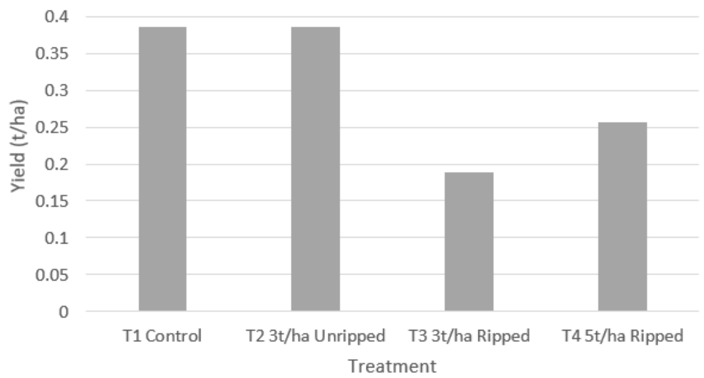

Figure 1: Yield (t/ha) as harvested on the 22/10/2020.

Comments

The area of the trial was salt affected and also suffered from non-wetting (hydrophobia). The site had a high weed burden consisting primarily of ice plant. Establishment was very poor across the entire site, with large patches (>20m^2) being left completely bare of crop. The crop present was poor and lacked vigour, come harvest the entire site yielded very low (380 kg/ha – 188 kg/ha) and there was no observable correlation between the treatments applied and yield. The poor crop performance was likely due to a combination of the lower than average rainfall and late start experienced at the site as well as the multiple constraints limiting the yield potential on the site.

There was no evident return on investment from any of the treatments at the trial this season. The trial will be continued into the 2021 season to see if returns are evident in more favourable seasonal conditions.

Please note this is an un-replicated demonstration and result must be interpreted with caution.

Acknowledgements

This Project is supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's National Landcare Program Smart Farms Small Grants.

The Liebe Group would like to thank Casey Shaw for the extensive time and effort he invested into implementing and managing the trial, and for his continued participation in the Gen Y Paddock Challenge.

Peer review

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The Gen Y Paddock Challenge – Optimising Tillering, Grain Fill and Yield Through Deep Ripping

Brendon Manuel, RD Manuel & Co, and Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- Cultivation treatments trended toward an increase in yield and profit at the site.
- Decreased plant numbers appeared to be a more significant factor than increased tillering in the double ripped treatment, leading it to achieve a lower yield and profit than the single ripped treatment. Although, it still outperformed the uncultivated treatment.

Aim

To increase tillering and grain fill through the implementation of soil cultivation to boost yield and increase profitability.

Background

Farmers are very good at trialling best practice soil management in the isolation of their own environment, however do not always effectively capture and analyse trial information beyond visual or yield assessments. Furthermore they don't always have the opportunity to share the information they are gathering publicly, limiting their opportunities to gain valuable feedback from peers. By building the capacity of farmers to actively trial, capture and share their on-farm trials, with input from their peers and in a trusted environment, we aim to increase engagement and foster the adoption of best practice soil management methods.

The trial presented has been conducted by Brendon Manuel. He is seeking to validate his own evidence that more aerated soil increases early production of tillers in wheat. He had noted that wheat grown on soil that had been deep ripped then rolled was producing fewer tillers than when on soil that had only been deep ripped. Brendon has theorized that one of the key differences could be the higher levels of O_2 and CO_2 in the soil which could be influencing the mineralization process and leaving more plant available Nitrogen (N) come sowing. Brendon is seeking to confirm his hypothesis by increasing soil aeration through double pass deep ripping.

Trial Details

Trial location	Brendon Manuel's property, Marchagee
Plot size & replication	12m x 200m x 1 replication
Soil type	Gravel loam duplex
Paddock rotation	2017 Lupin, 2018 Wheat, 2019 Wheat
Sowing date	20/05/2020
Sowing rate	70 kg/ha Zen Wheat
Fertiliser	20/05/2020: 18 kg/ha N, 10 kg/ha P, 10 kg/ha K 10/06/2020: 32 kg/ha N, 5 kg/ha K 15/08/2020: 21 kg/ha N
Herbicides, Insecticides & Fungicides	20/05/2020: 2 L/ha treflan, 2L/ha prosulfocarb 10/06/2020: 750 g/ha Jaguar 15/08/2020: 450 g/ha Jaguar, 100 g/ha Hammer

Treatments

	Treatment
1	Nil control (no cultivation)
2	Single pass deep ripping
3	Dual pass deep ripping with 15° offset

Results

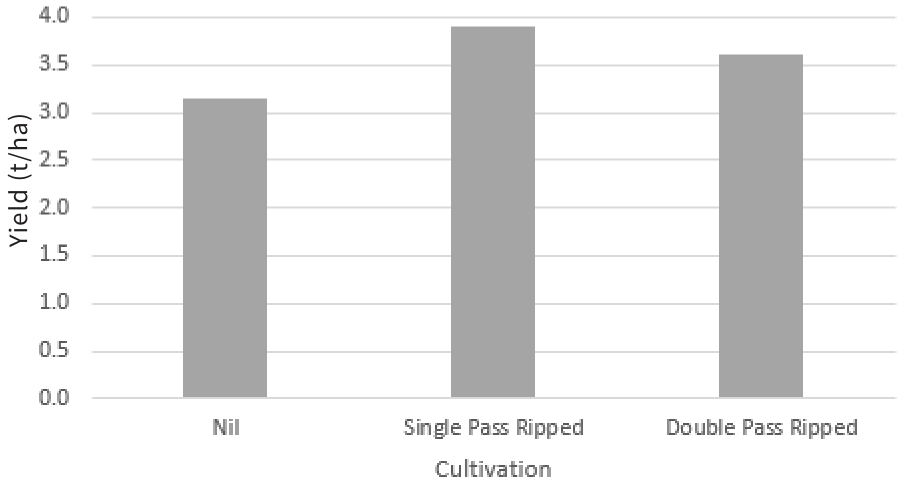

Figure 1: Average yield (t/ha) as harvested on the 22/10/2020, relative to each cultivation treatment.

There seems to be a positive yield response from the cultivation treatments (Figure 1). There was a high uneven weed burden at the site and a slightly uneven soil type that seems to have negatively impacted the double ripped plot, and there was a set of tram lines running through it. However, loss from the tram line was calculated at approximately 2.5% and has been allowed for in the graphed results.

Comments

There was a strong positive trend between yield and cultivation at the site, and the increased yield did correlate with increased profit at the site (Table 1) with the single cultivation treatment providing the highest EBT.

Table 1: Economic analysis of cultivation techniques in Marchagee

Cultivation		Nil	Single	Double
Yield	t/ha	3.15	3.9	3.61
Grade		ASW1	ASW1	ASW1
Average Grain Price	$/t	300	300	300
Income	**$/ha**	**945**	**1170**	**1083**
Variable Operating Costs	**$/ha**	**$**	**$**	**$**
Seed, Treatment & EPR’s		12	12	12
Grain Freight		16	20	18
Grain Handling Charges		28	34	32
Crop Contract		35	35	35
Other Crop Costs & Crop Ins		22	22	22
Wages Gross		28	28	28
R&M Mach./Plant/Vehicle		42	42	42
Fuel & Oil		27	27	27
Fertiliser		66	66	66
Cultivation		0	40	80
Variable Operating Costs	**$/ha**	**275**	**326**	**362**
Operating Gross Margin	**$/ha**	**670**	**844**	**721**
Fixed Operating Costs	**$/ha**	**73**	**73**	**73**
Total Operating Costs	**$/ha**	**348**	**399**	**435**
Operating Profit (BIT)	**$/ha**	**597**	**771**	**648**
Finance Costs	**$/ha**	**24**	**24**	**24**
Earnings Before Tax (EBT)	**$/ha**	**573**	**747**	**624**

However despite this positive increase in EBT from the single ripped treatment there was not a clear yield response to the second pass of deep ripping. There was a visual increase in tillering between the single and double deep ripping treatments however establishment was poorer on the double deep ripped treatment which limited overall yield. This decreased establishment on the double deep ripped treatment seems to be due to weed pressure and uneven soil type. Brendon also noted that tillering was good across the board this year, and all the effects on tillering observed at the trial were less pronounced than previously.

Note this is an un-replicated farmer demonstration and results should be interpreted with cation.

Acknowledgements
This Project is supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's National Landcare Program Smart Farms Small Grants.

The Liebe Group would like to thank Brendon Manuel for the extensive time and effort he invested into implementing and managing the trial, and for his continued participation in the Gen Y Paddock Challenge.

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Scan the QR code to view a video interview with Brendon.

The Gen Y Paddock Challenge – Comparing the Efficiacy of Pre Seeding Deep Ripping and Early Post Emergent Deep Ripping

Dylan Hirsch, BA & JM Hirsch

Take Home Messages

- Seeding canola into deep ripped soil can severely reduce establishment.
- Deep ripping canola EPE (early post-emergent) could be a solution if plant injury can be managed.

Aim

1. To demonstrate and quantify the plant establishment penalty of seeding canola into deep ripped soil, the loss of plants by deep ripping EPE.
2. To check if delaying deep ripping until EPE still produces a yield boost compared to ripping in typical summer conditions.

Background

Farmers are very good at trialling best practice soil management in the isolation of their environment, however, do not always effectively capture and analyse trial information beyond visual or yield assessments. Furthermore, they may not have the confidence to share the information they are gathering publicly, limiting their opportunities to gain valuable feedback from peers. By building the capacity of farmers to actively trial, capture and share their on-farm trials, with strong scientific rigour and in a trusted environment, we aim to increase engagement and foster the adoption of best practice soil management methods.

The Hirsch family have always seen canola and deep ripping as a package, because of canolas ability to use subsoil moisture and produce a reliable yield response, and the tillage effect of stimulating weeds where they can be controlled with glyphosate or selective herbicides. However, it has been risky, with plant establishment sometimes compromised by poor depth control in softer sands. This plant establishment can undo the yield response of canola in this system. With some other farmers deep ripping canola after seeding it to manage this issue, the Hirsch's didn't want to purchase an extra tractor and labour to do this at a time when they were seeding other crops. After seeing the effects of early post-emergent (EPE) deep ripping trial strips on previous canola crops, Dylan decided to implement this trial to better assess the effects of EPE deep ripping. The soil was previously deep ripped in 2017 and is a yellow sandy loam, which is considered easy to rip when there is moisture in the soil.

Trial Details

Trial ocation	Main Trial Site, Hirsch Property, Latham
Plot size & replication	12m x 300m x 2 replications
Soil type	Medium sandplain
Paddock rotation	2019 Barley, 2018 Barley, 2017 Fallow
Sowing date	03/05/2020
Sowing rate	1.6 kg/ha 410XX Canola
Fertiliser	Nil at seeding, 50L UAN @ 2 leaf, 60L UAN @ stem elongation
Herbicides, Insecticides & Fungicides	1 kg/ha Propyzamide 500, 1.5L Paraquat, 1.3L Glyphosate, 1.3L Glyphosate, 1.3L Glyphosate, 300mL Alpha-cypermethrin.

Treatments

	Treatment
1	Summer ripped on the 24th March to 550mm
2	EPE ripping to 550mm on the 5th July when canola was at the 8 leaf stage
3	Control tramline
4	Control CTF

Results

Treatment	Final Establishment plants/m^2	Harvested Yield t/ha *
Summer Rip	1.8	0.30
EPE Rip	5.2	0.32
Control	7.0	0.38
Tramline	6.5	0.38

*The trial was impacted by severe hail prior to harvest, with damage assessed at 85%.

Comments

The summer deep ripping happened in ideal conditions after approximately 100mm of summer rainfall. 550mm depth was achieved easily with the Nufab Tilco ripper during ripping activities. The site was seeded to 410XX canola in dry conditions at a target depth of 15mm with a JD 1830 air hoe drill with split boots. This type of air seeder can be prone to depth issues in these conditions. The area then received 6-7mm of rain on 6th May which was enough to germinate some plants but was extremely patchy. A subsequent wind and rain event on 24th May did not germinate the remaining plants, which were presumed to have shot from the previous rainfall event, resulting in low establishment numbers across the site.

The establishment across unripped and EPE ripped trials averaged 7.0 plants/m^2 before EPE ripping on 5th July, which is satisfactory for the Hirsch's for XX canola (however some areas were thinner). The summer ripped plots only averaged 1.8 plants/m^2, which may have been due to poor depth control when seeding into ripped soil and the marginal opening rain.

The EPE plots were ripped 'interrow' on 5th July with the major visual effects on plants being from tractor wheel traffic. Conditions were not great for ripping due to the dry start of the winter which caused the topsoil to fracture, which may have exacerbated damage to plants. Some plants were impacted by tynes and establishment counts on 30th July on EPE were down to 5.2 plants/m^2, a reduction of 26%. Surviving plants were visibly stunted and were shorter than the control strips. However, as at 1st September, it appeared that the EPE ripped plots had caught back up.

NDVI imagery from 29th August indicated the normal summer ripping plots had visibly lower NDVI scores, whilst you could not differentiate between unripped and EPE ripped plots from NDVI imagery.

Other EPE ripping strips on different areas of the farm showed different responses, from virtually 0% plant count reduction to over 70%. This indicates that EPE ripping results may be strongly dependent on the season and soil type. The Hirsch's will continue to trial EPE ripping based on opportunistic conditions where plant establishment is already high (>15/m^2) and the soil has sufficient moisture to minimise disturbance to root systems.

Acknowledgements

This Project is supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's National Landcare Program Smart Farms Small Grants.

The Liebe Group would like to thank Dylan Hirsch for the extensive time and effort he invested into implementing and managing the trial, and for his continued participation in the Gen Y Paddock Challenge.

Peer review

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Increasing Pasture Production Through Amelioration on Sandy Soils in the Coorow Area

Brianna Hindle, Mixed Farming Systems Officer, West Midlands Group & Chris O'Callaghan, Consultant, Liebe Group

Take Home Messages
- Soil amelioration increases dry matter production on non-wetting sandy soils.
- Mixing pasture varieties increases dry matter production, feed nutrition value and soil coverage.

Aim
1. To demonstrate the effects of soil amelioration on poorly fertile sandy soils in the Coorow/Warradarge area.
2. To evaluate new pasture species options to increase the total pasture biomass and nutritional value.

Background
Large pockets of poor fertility sandy soils are located in the Coorow/Warradarge area that currently produce limited pasture or crop growth. Being able to bring these areas back into a pasture rotation with the introduction of soil amelioration and new pasture options will increase the productive potential of these paddocks. A flow-on effect using correct timing of amelioration and stock management will decrease erosion risks from wind and water, which was an issue in the region for the 2020 season.

This demonstration site has been developed by the West Midlands Group in collaboration with the Liebe Group and guidance from the groups' members. The objective of this trial is to identify how soil amelioration can increase pasture production whilst evaluating multiple pasture mix options that can be grown on this soil type.

Trial Details

Trial location	Charles Wass property, Coorow
Plot size & replication	10m x 100m
Soil type	Sandy loam
Paddock rotation	2017 Pasture, 2018 Pasture, 2019 Bison triticale
Sowing date	07/05/2020
Sowing rate	See treatment list
Fertiliser	07/05/2020 - MAPZMOP @ 100 kg/ha
Herbicides, Insecticides & Fungicides	Dry sown, none used

Treatments

	Treatment
1	Bison triticale (70 kg/ha)
2	Bison triticale (50 kg/ha) & Santorini/Magurita Serradella (20 kg/ha)
3	Bison triticale (50 kg/ha) & Volga Vetch (20 kg/ha)
4	Rose clover (10 kg/ha)
5	Santorini/Margurita serradella (10kg/ha)
6	A shotgun mix of left-over seed (70 kg/ha)– Santorini/Marguerita serradella, Volga vetch, Bison triticale, Dictator 2 barley, Izmir/Dalkeith sub-clover, Appid Leafy turnip, Rose clover, Spartacus barley, Southern Green ryecorn

Soil Composition

Table 1: Soil test results for the ameliorated area of the trial site taken pre-seeding.

Depth	Colour	OC (%)	nitrate nitrogen	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	ph (CaCl2)	mir% clay %	mir% sand%
0-10	GRYW	0.26	6	6	< 15	1.6	5.5	16.81	78.31
10-20	GRYW	0.36	8	7	< 15	1.2	5.5	15.43	81.39
20-40	YWGR	0.27	5	6	17	1.0	5.2	17.50	76.41
40-60	YW	0.08	3	3	< 15	1.0	4.8	9.15	85.74
60-80	YW	0.08	< 1	< 2	< 15	1.0	5.5	13.34	78.65
80-100	GRBK	0.08	< 1	< 2	< 15	1.1	6.0	10.12	85.82

Table 2: Soil test results for the unameliorated area of the trial site taken pre-seeding.

Depth	Colour	OC (%)	Nitrate nitrogen	Col P (mg/kg	Col K (mg/kg)	S (mg/kg)	ph (CaCl2)	mir% clay	mir% sand
0-10	GRYW	0.36	8	7	<15	1.2	5.5	15.43	81.39
10-20	GRYW	0.25	2	5	15	0.8	5.6	19.24	79.76
20-40	YWGR	0.13	1	4	< 15	0.6	5.6	14.82	80.85
40-60	YW	0.11	< 1	2	< 15	0.7	5.5	15.74	80.99
60-80	YW	0.10	< 1	< 2	< 15	0.8	5.4	14.89	78.79
80-100	YW	0.10	< 1	< 2	< 15	1.4	5.9	10.01	86.94

Results

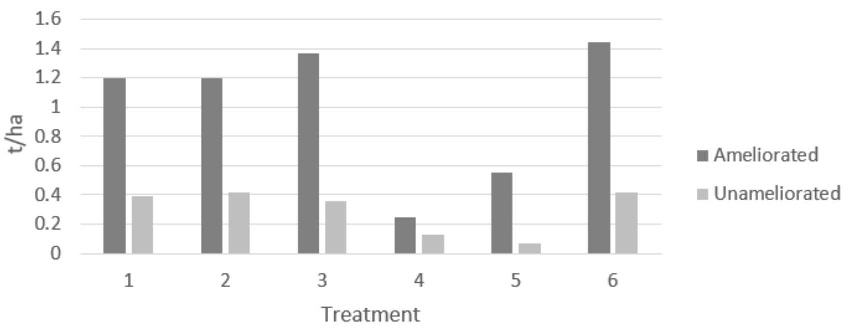

Figure 1: Average dry matter (t/ha) for the ameliorated and un-ameliorated pasture mix treatments.

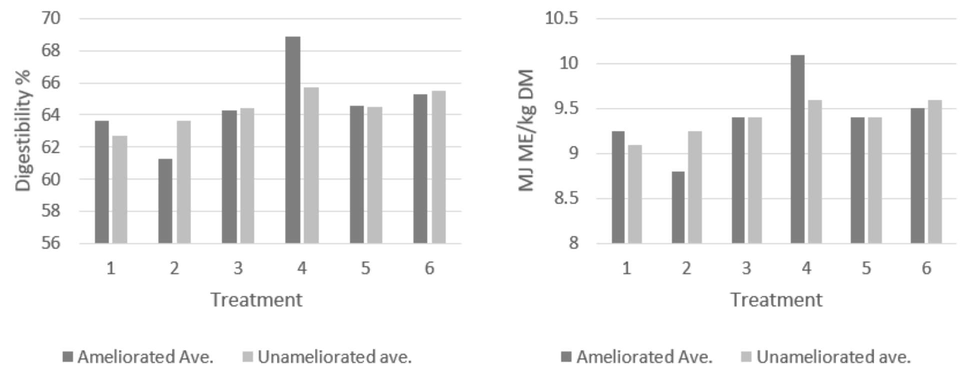

Figure 2: Average digestibility and Metabolisable Energy (ME) of each pasture mix taken at the end of July 2020.

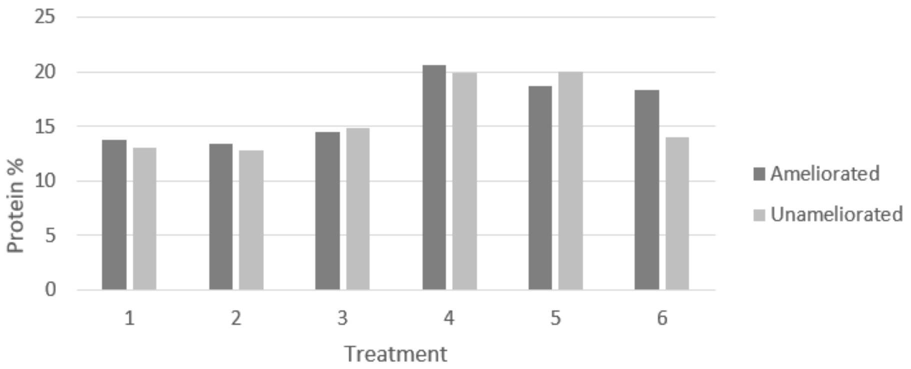

Figure 3: Average Protein percentage for each pasture mix, sampled at the end of July 2020.

Comments

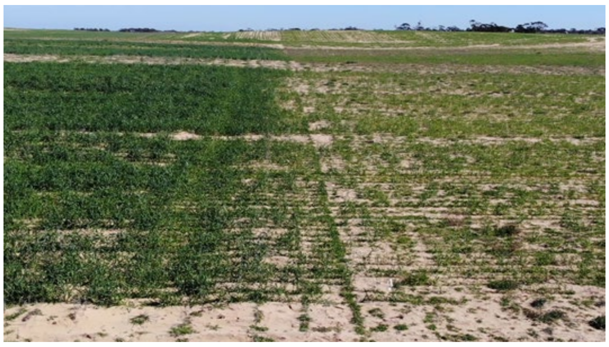

Image 1: A comparison of the ploughed (left) and unploughed (right) plots at Charles Wass's Gen Y trial on the Wass property, 2020.

In June 2019 the site was ameliorated using a Plozza plough by the grower and seeded immediately after to Bison triticale. The choice of ameliorating in winter decreased the risk of erosion that occurs when ameliorating earlier in the season. Pasture varieties and mixes were chosen at the start of the 2020 season and dry-sown on 5th May. A large wind event occurred on 24th and 25th May causing large amounts of wind erosion and furrow fill. By the 26th June, all treatments had germinated although patchy in areas. Biomass samples collected throughout the season by WMG in conjunction with Angelo Loi (DPIRD).

Pasture samples for both the ameliorated and un-ameliorated treatments were collected at the end of July, to compare differences in dry matter production between ameliorated and un-ameliorated treatments. It was evident that the amelioration increased plant growth rate for all pasture treatments leading to an increase in the total t/ha of dry matter produced (Figure 1). Treatment 6 produced 1.02 t/ha more dry matter in the ameliorated treatment compared to the un-ameliorated. Treatment 4 only produced 0.12 t/ha of dry matter due to plant size and minimal coverage of the plants (due to slow growth and establishment in winter) (Figure 1). The reduction of soil water repellence and increase in clay content was a factor that increased dry matter production for the ameliorated treatment using the Plozza plough (Table 1).

Visually pasture treatment 6 germinated the quickest whilst also aiding in fast ground cover decreasing the risk of soil erosion. It produced the highest amount of dry matter of 1.44 t/ha (Figure 1). It was noticeable in this treatment that areas where one species of pasture did not grow, this was replaced with another species allowing for increased coverage of the soil and limiting pockets of bare soil, decreasing erosion risk.

Digestibility ranged from 61% up to 69% while Metabolisable Energy (ME) ranged between 8.5 and 10.2 ME and indicates that all pasture mixes were good quality, but this quality declined after reaching the peak growth period in spring (Figure 2). Treatments containing Bison triticale had a lower digestibility in comparison to the pastures containing the legumes or mix of legumes/cereal. This was due to the triticale having reached stem elongation by the time it was sampled. It may be more beneficial in the future to lightly graze the cereal treatments early in the season. A second option would be to grow a forage cereal to increase biomass and decrease the risk of the plant running up when stressed due to climatic factors.

Protein percentage was highest in treatment 4 at 20.5% in ameliorated soil and 19.9% in the un-ameliorated treatment (Figure 3). Treatments 1 and 2 have the lowest protein amounts. The difference between these treatments is the addition of Bison triticale. It outlines the benefits of including a pasture legume in the pasture mix to increase protein percentage. In the future, a lower rate of Bison triticale should be used in pasture mixes due to its competitiveness especially against the slower-growing legumes.

The combination of soil amelioration and improved pasture mixes had a significant and positive impact on pasture dry matter production at this site in 2020. Adding pasture mixes into the paddock rotation increases the flexibility of the amelioration timing decreasing the risk of erosion and increasing establishment rate and time. Continued research into the further evaluation of pasture species that are suited to the soil type and environment is needed and further.

Acknowledgements
This project is part of the NRM Rotational Grazing project focusing on decreasing erosion on sandy soils. This project is supported by Smart Farms through funding from the Australian Government's National Landcare Program.

This project is in collaboration with the West Midlands Group and Liebe Group. Thank you to Andrew Loi (CSIRO) for completing the plant analysis, Alosca for donating the inoculants and to the Wass family for hosting and assisting with the management of the trial site.

The Liebe Group would like to thank Charles Wass for the extensive time and effort he invested into implementing and managing the trial, and for his continued participation in the Gen Y Paddock Challenge.

Peer review
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Scan the QR code to view a video interview with Charles.

PASTURES RESEARCH RESULTS

Agronomic Recommendations to Establish Lanza Tedera

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- For successful establishment Tedera needs to be treated as a crop and sown into a weed-free, clean paddock.
- Higher sowing rate correlates with lower weed numbers.
- Wider row spacing correlates with lower weed numbers.
- Higher seeding rates and narrower row spacing correlates with higher plant establishment numbers.
- From the second year onwards, Tedera can co-exist and be productive along with other companion species and can be primarily managed by grazing.

Aim

To investigate optimal sowing rate and row spacing for Tedera establishment in low rainfall areas.

Background

In traditional Wheatbelt broadacre mixed farming systems there is often a summer feed gap where there is limited to no grazing available for livestock. Over the past decade the Department of Primary Industries and Regional Development (DPIRD) has been researching Tedera as a potential pasture crop to help bridge this summer feed gap in medium to lower rainfall zones.

Tedera is a summer active pasture and is valuable as a high quality summer feed that retains its leaf. It has also shown to be drought resistant which makes it especially suited to use in lower rainfall production systems.

This trial aims to establish a set of guidelines outlining optimal sowing rates, and row spacing so producers can incorporate Tedera into their production systems. The trial was initially implemented in winter of 2019, however conditions were adverse causing the Tedera to die off over summer. The trial was then re-seeded in winter of 2020.

This project will be complimented by another trial in Three Springs that will also be implementing Tedera at different seeding depths.

Trial Details

Trial location	Fitzsimons property, Buntine
Plot size & replication	10m x 1.85m x 3 replications
Soil type	Loamy gravely sand
Paddock rotation	2017 Barley, 2018 Fallow, 2019 Tedera
Sowing date	15/06/2020
Sowing rate	As per treatment list
Fertiliser	16/06/2020 45 kg/ha K Start10 te
Herbicides, Insecticides & Fungicides	knockdown 4 L/ha Ultramax 16/06/2020 1 L/ha Propyzamide, 100 g/ha Spinnaker, 1 l/ha Pyrinex Super 20/08/2020 30 ml/ha Trojan

Treatments

	Treatment
1	5 kg/ha of tedera sown at 225mm rows
2	5 kg/ha of tedera sown at 450mm rows
3	5 kg/ha of tedera sown at 900mm rows
4	10 kg/ha of tedera sown at 225mm rows
5	10 kg/ha of tedera sown at 450mm rows
6	10 kg/ha of tedera sown at 900mm rows

Results

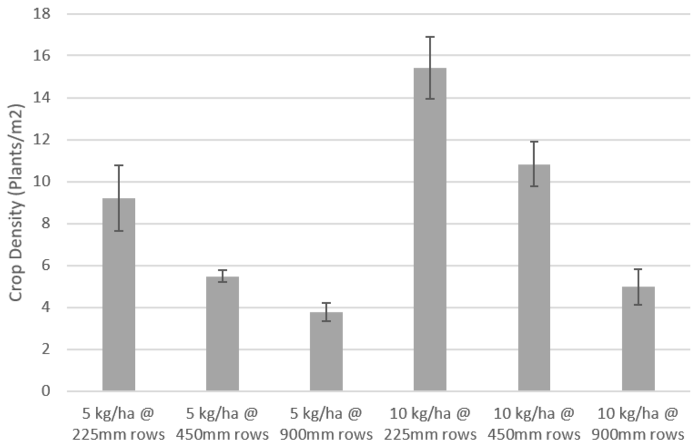

Figure 1: Average crop density (per m²) of Tedera after seeding at varied rates and row spacing, counts taken on 03/09/2020. Error bars are ± 1 S.E.

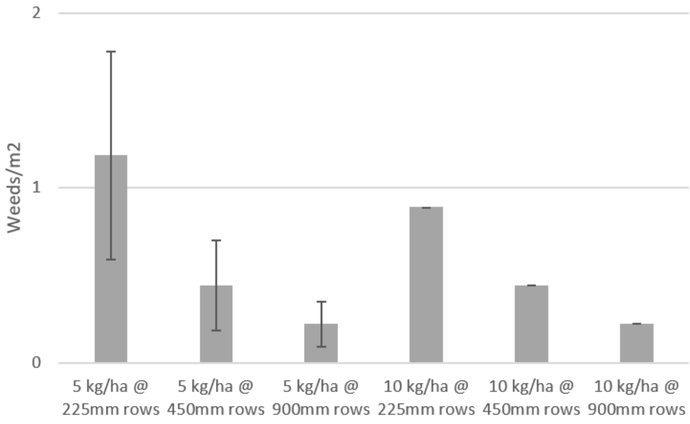

Figure 2: Average weed emergence (per m²) in Tedera after seeding at varied rates and row spacing, counts taken on 03/09/2020. Error bars are ± 1 S.E.

All plants looked larger and more vigorous than those observed in 2019. As is expected, the higher seeding rate resulted in higher average establishment numbers (Figure 1). Additionally, there was a strong correlation between narrower row spacing and higher establishment numbers, however there was also an adverse effect on weed numbers (Figure 2).

Weed pressure was low across the site, with all treatments averaging below two weeds per/m². However even with this low weed burden, some clear trends were visible. As is seen in other crop types, weed numbers decreased when a higher seeding rate was used (Figure 2), as there were more plants to compete with the weeds. Weed control was also more effective when a wider row spacing was used, perhaps due to the furrow effect on the pre-emergent herbicides being less prominent.

Comments

The trial was initially sown 2019 but perished over the 2020 summer due to adverse conditions. In the 2020 season the plants look more developed than they appeared at the start summer in 2019, and the outlook for late season and summer rainfall is higher. This more developed root system may help to maintain plant numbers over summer and coming seasons. Monitoring will continue for a further two seasons to continue to establish the long term performance of the plants under the different seeding treatments.

Acknowledgements

This project is funded and run by Nutrien Ag Solutions with support from the Liebe Group. Thanks to the Fitzsimons family for hosting the trial.

Peer Review

Richard Stone, Nutrien Ag Solutions

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FARMING SYSTEMS RESEARCH RESULTS

Optimising Plant Establishment, Density and Spacing to Maximise Crop Yield and Profit in Southern and Western Regions

Judith Storer, Research and Development Coordinator, Liebe Group

Take Home Messages

- Variation in speed and seeding rate did not significantly influence crop performance at any stage of monitoring.
- Variation in speed and seeding rate did significantly influence seeding depth, which may affect germination in other seasonal conditions.

Aim

To optimise seeder set up and use to maximise even establishment and early seedling vigour, primarily in canola.

Background

Rapid and even crop establishment is a foundation of vigorous and high yielding crops that are competitive against weeds. In recent years there has been growing interest in Australia and overseas in adapting precision seeding technology that is widely used in summer crop production, to winter crops. Particular interest has been shown in the potential of precision planting and singulation to reduce seeding rates and seed costs in crops such as hybrid canola where seed costs are high. However, there is little information at present on the current levels of crop establishment and stand uniformity in the major winter crops, the potential for improvements in crop establishment and the potential agronomic and economic benefits of improving crop establishment and stand uniformity within modern farming systems. While precision seeding may be seen as a 'gold standard' in improving stand uniformity, there may also be significant gains to be achieved by improving the operation of conventional seeders.

Trial Details

Trial location	McAlpine's Property, Buntine
Plot size & replications	12m x 200m x 3 replications
Soil type	Loamy sand
Paddock rotation	2017 Pasture, 2018 Pasture, 2019 Wheat
Sowing date	17/05/2020
Sowing rate	Bonito Canola, as per treatment description
Fertiliser	03/05/2020: 50 L/ha LF1, 50 L/ha BIO, 0.5 L/ha TMAgriculture 26/06/2020: 75 kg/ha SOA, 0.25 L/ha TMAgriculture 01/07/2020: 60 L/ha Compost Extra, 50 Kg/ha Urea 11/08/2020: 15 kg/ha UAN, 1.25 L/ha Ecohumate, 0.5 L/ha Express TE, 3 L/ha K18
Herbicides, Insecticides & Fungicides	20/03/2020: 1 L/ha Roundup Ultra 21/03/2020: 0.5 L/ha Propizamide, 1.125 L/ha Atrazine 03/05/2020: 2 L/ha Treflan, 2 L/ha Prosulfocarb 26/06/2020: 1.1 L/ha Atrazine, 0.2 L/ha Quizalafop, 0.07 L/ha Clopyralip, 0.375 L/ha Inbound

Treatments

	Treatment
1	2 kg/ha of canola sown at 12 km/h
2	4 kg/ha of canola sown at 12 km/h
3	4 kg/ha of canola sown at 18 km/h
4	2 kg/ha of canola sown at 18 km/h
5	2 kg/ha of canola sown at 15 km/h
6	4 kg/ha of canola sown at 15 km/h

Results
There was some noticeable variation in crop numbers within and between plots, and some bare patches were present. The cause of this variation is not clear but insect damage was present and may have killed some seedlings.

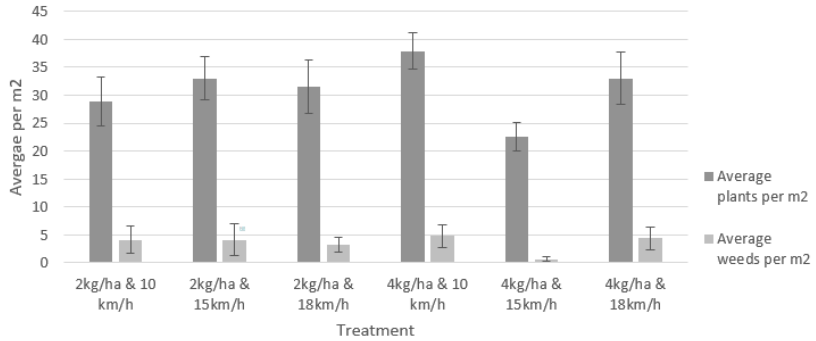

Figure 1: Average early (17/06/2020) crop and weed density (per m^2) in Bonito Canola at the crop establishment trial at Buntine. Error bars are ± 1 S.E.

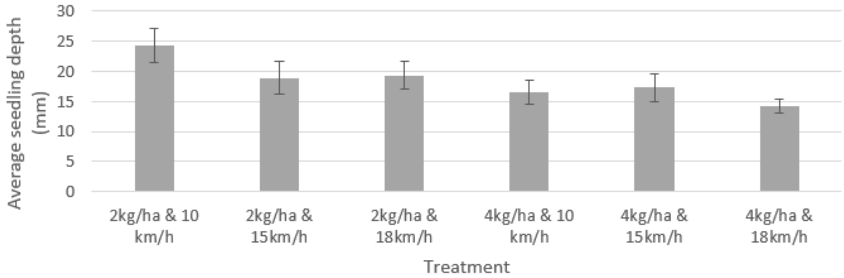

Figure 2: Average seedling depth (mm) taken on 23/06/2020, in Bonito Canola at the crop establishment trial at Buntine. Error bars are ± 1 S.E.

There seems to be no correlation between the treatments applied and the average interplant distance.

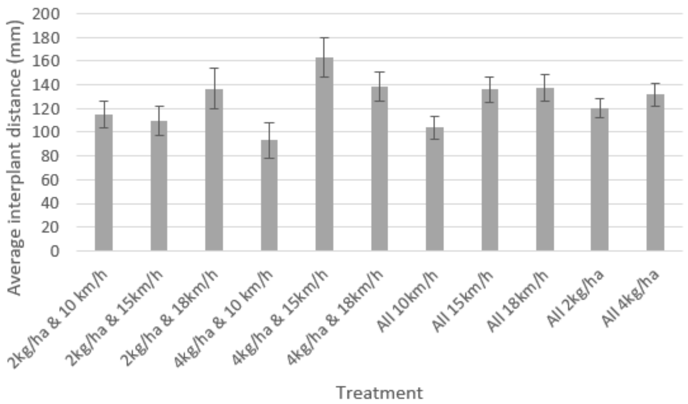

Figure 3: Average interplant distance (mm) taken on 23/06/2020, in Bonito Canola at the crop establishment trial at Buntine. Error bars are ± 1 S.E.

There is no correlation between the treatments applied and the average yield.

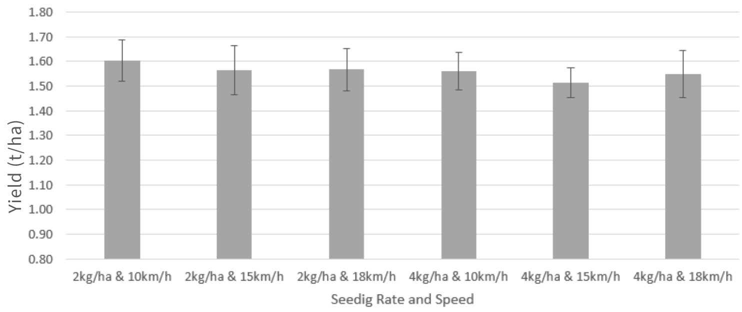

Figure 4: Average yield in tons per hectare taken on 23/06/2020, in Bonito Canola at the crop establishment trial at Buntine. Error bars are ± 1 S.E.

Comments

The data for figures one to four was collected on the 23rd of July 2020. The plants were at GS1 leaf production, and seemed to be at a consistent developmental stage across the trial site. There was evidence of insect damage at the site, and there was some evidence of old run lines at the site from more than five years ago before control traffic was implemented. These environmental factors may have influenced results and contributed to the anomaly seen in Figure 1, where treatment six (4 kg/ha & 15km/h) with a seeding rate of 4 kg/ha had a lower average establishment rate than the treatments with seeding rates of only 2 kg/ha. This anomaly is also expressed in the larger average interplant distance recorded for treatment 6. No errors in the seeding process were noticed by the grower when the trial was implemented.

During harvest large bare patches were noticed in two of the treatment 6 plots. This correlates to the poor performance of treatment 6 at all monitoring stages. There were no significant yield differences between treatments at harvest (Figure 4).

Acknowledgements

This demonstration was established through GRDC investment through the Optimising plant establishment, density and spacing to maximise crop yield and profit in the southern and western regions project (GRDC#9176134). The project has been led by Glen McDonald of the University of Adelaide, and the activities in Western Australia have been led by David Minkey of WANTFA. Thanks to Stuart McAlpine for hosting, implementing and managing the trial, and for his participating in the Virtual Field Walk that was filmed to showcase the demonstration.

Peer review

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GENERAL INFORMATION

Benchmarking with Farmanco

Farmanco is one of the largest agricultural consultancy companies in Australia. One of the key products that their specialist consultants produce annually is the Farmanco Profit Series, a specialist benchmarking document. The Profit Series is a powerful benchmarking tool, used by hundreds of businesses in the Western Australian wheatbelt. This specialist document is designed to enable producers to compare their results to the long term data presented, data that has been collected and analysed for over 21 years making it Australia's longest running benchmarking project.

Benchmarking is designed to give those who participate the competitive edge against their competitors. There are no two businesses the same and it is important to compare your farming business against those in the same rainfall zones with similar limitations. Benchmarking is an innovative process that uses key performance indicators to better understand how the physical and financial activities of a farming business impact the overall performance. It focuses on variables such as profitability, efficiency, liquidity and solvency. It is a tool used to compare your business externally to similar businesses or to make comparisons within the business itself. This comparison can then be used to identify business strengths and the areas for improvement to help assist with making decisions in the future to achieve the desired outcomes.

Benchmarking can be used to improve the understanding of the physical and financial performance of your business, increase motivation to improve your efficiency, identify trends and form an idea of your best practice, improve the business bottom line, improve awareness and allow farm managers to better align their performance with their business objectives.

The following data has been extracted from the 2019/20 edition and is based on the shires covered by the Liebe Group. For further information, please contact Farmanco on (08) 9295 0940 or email: mundaring@ farmanco.com.au

The three tables focus on the benchmark data from Agzones L2 and M2, as well as for the shires covered by the Liebe Group. Data has been omitted where the sample size is insufficient to provide effective analysis. The survey results should be viewed in the context of the individual business situation. If the performance of the business is low when compared to the benchmark figure, then the factors affecting the performance needs to be analysed. If the lower performance is due to something that can't be changed (e.g. the farm in question has lower than average rainfall or poorer than average soils when compared to the average for the group), then there may be little need for concern. However, if there are factors that influence performance that can be directly impacted by the changing management practices within the business, then an assessment needs to be made on what changes can be made to improve performance and profitability.

Definition of terms

Effective Area (ha) - land area used directly for the purposes of producing crops or livestock, not including non-arable land such as salt lakes, rocks and bush.

Gross Farm Income (GFI) / Ha) - all income produced from farm related activities with respect to the area farmed.

Operating Costs ($Eff/ha) -.relates to any payments made by the farm business for materials and services excluding capital, finance and personal expenditures with respect to the area farmed.

Farm Operating Surplus ($Eff/ha) - farm income less operating costs.

Chemical Cost ($Eff/ha) - cost of chemicals (herbicides and fertilisers) applied with respect to the area farmed.

Plant Investment ($/Crop ha)- measures the value of machinery with respect to the area cropped.

April - October Rainfall (mm) - growing season rainfall {GSR), from April - October, of survey participants. GSR s base on monthly rainfall records from April to October, with adjustments for effective summer rains and ineffective growing season rainfall.

Water Use Efficiency (WUE) = Yield (Kg)/ (GSR * .66 + Stored Moisture) mm.

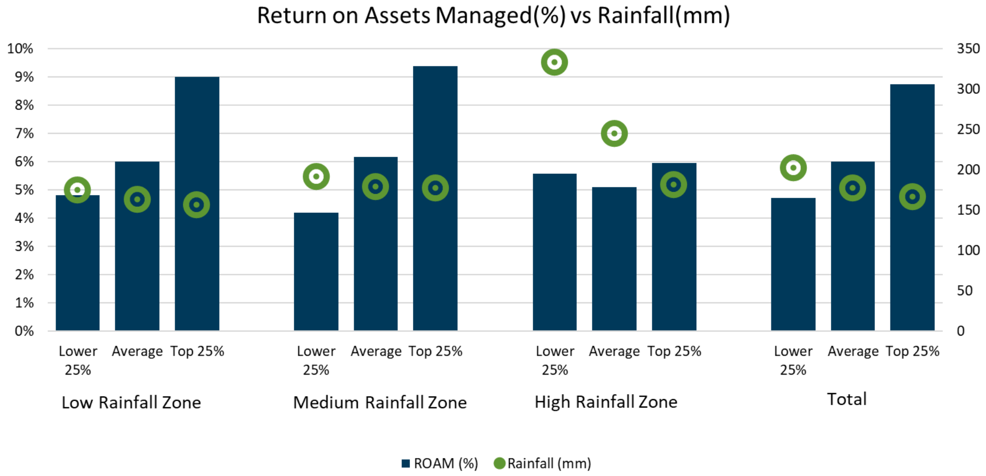
Total Sheep Shorn - total number of sheep shorn including lambs.

Wool Production (Kg/WGha) - amount of wool cut with respect to winter grazed hectares (less crop hectares).

Wool Price ($/kg) - value of wool sold with respect to the amount of wool cut.

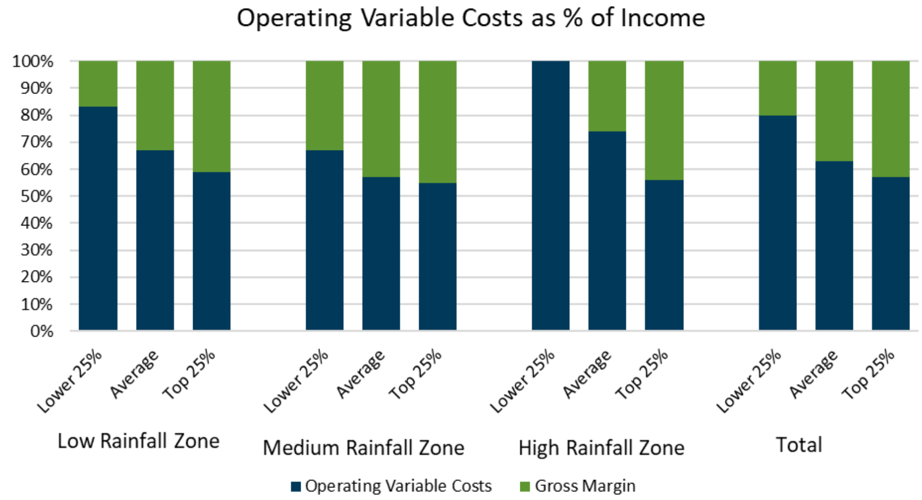
Lower 25% - the average of the lower 25% of farms in the group surveyed ranked by operating surplus.

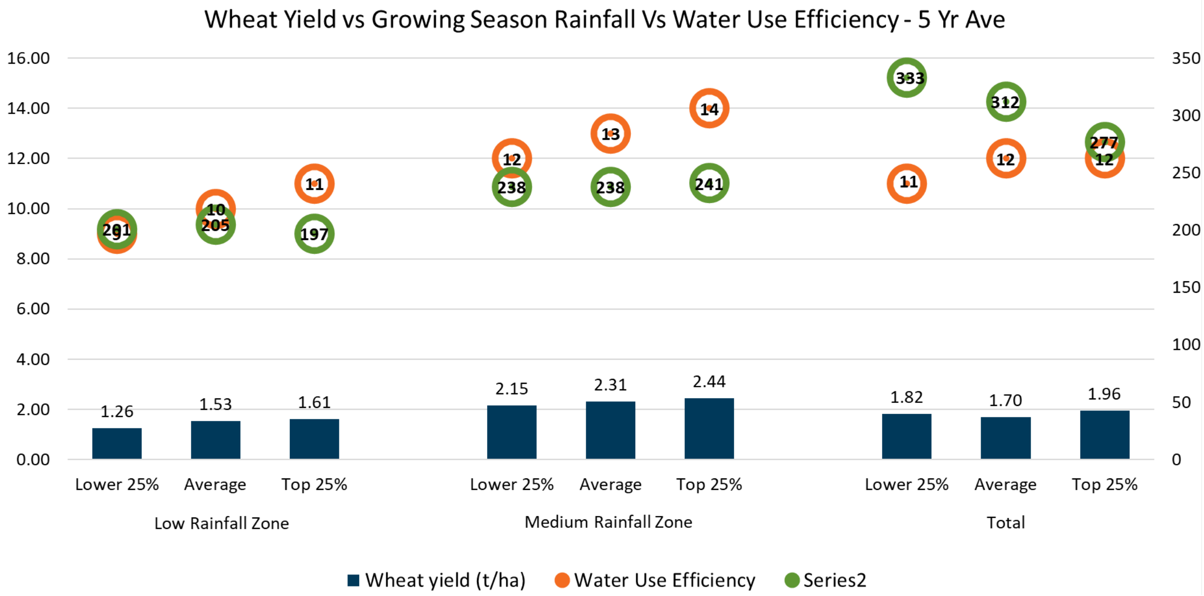
Top 25% - the average of the top 25% of farms in the group surveyed ranked by operating surplus.



Return on Assets Managed (ROAM) vs Rainfall: Effective rainfall above 200mm is the benchmark for profitable legume and canola production. With many businesses receiving below 200mm of effective rainfall in 2019, ROAM fell across all zones. Although there is a trend to higher ROAM as rainfall increases, decisions have been made that have seen profits generated at very low levels of rainfall. As can be seen in the above chart, the Top 25% are not necessarily the businesses to have received the most rainfall, but rather they are the businesses that are able to best manage their costs.

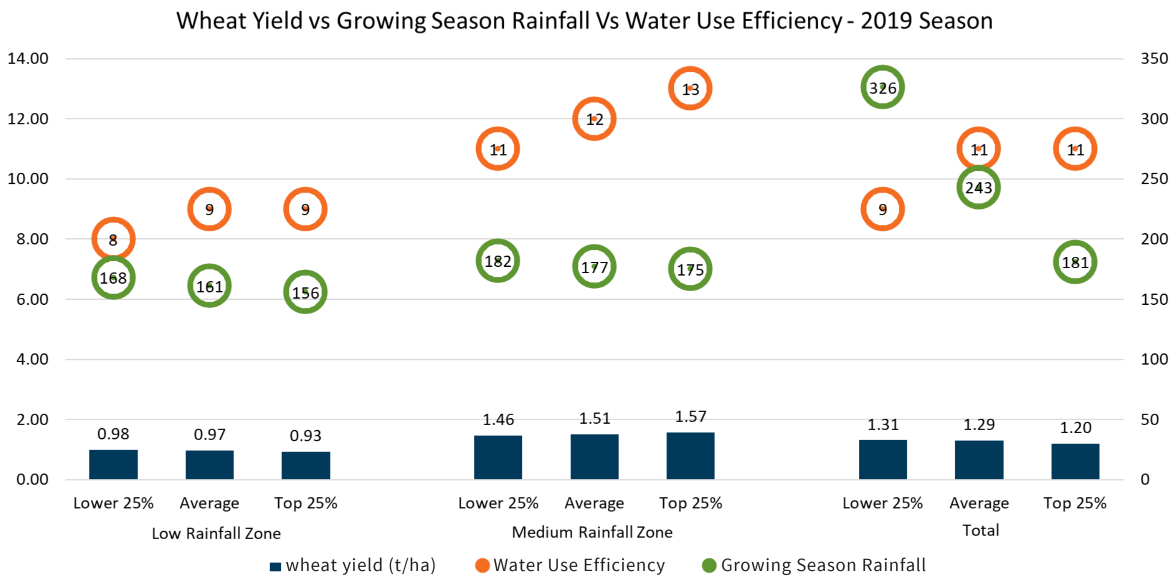
The Operating Variable Costs as a % of Income graph below displays a similar outcome. Businesses that were able to control their costs compared to their income were those that had the greatest ROAM, and therefore achieved a higher place in the ranking of the participating businesses. Although the target for costs as a percentage of income is less than 55%, in any given year this may not be achieved as this percentage is as much driven by seasonal conditions as it is by the good management of costs. The Low and Medium rainfall.

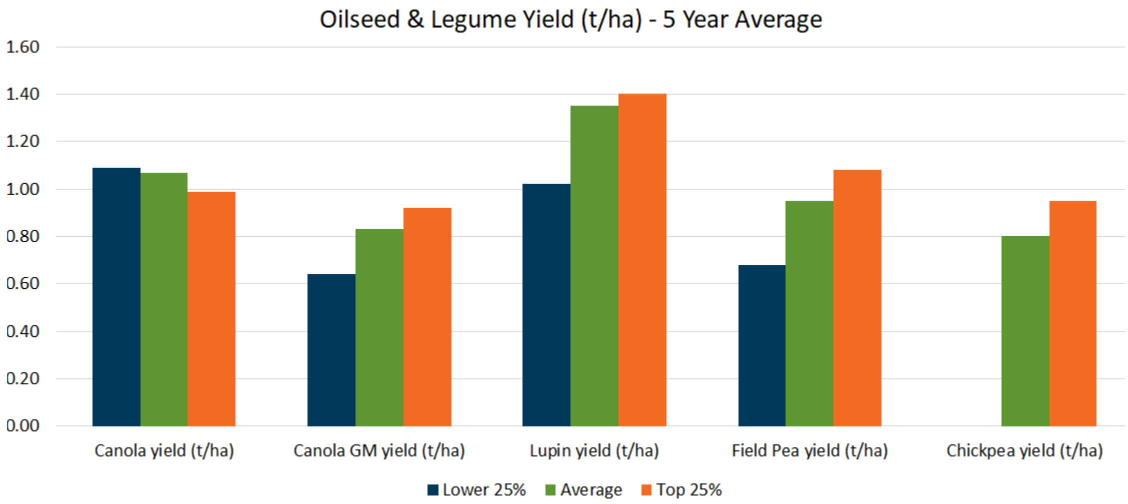




The above graph shows the 5 year average of yield, growing season rainfall and water use efficiency for each rainfall zone. As wheat is still the main profit drivers for the majority of farm businesses in Western Australia, the above graph has been included to show that the highest yield is not necessarily achieved by those who have the greatest amount of rainfall. There is great skill in being maximize your yield on a minimal amount of moisture. This is portrayed particularly well in the High Rainfall Zone results where the Top 25% averaged 1.96 t/ha on 277mm for the growing season to achieve a Water Use Efficiency of 12.

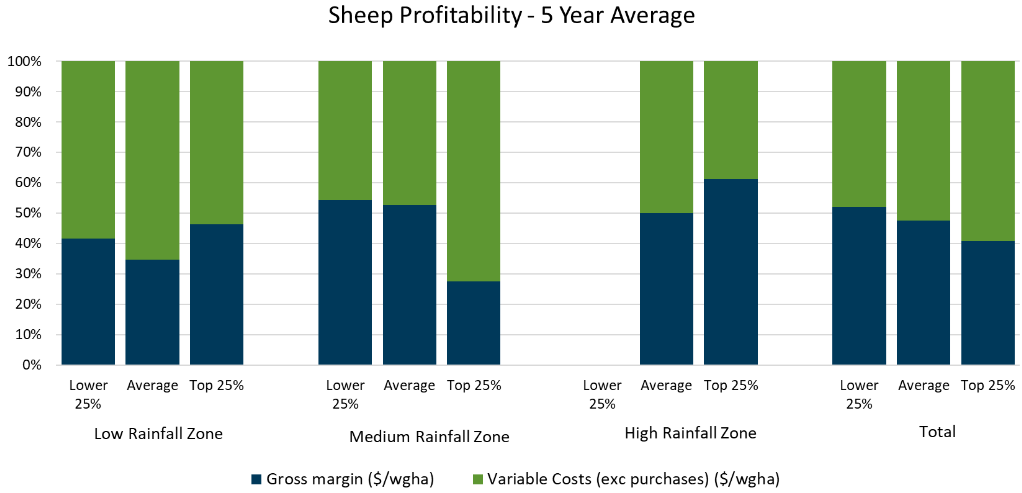
The spread of rainfall received, compared to yield and therefore WUE achieved is even more evident in the below chart showing specifically the 2019 data. The Medium Rainfall Zone showed that the Top 25% were able to grow 7% more grain on 4% less rainfall than the Lower 25%, and achieved a WUE 2 points higher than the Lower 25%. In contract, the High Rainfall Zone Top 25% grew 8% less crop on 45% less rainfall when compared to the Lower 25%, however they achieved a WUE 2 points higher.





The above chart (Oilseed & Legume Yield t/ha) has been included in this article as there is growing popularity of legumes as an alternative break crop to canola. Legumes can be challenging to grow, with lower rainfall resulting in lower WUE. Other seasonal events such as frost, heat and the time of sowing can also have a negative effect on these crops. The Liebe Group has been completing annual trials that include legume and oilseed crop types to increase the information available to growers in their area.

The following graphs are focused on sheep enterprises within the Liebe area. Pleasingly, in the 2020 Farmanco Profit Series nearly all farms made a profitable five year average. As 2014 dropped out of the 5 year average and was replaced by 2019 at a higher than average gross margin, the following chart shows that the businesses included in this analysis have all achieved positive results. As with the cropping enterprises, cost control is the key component to the success of the sheep enterprise.



2020 RAINFALL REPORT

	Dalwallinu	Kalannie	Coorow	Carnamah	Perenjori	Wongan Hills	Goodlands	MTS (Latham)
Jan	0.0	0.4	0.2	0.0	0.0	0.4	17.6	12.6
Feb	76.0	90.5	116.0	121.3	60.4	75.0	46.2	93.4
Mar	21.2	17.2	2.3	8.1	24.2	4.6	14.8	7.4
Apr	5.0	5.2	6.8	0.5	0.0	8.2	4.6	5.8
May	28.4	44.2	25.0	23.1	33.4	39.0	22.4	26.0
Jun	35.8	24.4	25.3	25.9	31.8	48.0	24.0	20.4
Jul	29.2	28.0	26.1	29.1	28.0	29.0	29.4	33.8
Aug	56.6	54.8	64.8	68.7	44.0	59.2	45.4	55.8
Sep	5.8	5.5	5.9	3.6	2.4	17.0	4.4	3.6
Oct	0.4	0.4	4.8	0.2	3.6	8.8	0.2	3.8
Nov	32.4	34.2	37.9	19.8	14.0	34.6	26.0	16.6
Dec	1.2	-	1.0	0.0	4.0	1.0	1.4	4.4
GSR (Apr - Oct)	161.2	162.5	158.7	151.1	143.2	209.2	130.4	149.2
Total	292.0	304.8*	316.1	300.3	245.8	324.8	236.4	283.6

*Note: Rainfall data not available for some months.

Information gathered from the Bureau of Meteorology at www.bom.gov.au and through Liebe Group rain gauges.

Contact the Bureau of Meteorology by phone (08) 9263 2222, by fax on (08) 9263 2233 or by email at climate.wa@bom.gov.au

2020 LIEBE GROUP R&D SURVEY RESULTS

Conducted September 2020 at the Liebe Group Spring Field Day.

What are the key issues affecting your farm business that could be addressed by the Liebe Group?

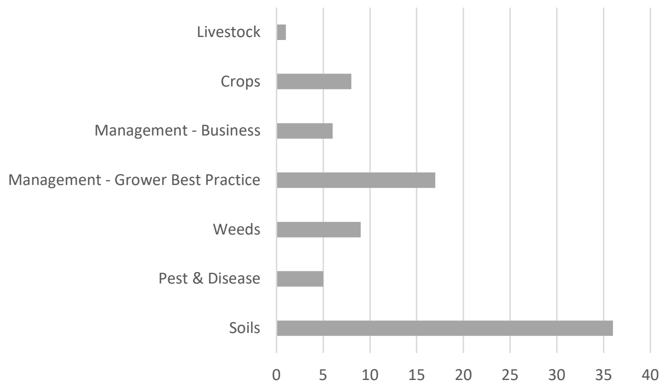


Figure 1: Farmers responses when asked about the key issues affecting their farm business, recorded at the Liebe Group Spring Field Day, 2020.

What are the key areas in relation to soils? (Figure 1).
- Acidity
- Salinity
- Compaction
- Sub-soil constraints
- Amelioration

What are the key areas of knowledge or skills you wish to build on through training and workshops?

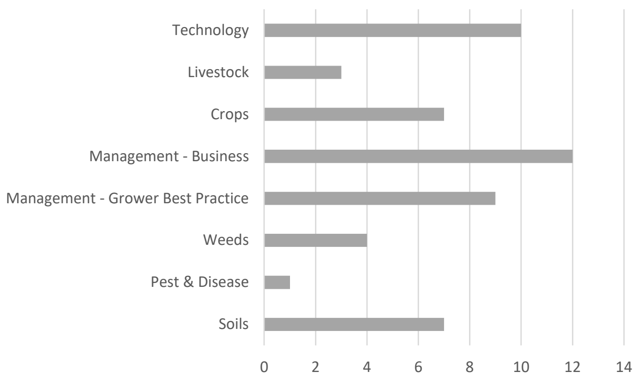


Figure 2: Farmers responses when asked what key areas could be addressed through training and workshops, recorded at the Liebe Group Spring Field Day, 2020.

What are the key areas in relation to business management? (Figure 2).
- General farm business management
- Labour relations
- Risk managment
- Budgeting
- software training

What particular concepts/products/practices would you like to see demonstrated by the Liebe Group?

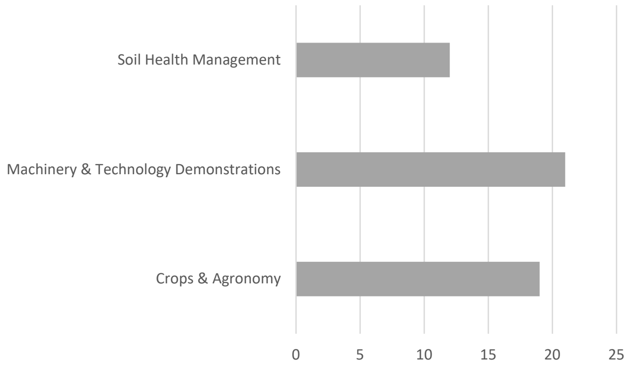


Figure 3: Farmers responses when asked what products, concepts or practices they would like to see demonstrated, recorded at the Liebe Group Spring Field Day, 2020.

What are the key areas in relation to machinery and technology demonstrations? (Figure 3).

- Strip and disc
- Tramlining
- Soil moisture probes
- CTF economics
- Machinery demonstrations

What long term research would you like to see the Liebe Group invest in?

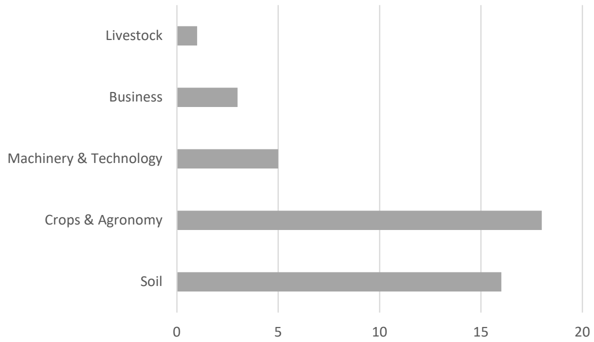


Figure 4: Farmers responses when asked what long term research they would like to see Liebe Group invest in, recorded at the Liebe Group Spring Field Day, 2020.

What are the key areas in relation to crops and agronomy? (Figure 4).

- Rotations
- Organic carbon
- Long term amelioration economics
- Nitrogen application for protein gain
- Chemical fallow

THE LIEBE GROUP STRATEGIC PLAN 2017 - 2022

Introduction

The 2017-2022 Strategic Plan was endorsed by the Liebe Group Management Committee in August 2017. It was developed in February 2017 by the members, with the assistance of Sue Middleton, independent consultant, and reviews and builds on the previous strategic plan. Strategic planning has always been a strong focus for the Liebe Group since the group's inception in 1997 and has become part of the group's progression and success over the years. This fifth strategic planning exercise comes at a time when the group celebrates 20 years of operation and is looking to the future, and to new challenges and opportunities that will arise in the agricultural sector. The strategic plan will assist the group in achieving its vision of farming communities and family businesses that are vibrant, innovative and prosperous.

During the plan review process members were asked to describe what the agricultural environment may look like in 5-10 years time. They described the future as having the following characteristics:

- Farming businesses that are more complex, therefore greater efficiencies required to manage them
- Digital agriculture and new technologies becoming available at an ever-increasing pace
- Livestock systems declining within farming systems in the region
- Business management requirements have increased, and farmers are more time poor
- Changes to the funding environment – decrease in public funding, potential decrease in overall R&D funding
- Food is highly valued and as a result, quality and accountability pressures are high
- Continued decline and more diverse rural populations
- Information is readily available and comes in many different forms and from many different sources
- Social media has a key source of information and norm setting has grown

The acknowledgement of these environmental factors, along with a strong group vision, provide the drive for the group for the next five years. This strategic plan really defines what the Liebe Group is about, how we operate, and how we support our members.

Our strategy will be reinforced by continual improvement and evaluation of impact and success, and will continue to provide the guidance to staff in operations and planning.

Role of Liebe Group

The Liebe Group is a dynamic, grower-driven, not for profit organisation that operates within the Dalwallinu, Coorow, Perenjori and Wongan-Ballidu Shires in the West Australian Wheatbelt. As a leading 'grass roots' group, the Liebe Group provides its members with access to innovative, timely and relevant research along with grower and industry network opportunities from all over Australia. The group is a valued information broker for Liebe members and industry.

The Liebe Group ensures regular consultation with members and industry to guarantee the group remains relevant. Liebe is governed by a central Management Committee which is informed by a range of operational sub-committees which are comprised of local growers and Industry partners.

The group conducts valuable research, development and extension through trials, demonstrations and workshops, and provides information to over 100 farming businesses in the local region, encompassing a land area of over 1,000,000ha.

Acknowledgements

The Liebe Group would like to acknowledge everyone who contributed to this Strategic Plan, and for continuing to support the group with passion and enthusiasm. We are excited about the future and look forward to continuing this journey with you all.

Our Vision
Vibrance and Innovation for Rural Prosperity.

Our Mission
To be a progressive group, working together to improve rural profitability, lifestyle and natural resources.

Our Core Business
Agricultural research, development, validation and adoption.
Provide information, education, skills and training opportunities to members and wider community.
Strengthen communication between growers, industry and whole community.

Our Values
The following are a set of evolving philosophies and values that the group maintains for members and employees. By accepting these values it enables us to build trust in order to make effective and efficient decisions and reach our potential.

Member Driven
Primarily, the Liebe Group is here to create value for its members through R&D, technology and capacity building extension. It is local and relevant, and prioritised by the membership.

Innovation and Progression
The group is innovative and progressive and this is encouraged and valued. An ethos of constant review is adhered to, to ensure we are on track and achieving best practice.

Inclusivity
The group is inclusive which means we involve, encourage and support staff, members and the community to take part, have a voice and maintain their ideas and views as individuals.

Apolitical
The group is apolitical, which means collectively we won't represent the members without following a process to ensure we are representing all their ideas or opinions.

Empowerment
Empowerment and capacity building is encouraged of members and staff to ensure everyone reaches their potential and supports their personal development.

Independence
The group is independent and acts under direction from the 'grass roots.' The group is objective in its views and stance.

Professionalism
The group is professional which is encouraged and nurtured in the membership. The group is driven by the decision-making capacity of the management committee and it's supporting sub-committees which use accountable and transparent processes. We expect staff to be confidential in their dealings within the group.

Collaborative
Effective networking and links to beneficial partnerships is encouraged to add value and opportunities. The group works collaboratively within the agricultural industry to value add. The group maintains an ethos of team work and cooperation within the group and values peer to peer learning.

Respect
The group values and respects it's members and partners, and their resources and experience. We expect people to be open and honest, and build processes that reflect the transparency of the administration and processes used in the group.

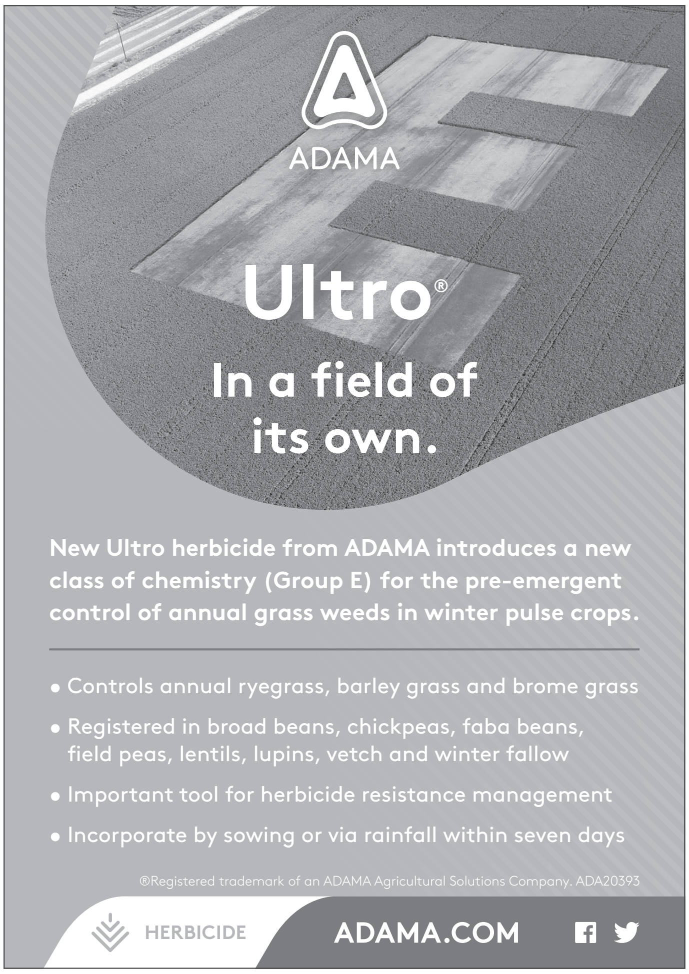
Fun
There is a social and fun philosophy within the group.

STRATEGY 01	STRATEGY 02	STRATEGY 03
High priority research and development, supported by targeted extension and driven by grower innovation.	Supporting members to have high business & farming aptitude	A Collaborative and Connected Organisation
Target: 100% of Liebe Group members have made an effective adoption decision concerning the adoption of new technologies & practices.	Target: Liebe Group members are recognised as being highly skilled in managing their farming enterprises.	Target: Recognised by key stakeholders as a leading grower group in Western Australia and nationally.
Tactics: 1. Develop and implement trials and demonstration to address local priorities and maximise value to members 2. Attract and develop strategic, long term partnerships with agribusiness and research organisations 3. Understand the value of the group's RD&E functions for members and partners 4. Support the development of, and provide access to, innovations for farming systems 5. Extend results of Research, Development and Validation	Tactics: 1. Understand, and annually review, the key drivers of change for farming businesses and the agricultural industry 2. Provide Member Development and Leadership Opportunities 3. Communicate with members 4. Encourage all sectors of the community to attend Liebe Group events.	Tactics: 1. Review and maintain the Liebe Group brand and identity as a leading professional grower group. 2. Pro-actively engage and maintain linkages with agribusiness, grower groups, government agencies, tertiary institutions and political organisations 3. Review, maintain and deliver a strong multifaceted communications strategy. 4. Celebrate Liebe and member successes.

STRATEGY 04	STRATEGY 05	STRATEGY 06
Sustainable Group Finances	High Performing Skilled Staff and Committee	Highly Effective Governance
Target: Have 12 months' operational costs in reserve. Have effective levels of accountability.	Target: The Liebe Group is viewed by the industry as a desired place of employment. Liebe Group leaders are professional & positions within committees are highly sought after.	Target: The Liebe Group is a 'best-practice' not for profit organisation.
Tactics: 1. Maintain highly skilled finance committee to oversee Liebe Group financials and budgets 2. Broaden Liebe Group funding base 3. Manage and measure membership contributions.	Tactics: 1. Support and develop Liebe Group employee's and committee members' skills and capacity 2. Maintain and increase employment base in order to meet group requirements 3. Encourage the development of staff and committee members to build skilled leaders.	Tactics: 1. Implement and maintain a professional management structure 2. Ensure that constitution is compliant and relevant and enables best practice management of the Liebe Group 3. Effective group process.

LIEBE GROUP CALENDAR OF EVENTS - 2021

EVENT	DATE	LOCATION
Annual General Meeting	Wednesday 10th March	Dalwallinu Recreation Centre
Crop Updates & Trials Review Day	Wednesday 10th March	Dalwallinu Recreation Centre
Women's Field Day	Tuesday 15th June	Dalwallinu Recreation Centre
Post Seeding Field Walk	Wednesday 21st July	Main Trial Site, Dalwallinu
Liebe Group Annual Dinner	TBC	Liebe Group Office
Spring Field Day	Thursday 9th September	Main Trial Site, Dalwallinu
December Christmas Drinks	TBC	Liebe Group Office


ADAMA
Ultro®
In a field of its own.
New Ultro herbicide from ADAMA introduces a new class of chemistry (Group E) for the pre-emergent control of annual grass weeds in winter pulse crops.
• Controls annual ryegrass, barley grass and brome grass
• Registered in broad beans, chickpeas, faba beans, field peas, lentils, lupins, vetch and winter fallow
• Important tool for herbicide resistance management
• Incorporate by sowing or via rainfall within seven days
®Registered trademark of an ADAMA Agricultural Solutions Company. ADA20393
HERBICIDE
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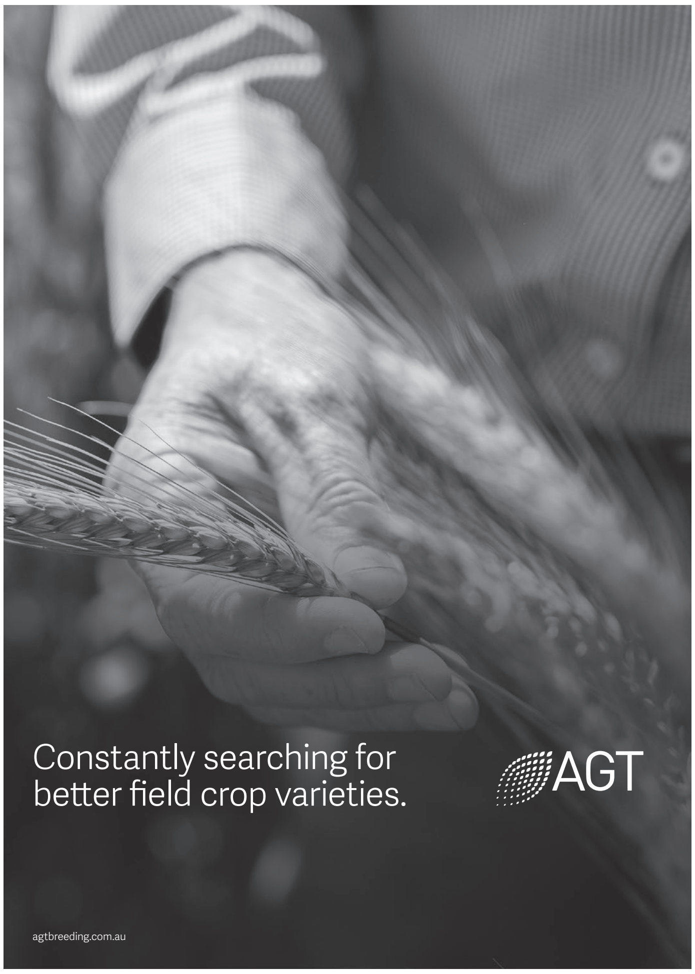
Constantly searching for better field crop varieties.
AGT
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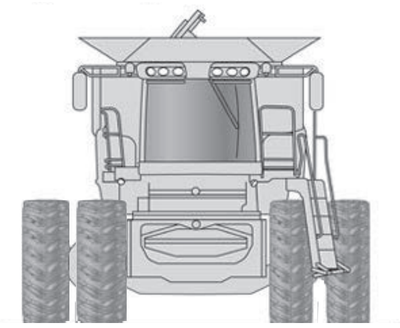


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