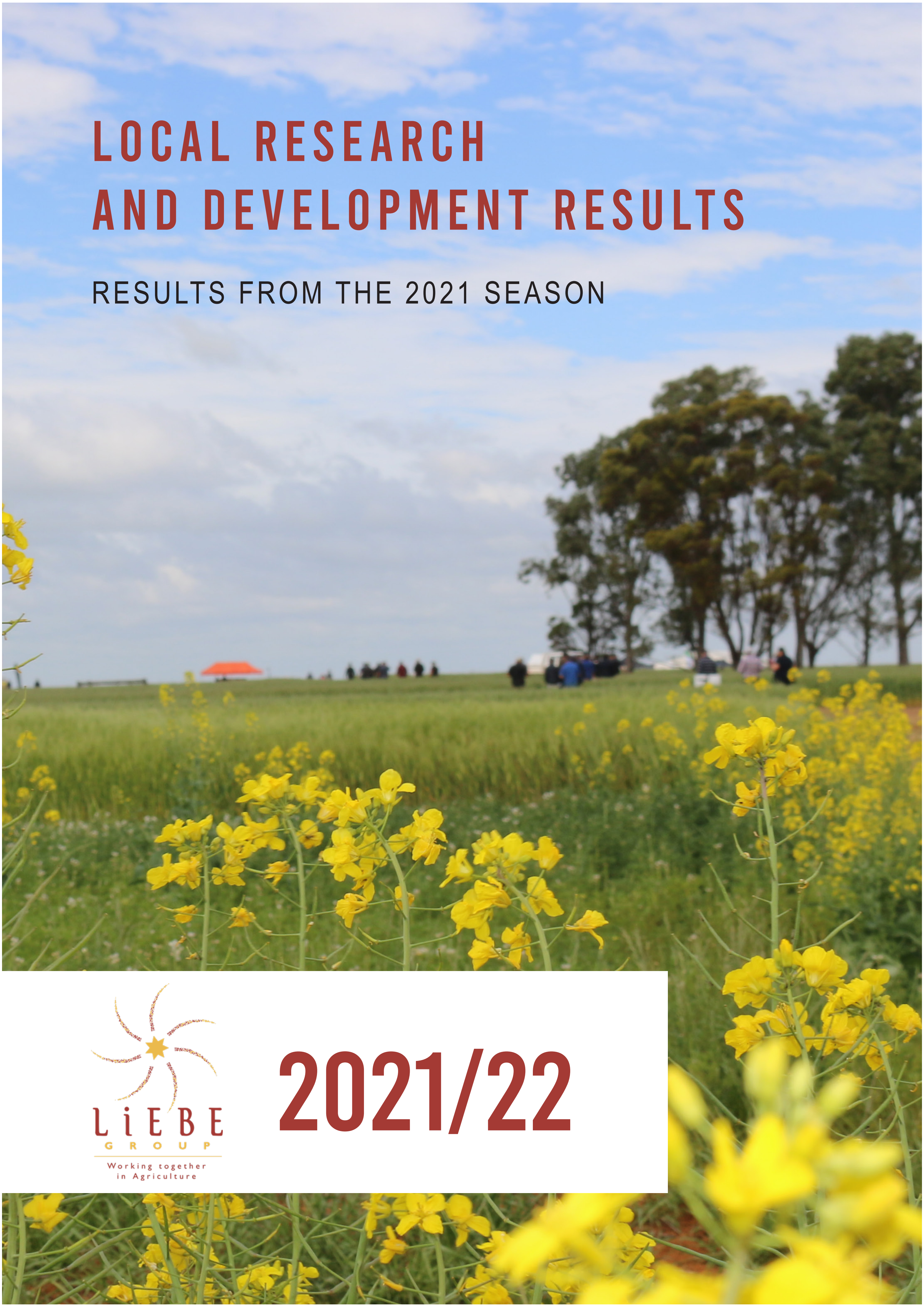
LOCAL RESEARCH AND DEVELOPMENT RESULTS

RESULTS FROM THE 2021 SEASON



LiEBE GROUP

Working together in Agriculture

2021/22

Dear Liebe Group Members and Supporters,

The Liebe Group team are proud to present the annual Local Research and Development Results Book for 2022. This publication contains the results from research trials and demonstrations conducted in the Liebe Group region from the 2021 season, as well as current projects across the district.

The past 12 months have highlighted the resilience and strength of farming communities, with harvest records broken throughout the state. The season did not come without its challenges though including frost impacts, wet harvest conditions and machinery shortages among other factors. However thanks to some decent rainfall events, high grain prices and innovative farming practices, it was an overall positive outcome for the Liebe Group region.

We would like to sincerely thank the Liebe Group committee members and staff 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 25th year of research, development and extension activities.

Many thanks are also extended to Matt, Harry and Jane Hyde for hosting the 2021 Main Trial Site at their property in Dalwallinu, along with all other members who have hosted or contributed towards research, trial and demonstration efforts throughout the region.

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), the Farm Weekly, the Shire of Dalwallinu and the Grower Group Alliance. We would also like to thank our long term 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 Sam, Terry and Andrea Reynolds at their property north of Miling.

Liebe Group's main events this year are scheduled for:

- Crop Updates and Trials Review Day on Wednesday 2nd March
- Women's Field Day on Tuesday 14th June
- Post-Seeding Field Walk on Wednesday 27th July
- Spring Field Day on Thursday 8th September

Please note that 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 particular trial.

We wish you all the best for a successful 2022 season and look forward to working with you throughout the year.

Kind regards,

Katrina Venticinque	Executive Officer	eo@liebegroup.org.au
Danielle Hipwell	Administration Officer	admin@liebegroup.org.au
Lisa-May Shaw	Administration Assistant	office@liebegroup.org.au
Sophie Carlshausen	Finance Manager	sophie@liebegroup.org.au
Rebecca Wallis	Development & Support Officer	rebeccawallis01@gmail.com
Chris O'Callaghan	Project Support Officer	chrisocallaghan60@bigpond.com

The Liebe Group
PO Box 340
Dalwallinu WA 6609
(08) 9661 1907
www.liebegroup.org.au

LIEBE GROUP PARTNERS 2021

DIAMOND

GOLD

SILVER

LIEBE GROUP COMMITTEE MEMBERS 2021

The Liebe Group would like to recognise the support and contribution of the Liebe Group Committees throughout the 2021 season.

Management Committee

Blayn Carlshausen (President)
Brad McIlroy (Vice President)
Ross Fitzsimons
Alex Keamy
Boyd Carter
Mike Dodd
Gavin Carter
Wendy Sawyer
Rebecca Wallis

Finance Committee

Mike Dodd (Chair)
Blayn Carlshausen
Ross Fitzsimons
Georgina Day
Wendy Sawyer

Research & Development Committee

Dylan Hirsch (Chair)
Boyd Carter
Rob Nankivell
Daniel Birch
Todd Carter
Matthew Hyde
Steve Sawyer
Sam Reynolds
Ty Henning
Casey Shaw
Peter Borstel
Tristan Clarke
Angus McAlpine
Lois Kowald

Women's Committee

Jennifer Birch (Chair)
Georgina Day
Cathy Northover
Narelle Dodd
Tracy McAlpine
Kirsty Carter
Kelly Carter
Rebecca McGregor
Leanne Sawyer
Danielle McNamee
Jane Hyde

Employment Advisory Committee

Blayn Carlshausen
Alex Keamy
Brad McIlroy
Wendy Sawyer
Ross Fitzsimons

INDEX

youthfocus

MIFWA

Lifeline WA

Black Dog Institute

Supporting our regional mental health.

We have joined with four organisations to improve the mental health of Western Australian regional communities.

Together, we're aiming to make help easier to access for growers and communities so that we can all look after our mental health.

For more information on our program and services our partners offer, visit our website.

cbh.com.au

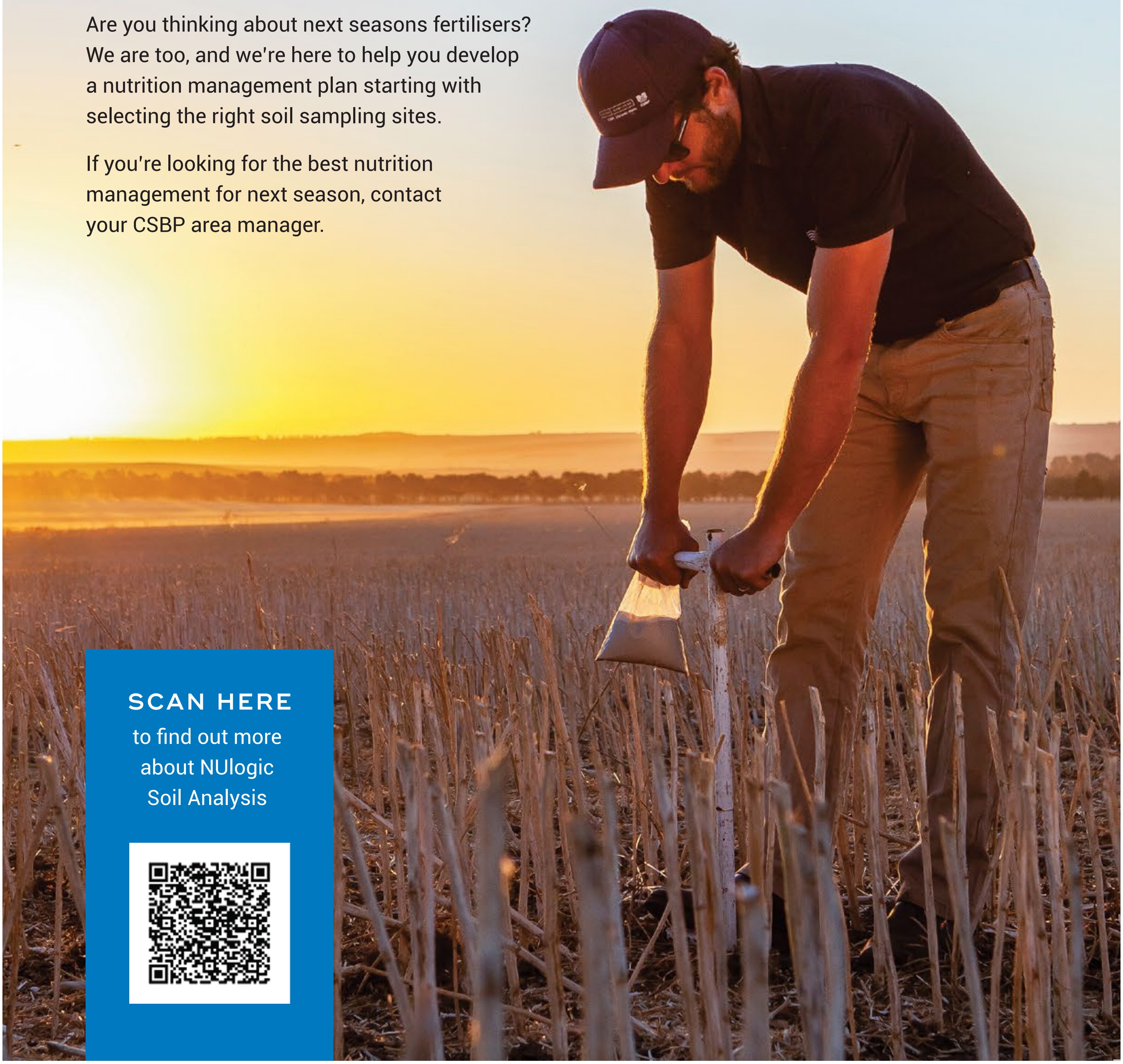
CBH GROUP

We're here to help.

Optimise your fertiliser plan with NUlogic Soil Analysis.

Are you thinking about next seasons fertilisers? We are too, and we're here to help you develop a nutrition management plan starting with selecting the right soil sampling sites.

If you're looking for the best nutrition management for next season, contact your CSBP area manager.



SCAN HERE

to find out more about NUlogic Soil Analysis

CSBP

Grow with your local Rabobank team

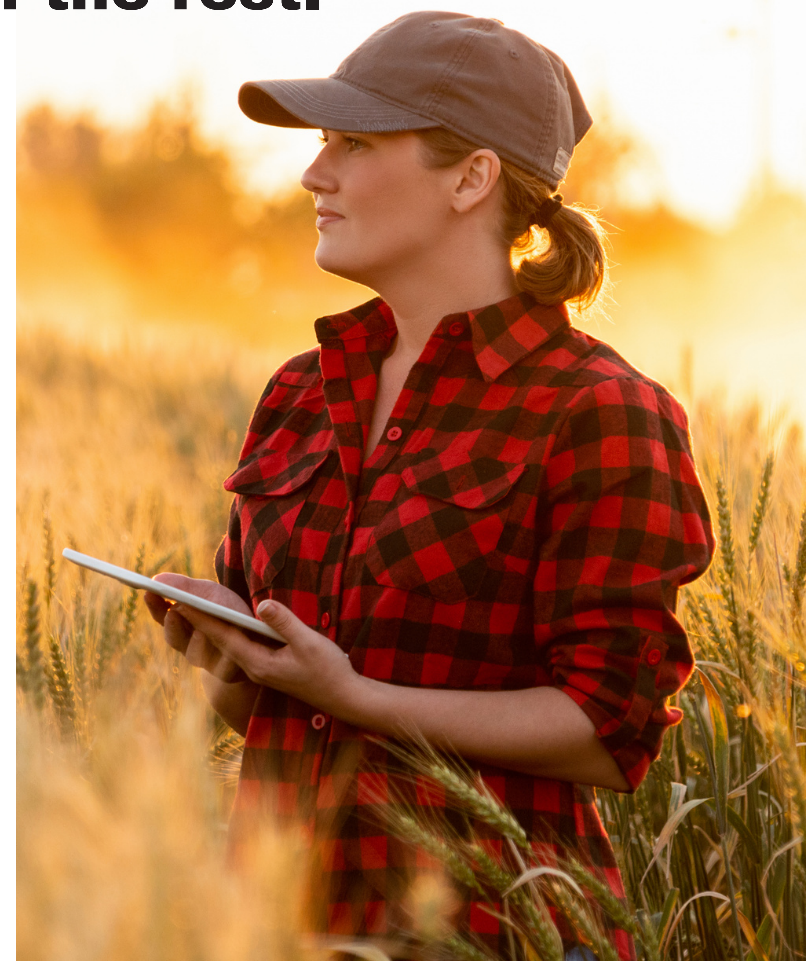
Our single focus is agriculture

Our agri-banking experts live and work where you do and are passionate about the future of rural communities. That's why, season after season, year after year, we'll be here to help you grow.

If you'd like to grow with Rabobank call us today on **9690 8500**

Rabobank

RAB01121-14532



LIEBE GROUP CALENDAR OF EVENTS - 2022

EVENT	DATE	LOCATION
Annual General Meeting	Wednesday 2nd March	Dalwallinu Recreation Centre
Crop Updates & Trials Review Day	Wednesday 2nd March	Dalwallinu Recreation Centre
Women's Field Day	Tuesday 14th June	Dalwallinu Recreation Centre
Post Seeding Field Walk	Wednesday 27th July	Main Trial Site, North Miling
Liebe Group Annual Dinner	TBC	Liebe Group Office
Spring Field Day	Thursday 8th September	Main Trial Site, North Miling
December Christmas Drinks	TBC	Liebe Group Office

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 (SE)

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 Least Significant Difference (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.

Glossary of terms

DAA	Days After Application
ToS	Time of Sowing
NSD	No significant difference
GSR	Growing Season Rainfall
IBS	Incorporated by Sowing
PSPE	Post Seeding Pre Emergent
EPE	Early Post Emergent
ANA	Analysis not Applicable

Disease Ratings

Disease ratings in Australia are developed by plant pathologists in a nationally co-ordinated program of both field and controlled environment testing. The work is funded by the GRDC through its NVT program with the work undertaken by specialist plant pathologists across Australia.

VS = Very susceptible, SVS = Susceptible to very susceptible, S = Susceptible, MSS = Moderately susceptible to susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, RMR = Resistant to moderately resistant, R = Resistant. No score '-' = no rating is currently available. p = Provisional assessment. * = some races in eastern Australia can attack these varieties, including races with Yr17 virulence for stripe rust and races with Lr24 virulence for leaf rust. Combined P. neglectus ratings from DPIRD, SARDI, AgVic and USQ data. Not all varieties have been tested in WA. P. quasitereoides ratings are from DPIRD glasshouse and field trials. Provisional ratings provided for varieties with fewer than three observations or where there has been no field trial verification of the glasshouse rating. CCN ratings from GRDC NVT data. R = resistant – nematode numbers will decrease when this variety is grown. MR = Moderately resistant – nematode numbers will slightly decrease when this variety is grown. MS = Moderately susceptible – nematode numbers will slightly increase when this variety is grown. S = Susceptible – nematode numbers will increase greatly when this variety is grown. Crown rot ratings from SARDI, USQ and DPI NSW data.

2021 Season Overview

Dylan Hirsch, R&D Committee Chair

2021 was quite a few things, but most certainly another unique year of farming for both commercial and research outcomes. There were many "what-could-have-been" crops as frost, cyclone, paddock trafficability, staff access and broader industry logistics challenged us from reaching record production potentials. However despite this there were plenty of crops which made it through to what almost certainly will be a record production for the Liebe region. And I can't help but think of how much of this is thanks to the continuous improvement of farming practices of which the Liebe Group contributes so much.

2021 was also the second year of pandemic affected event organisation. However Katrina and the team did a great job navigating through these challenges. Plan Bs were used when needed, and virtual meetings were used for main events and workshops effectively. While we hope we can go back to physical engagement in 2022, I'm confident the Liebe staff are well skilled to use this technology effectively again. There were a total of 27 events held throughout the year, including five AgChats workshops which seem to work well for smaller extension activities. We even had another seven podcasts to add to the first six published in 2020. Grower participation at R&D events seems to be down a lot in 2021 right across WA, possibly due to fatigue from the extra passes the crops required, lack of good spray days and labour shortages. However attendance at Liebe's major events was still very high, with 186 at the Spring Field Day and 130 at the Women's Field Day. Again this is a credit to the team at Liebe, as well as previous committees who have developed such a strong reputation.

Matthew and the Hyde family hosted an excellent trial site, on some heavier loams typical of farm surrounding Dalwallinu town. A total of 17 trials were implemented, each of which were impacted in some way by the extremely wet year. From the residual herbicide injury trial which showed surprisingly little effect, to the CSBP early season wheat trial which seemed to capitalise on the early season break. The ability to respond to seasonal opportunities (and challenges) and adapt trials illustrates the importance of having active grower and industry representatives on the R&D Committee. The Spring Field Day was well capped off by guest grower Callum Wesley, who inspired some interesting discussion with members into the evening. I hope this energy can be carried into future R&D work with the group.

2021 saw the completion of two 3-year GRDC projects, the initial 'Ripper Gauge' and Legume Profitability Demonstration projects. However judging by our R&D brainstorming session, the appetite for more information and trials in both of these areas is significant, so I suspect follow on projects from both of these. Other projects ongoing in 2021 include the Aluminium Toxicity Demonstrations, Crop Establishment, Lupin Seed Integrity, Gen Y Paddock Challenge, Double Break and the Soil Pathogen Project.

Several new projects were also started in 2021. The second phase of the ripper gauge project was established to investigate novel methods of deep ripping in conjunction with other grower groups. The Liebe Soil Moisture Probe Network was established, which I'm sure will become an important tool for years to come. The Stubble Height Project has also been established, which looks to demonstrate and assess the impact of tall stripper stubble on moisture conservation and other things. It's particularly pleasing to see new systems like this analysed as it has been a popular R&D topic in recent years based on member feedback.

The 2022 main trial site is set to be located at the Reynold family's North Miling property on lighter sandplain typical of much of that area. The herbicide residue (IMI) trial has already been established which should produce more visual crop injury with the lighter soil type. We look forward to working with Sam and the Reynolds family to implement trials relevant to other issues pertaining to these sandy soils including non-wetting soil, subsurface compaction, erosion, canola establishment, and grass weed management. I strongly encourage other members with similar soils to get in touch with the R&D committee with any issues or ideas they would like investigating.

Like many years, in 2022 we say goodbye to a few R&D committee members, and we would like to thank them for their contribution. Most notably I'd like to thank outgoing R&D Coordinator Judith Storer for her efforts over the past two years. We wish her all the best for her future endeavours, and look forward to working with the incoming R&D Coordinator.

CEREAL RESEARCH RESULTS

Wheat Variety Depth of Sowing

Alana Hartley, Marketing Manager WA, Australian Grain Technologies

Key Messages

- Calibre is a new high yielding wheat variety from AGT, with a longer coleoptile than its parent Scepter.
- Sowing depth had the most significant effect on establishment but there was no significant differences between varieties across sowing depths.
- A significant difference in yield was observed between varieties, and sowing depths, but not in the combined interaction of both variety and sowing depth.
- Scepter was the highest yielding variety in this trial.
- Calibre was significantly higher yielding than the previous industry standard longer coleoptile variety Magenta.
- Protein was significantly different between varieties, although inversely proportionate to yield.
- Further investigation into how longer coleoptile varieties fit into the farming system is needed.

Aim

Measure the impact of deep sowing on establishment, yield and grain quality of longer coleoptile wheat line Calibre, when compared to Magenta and Scepter.

Background

The maximum coleoptile length of a wheat variety is a limiting factor in how deep you can plant that variety. In most cases, sowing depth is shallow enough to allow all commonly grown varieties to establish well. However, there are some instances where deeper sowing may be warranted: when there is a chance of furrow fill by wind or rain, when chasing receding moisture profiles, when anticipating uneven sowing depths across a seeding bar on renovated soils or, when trying to achieve adequate pre-emergent herbicide separation. Shorter coleoptile varieties may not be as well suited compared to longer coleoptile varieties in these situations. Magenta is a good example of a more recently released variety with a longer coleoptile that has been successfully used by WA growers to manage such situations.

AGT have developed the variety Calibre as an elite yielding Scepter replacement, which is agronomically very similar to Scepter, but importantly, has a longer coleoptile of similar length to Magenta (Figure 1). This trial was designed to assess the value of Calibre's longer coleoptile to the previous longer coleoptile industry standard Magenta, and short coleoptile industry standard Scepter, at three sowing depths.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	1.52m x 12m x 3 replications
Soil type	Heavy red clay loam
Paddock rotation	Chemical Fallow 2020, Barley 2019
Sowing date	22/05/2021
Sowing rate	Target 110 plants/m^2
Fertiliser	22/05/2021 – Gusto Gold 100 kg/ha (10.2N, 12.0K, 7.2S) 22/05/2021 – Urea 100 kg/ha (46.0N) 02/07/2021 – Flexi N 100 L/ha (42.2N) 05/08/2021 – Flexi N 100 L/ha (21.1N)
Herbicides, Insecticides & Fungicides	22/05/2021 – Glyphosate (570 g/L) 2.5 L/ha, Pyroxaulfone (480 g/L) 210 ml/ha, Trifluralin 2 L/ha, Diuron 250 g/ha, Clopyralid 80 g/ha, Chlorpyrifos 500 ml/ha, Bifenthrin 100 ml/ha 16/06/2021 – Prosulfocarb (800 g/L)/S-Metolachlor (12 g/L) 2.5 L/ha, Velocity 700 ml/ha 17/08/2021 – Bixafen (75 g/L)/Prothioconazole (150 g/L) 300 ml/ha, Sulfoxaflor (500 g/kg) 50 g/ha
Harvest date	23/11/2021

Treatments

Treatment	Variety	Sowing depth (mm)
1	Scepter	
2	Calibre	20 ‘standard’
3	Magenta	
4	Scepter	
5	Calibre	60 ‘moderate’
6	Magenta	
7	Scepter	
8	Calibre	110 ‘deep’
9	Magenta	

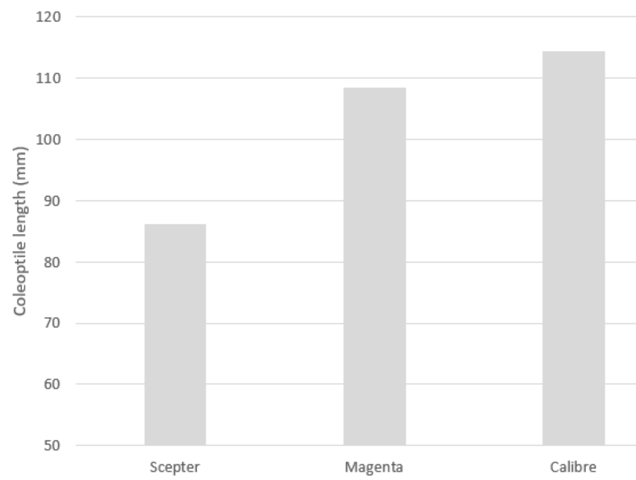


Figure 1: Coleoptile length of Calibre versus Scepter and Magenta (AGT controlled environment test, average of seven experiments).

Results

Table 1: Impact of Variety on establishment, yield and grain quality.

Treatment	Variety	Est. Count (plants/m²)	Yield (t/ha)	Protein (%)	Hectolitre (kg/hl)	Screenings (%)
1	Scepter	64	4.21[a]	10.1[b]	81.2[a]	1.8
2	Calibre	68	3.80[b]	10.5[b]	79.0[b]	1.6
3	Magenta	65	3.31[c]	11.4[a]	79.9[b]	1.8
Variety	***P Value***	NS	<0.05	<0.05	<0.05	NS
	LSD	21	0.38	0.8	1.15	0.45

Table 2: Impact of Sowing Depth on establishment, yield and grain quality

Treatment	Sowing depth	Est. Count (plants/m²)	Yield (t/ha)	Protein (%)	Hectolitre (kg/hl)	Screenings (%)
1	20 mm	84[a]	4.12[a]	10.6	80.2	1.7
2	60 mm	62[b]	3.80[b]	10.6	80.2	1.7
3	110 mm	51[b]	3.40[c]	10.8	79.8	1.8
Sowing depth	***P Value***	<0.05	<0.05	NS	NS	NS
	LSD	4	0.24	0.65	1.46	0.45

Table 3: Impact of the interaction between Variety and Sowing Depth on yield and grain quality

Treatment	Variety	Sowing depth (mm)	Yield (t/ha)	Protein (%)	Hectolitre (kg/hl)	Screenings (%)
1	Scepter		4.71	9.9	81.5	1.8
2	Calibre	20 ‘standard’	4.12	10.6	78.8	1.7
3	Magenta		3.47	11.2	79.9	1.7
4	Scepter		4.21	10.1	81.8	1.6
5	Calibre	60 ‘moderate’	3.80	10.4	79.1	1.5
6	Magenta		3.36	11.3	80.0	1.9
7	Scepter		3.71	10.3	80.3	2.0
8	Calibre	110 ‘deep’	3.48	10.5	79.1	1.7
9	Magenta		3.07	11.6	79.8	1.8
Variety x sowing depth		***P Value***	NS	NS	NS	NS

Comments

The trial site received 165mm of rainfall from March through to sowing in late May, with good rainfall post seeding providing ideal conditions for establishing the trial. Due to the heavy nature of the soil type, trial equipment did experience difficulties achieving consistent sowing depths across plots. Large clods were deposited throughout the rows in the 'moderate' and 'deep' treatments which did affect establishment however, these areas were avoided when collecting establishment data.

Establishment counts were taken on 2nd July, when the crop had reached early tillering. A significant difference in establishment was observed between sowing depths, with deeper sowing having a negative effect on plant numbers. There was no difference in establishment between varieties, as all varieties were similarly affected by sowing depth.

Harvest results did show several effects that significantly impacted yield and grain quality. Each variety yielded significantly differently, with Scepter being the highest yielding variety across the trial. Variety alone also influenced protein and hectolitre results. Protein results were inverse to yield, where higher yielding Scepter achieved a lower protein, compared to lower yielding Magenta which had a significantly higher protein. This is known as the yield dilution effect. Hectolitre weight also differed significantly between varieties, with Scepter having the largest weight.

Sowing depth significantly influenced establishment and therefore yield however, it did not have the same influence on grain quality as variety did. There was a significant yield loss from 'moderate' and 'deep' sowing, compared to plots sown at 'standard' depth. However, in the 'deep sowing' this may have been attributed to the variable establishment across tines, within a plot. This suggests the 'standard' sowing depth was the best choice for maximising yield potential at this site in the 2021 season.

When comparing the performance of new longer coleoptile variety Calibre, to the previous longer coleoptile standard, Magenta, this trial demonstrates that Calibre is significantly higher yielding under all sowing depths. Although not as high yielding as Scepter in this trial, AGT long term data and NVT data from 2020 showed that Calibre offered a yield improvement over Scepter.

Calibre was significantly higher yielding than the previous long coleoptile standard, Magenta, in this trial, and also offers agronomic improvements such as a wider sowing window, improved pre harvest sprouting tolerance and AH quality classification.

Acknowledgements

Harry, Jane and Matt Hyde, Damrosehay (Liebe Group 2021 Main Trial Site hosts), Liebe Group staff and Living Farm for sowing, managing and harvesting the trial in 2021.

Peer review

Angus McAlpine, CSBP

Contact

Alana Hartley
Alana.hartley@agtbreeding.com.au
0417 919 299

Dion Bennett
Dion.bennett@agtbreeding.com.au
0400 031 911

CANOLA & PULSES RESEARCH RESULTS

Comparison of Chickpea Inoculant Methods and the Interaction with Seed Applied Fungicide

Stacey Power, Research Scientist, Department of Primary Industries and Regional Development

Key Messages

- Peat-based inoculant methods (slurry or granules) had more root nodules than nil and ALOSCA® with fertiliser treatments.
- There were no biomass differences measured between any of the treatments at any stage in the season.
- Nodulation differences did not lead to yield differences, likely due to good growing conditions through most of the season.

Aim

We plan to demonstrate a range of both peat and granular inoculant options for chickpeas, placement of these products with seed versus with fertiliser, and the interactions of these products with seed applied fungicide.

Background

Chickpeas are a well suited break crop option for the Dalwallinu region. Good root nodulation from symbiosis of rhizobia and plant roots is required to get the most out of growing chickpeas. This improves crop growth and provides nitrogen benefits to following cereal crops. It is recommended that all chickpeas are inoculated prior to sowing to ensure good nodulation. Whilst reliance on background soil rhizobia from previous crops may be suitable for other legumes, such as lupins, this is not the case with chickpeas. Paddocks generally do not have enough of a history of chickpeas or adequate soil pH to ensure survival of rhizobia over the recommended four-year break between chickpea crops.

Traditionally, grain legumes have been inoculated using a peat slurry product. Rhizobia are sensitive to both temperature and desiccation; therefore, peat needs to be stored in the fridge until it is ready to be used, and once inoculated seed should be sown within 6-24 hours to prevent drying out. Seed inoculated with peat slurry is best suited to sowing into moist conditions, as the rhizobia has no protection from drying out when sown into dry soil and rhizobia death can occur in high numbers quite quickly.

Recently, peat based granules such as Tagteam® have become available to inoculate pulses. These are a 'wet granule', which are used in a similar method to clay based granules, however they retain the high rhizobia number of peat slurry products and the need to be refrigerated prior to inoculation of seed. Clay based granules, such as ALOSCA®, can help overcome sowing in to dry/drying soil as the clay is better able to protect rhizobia from both drying out and heat. The clay may also provide more protection from potentially acidic conditions, such as exposure to fungicidal seed dressing or fertiliser. These granules require no special treatment (such as refrigeration) and can be mixed with seed into the cart, so they are easy to use, however they usually require higher application rates due to a lower number of rhizobia per gram of inoculant.

With some pulses, in situations where sowing conditions are not ideal, i.e. pH lower than 5.5 or marginal soil moisture, the recommended rate of peat slurry is doubled or a single rate of peat slurry is combined with ALOSCA® granules as an insurance policy. In these situations, it is known that some rhizobia death is likely to occur due to the imperfect soil conditions. Using either the double peat or combination of peat slurry and clay granules can ensure that there is still adequate surviving rhizobia numbers even after some death has occurred.

In addition to inoculation with rhizobia, it is recommended that all chickpea crops are treated with seed applied fungicide to manage seed borne ascochyta risk, however it is also known that fungicide based seed dressings can impact on survival of rhizobia due to their acidic nature. It is recommended to sow as soon as possible after inoculation to minimise the time that rhizobia are exposed to the fungicide on seed. Another method that growers commonly use to avoid fungicide impacting on rhizobia survival is to place clay based granules with fertiliser at seeding, therefore achieving separation of the fungicide and rhizobia.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	10m x 1.54m x 3 replications
Soil type	Heavy red clay
Paddock rotation	2020 chemical fallow, 2019 barley
Sowing date	11/05/2021 into wet soil
Sowing rate	CBA Captain, 103 kg/ha
Fertiliser	Superphosphate 100 kg/ha (9.1P, 10.5S, 20.0Ca)
Herbicides, Insecticides & Fungicides	Seed treatment, as per plot treatment: 200 mL/100kg seed thiram (360 g/L) + thiabendazole (200 g/L) At seeding: 860 kg/ha terbuthylazine (875 g/kg) + 1500 mL/ha fomesafen (240 g/L) + 1 kg/ha propyzamide (500 g/kg) + 500 mL/ha chlorpyrifos (400 g/L) & bifenthrin (20 g/L) 16/06/2021 - 880 mL/ha tebuconazole (400 g/L) & azoxystrobin (20 g/L) 05/08/2021 - 330 mL/ha clethodim (360 g/L) + 180 g/ha butroxydim (250 g/kg) + 500 mL/100mL water non-ionic surfactant 30/08/2021 - 600 mL/ha prothioconazole (150 g/L) & bixafen (75 g/L) 04/10/2021 - 160 mL/ha alpha-cypermethrin (100 g/L) 11/10/2021 - 875 mL/ha tebuconazole (200 g/L) & azoxystrobin (120 g/L)
Harvest date	01/12/2021

Treatments

Treatment #	Inoculant method	Seed dressing
1	Nil rhizobia	None
2	Nil rhizobia	P-Pickel T
3	Peat slurry	None
4	Peat slurry	P-Pickel T
5	Double rate peat slurry	None
6	Double rate peat slurry	P-Pickel T
7	Peat slurry + ALOSCA® with seed	None
8	Peat slurry + ALOSCA® with seed	P-Pickel T
9	Peat slurry on seed + ALOSCA® with fertiliser	None
10	Peat slurry on seed + ALOSCA® with fertiliser	P-Pickel T
11	ALOSCA® with seed	None
12	ALOSCA® with seed	P-Pickel T
13	ALOSCA® with fertiliser	None
14	ALOSCA® with fertiliser	P-Pickel T
15	Tagteam® with seed	None
16	Tagteam® with seed	P-Pickel T

Seed dressing: 200 mL/100kg seed of P-Pickel T (360 g/L thiram + 200 g/L thiabendazole)

Soil Composition

Depth (cm)	pH (CaCl2)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO3) (mg/kg)	N (NH4) (mg/kg)	EC (ds/m)	OC (%)
0-10	7.4	41	752	2.6	5	2	0.093	0.97
10-20	7.6	8	418	2.6	1	<1	0.196	0.58
20-30	8.1	5	303	1.5	2	<1	0.234	0.45

Results

This trial was sown into wet soil following 40mm of rainfall in the week prior to seeding. Plant establishment was excellent, with all treatments close to or exceeding the target density of 45 plants/m^2. Neither seed dressing nor inoculant treatment had any impact on plant density. The wet soil at seeding in combination with sowing occurring within 24 hours of inoculation provided excellent conditions for root nodulation to occur.

Ideally, sampling of plants to assess root nodulation would occur 8-12 weeks after a trial is sown. Unfortunately, in 2021, the very heavy soil and wet winter combined to make the plants extremely difficult to sample without destruction of the roots or the surrounding plants. Therefore, sample collection for nodulation assessments in this trial was done on 24 August, 15 weeks after sowing. Despite sampling occurring later than ideal, we were still able to make an accurate assessment of nodulation. Figure 1 was used to assess 20 plants from each plot. Nodules were also opened to check internal colour as a guide to their effectiveness.

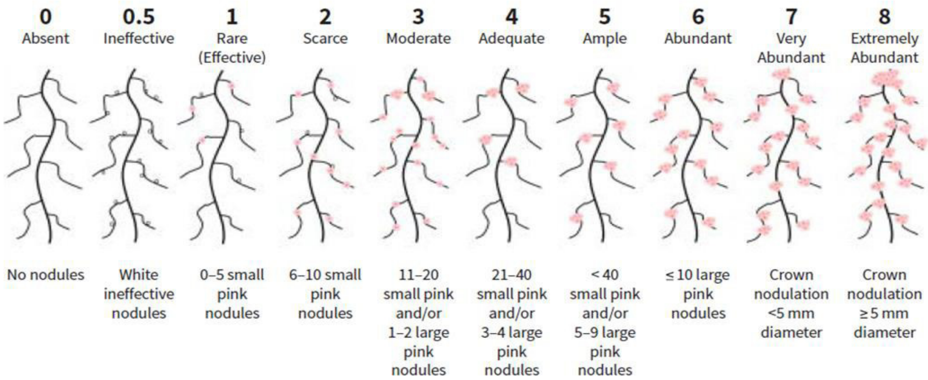


Figure 1: Nodulation rating scale used to assess samples from this trial. Taken from Howieson, et al. (2016)

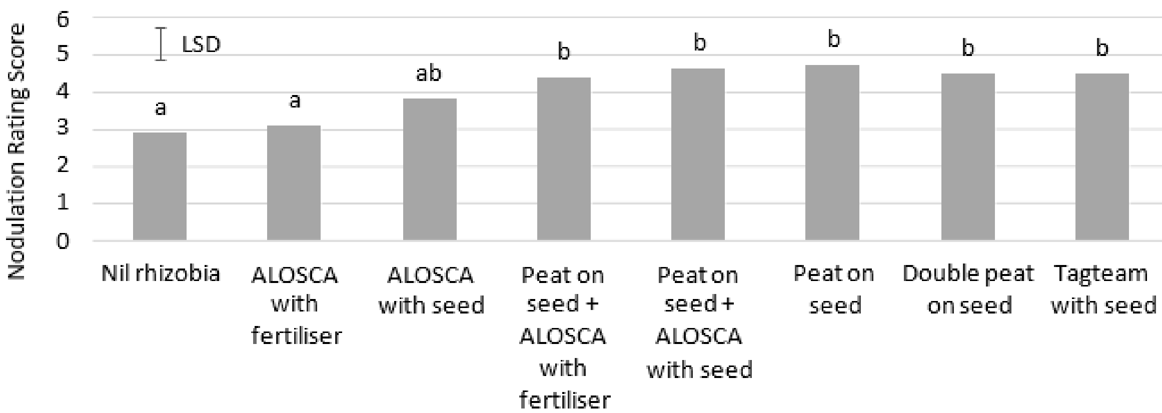


Figure 2: Average rating for each rhizobia treatment from samples taken on 24th August, $p = 0.003$.Treatments that share a common letter are not significantly different.

In this trial there was a significant difference in the nodulation rating score when treatments were separated by the rhizobia they were inoculated with (Figure 2). Despite the acidic nature of seed applied fungicide treatment, it did not affect root nodulation in this trial and all treatments achieved the same nodulation when sown with seed dressing as they did when sown without.

The nil rhizobia treatment in this trial did have some effective nodules present on plant roots, despite cleaning machinery with ethanol between seeding each treatment. This suggests that there may have been some contamination between treatments or that there were background rhizobia present in the soil. All treatments that were peat based, whether they were applied as a slurry or granule, at single or double the recommended rate, or in combination with ALOSCA® granules, had significantly more nodules than the nil and ALOSCA® with fertiliser treatments. The peat-based products achieved adequate nodulation, whilst the nil, ALOSCA® with fertiliser and ALOSCA® with seed treatments had moderate–adequate nodulation. Root and shoot biomass were also measured at the time of nodulation ratings, however neither of these measures showed differences between any of the treatments.

There was no extra benefit to nodulation when the double rate of peat slurry was used, nor was there an added benefit when peat slurry was combined with ALOSCA® granules. The soil pH was also well within the acceptable range for chickpeas. Hence, the peat-based products, which would likely have suffered more rhizobial death if left sitting in dry soil or lower pH, were able to nodulate better than the ALOSCA® based treatments. As mentioned above, ALOSCA® granules can perform very well when sowing in to dry or drying conditions and we may have seen different results if this trial was sown into dry soil.

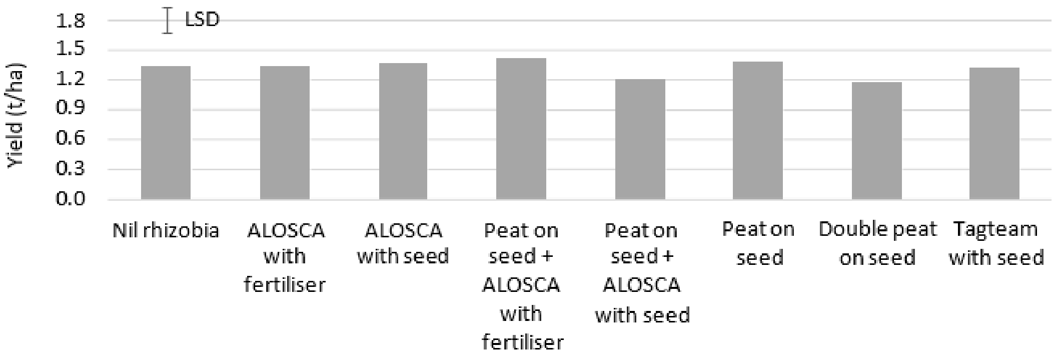


Figure 3: Seed yield at Dalwallinu in 2021. Rhizobia p = not significant.

As mentioned, the site was extremely wet throughout winter after 114mm of rainfall fell in July. Chickpeas are sensitive to waterlogging at any stage of growth; with their most sensitive stages being flowering and podding. Fortunately, waterlogging receded in early August, and it did not appear to hamper seed yield. Yields were quite good, with a site average of 1.3 t/ha (Figure 3). Despite the differences in nodulation between treatments, they all yielded the same. In a season such as 2021, after sowing into wet soil and with regular rainfall throughout the season, the subtle yet significant differences in nodulation did not translate to differences in seed yield. This was expected in 2021 given the lack of differences in biomass both at the time of nodulation ratings and at harvest time. In a more difficult season, the improved nodulation achieved by using peat-based products may have resulted in yield differences between treatments.

Comments

Seed dressing did not have any impact on plant density or nodulation success in this trial. This is reassuring, given fungicidal seed dressing is recommended on all chickpea crops as a first line of defence against Ascochyta blight and other fungal diseases, such as pythium. Plots that were inoculated with a peat-based product had significantly more nodulation than those that did not have a peat-based product. Yields across the trial were satisfactory and all rhizobia and seed dressing treatments yielded the same despite differences in nodulation, likely due to the wet soil conditions at seeding and good spring growing conditions.

While chickpeas can grow without adequate nodulation, they will fix less atmospheric nitrogen. This can cause yield loss in the year the pulse is grown, as well as deplete soil N reserves and minimise the N benefits to the following cereal crop. Many factors can impact on rhizobia survival and ability to form nodules. These can include storage conditions prior to seed application, such as not refrigerating peat inoculant, interaction with seed applied fungicide or fertiliser, low soil pH or moisture and crop stress soon after sowing such as waterlogging. It is important to handle and apply inoculants as per the manufacturer's instructions to maximise crop nodulation and nitrogen fixation.

Using the scale in Figure 1, it is easy for growers to assess nodulation in their own pulse crops. The scale can be used for all pulses. Samples can be collected following the instructions in the GRDC video Legume Nodulation: Sample Preparation https://www.youtube.com/watch?v=0VL7ClY-K9w.

Acknowledgements
This trial is part of the DPIRD/GRDC co-investment "DAW1903-004RTX: High Value Pulses - Raising awareness, optimising yield and expanding the area of lentil, chickpea and faba bean in Western Australia". Thanks to Salzar Rahman for excellent technical assistance, the Wongan Hills Trial Support Unit for trial management, and Liebe Group and Matthew Hyde for the trial site.

References

Grains Research and Development Corporation, 3 September 2015, Legume Nodulation: Sample Preparation.

Howieson, J.G. and Dilworth, M.J. (Eds.). 2016. Working with Rhizobia. Australian Centre for International Agricultural Research: Canberra.

Peer review
Mark Seymour, DPIRD

Contact

Stacey Power
stacey.power@dpird.wa.gov.au
0472 847 815

Clean Seed and Seed Dressing – An Essential First Step to Managing Chickpea Ascochyta

Stacey Power, Research Scientist, Department of Primary Industries and Regional Development

Key Messages
- Management of Ascochyta remains critical to growing successful chickpea crops and application of an appropriate seed dressing followed by foliar fungicide 4-6 weeks later are essential first steps.

Aim
To demonstrate the effectiveness of using clean seed and seed applied fungicide to minimise the amount of Ascochyta in a chickpea crop, and to demonstrate the effectiveness of early season foliar fungicides to keep disease levels at bay.

Background
Ascochyta is the main disease that needs to be managed when growing chickpea crops. It 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. Best practice guidelines recommend that all chickpea seed should be treated with a fungicidal seed dressing, which should be followed by an early season (4-6 weeks after sowing) foliar fungicide to minimise seed borne Ascochyta infection. A late season spray (mid-podding) should be applied, particularly if disease levels are high and/or if seed is to be retained for the following crop, this protects the yield potential that has been grown in this season and may result in cleaner seed to be used the following year. Our observations in 2020 indicated that the majority of Ascochyta infections in grower's paddocks were seed borne, rather than entering paddocks off stubble - suggesting that best practice guidelines are not always being followed.

At present screening for variety resistance ratings for chickpea Ascochyta are performed interstate, using isolates collected from those states. Different strains of Ascochyta with varying virulence exist around Australia. It has generally been observed that many varieties perform one or two ratings better with West Australian isolates than they do with those collected interstate. Neelam is currently rated S to Ascochyta for the southern and northern regions, although it tends to perform more like an MR/MS rating in WA, meaning it may perform better than some other varieties, but will still need active Ascochyta management.

DPIRD is currently running screening nurseries using West Australian Ascochyta strains and hopes to be able to provide a WA rating system soon. Suppressing the development of Ascochyta with fungicide may play a role in protecting varietal resistance that has been developed through crop breeding programs. Over-reliance on genetic resistance by not using fungicides may accelerate the break-down of the limited varietal resistance to these strains, thus the recommended management strategy for chickpea Ascochyta in WA does not change based on which variety is grown.

Soil Composition

Depth (cm)	pH (CaCl2)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO3) (mg/kg)	N (NH4) (mg/kg)	EC (ds/m)	OC (%)
0-10	7.4	41	752	2.6	5	2	0.093	0.97
10-20	7.6	8	418	2.6	1	<1	0.196	0.58
20-30	8.1	5	303	1.5	2	<1	0.234	0.45

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	10m x 1.54m x 4 replications
Soil type	Heavy red loam
Paddock rotation	2020 chemical fallow, 2019 barley
Sowing date	11/05/2021 into wet soil
Sowing rate	Neelam, adjusted for seed size and germination to target 45 plants/m2 Clean seed 90 kg/ha, Infected seed: 116 kg/ha
Fertiliser	At seeding - Superphosphate 100 kg/ha, (9.1P, 10.5S, 20.0Ca)
Herbicides, Insecticides & Fungicides	At seeding - 860 kg/ha terbuthylazine (875 g/kg) + 1500 mL/ha fomesafen (240 g/L) + 1 kg/ha propyzamide (500 g/kg) + 500 mL/ha chlorpyrifos (400 g/L) & bifenthrin (20 g/L) 05/08/2021 - 330 mL/ha clethodim (360 g/L) + 180 g/ha butroxydim (250 g/kg) + 500 mL/100mL water non-ionic surfactant 04/10/2021 - 160 mL/ha alpha-cypermethrin (100 g/L)
Harvest date	01/12/2021

Treatments

Treatment #	Seed Source	Seed Treatment	Foliar Fungicide
1	Clean	Thiram + thiabendazole	Early + Podding
2	Clean	Thiram + thiabendazole	Podding only
3	Clean	None	Early + Podding
4	Clean	None	Podding only
5	Infected	Thiram + thiabendazole	Early + Podding
6	Infected	Thiram + thiabendazole	Podding only
7	Infected	None	Early + Podding
8	Infected	None	Podding only

Both clean and infected seed were collected from the same paddock near Mingenew in 2020. Clean seed was taken from a trial which received several fungicide applications and showed no signs of Ascochyta infection. Infected seed was collected from the farmer's crop which showed extensive Ascochyta, including pod lesions.

- Foliar fungicides applied as per treatment schedule:
- 16/06/2021: 875 mL/ha tebuconazole (400 g/L) & azoxystrobin (20 g/L).
- Foliar fungicides applied as blanket applications:
- 30/08/2021: 600 mL/ha prothioconazole (150 g/L) & bixafen (75 g/L)
- 11/10/2021: 875 mL/ha tebuconazole (200 g/L) & azoxystrobin (120 g/L)

A typical Ascochyta leaf lesion. Similar lesions can appear on pods and lead to seed infection.

Table 2: Rating scale used to assess plots for Ascochyta.

Rating	Description
0	No Infection
1	Small lesions – leaf lesion or petiole infection
2	Some stem lesions – Minor stem breakage in upper foliage
3	1-2 branches broken – several girdling stem lesions at the base of branches
4	Large basal stem lesions or several branches broken near to stem
5	Half foliage dead or partly severed
6	More than half foliage dead or dying, young shoots still actively growing from base
7	Most foliage dead, some healthy stem tissue with lateral buds
8	Most foliage dead, no healthy lateral buds in leaf axils
9	Most foliage dead or completely dead

Results

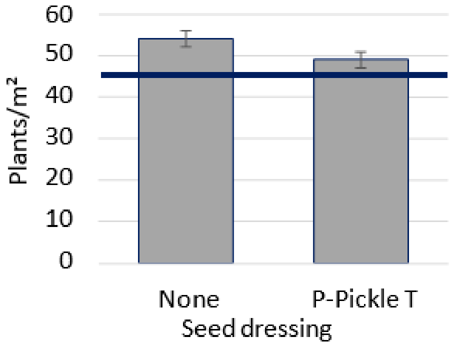


Figure 1: Plant establishment at Dalwallinu in 2021. Seed dressing p = 0.018

Plots that were treated with fungicidal seed dressing established at a lower density than those that were not treated with seed dressing, however both treatments exceeded the target density of 45 plants/m² (Figure 1).

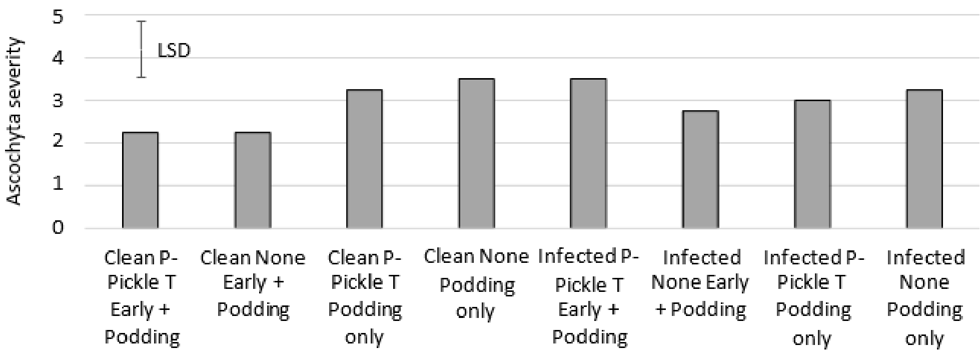


Figure 2: Ascochyta severity at Dalwallinu on 30 September, when the crop was podding. Severity was rated according to the scale in Table 2. Seed source x Seed dressing x Spray p= not significant.

By spring, all treatments in this trial averaged Ascochyta ratings between 2-4 on the scale in Table 2 and there was no difference between any of the treatments (Figure 2). The plots typically showed symptoms that included stem lesions with upper canopy breakage and some branches broken lower on the stem. Within the trial there were hotspots that had considerably more disease, where plants had significant loss of foliage and even occasional plant death. Whilst there was ultimately no difference in the level of Ascochyta between treatments in this trial, there was some trends observed.

The clean seed source showed less disease when both early and podding sprays were applied, compared to the clean seed plots that only got a foliar fungicide at podding. This demonstrates that the early spray did have some effect in holding disease back, even when a supposedly ‘clean’ seed source was used.

Despite the very wet winter in 2021, low levels of disease were seen in this trial until the end of July. Ascochyta grows best at temperatures between 15-25°C. It was likely too cold during the earlier part of the season for the disease to progress. From the middle of August, as temperatures became warmer, disease development was quite rapid, and it became more easily detectable in trial plots. By the end of the season low-moderate levels of disease were seen although there was a lot of variation throughout the trial. Disease was seen even in plots that used clean seed and followed our recommended 2 foliar spray fungicide program. The trial differs from a farmer's crop in that there were plots nearby that were sown with infected seed and received no Ascochyta management at all. These infected plots may have had the opportunity to spread disease in to the 'clean' plots despite our efforts to minimise this by sowing faba bean buffers in between, thus the lack of difference in disease between seed sources in this trial.

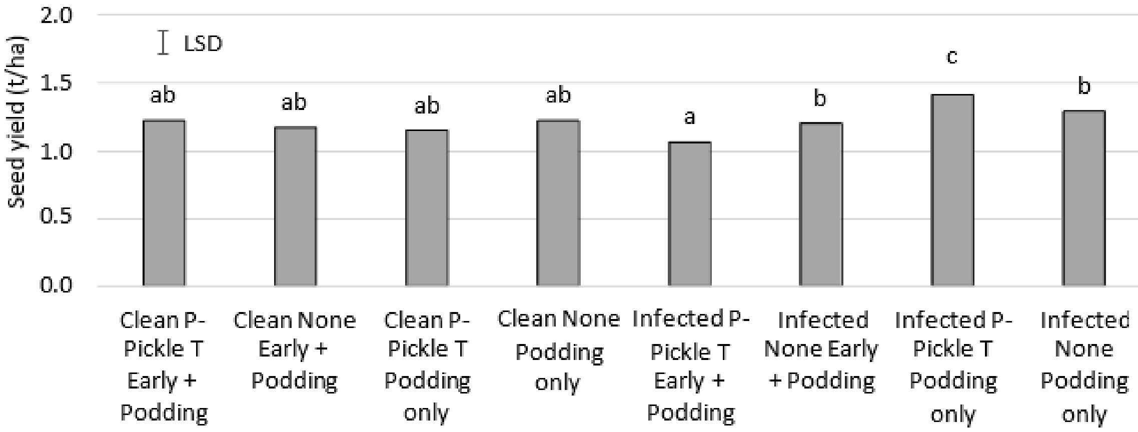


Figure 3: Seed yield (t/ha) from Dalwallinu. Seed source x Seed dressing x Spray p= <0.001. Treatments that share a common letter are not significantly different

As discussed above, there was not a significant difference in disease levels between treatments in this trial, however we did see some minor differences in seed yield (Figure 3). The plots that were sown with Ascochyta infected seed with no seed dressing and only received one foliar fungicide at podding yielded more than any of the other treatments. This is unexpected and could be due to the large variation in disease levels within replicates of the same treatments. If a whole paddock was sown with such a poor Ascochyta management strategy we would expect it to show more disease and yield less than a paddock of certified clean seed sown with a robust fungicide regimen (seed dressing followed by early and podding foliar sprays).

Comments

Ascochyta has the potential to cause very large yield loss in chickpea crops. Foliar fungicides cannot be used to 'cure' an Ascochyta infection, they will only protect new growth from becoming infected, therefore Ascochyta management needs to be a priority for all chickpea growers. Once an infection is established in a crop, regular fungicides may need to be applied to prevent infection spreading up the canopy. As such, keeping disease levels low from the beginning of the season with the critical first steps of using a quality seed dressing and applying a foliar fungicide 4-6 weeks later is key to ensuring that large crop losses do not occur.

We have previously observed that using a seed dressing alone can make a difference to disease levels during the vegetative stage, however it is not enough to hold disease at bay for the season and needs to be followed by foliar fungicide applications. In a similar trial at Mingenew in 2020, a 500kg/ha yield benefit was achieved with a fungicidal seed dressing plus two fungicide spray strategy compared to no foliar fungicides, despite lower-than-average rainfall occurring. This demonstrates the large impact that Ascochyta can have, even in a below average rainfall year.

If you are concerned that your seed source may be contaminated with Ascochyta, it can be tested at an accredited laboratory. Further information on DDLS Seed Testing and Certification and request forms can be accessed at https://www.agric.wa.gov.au/plant-biosecurity/seed-testing.

Acknowledgements

This trial is part of the DPIRD/GRDC co-investment "DAW1903-004RTX: High Value Pulses - Raising awareness, optimising yield and expanding the area of lentil, chickpea and faba bean in Western Australia". Thanks to Salzar Rahman for excellent technical assistance, the Wongan Hills Trial Support Unit for trial management, and Liebe Group and Matthew Hyde for the trial site.

Peer review

Mark Seymour, DPIRD

Contact

Stacey Power

Stacey.power@dpird.wa.gov.au

0472 847 815

Demonstrating the Effects of Reduced Lupin Seed Integrity on Crop Establishment

Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages

- Germination percentages at seeding are variable across the district.
- Growers should aim to harvest lupins when moisture is high and conditions cool.
- Germination percentages can decline significantly between harvest and seeding.

Aim

The aim of this project is to assess the effects of mechanical handling on lupin seed germination quality and crop establishment.

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.

It is widely accepted that manganese (Mn) deficiency is a contributing factor to poor germination due to its expression in lupins as split seed, it is however unclear under what circumstances Mn deficiency is most prevalent and what other factors contribute to this issue. Previous research suggests mechanical damage is considered a likely contributing factor as excessive impact can damage the seed coating, an effect likely exacerbated by grain moisture, harvesting conditions and condition of equipment such as augers.

Farmer Case Studies

In 2020 lupin seed samples were collected from 27 paddocks across the Liebe Group region at different operational timings and germination tests completed by DPIRD seed laboratories. The results showed a large amount of variation across the district, ranging from 50% to 96% germination at seeding time. These tests were repeated in 2021 on six paddocks located in Maya, Wubin, Marchagee, Watheroo, Wongan Hills and Miling. Germination tests were carried out on seed sampled immediately prior to harvest, immediately post harvest, immediately post seed cleaning, pre-seeding after storage and post seeding from the seeder boot. The results (Figure 1) show a range of outcomes, from very little impact on germination at seeding (Miling site), to below DPIRD recommendations of 80% germination rate for seed, at the Watheroo and Marchagee sites, despite starting above 95% germination before harvest. The most dramatic reductions in germination percentage occurred during the harvest operation at Watheroo and Marchagee, and during the seeding operation at Wongan Hills.

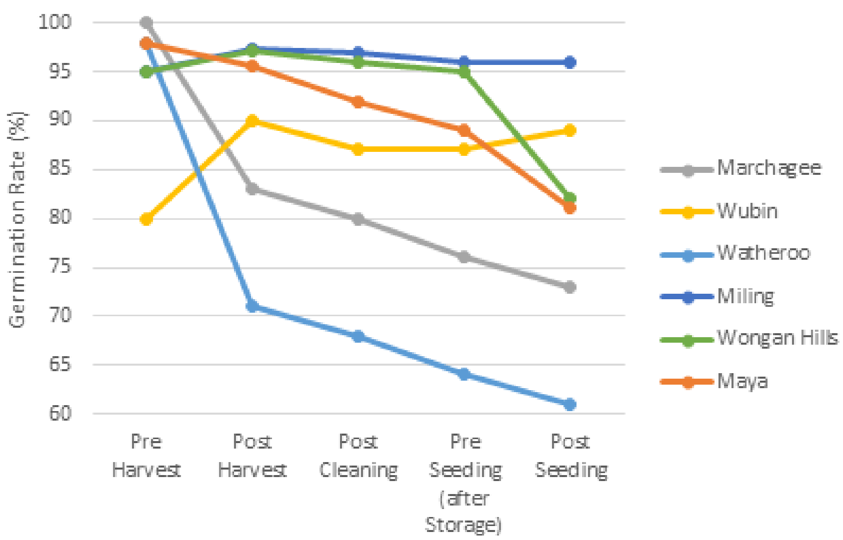


Figure 1: Lupin germination percentages in 2021 at different operational stages across six paddocks in the Liebe Group Region.

Rotor Speed Trial
Five farmer-scale lupin harvest experiments were also conducted during the 2020 harvest period from October-December. At each site, samples were collected from the harvester at three different rotor speeds between 320 and 650rpm. The concave setting was kept consistent. There were 3 replicates of each treatment except for the Watheroo site which was a side by side comparison.

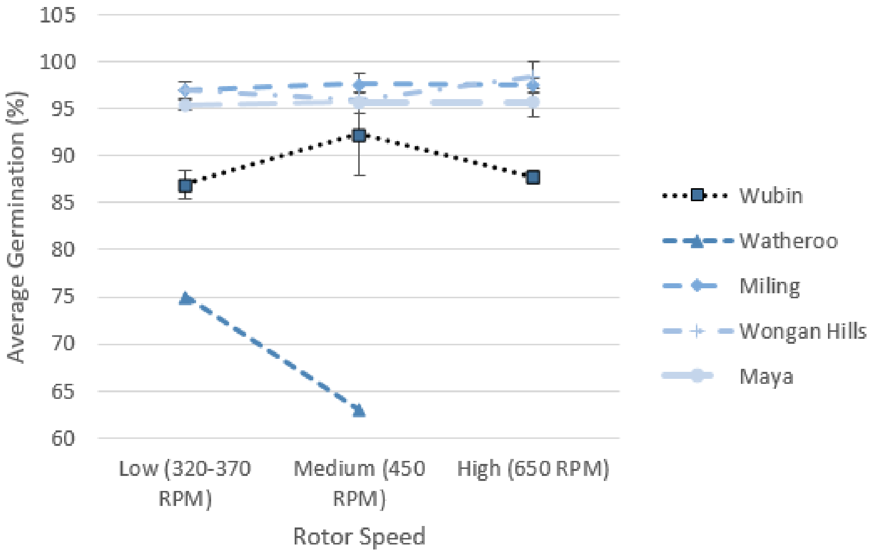


Figure 2: How harvester rotor speed affects average lupin germination rate (%). Error bars are ± 1 S.E. Note Watheroo site is unreplicated.

The Wubin site had observable patches of Mn deficiency that had caused split seed, which may have affected germination rates unevenly across the site and also may have made some plots more susceptible to mechanical damage. The Watheroo site was harvested in late December, and the seed had been impacted by rainfall events by that time (~30mm in November). This may have influenced the overall germination rate and left the seed more prone to damage. There is no indication in this data that increasing rotor speed alone has a negative effect on lupin germination.

Auger Quality Trial
This experiment was conducted in February 2021 using lupin seed harvested in 2020, and looked at the effect the number of auger journeys and auger quality has on lupin germination. Two seed sources were identified, seed source 1 was variety Mandelup from a crop treated with Mn fertiliser, whilst seed source 2 was variety Jurien from a crop without any Mn fertiliser applied. Some slight split seed was visible on seed source 2. Two augers were examined, an old auger with worn blades and a new auger. Seed was put through the augers ten times with a sample collected at the end of each journey.

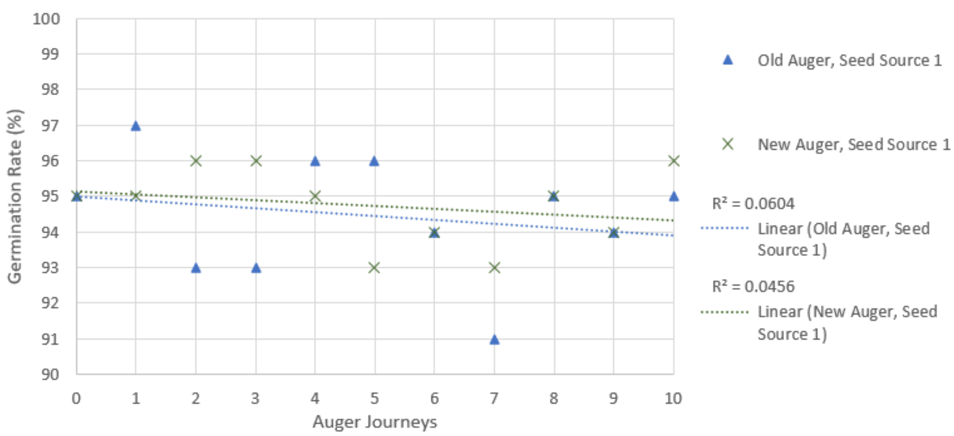


Figure 3: How the number of successive augerings and auger blade wear affect lupin germination rate using seed source 1 (good Mn status).

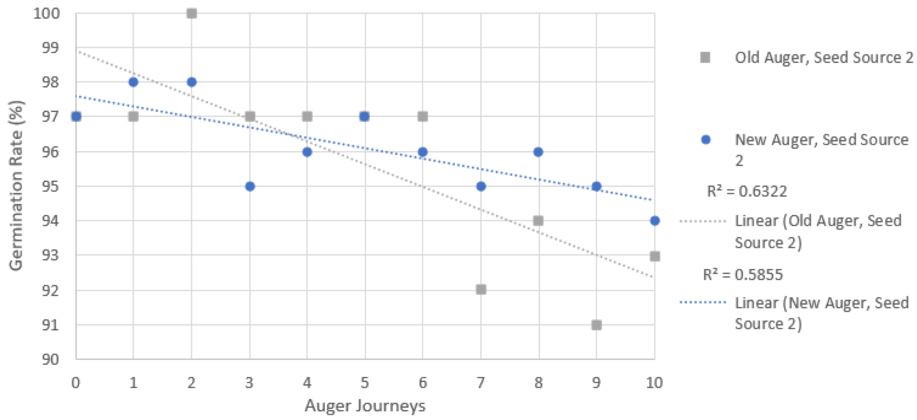


Figure 4: How the number of successive augerings and auger blade wear affect lupin germination rate using seed source 2 (poor Mn status).

Despite the variability in the data, there appeared to be a trend with number of auger journeys and the age and quality of the auger blades particularly in seed source 2. However, all samples returned a germination above 91% which is well within DPIRD recommendations to only sow seed with germination percentage of 80% or above.

Comments

The benchmarking study conducted as part of this project of Liebe members in 2020 showed there was a wide range of germination percentages across the district, with samples taken at seeding time ranging from 50% - 96%. The case studies of six farmers in 2021 again showed a wide range of results at seeding. From the data collected in this project it is difficult to ascertain any causal relationships between specific operations and reduced germination percentage. The most likely explanation is that seed damage is compounded over time by a number of different factors. Further interrogation of the data collected in this and other related projects is required to gain a fuller understanding of the situation.

Best practice lupin handling says to harvest lupins as soon as they are ready, ideally when moisture content first reaches 14%. Lupins are prone to embryo damage through excessive mechanical handling and are especially sensitive to impact if they are dry and brittle. Even if seeds have no visible damage they still may have low germination percentages. DPIRD recommends that seed with germination percentages of below 80% should not be used for sowing (White, French & McLarty, 2008). Germination percentages can be accurately tested by DPIRD and can be worth doing to ensure good germination of retained seed the next year

Acknowledgements

This is a GRDC investment, 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.

References

White, P., French B., and McLarty A., (2008), Producing Lupins, Department of Primary Industries and Regional Development.

Peer review

Bob French, DPIRD

Contact

Liebe Group
research@liebegroup.org.au
08 9661 1907

Increasing the Profitability of the Double Break Rotation Through Incorporation of an Early Sown High Value Pulse

Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages
- Early sown chickpea achieved the highest grain yield (4.4 t/ha) of all treatments.
- The benefit to cereal production will be evaluated in the 2022 season.

Aim
The first part of this trial was to 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 the legume crop was also evaluated in this trial.

The second part of this trial is to 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. However, the short-term decrease in economic return from growing a break crop is likely to be offset by the longer-term benefits of decreased production costs and increased productivity of cereal crops for following seasons.

The most desired traits of a break crop are to be highly effective in controlling weeds and disease while also being highly 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 in 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.

Comparison of early sown (left) v late sown (right) chickpeas, taken mid-August 2021.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu			
Plot size & replication	200m x 18.3m x 1 replication			
Soil type	Medium Clay Loam			
Paddock rotation	2020 Fallow, 2019 Barley, 2018 Wheat, 2017 Field peas			
2021 Crop Type	Scepter Wheat	CBA Captain Chickpea (Early sown)	CBA Captain Chickpea (Late sown)	Twilight Field Pea
Sowing date	17/05/2021	17/04/2021	07/06/2021	07/06/2021
Sowing rate	70 kg/ha	150 kg/ha	150 kg/ha	120 kg/ha
Fertiliser	17/05/2021 - 50 kg/ha MAP Zinc 23/06/2021 - 60 kg/ha Urea	17/05/2021 - 50 kg/ha MAP Zinc	07/06/2021 - 50 kg/ha MAP Zinc	07/06/2021 - 50 kg/ha MAP Zinc
Herbicides, Insecticides & Fungicides	Knockdown 17/05/2021 - 2 L/ha Trifluralin 17/05/2021 - Prosulfocarb 17/05/2021 - Flutriafol 0.4 L/ha 03/07/2021 - Bromoxinil	Data not available		Data not available

Treatments

	Treatments
T1	Cereal Crop – Current grower practice
T2	Chickpea – Early Sown
T3	Chickpea – Late Sown
T4	Field Pea – Late Sown (Standard Practice)

Results

Crop establishment was adequate for all treatments in the trial to allow the crop to fulfil the seasons yield potential (Figure 1). For the break crops evaluated in this trial, the lowest number of weeds were found in the early sown chickpeas while the highest were in the field pea (that were late sown). This was likely due to deceased competition in the late sown treatments that allowed weeds to be more vigorous, while the early sown legumes and wheat treatments achieved canopy closure earlier in the year to shade out weed competition.

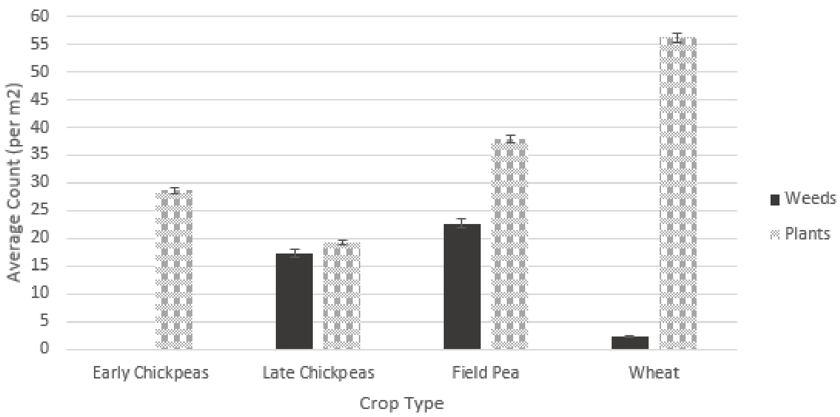


Figure 1: Crop establishment counts by crop type as of GS 30 at double break trial, Dalwallinu, 2021. Error Bars are ± SE

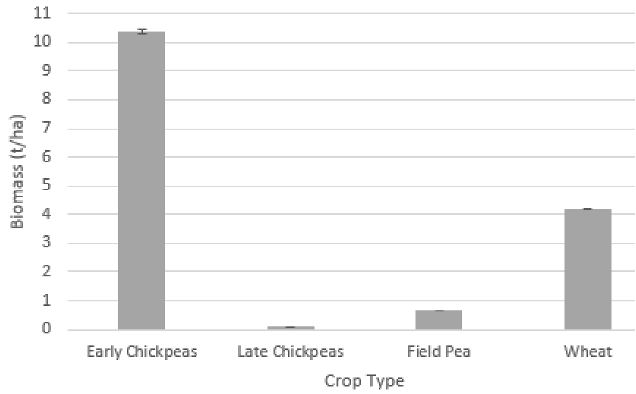


Figure 2: Crop biomass by crop type as of GS 30 at double break trial, Dalwallinu, 2021. Error Bars are ± SE

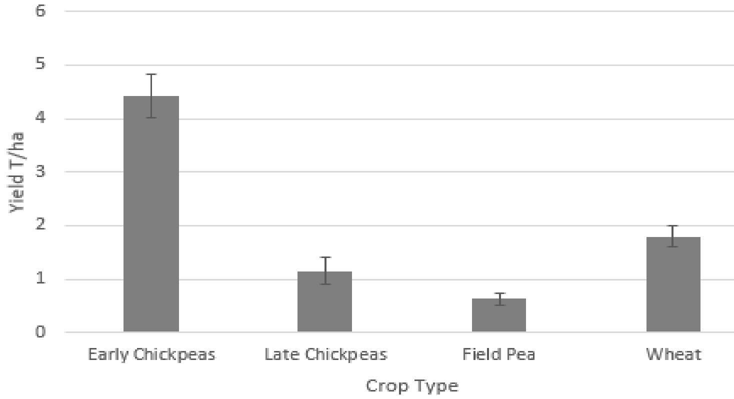


Figure 3: Yield of different crops at double break trial, Dalwallinu, 2021. Error Bars are ± SE

The early sown (17th April) chickpeas had significantly higher biomass compared to all other treatments when measured at the GS 30 growth stage of wheat timing (Figure 2). This was a direct consequence of the early seeding (17th April) for this treatment and good conditions for early growth. The late sown chickpea and field pea had very low biomass at this early stage. The early sown chickpea had the highest grain yield of all treatments in the trial (Figure 3). The grain yield of wheat was reduced by the impact of frost and yielded less than 2 t/ha compared to 4.4 t/ha for the early sown chickpea. The indeterminant flowering pattern of chickpea was likely to have reduced the impact of frost on grain yield compared to wheat.

The combination of high biomass production and low weed numbers in the early seeded chickpea highlights the potential of a double break crop rotation to be highly effective and profitable rotation option. Previous research has shown that the amount of nitrogen fixed by a legume correlates directly to the amount of biomass produced by that legume, minus the amount of nitrogen taken off in the seed. It is likely that much of the nitrogen that was fixed in the season was removed in the high grain yield (4.4 t/ha), but residual nitrogen in the biomass will likely have a positive impact on the following crops as it breaks down and releases nutrients.

In wetter seasonal conditions there is a high risk of Ascochyta infection in chickpea which can severely reduce plant growth and grain yield. This disease was closely monitored at this site but was not detected in this season. As a preventative, one fungicide application at the start of flowering for the early seeded chickpea was completed on the 24th of June.

Acknowledgements
This is a GRDC funded project, WMG2003-001SAX, led by the West Midlands Group, and managed by the Liebe Group. This site is one of four sites across the Wheatbelt that aims to evaluate the crop rotation benefit of a double break crop rotation. Thanks to the Hyde family for their assistance, hosting, implementing and managing the trial. Thank you to Chickpea Breeding Australia (CBA) for providing CBA Captain Chickpea seed for this trial.

Peer Review
Nathan Craig, WMG and Glenn Lendon, NSW DPI

Contact
Liebe Group
research@liebegroup.org.au
08 9661 1907

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

Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages

- In 2021 crop emergence was generally good across all treatments.
- Increasing seed rate did not increase plant establishment and generally had a shallower seeding depth with the exception of the 18 km/hr treatment.
- In other trials across the state, in general, a slower speed rate resulted in deeper and more consistent plantings with better crop establishment.
- Yield was not influenced by seedling depth or density in this season.

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	Boyd Carter Property, Jibberding
Plot size & replication	12m x 200m x 3 replications
Soil type	Sandy loam
Paddock rotation	2021 Canola RR, 2020 Lupins, 2019 Wheat
Sowing date	02/05/2021
Sowing rate	2.5 kg/ha
Fertiliser	02/05/2021 - Flexi N 50 L/ha, Agflow Extra 90 kg/ha 35:35:30 07/05/2021 - FlexiN 45 L/ha 03/09/2021 - Urea 80 kg/ha
Herbicides, Insecticides & Fungicides	07/04/2021 - Para-trooper 1.5 L/ha, Alpha Cypermethrin Due 0.15 L/ha 20/04/2021 - Glyphosate 540 1.2 L/ha, Propyzamide 900 0.55 kg/ha, Ammonium Sulphate 1%, Li700 0.3% 02/06/2021 - Glyphosate 540 1.350 L/ha, Ammonium Sulphate 1%, Li700 0.3% 18/06/2021 - Glyphosate 540 1.2 L/ha, Clopyralid 750 0.06 L/ha, Hasten 0.5%, Li700 0.3%
Harvest date	02/11/2021

Treatments

Treatment	Seed Rate (kg/ha)	Speed (km/hr)
1	1 kg/ha	12 km/h
2	1 kg/ha	15 km/h
3	1 kg/ha	18 km/h
4	2 kg/ha	12 km/h
5	2 kg/ha	15 km/h
6	2 kg/ha	18 km/h

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	6.7	89	110	2.4	8	3	0.05	0.88

Results

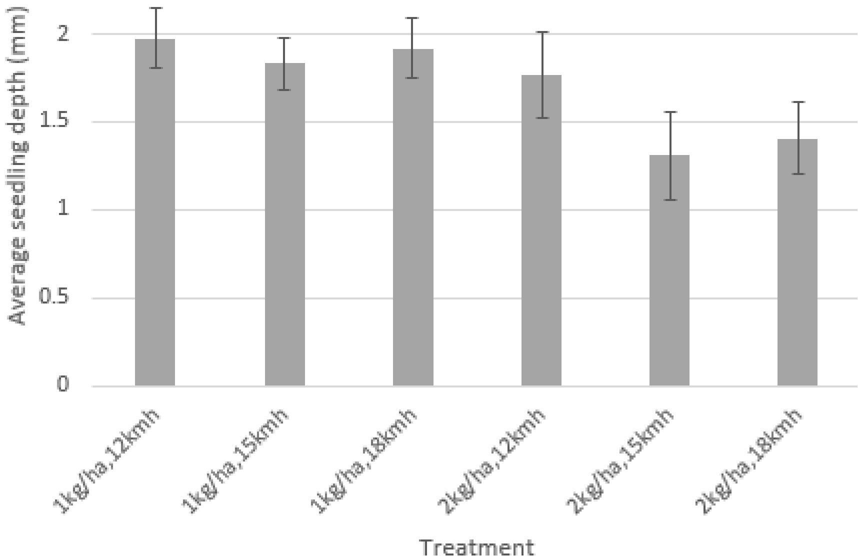


Figure 1: Average seedling depth (mm) on the 27/05/2021 in Canola at the crop establishment trial at Jibberding. Error bars are ± 1 S.E.

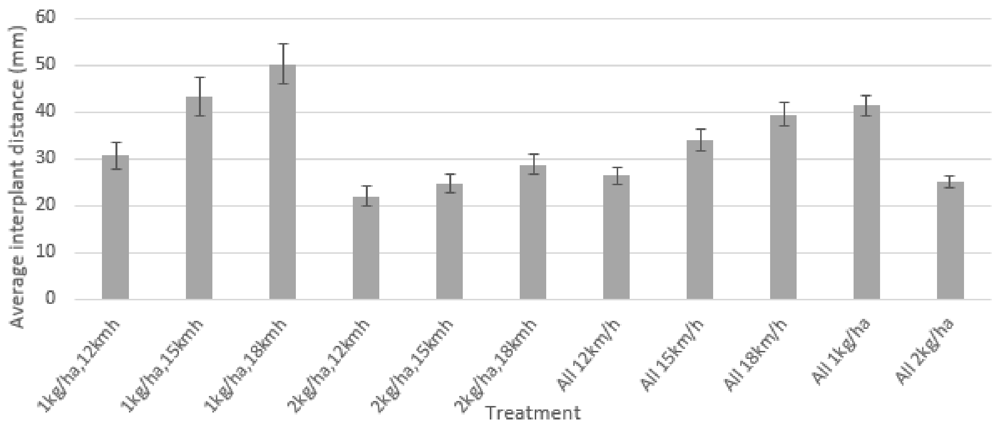


Figure 2: Average interplant distance (mm) taken on 27/05/2021 at the crop establishment trial at Jibberding. Error bars are ± 1 S.E.

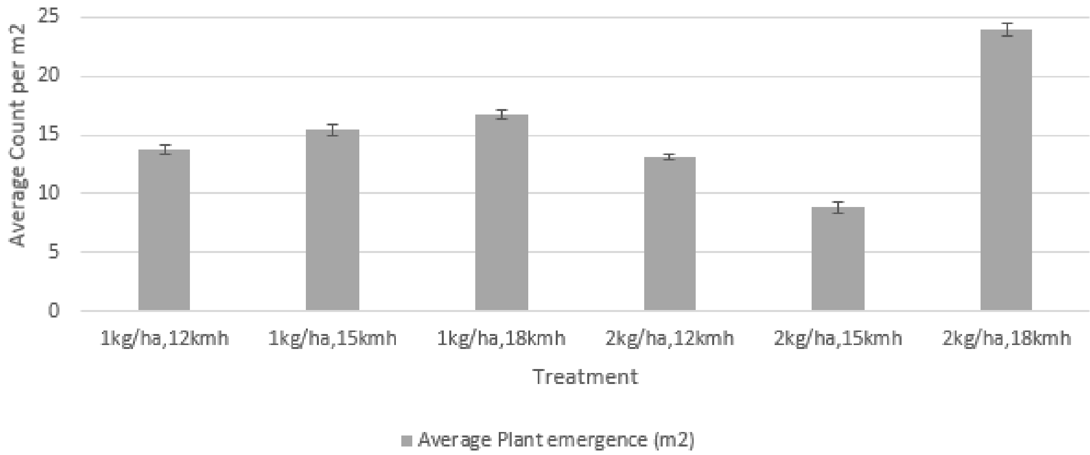


Figure 3: Average crop and weed density (per m^2) taken on 27/05/2021 at the crop establishment trial at Jibberding. Error bars are ± 1 S.E.

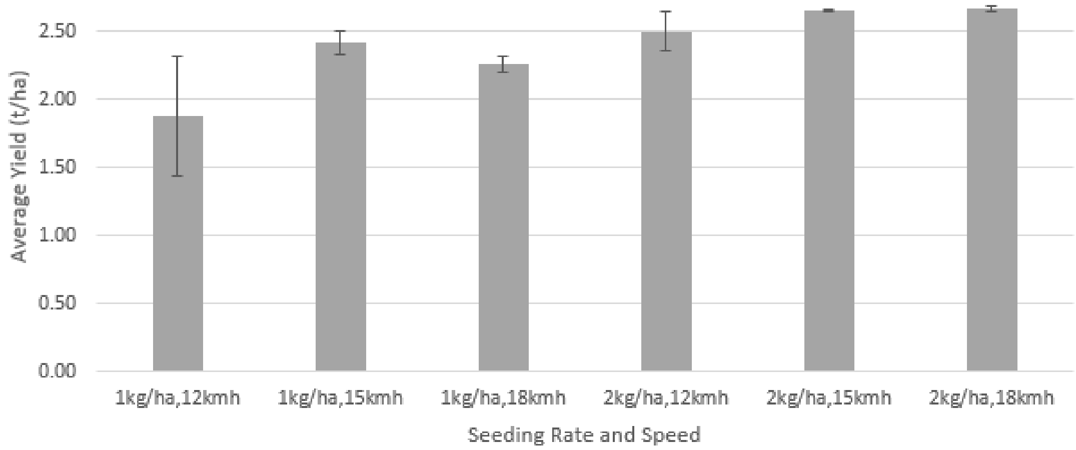


Figure 4: Average yields (t/ha) at the Crop Establishment trial at Jibberding. Error bars are ± 1

Comments

Seasonal conditions appeared to override most of the treatment affects in this trial. There was some indication that shallow seeding resulted in higher plant numbers and that occured at the higher seeding rates but the cause is unknown (Figure 1). There is also some discrepancy on the interplant distance (Figure 2) and plant density (Figure 3) which makes interpretation difficult. There was no significant observable differences in yield between treatments (Figure 4).

In other similar trials across WA over the past three years a slower seeding rate has led to a deeper more consistent seeding depth resulting in better crop establishment. A more even distribution of plants has also seen improvements in yield and weed competition.

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 Boyd Carter for hosting, implementing and managing the trial.

Peer review

David Minkey, WANTFA

Contact

Liebe Group
research@liebegroup.org.au
08 9661 1907

NATIONAL VARIETY TRIALS

Wheat and Pulses National Variety Trials - Liebe Group Main Trial Site, Dalwallinu

Pip Payne, NVT Co-ordinator, Living Farm

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

Location	Main Trial Site, Hyde Proerty, Dalwallinu
Plot size & replication	10m x 1.72m x 3 replications
Soil type	Wheat Sandy loam, Pulses – Loam-loamy clay
Paddock rotation	Wheat 2020 Lupins, Pulses – 2020 Fallow
Sowing date	Wheat - 18/05/2021, Chickpeas, Field Pea & Lentils: 20/05/2021
Sowing rate	Wheat 200 seed/m^2, Chickpeas 45 seed/m^2, Field Pea 55 seed/m^2, Lentils 120 seed/m^2
Fertiliser	Wheat: 18/05/2021 - Urea 100 kg/ha, Macro Pro Extra 130 kg/ha + Impact 02/07/2021 - Flexi N 100 L/ha 05/08/2021 - Flexi N 50 L/ha 122 Units Nitrogen Pulses: At seeding 160 kg/ha Gusto Gold
Herbicides, insecticides & fungicides	Details of chemicals used and rates available at https://nvt.grdc.com.au/trials/results
Harvest date	Wheat 22/11/2021, Chickpeas, Lentils 30/11/2021, Field Pea 08/11/2021

Soil Composition

Depth (cm)	Texture (1 sand,2 sandy loam, 3 loam, 4 loamy clay, 5 clay)	Total Nitrogen (mg/kg)	Phosphorus (mg/kg)	P Test Type	Organic Carbon (%)	pH (water)	pH ($CaCL_2$)	Conductivity (EC) dS/m	ESP (%
	Wheat trial site								
0-10	1.5	23	85	Colwell	1.43	6.9	6.4	0.1	0.37
10-30	1.5	8				6.7	5.9	0.1	1.02
	Pulse trial site								
0-10	3.5	23	24	Colwell	0.87	7.7	6.8	0.1	2.29
10-30	1.5	28				8.3	7.3	0.2	4.8

Wheat Entries

1	16Q2H1857	18	Emu Rock	35	Mace
2	16Q2H1863	19	HammerCL Plus	36	Magenta
3	16Q2H2040	20	IGW6483	37	Ninja
4	16Q2H4391	21	IGW6683	38	RAC2721 (Calibre)
5	Ballista	22	IGW6709	39	Razor CL Plus
6	BSWDH05-233	23	IGW6783	40	RockStar
7	BSWDH05-353	24	IGW8139	41	Scepter
8	Catapult	25	IGW8192	42	Sheriff CL Plus
9	Chief CL Plus	26	Kinsei	43	Sting
10	Cutlass	27	LPB15-0004	44	Supreme
11	Denison	28	LPB17-5691	45	Tungsten
12	Devil	29	LPB17-6157	46	V09063-47-16 (Boree)
13	EDGE12W-011-04	30	LRPB Cobra	47	Valiant CL Plus
14	EDGE16Q-0155	31	LRPB Havoc	48	Vixen
15	EDGE19SA-0178	32	LRPB Nyala	49	Wedin
16	EDGE19SA-1098	33	LRPB Oryx	50	Yitpi
17	EDGE19WB-4112	34	LRPB Trojan	51	Zen

Chickpea Entries		Field Pea Entries		Lentil Entries	
1	CBA Captain	1	GIA Kastar	1	CIPAL1821
2	CBA2041	2	GIA Ourstar	2	CIPAL1921
3	CBA2042	3	GIA2003P	3	CIPAL2121
4	CBA2043	4	GIA2005P	4	CIPAL2122
5	CBA2061	5	Kaspa	5	GIA Leader
6	CBA2141	6	OZP1408	6	GIA1703L
7	CBA2142	7	OZP1901	7	GIA2001L
8	CBA2143	8	OZP1903	8	GIA2002L
9	CBA2144	9	OZP2103	9	GIA2003L
10	Genesis 090	10	OZP2105	10	GIA2004L
11	Genesis 836	11	PBA Butler	11	PBA BLITZ
12	Neelam	12	PBA Gunyah	12	PBA BOLT
13	PBA Maiden	13	PBA Oura	13	PBA HALLMARK XT
14	PBA Slasher	14	PBA Twilight	14	PBA Highland XT
15	PBA Striker	15	PBA Wharton	15	PBA HURRICANE XT
				16	PBA JUMBO2
				17	PBA Kelpie XT

Variety Descriptions

For variety descriptions and information see the 2022 WA Crop Sowing Guide at https://grdc.com.au/resources-and-publications/all-publications/nvt-crop-sowing-guides/wa-crop-sowing-guide

New Varieties

Wheat

Calibre is an AH wheat released by Australian Grains Technologies (AGT) in 2021, which is derived from Scepter with a slightly shorter maturity, similar to Mace. Calibre was included in the WA NVT for the first time in 2020, where it was one of the highest yielding varieties. It has a similar disease package to Scepter with provisional ratings of RMRp for stem and stripe rust, Sp for leaf rust and powdery mildew but a slightly poorer yellow spot rating (MSp) than Scepter. Calibre has a longer coleoptile than Scepter and Mace, similar to Magenta.

Valiant CL Plus is an imidazolinone herbicide tolerant AH wheat released by InterGrain in 2021. Valiant CL Plus was included in the WA NVT for the first time in 2020, in Agzones 2, 3, 5 and 6. InterGrain suggests that Valiant CL Plus has a slower/longer maturity than Cutlass and has provisional ratings of RMRp for stripe rust, MRp for stem rust and MSSp for leaf rust. Valiant CL Plus yields similar to Cutlass and Denison when sown in NVT main season trials and slightly lower than other CL Plus varieties of shorter/quicker maturity in main season sowing times. Valiant CL Plus provides a longer coleoptile length and is a new option for maximising early sowing opportunities in a Clearfield system.

LRPB Avenger is an APW and APWN wheat variety released by Longreach in 2021. LRPB Avenger offers a maturity between Corack and Vixen. LRPB Avenger has been tested in the NVT since 2019, where it out yields Scepter and Mace under tight finishes when yield potentials are<2.5t/ha. Disease ratings are MS for yellow spot and stem rust, MRMS for stripe rust and S for leaf rust, with provisional rating of Sp for powdery mildew. LRPB Avenger has a longer coleoptile length similar to Magenta.

Chickpea
CBA Captain is a desi chickpea with medium seed size and broad adaptation to all desi chickpea- growing areas. It has an erect plant type with good plant height and height to lowest pod. It is early to mid-flowering across Australian chickpea-growing environments with early to mid-maturity. CBA Captain provides a competitive desi option with an erect plant type for western regions. CBA Captain has good grain quality similar to PBA HatTrick and it meets the requirements of a Jimbour-type suitable for the subcontinent market.

Lentil
GIA Leader is a medium seed-size red lentil with IMI tolerance. GIA Leader is a longer season variety best suited to areas with a favourable finish – it has had limited testing in WA. GIA Leader has the best disease resistance package of the IMI lentils. GIA Leader is available from PB Seeds and has an EPR of $5.94/t.

Comments
The interim harvest reports are available at https://nvt.grdc.com.au/trials/results
The final reports including MET (Multi Environment Trial) analysis will be available at the above web site in February/March 2022

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

Contact
Pip Payne, Living Farm
pip@livingfarm.com.au
0439 771 194

Richard Devlin, Living Farm
richard@livingfarm.com.au
0400 123 596

Canola, Barley and Wheat National Variety Trials - Hirsch Property, Latham

Pip Payne, NVT Co-ordinator, Living Farm

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

Location	Hirsch property, Latham
Plot size & replication	10m x 1.85m x 3 replications
Soil type	Canola - Sandy Loam, Barley & Wheat - Sand–Sandy Loam
Paddock rotation	Canola NVT - 2020 Wheat, Barley & Wheat NVT – 2020 Canola
Sowing date	Canola 07/05/21, Barley & Wheat 10/05/2021
Sowing rate	Canola 50 seed/m^2, Barley & Wheat 200 seed/m^2
Fertiliser	Canola: 07/05/2021 - Macro Pro Extra 130 kg/ha, Urea 100 kg/ha 16/06/2021 - SOA 300 kg/ha 02/07/2021 - Flexi N 100 l/ha Barley & Wheat 10/05/2021 - Urea 100 kg/ha, Macro Pro Extra 130 kg/ha + Impact 02/07/2021 - Flexi N 100 L/ha 05/08/2021 - Flexi N 100 L/ha
Herbicides, insecticides & fungicides	Details of chemicals used and rates available at nvtonline.com.au
Harvest date	Canola 26/10/2021, Barley 29/10/2021, Wheat 22/11/2021

Soil Composition

Depth	Texture (1 sand,2 sandy loam, 3 loam, 4 loamy clay, 5 clay)	Total Nitrogen (mg/kg)	Phosphorus (mg/kg)	P Test Type	Organic Carbon (%)	pH (water)	pH ($CaCL_2$)	Conductivity (EC) dS/m	ESP (%)
	Canola								
0-10	2.0	17	38	Colwell	0.76	7.3	6.5	0.076	1.36
10-30	2.5	11				7.8	6.6	0.078	2.13
	Barley & Wheat								
0-10	1.5	11	12	Colwell	0.62	5.2	4.7	0.072	6.13
10-30	2.0	9				5.3	4.8	0.105	4.41

Canola Entries

Glyphosate Tolerant Entries				Triazine Tolerant Entries			
1	AA2568R	10	InVigor R 4520P	1	AFP Cutubury	11	InVigor T 4510
2	AA2571R	11	NCH20Q733	2	AGTC0006	12	NCH19T588
3	AA2572R	12	Nuseed Emu TF	3	AGTC0010	13	NCH19T594
4	AN20LR005	13	Nuseed Raptor TF	4	AGTC0034	14	NCH20T711
5	DG Lofty TF	14	Pioneer 44Y27 (RR)	5	ATR Bluefin	15	PHT-4381
6	Hyola 410XX	15	Pioneer 44Y30 RR	6	ATR Bonito	16	PS-21CT101
7	Hyola Battalion XC	16	PS-21XC316	7	CHYB4372TT	17	PS-21CT102
8	InVigor R 3520	17	PS-21XC318	8	DG1927TT	18	RGT Capacity TT
9	InVigor R 4022P	18	PS-21XC319	9	HyTTec Trident	19	SF Dynatron TT
				10	InVigor LT 4530P	20	SF Spark TT

Barley Entries

1	AGTB0201	9	Cyclops	17	IGB20126	25	Rosalind
2	Alestar	10	EDGE07-8120	18	La Trobe	26	SCA21-Y001
3	Bass	11	EDGE07-8424A	19	Laperouse	27	SCA21-Y002
4	Beast	12	Fathom	20	Leabrook	28	SCA21-Y003
5	Buff	13	IGB1825	21	Litmus	29	SCA21-Y003
6	CA14255088	14	IGB1922	22	Maximus CL	30	Scope CL
7	Commodus CL	15	IGB1944	23	Minotaur	31	Spartacus CL
8	Compass	16	IGB20125	24	RGT Planet		

Variety Descriptions

For variety descriptions see the 2022 WA Crop Sowing Guide at https://grdc.com.au/resources-and-publications/all-publications/nvt-crop-sowing-guides/wa-crop-sowing-guide

New Varieties

GT Canola

Nuseed Emu TF is an early (3) maturity variety, with the TruFlex® trait and has a MRMS blackleg rating. Nuseed Emu TF also has a relatively high oil content, 0.6% above the average of all GT varieties.

Pioneer 44Y30 RR has an early-mid (4) maturity Roundup Ready® (RR) variety with a MR blackleg rating.

DG Lofty TF is an early maturity variety with the TruFlex® trait. As 2021 is its first entry into the NVT, NVT data is not yet available for this variety. Small quantities of seed will be commercially available in 2022.

Hyola Battalion XC has combined GT (TruFlex®) + CL resistance. It is an early maturity variety with an R blackleg rating. It has the additional advantage of handling imidazolinone soil residuals and imidazolinone boom spray contamination as well astwo modes of action for enhanced weed control.

TT Canola

ATR-Bluefin is an early open pollinated TT variety with a compact plant type released by Nufarm.

InVigor® LT 4530P is triazine tolerant (TT) combined with LibertyLink® (LL). Varieties with LibertyLink® are tolerant of Liberty registered herbicide, with the active ingredient glufosinate. LibertyLink® allows in-crop use of a Group 10 herbicide, a new mode of action for Australian broadacre crops. InVigor LT 4530P is an early-mid (4) maturity, with the PodGuard® trait. It has been released by BASF.

RGT Capacity TT is an early-mid (4) maturity TT variety being commercialised by Seed Force. It was among the highest yielding varieties of the early series NVT in 2020 and is moderately susceptible (MS) to blackleg.

Barley

Beast in Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023. Targeted for sowing in low to medium rainfall zones. Beast has been tested in WA barley NVT for two seasons (2019 and 2020). State wide performance was comparable to Rosalind in 2019 and 2020, achieving the same yield in two of every three WA barley NVT. Scald and NFNB (Beecher avirulent) need management as an adult plant.

Buff in Stage Two assessment for malt accreditation in 2021, with the earliest accreditation date being March 2022. Targeted for sowing on soils with an acidic profile in low to medium rainfall zones. Unlike Litmus, it does not have a blue aleurone that is often associated with varieties with Al tolerance. Due to a more consistent yield across a range of soils, Buff supersedes Litmus as it has yielded higher in two out of every three WA barley NVT since 2016. Between Rosalind and Spartacus CL in its state wide yield potential. SFNB, PM and BLR need management.

Commodus CL in Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023. Targeted for sowing in low to medium rainfall zones and lighter soil types. Commodus CL has only been tested in WA barley NVT for one season (2020). State wide performance was marginally below Compass in 2020, with Compass having a slight yield advantage in environments that yielded less than 4t/ha. Commodus CL, like Spartacus CL, possesses the gene conferring tolerance to label application rates of registered IMI products. NFNB (Oxford avirulent) and BLR need management.

Cyclops in Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023. Targeted for sowing in all rainfall zones. Cyclops has only been tested in WA barley NVT for one season (2020). State wide performance was comparable to Rosalind in 2020, with a potential advantage in environments that yield more than 3t/ha. NFNB (Oxford avirulent) and BLR need management.

Laperouse in Stage Two assessment for malt accreditation in 2021, but accreditation has been delayed. The earliest accreditation date is March 2023. Targeted for sowing in medium to higher rainfall areas. Laperouse has been tested in WA barley NVT since 2016. Between Rosalind and Spartacus CL in its state wide yield potential and competitive with Rosalind at sites with a potential above 4 t/ha. NFNB (Oxford virulent) needs management.

Maximus CL Accredited for malting and brewing use in March 2021. Targeted for sowing in all rainfall zones. Maximus CL has been tested in WA barley NVT since 2018. Between Rosalind and Spartacus CL in its state wide yield potential. Maximus CL, like Spartacus CL, possesses the gene conferring tolerance to label application rates of registered IMI products. Later flowering than Spartacus CL when sown in mid-April, but similar when sown in May. NFNB (Oxford virulent) needs management.

Minotaur in Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023. Targeted for sowing in medium to high rainfall zones. Minotaur has only been tested in WA barley NVT for one season (2020). State wide performance is an improvement over RGT Planet in environments that yield less than 4 t/ha, but it has not matched Rosalind in those environments. Scald, SFNB and BLR need management.

Comments

- The interim harvest reports are available at https://nvt.grdc.com.au/trials/results.
- The wheat trial data is quarantined as it was compromised due to frost. The quarantined report will be available next year at https://nvt.grdc.com.au/trials/quarantined-trial-reports
- The final reports including MET (Multi Environment Trial) analysis will be available at https://nvt.grdc.com.au/trials/results in February/March 2022.

Acknowledgements

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

Contact

Pip Payne, Living Farm
pip@livingfarm.com.au
0439 771 194

Richard Devlin, Living Farm
richard@livingfarm.com.au
0400 123 596

WEEDS RESEARCH RESULTS

Mateno® Complete: Control of Grass and Broadleaf Weeds in Cereals

Matt Willis, Market Development Agronomist, Bayer Crop Science

Key Messages

- Mateno Complete is a new herbicide to be released for the 2022 growing season.
- At this site the highest level of annual ryegrass control was achieved by the IBS Mateno Complete treatment, Sakura Flow, and trifluralin followed by an EPE application of Mateno Complete.
- The best control of volunteer canola control at this site were achieved by IBS Boxer Gold + Callisto, and all EPE treatments containing Mateno Complete.

Aim

To demonstrate the annual ryegrass and volunteer canola weed control efficacy and crop safety of a range of herbicides in wheat when used as an Incorporated by Sowing (IBS) or Early Post Emergent (EPE) application.

Background

Mateno Complete is a new herbicide being released to the market by Bayer Crop Science in 2022. It can be applied at either the pre-sowing or early post emergent timing; and controls a number of key grass and broadleaf weeds including annual ryegrass, barley-grass, wild radish and capeweed.

The site was identified in late autumn 2020 to ensure a suitable burden of annual ryegrass, and canola seed was spread pre-sowing to ensure broadleaf weed control could be demonstrated. At the early post-emergent application, 572 plants per m^2 of annual ryegrass and 197 plants per m^2 of volunteer canola was counted in the untreated plots. The spray was applied twenty-six days after seeding on three leaf wheat, when the annual ryegrass and volunteer canola were both at a majority growth stage of two leaf.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	10m x 2.5m x 3 replications
Soil type	Sandy clay loam, pH 4.8
Paddock rotation	2020 wheat, 2019 fallow, 2018 wheat, 2017 wheat, 2016 wheat
Sowing date	21/05/2021
Sowing rate	75 kg/ha Vixen wheat
Fertiliser	21/05/2021 - 120 kg/ha CropBuilder9 (19.2N, 10.44P, 15.6S) 20/07/2021 - 100 kg/ha urea (46N)
Herbicides, Insecticides & Fungicides	21/05/2021 - 2.0 L/ha glyphosate 450 + 0.2% BS1000 + 1% ammonium sulphate 21/05/2021 - as per treatment list (IBS) 16/06/2021 - as per treatment list (wheat Z13, annual ryegrass Z12, canola GS12)
Harvest date	12/11/2021

Treatments

	IBS Treatment	EPE Treatment (Z13)
1	Nil	nil
2	2.0 L/ha trifluralin	nil
3	210 mL/ha Sakura® Flow	nil
4	500 mL/ha Luximax®	nil
5	2.5 L/ha Boxer Gold® + 200 mL/ha Callisto®	nil
6	1.25 L/ha Overwatch®	nil
7	1.0 L/ha Mateno Complete	nil
8	2.0 L/ha trifluralin	750 mL/ha Mateno Complete
9	2.0 L/ha trifluralin	1.0 L/ha Mateno Complete
10	nil	1.0 L/ha Mateno Complete
11	2.0 L/ha trifluralin	3.0 L/ha Boxer Gold
12	2.0 L/ha trifluralin	750 mL/ha Mateno Complete + 700 mL/ha bromoxynil
13	2.0 L/ha trifluralin	3.0 L/ha prosulfocarb + 1.0 L/ha Colt®

Table 1: Herbicide resistance test results for the annual ryegrass at this site from Plant Science Consulting.

Herbicide	Herbicide Group	Paddock Sample St. Bayer 2021	
		Survival	Rating
Trifluralin 2 L/ha	Group D	5	R
Boxer Gold 2.5 L/ha	Group J	0	S
Sakura 118 g/ha	Group K	0	S
Herbicide	**Herbicide Group**	**Paddock Sample Qt, Bayer Late Arg (Liebe 2021 Site), Bayer 0930**	
		Survival	**Rating**
Glyphosate 540@ 2 L/ha	Group M	50	RR
Glyphosate 540@ 2 L/ha	Group M	40	RR
Resistance-rating:			
RRR - indicates plants tested have strong resistance	RR - indicates medium level resistance	R - indicates low-level but detectable resistance	S - indicates no detection of resistance

An annual ryegrass seed sample was taken in October 2020 and sent to Plant Science Consulting to be tested for herbicide resistance. Low level resistance to trifluralin was detected in this population, as was medium level resistance to glyphosate. No resistance was detected to Sakura (pyroxasulfone) or Boxer Gold (prosulfocarb + s-metolachlor).

Results

Table 2: Crop phytotoxicity assessments (both plant discolouration and biomass reduction ratings) taken 20, 35 and 64 days after the early post emergent treatment, and final crop yield. Means followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level). Fb = followed by.

Assessment Date	**06-Jul-21**		**21-Jul-21**		**19-Aug-21**		**12-Nov-21**	
Days after application	**46 DAA, 20 DAB**		**61 DAA, 35 DAB**		**90 DAA, 64 DAB**		**175 DAA, 149 DAB**	
Treatment	**Crop Biom. Red. %**	**Crop Discolour %**	**Crop Biom. Red. %**	**Crop Discolour %**	**Crop Biom. Red. %**	**Crop Discolour %**	**Yield (t/ha)**	**Yield % UTC**
Untreated	0	0	0	0	0	0	1.89^{e}	100.0
Trifluralin	3	0	3	0	0	0	2.01^{de}	106.5
Sakura Flow	3	0	0	0	0	0	2.85^{abc}	151.0
Luximax	9	0	0	0	0	0	1.90^{e}	100.6
Boxer Gold + Callisto	4	0	0	0	0	0	2.57^{b-e}	135.9
Overwatch	0	0	0	0	0	0	2.88^{ab}	152.5
Mateno Complete (IBS)	2	0	0	0	0	0	3.39^{a}	179.7
Trifluralin fb. low Mateno Complete (EPE)	9	10	2	0	2	0	2.63^{bcd}	139.5
Trifluralin fb. high Mateno Complete (EPE)	5	12	0	0	0	0	2.95^{ab}	156.4
Nil fb. high rate Mateno Complete (EPE)	0	8	0	0	0	0	3.09^{ab}	163.8
Trifluralin fb. Boxer Gold (EPE)	8	7	3	0	0	0	2.17^{cde}	114.7
Trifluralin fb. low Mateno Complete + bromoxynil (EPE)	16	18	10	0	5	0	2.38^{b-e}	126.3
Trifluralin fb. prosulfocarb + Colt (EPE)	16	19	8	0	2	0	2.99^{ab}	158.6
					LSD P=.05		0.631	
					Standard Deviation		0.374	
					CV		14.43	

Crop safety was assessed at three timings throughout the season: at 20, 35 and 64 days after the early post emergent herbicide (EPE) application (Table 2). At 20 days after application (20 DAB) crop discolouration was detected in all treatments with an EPE application, and none in treatments with only incorporated by sowing (IBS) treatments. All discolouration levels were considered commercially acceptable, with the highest being 19% discolouration in the trifluralin followed by prosulfocarb + Colt (diflufenican + bromoxynil) treatment, and the lowest being 7% in the trifluralin followed by Boxer Gold treatment. No discolouration was detected by the 35 DAB and 64 DAB assessments.

Crop biomass reduction was also assessed at these timings, with most treatments showing some reduction in biomass relative to the untreated at 20 DAB. Of the IBS only treatments the highest reduction was seen in the Luximax treatment (9%), and the lowest in the Overwatch treatment (0%). In the EPE treatments the highest biomass reduction was 16% in both the trifluralin followed by prosulfocarb + Colt and trifluralin followed by Mateno Complete + bromoxynil treatments. Most treatments had completely recovered by 64 DAB.

Crop yield was also determined at the end of the season (Table 2), and there was a strong correlation between high yield and the treatments that had high levels of control of both weeds. The highest yielding treatment was the IBS Mateno Complete (3.39 t/ha), with high yields also present in the nil IBS followed by high rate Mateno Complete (3.09 t/ha), trifluralin followed by prosulfocarb + Colt (2.99 t/ha), trifluralin followed by high rate Mateno Complete (2.95 t/ha), Overwatch (2.88 t/ha) and Sakura Flow (2.85 t/ha) treatments. The lowest yielding treatments were Luximax (1.90 t/ha) and trifluralin (2.01 t/ha).

Table 3: Annual ryegrass visual control ratings taken 20, 35, 64 and 85 days after the early post emergent treatment, and final annual ryegrass panicle counts in September. Means followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

Assessment Date	**06-Jul-21**	**21-Jul-21**	**19-Aug-21**	**09-Sep-21**		
Days after application	**46 DAA, 20 DAB**	**61 DAA, 35 DAB**	**90 DAA, 64 DAB**	**111 DAA, 85 DAB**		
Treatment	**ARG Control Rating %**	**ARG Control Rating %**	**ARG Control Rating %**	**ARG Control Rating %**	**ARG Panicles per m^2**	**ARG Panicles % UTC**
Untreated	0	0	0	0	480[a]	0
Trifluralin	64	60	55	27	311[ab]	35
Sakura Flow	91	92	89	87	66[cd]	86
Luximax	77	77	68	55	228[bc]	53
Boxer Gold + Callisto	88	78	73	63	186[bcd]	61
Overwatch	75	70	70	58	220[bc]	54
Mateno Complete (IBS)	94	95	93	94	21[d]	96
Trifluralin fb. low Mateno Complete (EPE)	84	83	85	80	83[cd]	83
Trifluralin fb. high Mateno Complete (EPE)	83	87	90	87	76[cd]	84
Nil fb. high rate Mateno Complete (EPE)	69	68	82	80	100[cd]	79
Trifluralin fb. Boxer Gold (EPE)	79	73	63	53	228[bc]	53
Trifluralin fb. low Mateno Complete + bromoxynil (EPE)	86	87	83	82	103[cd]	79
Trifluralin fb. prosulfocarb + Colt (EPE)	85	87	81	79	139[bcd]	71
			LSD P=.05		171.1	
			Standard Deviation		101.5	
			CV		58.95	

Annual ryegrass control was assessed with visual control ratings at 20, 35, 64 and 85 DAB (Table 3). The standalone trifluralin treatment performed very poorly at this site (55% control by 64 DAB and 27% by 85 DAB), which could suggest higher levels of herbicide resistance than what was reported in the herbicide resistance test (which showed only low-level resistance with 5% survival). Of the IBS treatments the best performing products were 1.0 L/ha Mateno Complete (94% at 85 DAB) and 210 mL/ha Sakura Flow (87%). The best EPE treatment was 2.0 L/ha trifluralin followed by 1.0 L/ha Mateno Complete (87%).

Annual ryegrass panicle counts were conducted at 85 DAB, with most numbers aligning closely with the visual assessment. The IBS Mateno Complete treatment reduced panicle numbers by 96% (from 480 to 21 per m^2), the Sakura Flow by 86%, and the trifluralin followed by low and high EPE Mateno Complete by 83% and 84% respectively. The use of a pre-emergent herbicide in combination with an EPE Mateno Complete application was evident, with annual ryegrass panicle control increasing from 79% to 84% with the addition of trifluralin, even in this site where trifluralin efficacy was marginal. The lowest reductions in annual ryegrass panicle numbers were from the standalone trifluralin (35%), Luximax (53%), Overwatch (54%), trifluralin followed by Boxer Gold (53%), and IBS Boxer Gold + Callisto (61%).

Table 4: Volunteer canola visual control ratings taken 20, 35, 64 and 85 days after the early post emergent treatment, and volunteer canola plant counts in July. Means followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

Assessment Date	06-Jul-21				21-Jul-21	19-Aug-21	09-Sep-21
Days after application	46 DAA, 20 DAB				61 DAA, 35 DAB	90 DAA, 64 DAB	111 DAA, 85 DAB
Treatment	**Vol. Canola (plants/ m²)**		**Control %**	**Vol. Canola Control Rating %**	**Vol. Canola Control Rating %**	**Vol. Canola Control Rating %**	**Vol. Canola Control Rating %**
Untreated	144[a]	a	0	0	0	0	0
trifluralin	133[a]	a	8	10	3	0	0
Sakura Flow	18[c]	c	88	73	68	60	30
Luximax	123	a	14	23	17	7	0
Boxer Gold + Callisto	0[c]	c	100	99	99	99	99
Overwatch	35	bc	76	78	60	68	63
Mateno Complete (IBS)	0[c]	c	100	99	99	96	96
Trifluralin fb. low Mateno Complete (EPE)	0[c]	c	100	99	99	99	99
Trifluralin fb. high Mateno Complete (EPE)	1[c]	c	99	99	99	99	99
nil fb. high rate Mateno Complete (EPE)	4[c]	c	97	99	99	99	99
Trifluralin fb. Boxer Gold (EPE)	88	ab	39	40	47	48	35
Trifluralin fb. low Mateno Complete + bromoxynil (EPE)	0[c]	c	100	99	99	99	99
Trifluralin fb. prosulfocarb + Colt (EPE)	0[c]	c	100	99	99	99	99
LSD P=.05	60.2						
Standard Deviation	35.7						
CV	85.09						

Volunteer canola control was assessed with visual control ratings at four timings: 20, 35, 64 and 85 DAB (Table 4). The number of canola plants were also counted in each treatment at 20 DAB. Several treatments achieved complete (99%) control of the volunteer canola: 2.5 L/ha Boxer Gold + 200 mL/ha Callisto (IBS), all three EPE treatments of Mateno Complete, and the trifluralin followed by prosulfocarb + Colt treatment. The IBS Mateno Complete treatment also performed strongly (96%), whilst the IBS Overwatch treatment showed some suppression (63%).

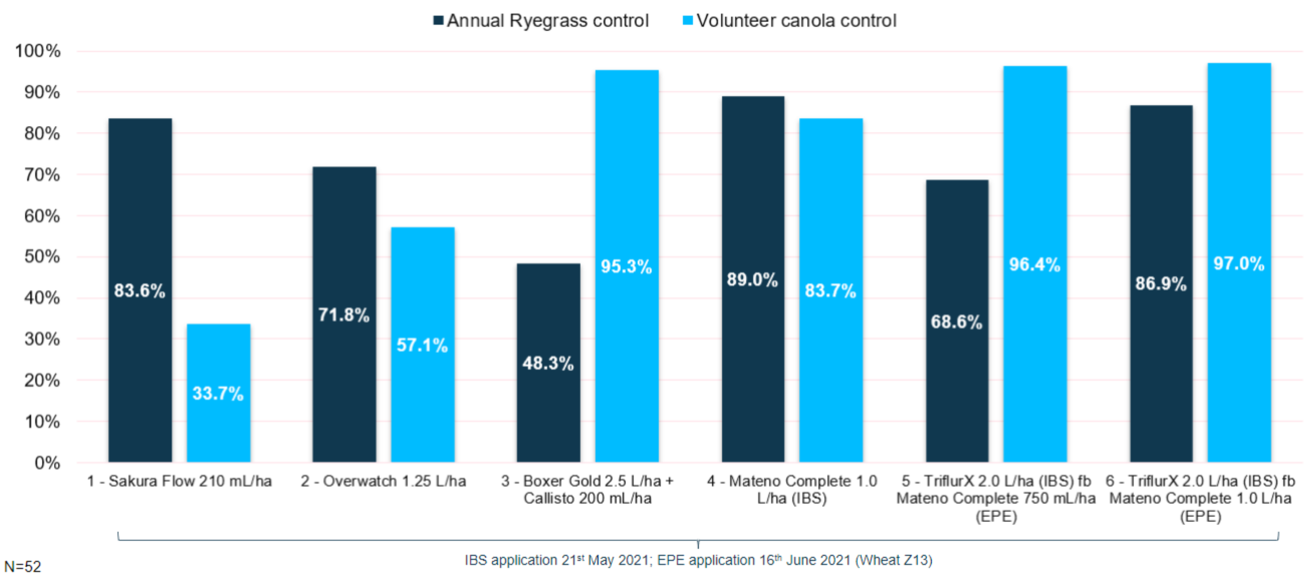


Figure 1: Interactive trial assessment results from the 2021 Liebe Group Spring Field Day summarising visual control ratings for annual ryegrass and volunteer canola from 52 attendees.

During the 2021 Liebe Group Spring Field Day attendees were given the opportunity to blind rate six treatments in the third replicate of this trial for control of annual ryegrass and volunteer canola relative to the untreated. 52 responses were submitted, and the results compiled in Figure 1. Most results were similar to the previously listed results, although annual ryegrass control in Overwatch (71.8% compared to 58%) and annual ryegrass control in trifluralin followed by the low rate of Mateno Complete (68.6% compared to 80%) were noticeably different; although this could be explained by variability between replicates.

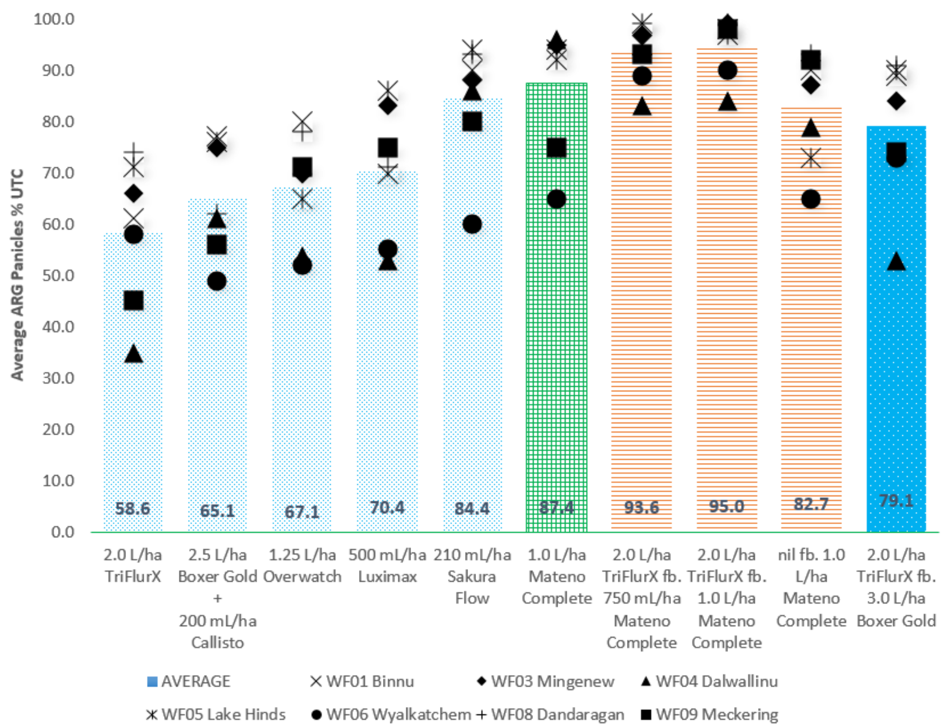


Figure 2: Average annual ryegrass panicle reduction across seven trials in the 2021 season with the same protocol as the trial at the Liebe Group Spring Field Day site.

This trial was conducted by Bayer Crop Science with an identical protocol across seven trials in the northern WA Wheatbelt in 2021, with the other trials in Binnu, Mingenew, Lake Hinds, Wyalkatchem, Dandaragan, and Meckering alongside the Liebe Group trial at Dalwallinu. The graph in Figure 2 summarises the annual ryegrass panicle reduction across these seven trials with a range of soil types and conditions. Relative to the other trials, at the Liebe Group site there was an over performance from the IBS Mateno Complete treatment and an underperformance from the standalone trifluralin, Overwatch, Luximax and all EPE treatments (represented by a triangle in the graph).

Comments

The most challenging aspects of this trial were the glyphosate and trifluralin herbicide resistance, as well as the waterlogging of the site throughout June and July. This meant that some herbicides did not perform as well as they would be expected to under normal conditions. As some small annual ryegrass was present at sowing a knockdown of glyphosate was applied prior to IBS treatments being applied.

Due to herbicide resistance some of these plants survived the knockdown and persisted throughout the season. This was compounded by the trifluralin resistance at the site, which meant that the treatments with trifluralin applied IBS were not able to suppress these weeds effectively. These survivors were present at the application of the EPE treatments, and whereas most annual ryegrass at this timing were only at the targeted two leaf growth stage, the survivors had begun tillering by that point and were too developed for any of the EPE treatments to control them completely.

The waterlogging at this site also meant that some IBS products had much lower residual weed control than would normally be expected. The IBS Boxer Gold, Luximax and Overwatch treatments all provided acceptable levels of annual ryegrass control early in the season, but by the 90 DAA assessments they began to drop away relative to the Sakura, IBS Mateno Complete and all the EPE treatments.

At all other trials using this protocol this season in the northern WA Wheatbelt the trifluralin followed by EPE Mateno Complete treatments consistently demonstrated the highest level of annual ryegrass control (see Figure 2). This is due to it being able to control weeds in the furrow that otherwise would escape an IBS herbicide treatment due to the placement of the herbicide across the entire soil surface, combined with the residual control being moved later into the season.

This trial demonstrates the importance of being aware of the herbicide resistance status of the target weed population and achieving a successful knockdown prior to sowing and to reduce the likelihood of large weed transplants being present at an EPE application with weed growth stage limitations.

The use of early post emergent herbicides such as Mateno Complete, Boxer Gold and prosulfocarb will remain a very important tool for growers to achieve high levels of annual ryegrass control in this region, but growers must understand and appreciate the post-application rainfall requirements and the maximum weed growth stage allowed to do so. Logistical limitations mean that IBS herbicides will remain a critical component of weed control in our cropping systems, of which there are still multiple herbicide options for growers to rotate between to keep annual ryegrass numbers low.

Even so, in combination with an effective pre-emergent grass herbicide like trifluralin or triallate the use of Mateno Complete in an EPE use pattern on small weeds provides the new industry benchmark for annual ryegrass control, whilst also achieving a high level of broadleaf weed control. Given its long residual activity, applying Mateno Complete as early as possible in its EPE use pattern, even before weeds have germinated, will give the most consistent and reliable weed control possible.

Acknowledgements
To Harry, Jane and Matt Hyde for hosting the site, and for the Liebe Group for co-ordinating the event. Also, to SLR Pty Ltd for seeding and maintaining the trial, and to Tristan Clarke (Elders Scholz Rural), Tim Sippe, Jeff Lander and Jonas Hodgson for assisting with assessments.

Peer reviewed
Tristan Clarke, Elders Scholz Rural Dalwallinu

Contact
Matt Willis
matt.willis@bayer.com
0438 516 011

Herbicide x Species Matrix Demonstration

Bevan Addison, Market Development Manager, Adama Australia
Tristan Clarke, Agronomist, Elders Dalwallinu

Key Messages

- The demonstration highlights a range of pre sowing, early post- em and knockdowns across a range of crop species.
- Good coverage of annual ryegrass emerged enabling assessments to be taken. There were minimal broadleaf weeds or other grasses, hence no ratings of other weeds were undertaken.
- Group G spikes can add additional control to broaden spectrum and increase brownout of a range of weeds/ volunteer crops.

Aim

This demonstration is designed to showcase the effect of several different herbicide treatments across a range of crop types. It is non-replicated but showcases the likely effects, with some herbicides safe on the various crops and some herbicides controlling the crops, as would be the case if they were self-sown weeds. This type of demonstration is designed to provide a very interactive experience and open discussion of the options available to growers.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	2.5m crop types cross sprayed with 2m boom. Non-replicated
Soil type	Heavy red loam
Paddock rotation	2021 wheat, 2020 wheat, 2019 fallow
Sowing date	20/05/2021
Sowing rate	Sceptre Wheat 85 kg/ha, Spartacus Barley 80 kg/ha, Hyola 530 XT Canola 3 kg/ ha, RM4 Vetch 40 kg/ha, Bendock Faba Beans 150 kg/ha, Jurien lupins 100 kg/ha, Wharton Field peas 100 kg/ha and Sub Clover 7 kg/ha.
Fertiliser	All treated with Macro-Pro extra @ 100 kg/ha (9.7N, 11.2P, 11.2K,10.2S, 0.1CU, 0.2Zn) and wheat, barley and canola 100 kg/ha Urea (46N)
Herbicides, Insecticides & Fungicides	As per below treatment list. IBS – 20/05/2021 EPE 02/07/2021 - (RH 48%, 16°C, clear skies and good soil moisture). LPE 30/08/2021 - (RH 48%, Temperature 16°C, clear skies and good soil moisture)
Growth stage	EPE application - Cereals; early tillering, canola and clover; 4-6 leaf, faba beans and lupins; 8-10 leaf, field peas; 6-8 leaf, vetch; 4 internodes main stem, ryegrass; 2 leaf – early tillering

Pre and early post-em Treatments

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clover Field peas Lupins Faba beans Vetch Canola Barley Wheat	UTC	Ultro 1100g	Ultro 1700g	Propyzamide 560g	Tenet 1000mL	Tenet 1500mL	Ultro 1100g + Simazine 800g	Terbuthylazine 1000g	Ultro 1100g + Terbuthylazine 1000g	Ultro 1100g + Spinnaker 70g	Ultro 1100g + Reflex 1000mL	Raptor 45g + Wetspray 0.2%	Bonanza Elite (DFF) 150mL	Mentor (Metribuzin) 150g + Bonanza Elite 125 mL	Priority 25mL + Uptake 0.5%	Quadrant 1000mL	Quadrant 1000mL + Priority 25mL + Wetspray 0.2%	Clopyralid 120g	Metsulfuron 5g + Wetspray 0.2%	Zulu XT 500mL + Priority 25mL + Uptake 0.5%

Knockdown Treatments

Species	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Clover Field peas Lupins Faba beans Vetch Canola Barley Wheat	Roundup Ultramax 1.4L fb Spraytop 330 @ 2L	Voraxor 100ml + Hasten 1%	Voraxor 200ml + Hasten 1%	Terrad'or 20g + Hasten 1%	Terrad'or 40g + Hasten 1%	Sharpen 17g + Hasten 1%	Sharpen 34g + Hasten 1%	Butafenacil 100ml + Hasten 1%	Hammer (Carfentrazone) 25ml	Flagship 400 250ml + Uptake 0.5%	UTC	Roundup Ultramax 1400ml	Spraytop 330 2000ml	Roundup Ultramax 1400ml + Terrad'or 20g + Hasten 1%	Spraytop 330 2000ml + Terrad'or 20g + Hasten 1%

Results/Comments

It is important to recognise that results presented in a matrix trial such as this only provide an indication of the results likely to occur in field. They are extremely small plots of 2 x 2.5 m and non-replicated so should be used as a guide only. Results are presented separately for the in-crop herbicides and the knockdown treatments.

The pre sowing and early post-em treatments are presented as a matrix with ratings representing percentage control (or biomass reduction) of the treatment on any given species.

While annual ryegrass was not seeded, it was distributed evenly across the site. It was rated visually across the range of seeded crop types and given an aggregated rating and is presented as a species although not sown as per other crop types.

Initial ratings on ryegrass control and cereal crop effects were undertaken on 02/07/21 (43 DAA) at the time that the early post emergence spray was applied (Table 1).

Annual ryegrass control by Ultro and Propyzamide and mixes involving these products was generally good and in excess of 80% at this early assessment. Tenet (Metazachlor) was also performing well in terms of ryegrass control. Ryegrass control from terbuthylazine was well behind the other three products.

The surprising thing in this site is the lack of crop effect from some of these herbicides on the wheat and barley. Many trials over the years have shown severe effects, particularly from ultro on the cereal crops.

Table 1: Control ratings 2/7/21 (43 DAA).

Species	Herbicide Treatments										
Barley	0	30	60	30	40	55	50	30	50	50	55
Wheat	0	70	80	55	75	75	60	40	60	60	65
Annual Ryegrass	0	85	95	85	90	90	80	30	85	80	85
Application	Immediately pre sowing (A)										
	UTC	Ultro 1100g	Ultro 1700g	Propyzamide 560g	Tenet 1000mL	Tenet 1500mL	Ultro 1100g + Simazine 800g	Terbuthylazine 1000g	Ultro 1100g + Terbuthylazine 1000g	Ultro 1100g + Spinnaker 70g	Ultro 1100g + Reflec 1000mL

A second rating was undertaken on 9th September. This was 112 DAA of the pre sowing herbicides and 69 days after the early post emergence application (Table 2). At this later stage there was either some regrowth from the pre sowing herbicides or later germinations however the ryegrass control provided by Ultro and Ultro mixes held on and provided the highest levels of control overall.

The newly released product Priority (200 g/L Florasulam) provided a very high-level control of grain legumes, sub clover and canola. This compared well with Clopyralid which provided a high level of control of grain legumes but is safe on canola.

Some of the crop safety ratings of grain legumes with Ultro, Tenet, Propyzamide and Terbuthylazine were surprising and are not representative of the high levels of crop safety seen in replicated trial work over multiple years and, in the case of propyzamide, millions of hectares of commercial use over many years. Remember, all observations in this instance came from a very small area 10m x 25m with no understanding of history of that particular area.

Table 2: Control ratings 112 days after pre sowing and 69 days after post-em applications.

Species	Herbicide Treatments																			
	UTC	Ultro 1100g	Ultro 1700g	Propyzamide 560g	Tenet 1000mL	Tenet 1500mL	Ultro 1100g + Simazine 800g	Terbuthylazine 1000g	Ultro 1100g + Terbuthylazine 1000g	Ultro 1100g + Spinnaker 70g	Ultro 1100g + Reflec 1000mL	Raptor 45g + Wetspray 0.2%	Bonanza Elite (DFF) 150mL	Mentor (Metribuzin) 150g + Bonanza Elite 125 mL	Priority 25mL + Uptake 0.5%	Quadrant 1000mL	Quadrant 1000mL + Priority 25mL + Wetspray 0.2%	Clopyralid 120g	Metsulfuron 5g + Wetspray 0.2%	Zulu XT 500mL + Priority 25mL + Uptake 0.5%
Application	Immediately pre sowing (A)											Early post em (B)								
Clover	0	0	0	0	0	20	20	20	10	20	0	10	10	80	100	80	95	100	99	100
Field peas	0	0	0	5	35	30	10	20	10	5	5	5	0	5	100	50	97	90	85	100
Lupins	0	15	25	10	30	50	20	20	20	30	0	40	0	70	100	100	100	90	50	98
Faba beans	0	20	45	25	20	60	25	5	5	5	0	5	0	35	90	75	90	95	60	80
Vetch	0	5	30	0	10	40	5	0	15	15	15	30	10	15	100	15	100	100	100	100
Canola	0	0	0	0	0	10	0	0	0	60	50	100	50	60	100	100	100	0	97	100
Barley	0	20	60	30	50	50	20	30	30	30	35	45	0	0	0	0	0	0	0	0
Wheat	0	50	80	35	50	60	20	30	10	30	35	95	0	5	0	0	0	0	0	0
Annual Ryegrass	0	80	90	65	75	80	90	45	90	70	90	30	0	30	0	0	20	0	0	0

Annual ryegrass is the major weed of interest, so ryegrass weed control was examined separately and presented as control over time at the two different rating timings to give a clearer picture of ryegrass control by pre seeding herbicides (Figure 1).

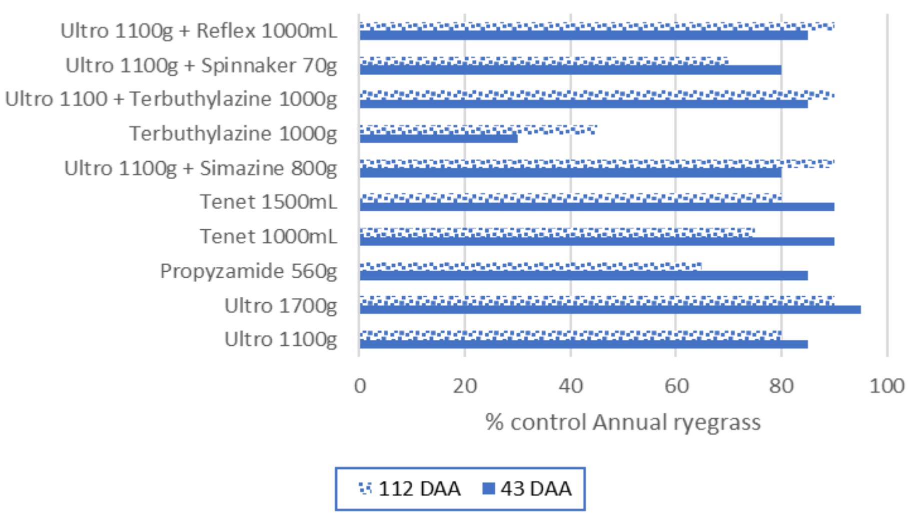


Figure 1: Annual ryegrass control 43 and 112 days after pre sowing applications.

Ultro treatments provided the best overall control over the longer term of the trial. This is commonly seen in trial work and is often reflected in reduced panicle counts compared to other treatments which may do well in the short term but do not have the extended control.

Tenet (Metazachlor) provided reasonable control at this site and over time it has been shown to perform relatively better on a more medium soil type such as this one. There can be some canola crop safety risks at the higher rates on lighter sandy soils, especially where furrow fill is an issue. As shown on these better soil types, rates of 1500mL gave no real crop effect and good weed control so provide a viable alternative for ryegrass control in canola.

Grain legume control can often be difficult to control when they emerge as self-sown weeds in crop, so some key products have been selected for comparison of performance on difficult to control legume species.

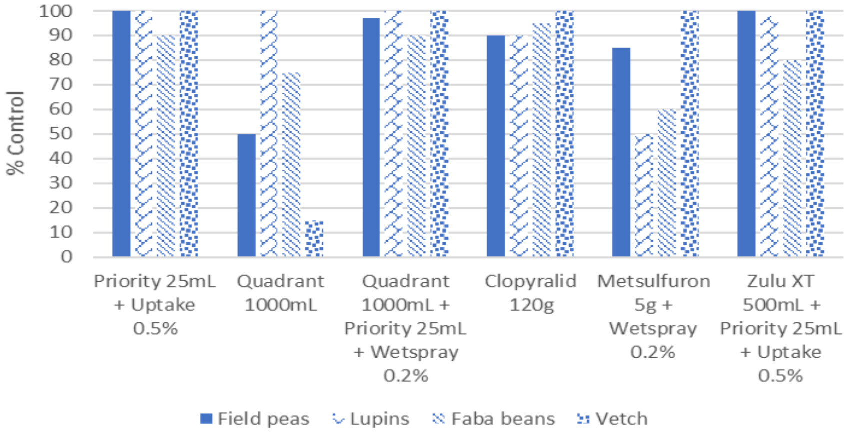


Figure 2: Grain legume control 69DAA.

The new low residual group B herbicide Priority (Florasulam 200g/L) performed well across the range of grain legumes. This is one of its key strengths although it does have 54 labelled weeds for control or suppression. It performed similarly to the long held standard Clopyralid however this is being used less and less due to long soil residues for carryover crops and residues in plant material such as hay crops. Priority also has the benefit of controlling in crop non Imi tolerant canola.

Metsulfuron is often used as a less expensive alternative or spike in situations with self-sown legumes in crop however as can be seen in Figure 2, this can also struggle at times. All these products had excellent cereal crop safety.

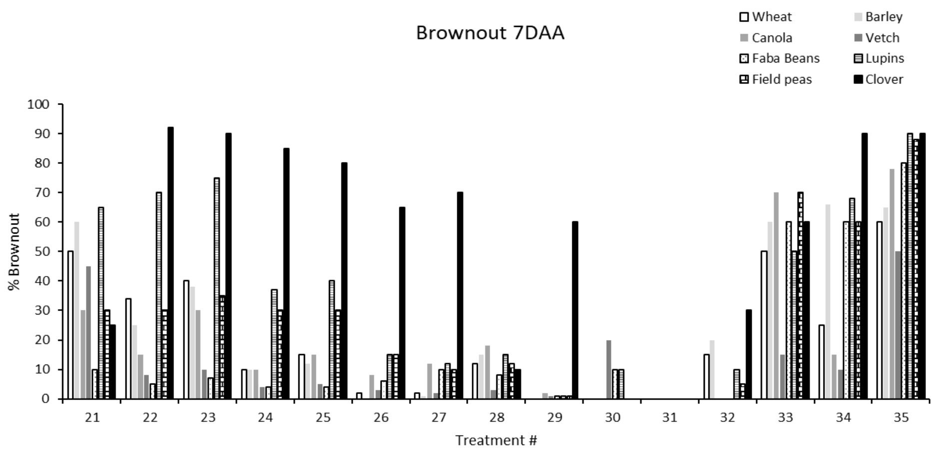


Figure 3: Brownout assessment 7 DAA

Group G spikes when applied alone provided good brownout of the broadleaf crop types in the trial however showed their weaknesses on the cereal crops (Figure 3). Some of the newer generation Group G's that have grass activity in voraxor and terrad'or (Trt 22-25) showed increased level of activity on the ryegrass in the trial as well as wheat and barley while demonstrating exceptional speed of brownout over all other crop types. When compared to the likes of sharpen and butafenacil these treatments showed increased speed of brownout and overall control. Combinations of terrad'or and paraquat provided the highest level of brownout after 1 week with almost complete control within a very short period. This is a good option for growers who are requiring quick brownout of a range of weeds with the group G complementing the paraquats weakness in BLW control as seen in the lower overall brown out of solo paraquat treatment (33). Adding terrad'or to the roundup treatment (34) increased speed of brown out and aided in overall control earlier when compared to standalone roundup (32).

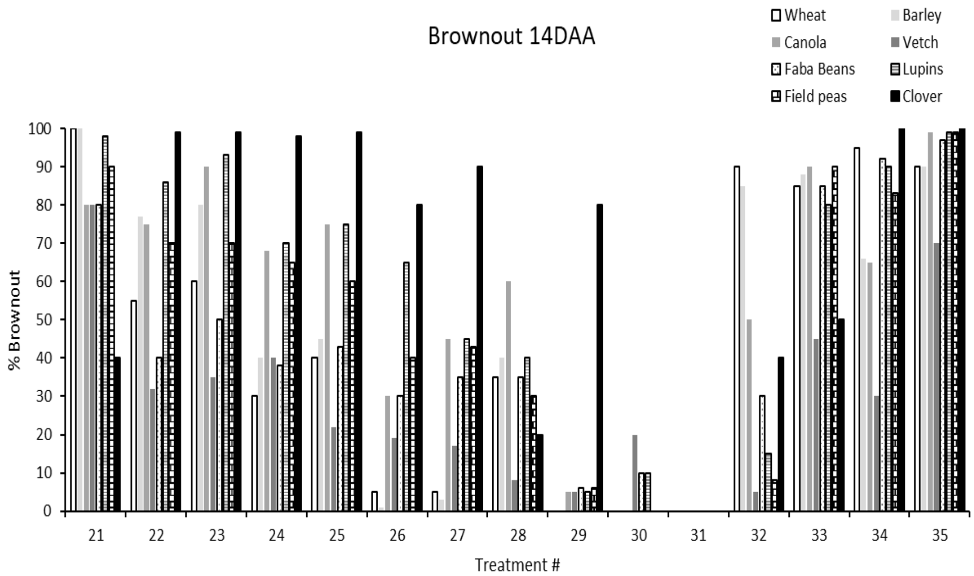


Figure 4: Brownout assessment 14 DAA.

14 days after application the standout treatments included the double knock (21) as well as both Glyphosate + terrad'or and Paraquat + terrad'or (34 & 35). All three of these treatments proved to control all crop types well and provided exceptional brownout (Figure 4). Slower acting Group G spikes began to catch up but were struggling with consistency across the spectrum of weeds present.

Adding a spike to knockdown brews was shown to be an effective way of getting additional activity on a broad range of target weeds without the need for multiple passes over a paddock.

Acknowledgements
Thank you to the Hyde family for hosting the Liebe Group trial site and seeding the trial.

Peer review
Shannon Meyer, Elders Coorow

Contact
Bevan Addison
bevan.addison@adama.com
0427422852

Tristan Clarke
Tristan.clarke@elders.com.au
0417253586

Investigation in Host Crop Safety of Propyzamide Applied PSPE and Post-Emergent to Field peas

Nathan Moyes, National Technical Manager, and Jeremy Samson, Technical Agronomist, Imtrade CropScience

Key Messages

- Caution to field peas post sowing pre-emergent Propyzamide applications with attention to seeding details especially if accompanied by heavy rainfall after seeding or transient water logging.
- Phytotoxic damages observed on field peas treated post sowing pre-emergent eventually fully recovered.
- No host crop safety effects were observed in this trial with post-emergent (field pea 6-Leaf) Propyzamide applications

Aim

To investigate host crop safety of Propyzamide when applied post sowing pre-emergent (PSPE) and post-emergent in field peas.
To experiment with post sowing (i.e. PSPE and PE) applications of propyzamide to lengthen residual and improved overall annual ryegrass control in field peas.

Background

This trial was conducted to show to growers the potential different use patterns and safety considerations for Propyzamide used in PSPE and post-emergent applications. Propyzamide is a Group D herbicide, absorbed through shoots and roots, with its specific mode of action preventing cell division, inhibiting root growth in certain monocots weeds. Propyzamide is very reliant on soil moisture and lowering soil temperature. Imtrade Edge 900 WG currently is only registered in Field peas as an IBS application at 0.55 – 1.1 kg/ha.

In this trial Propyzamide was applied at low label, high label and 2x high label rates, at PSPE and post-emergent timings, with two different Propyzamide formulations. Overall crop biomass and crop phytotoxicity were assessed in this trial.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	10m x 2m x 3 replications
Soil type	Red Clay Loam
Paddock rotation	2020 wheat, 2019 wheat, 2018 wheat
Sowing date	08/06/2021
Sowing rate	115 kg/ha Field peas
Fertiliser	100 kg/ha MacroPro Extra at seeding (12.6 kg N, 14.6 kg P, 14.6 kg K, 13.3 kg S)
Herbicides, Insecticides & Fungicides	N/A

Treatments

	Product	Active - Application Timing	Rate (kg/ha)
1	Untreated Control		
2	Edge 900 WG	Propyzamide - PSPE (Low 1x rate)	0.55 kg/ha
3	Edge 900 WG	Propyzamide - PSPE (High 1x rate)	1.1 kg/ha
4	Edge 900 WG	Propyzamide - PSPE (2x rate)	2.2 kg/ha
5	Dev. Product WG	Propyzamide - PSPE (Low 1x rate)	0.56 kg/ha
6	Dev. Product WG	Propyzamide - PSPE (High 1x rate)	1.1 kg/ha
7	Dev. Product WG	Propyzamide - PSPE (2x rate)	2.2 kg/ha
8	Edge 900 WG	Propyzamide – Post Emergent 3-Node, 6 leaf stage (Low 1x rate)	0.55 kg/ha
9	Edge 900 WG	Propyzamide - Post Emergent 3-Node, 6 leaf stage (High 1x rate)	1.1 kg/ha
10	Edge 900 WG	Propyzamide - Post Emergent 3-Node, 6 leaf stage (2x rate)	2.2 kg/ha
11	Dev. Product WG	Post – Crop stage 3-Node, 6 leaf stage	0.56 kg/ha
12	Dev. Product WG	Post – Crop stage 3-Node, 6 leaf stage	1.1 kg/ha
13	Dev. Product WG	Post – Crop stage 3-Node, 6 leaf stage	2.2 kg/ha

Edge 900: Propyzamide 900 g/kg
Dev. Product: IMTRADE Development Product

PSPE applied 11th June, post-emergent applied 8th July (Field peas 3-node, 6-leaf stage) Field peas.

Results

Table 1: Field peas Biomass – mean %.

No.	Formulation	App. rate (kg/ha)	14 DAA 1 25-Jun-21	27 DAA 1 8-Jul-21	13 DAA 2 21-Jul-21	27 DAA 2 4-Aug-21	63 DAA 2 9-Sep-21
1	Untreated	0	100.0	100.0[a]	100.0[a]	100.0[a]	100.0
2	Edge 900 PSPE	0.55	100.0	100.0[a]	98.3[a]	100.0[a]	100.0
3	Edge 900 PSPE	1.1	100.0	95.0[ab]	91.7[c]	95.0[ab]	100.0
4	Edge 900 PSPE	2.2	100.0	90.0[b]	86.7[d]	88.3[cd]	100.0
5	Dev. Product PSPE	0.55	100.0	98.3[a]	100.0[a]	98.3[ab]	100.0
6	Dev. Product PSPE	1.1	100.0	96.7[a]	95.0[b]	93.3[bc]	100.0
7	Dev. Product PSPE	2.2	100.0	90.0[b]	83.3[e]	85.0[d]	100.0
8	Edge 900 Post	0.55	100.0	100.0[a]	100.0[a]	100.0[a]	100.0
9	Edge 900 Post	1.1	100.0	100.0[a]	100.0[a]	100.0[a]	100.0
10	Edge 900 Post	2.2	100.0	100.0[a]	100.0[a]	100.0[a]	100.0
11	Dev. Product Post	0.55	100.0	100.0[a]	100.0[a]	100.0[a]	100.0
12	Dev. Product Post	1.1	100.0	100.0[a]	100.0[a]	100.0[a]	100.0
13	Dev. Product Post	2.2	100.0	100.0[a]	100.0[a]	98.3[ab]	100.0
		P value	ana	<0.001	<0.001	<0.001	ana
		LSD	ana	5.12	3.12	6.18	ana

DAA- Days After Application

Table 2: Mean visual Phytotoxicity to field peas.

No.	Treatment	App. rate (kg/ha)	14 DAA 1 25-Jun-21	27 DAA 1 8-Jul-21	13 DAA 2 21-Jul-21	27 DAA 2 4-Aug-21	63 DAA 2 9-Sep-21
1	Untreated	0	0.0	0.0	0.0[a]	0.0[a]	0.0
2	Edge 900 PSPE	0.55	0.0	0.0	0.0[a]	0.0[a]	0.0
3	Edge 900 PSPE	1.1	0.0	0.0	3.3[ab]	3.3[bc]	0.0
4	Edge 900 PSPE	2.2	0.0	0.0	6.7[bc]	3.3[bc]	0.0
5	Dev. Product PSPE	0.55	0.0	0.0	0.0[a]	1.7[ab]	0.0
6	Dev. Product PSPE	1.1	0.0	0.0	1.7[a]	3.3[bc]	0.0
7	Dev. Product PSPE	2.2	0.0	0.0	8.3[c]	5.0[c]	0.0
8	Edge 900 Post	0.55	0.0	0.0	0.0[a]	0.0[a]	0.0
9	Edge 900 Post	1.1	0.0	0.0	0.0[a]	0.0[a]	0.0
10	Edge 900 Post	2.2	0.0	0.0	0.0[a]	0.0[a]	0.0
11	Dev. Product PSPE	0.55	0.0	0.0	0.0[a]	0.0[a]	0.0
12	Dev. Product PSPE	1.1	0.0	0.0	0.0[a]	0.0[a]	0.0
13	Dev. Product PSPE	2.2	0.0	0.0	0.0[a]	0.0[a]	0.0
		P value	ana	ana	<0.001	<0.001	ana
		LSD	ana	ana	3.46	2.43	ana

DAA – Days After Application
ana = analysis not applicable

Only PSPE treatments significantly affected field pea crop biomass where inhibition was observed at up to two months after PSPE treatment applications (Table 1). They started to recover after this period. This biomass inhibition was due to seeding conditions, seeding depth and furrow fill and significant rainfall causing some more distinct herbicide damage to the crop in some rows. There was no biomass reduction observed with post emergent applications indicating greater safety compared to PSPE and the safety at higher rates is highly dependent on maintaining good seeding practices and consistent seed depth.

Crop Phytotoxicity was only observed for PSPE applied treatments at label or double rates (Table 2). This phytotoxic damage started to recover two months after first treatment application. Three months after the first application, no phytotoxic damage was evident.

Comments

Caution is required if applying Propyzamide to field peas as a PSPE spray. Heavy rainfall after seeding can result in increased chemical solubility and moving into the root zone of the emerging crop. Phytotoxicity can be further enhanced by transient waterlogging due to hypocotyl damage.

No phytotoxic effects were observed with post-emergent applications (field peas 3-Node, 6-Leaf stage). Little to no biomass inhibition was evident for post-emergent applications applied 27 Days after PSPE application timings.

Acknowledgements

Thanks to the Liebe Group and the Hyde family for hosting the trial at the Liebe Group Main Trial Site and for site preparation, seeding and assisting in trial maintenance.

Peer review

Bill Campbell, Bill Campbell Consulting

Contact

Nathan Moyes, IMTRADE CropScience
nathan.moyes@imtrade.com.au
0457 774 787

Jeremy Samson, IMTRADE CropScience
jeremy.samson@imtrade.com.au
0481 170 277

Investigation in Host Crop Safety of Propyzamide Applied PSPE and Post-Emergent to Canola

Nathan Moyes, National Technical Manager, and Jeremy Samson, Technical Agronomist, Imtrade CropScience

Key Messages

- Caution is required if applying Propyzamide post sowing pre-emergent (PSPE) to canola. Crop biomass will result if accompanied by heavy rainfall after seeding or transient water logging.
- No host crop safety effects were observed in this trial with Post-Emergent (canola 4-Leaf) Propyzamide applications.
- Propyzamide is compatible with Clethodim 240 g/L @ 500 ml/ha as a Post-Emergent (PE) herbicide treatment for excellent residual annual ryegrass control.

Aim

To investigate host crop safety of Propyzamide when applied PSPE and post-emergent in canola. In addition, to assess efficacy on overall ryegrass control.
To experiment with post sowing (ie PSPE and PE) applications of propyzamide to lengthen residual and improved overall ARG control in canola.

Background

This trial was conducted to demonstrate potential different use patterns and safety considerations for Propyzamide as PSPE and post-emergent applications. Imtrade Edge 900 WG currently is only registered in Canola for IBS applications at 0.55 kg/ha. Propyzamide is a Group D herbicide, absorbed through shoots and roots, with its specific mode of action preventing cell division, inhibiting root growth in annual ryegrass. As propyzamide is reliant on soil moisture and lowering soil temperature.

Propyzamide was applied at 1 x label and 2x Label rates, at PSPE 19/05/2021 and Post-emergent 08/07/2021 at 4 leaf crop stage timings, with two different Propyzamide formulations. Weed counts, rye grass control, crop biomass and crop phytotoxicity were assessed in this trial.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	10m x 2m x 3 replications
Soil type	Heavy red loam
Paddock rotation	2020 wheat, 2019 wheat, 2018 wheat
Sowing date	19/05/2021
Sowing rate	3.5 kg/ha Bonito Canola
Fertiliser	130 kg/ha MacroPro Extra at seeding (12.6 kg N, 14.6 kg P, 14.6 kg K, 13.3 kg S) 100 kg/ha Urea (46 kg/ha N) spread 3-4 leaf
Herbicides, Insecticides & Fungicides	Pirimicarb 500 WG applied @ 500 g/ha (08/09/2021)

Treatments

	Product	Active – Application Timing	Rate (kg or L /Ha)
1	Untreated Control	--	--
2	Edge 900 WG	Propyzamide – PSPE (1x rate)	0.55
3	Edge 900 WG	Propyzamide – PSPE (2x rate)	1.10
4	Dev. Product WG	Propyzamide – PSPE (1x rate)	0.56
5	Dev. Product WG	Propyzamide – PSPE (2x rate)	1.10
6	Edge 900 WG	Propyzamide – Post Emergent Z1.4 (1x rate)	0.56
7	Edge 900 WG	Propyzamide – Post Emergent Z1.4 (2x rate)	1.10
8	Dev. Product WG	Propyzamide – Post Emergent Z1.4 (1x rate)	0.56
9	Dev. Product WG	Propyzamide – Post Emergent Z1.4 (2x rate)	1.10
10	Edge 900 + Clethodim 240 EC	Ppz. + Cleth + Hasten – Post Em Z1.4	0.56 + 0.50 + (0.50L/100L)
11	Dev. Prod. + Clethodim 240 EC	Ppz. + Cleth + Hasten – Post Em Z1.4	0.56 + 0.50 + (0.50L/100L)
	Edge 900: Propyzamide 900 g/kg Dev. Product: IMTRADE Development Product		

PSPE applied 19th May, Post-emergent applied 8th July (Canola 4-leaf stage)

Results

Table 1: Comparison of treatment means. Mean Biomass by treatment on Canola cv. Bonito

No.	Treatment	App. rate (kg/ha)	23 DAA 1 11-Jun-21	37 DAA 1 25-Jun-21	13 DAA2 21-Jul-21	27 DAA 2 4-Aug-21
1	Untreated	0	100.0	100.0[a]	100.0[a]	100.0[a]
2	Edge 900 PSPE	0.56	100.0	73.3[b]	73.3[bc]	81.7[a]
3	Edge 900 PSPE	1.1	100.0	40.0[c]	35.0[e]	43.3[b]
4	Dev. Product PSPE	0.56	100.0	48.3[c]	66.7[cd]	53.3[b]
5	Dev. Product PSPE	1.1	100.0	38.3[c]	46.7[de]	53.3[b]
6	Edge 900 Post	0.56	100.0	100.0[a]	95.0[ab]	95.0[a]
7	Edge 900 Post	1.1	100.0	100.0[a]	96.7[ab]	95.7[a]
8	Dev. Product Post	0.56	100.0	100.0[a]	96.7[ab]	101.7[a]
9	Dev. Product Post	1.1	100.0	100.0[a]	100.0[a]	99.7[a]
10	Edge + Clethodim	0.56 +0.5L	--	--	96.7[ab]	100.0[a]
11	Dev. Prod. + Clethodim	0.5 6+0.5L	--	--	100.0[a]	100.0[a]
		P value	ana	<0.001	<0.001	<0.001
		LSD	ana	12.94	21.80	25.05

DAA = Days after Application
ana = analysis not applicable

Table 2: Comparison of treatment means. Mean Visual Phytotoxicity by treatment on canola cv. Bonito.

No.	Treatment	App. rate (kg/ha)	23 DAA 1 11-Jun-21	37 DAA 1 25-Jun-21	13 DAA2 21-Jul-21	27 DAA 2 4-Aug-21
1	Untreated	0	0.0	0.0a	0.0a	0.0
2	Edge 900 PSPE	0.56	0.0	11.7b	0.0a	0.0
3	Edge 900 PSPE	1.1	0.0	16.7b	0.0a	0.0
4	Dev. Product PSPE	0.56	0.0	16.7b	0.0a	0.0
5	Dev. Product PSPE	1.1	0.0	23.3c	0.0a	0.0
6	Edge 900 Post	0.56	0.0	0.0a	0.0a	0.0
7	Edge 900 Post	1.1	0.0	0.0a	0.0a	0.0
8	Dev. Product Post	0.56	0.0	0.0a	0.0a	0.0
9	Dev. Product Post	1.1	0.0	0.0a	0.0a	0.0
10	Edge + Clethodim	0.56 +0.5L	--	--	13.3b	0.0
11	Dev. Prod. + Clethodim	0.56 +0.5L	--	--	0a	0.0
		P value	ana	<0.001	<0.001	ana
		LSD	ana	12.94	1.48	ana

DAA = Days after Application
ana = analysis not applicable

Crop safety

Propyzamide has excellent crop safety when used as an IBS treatment, however due to seed soil separation with PSPE application which is not a registered use, crop safety can vary depending on seeding practices and environmental conditions. In ideal situations, PSPE application is safe showing no phytotoxicity. This trial demonstrated with significant rainfall, furrow closure, increased seed depth and waterlogging resulted in loss of vigour and affected biomass (Table 1). The significant rainfall combined with slotting (a technique used to move topsoil down the soil profile) caused the herbicide to move into the furrow, damaging the crop by showing phytotoxicity. No yield data was collected.

Additional treatments of Propyzamide at equivalent label rates were applied with Clethodim to showcase possible grower practice for weed control. A slight biomass inhibition was observed with Edge + Clethodim treatment, however this was not evident with the Dev. Prod. + Clethodim plots (Table 1).

Symptoms of crop phytotoxicity were still evident in PSPE treatments at 37 DAA 1 with yellow growing points and cupped leaves whereas no phytotoxicity was observed with the Post-Emergent standalone Propyzamide application (Table 2). Some phytotoxic damage was observed on Edge + Clethodim plots at 13 DAA 2 which is typical from Clethodim on canola. However, this phytotoxic damage was not observed from Dev. Prod. + Clethodim plots.

Weed Control

Table 3: Mean Annual Ryegrass (plants/m²) counts by treatment in canola cv. Bonito.

No.	Treatment	App. Rate (kg/ha)	23 DAA 1 11-Jun-21	37 DAA 1 25-Jun-21	27 DAA 2 4-Aug-21
1	Untreated	0	20.2bc	48.6b	61.8b
2	Edge 900 PSPE	0.55	0.0a	1.2a	5.6a
3	Edge 900 PSPE	1.1	0.1a	1.1a	2.3a
4	Dev. Product PSPE	0.56	1.0a	1.4a	3.7a
5	Dev. Product PSPE	1.1	0.1a	0.9a	2.6a
6	Edge 900 Post	0.55	12.2b	38.4b	14.0a
7	Edge 900 Post	1.1	20.7bc	47.2b	9.3a
8	Dev. Product Post	0.56	26.9c	35.1b	11.3a
9	Dev. Product Post	1.1	26.4c	39.6b	9.7a
10	Edge + Clethodim	0.5 +0.5L	--	--	1.8a
11	Dev. Prod. + Clethodim	0.5 +0.5L	--	--	1.0a
		P value	<0.001	<0.001	<0.001
		LSD	9.29	22.92	14.94

DAA = Days after Application

Table 4. Control (Mean Percentage) of Annual Ryegrass by Treatment in canola cv. Bonito.

No.	Treatment	App. Rate (kg/ha)	23 DAA 1 11-Jun-21	37 DAA 1 25-Jun-21	13 DAA2 21-Jul-21	27 DAA 2 4-Aug-21
1	Untreated	0	0.0c	0.0b	0.0d	0.0c
2	Edge 900 PSPE	0.55	100.0a	97.3a	91.0a	94.0a
3	Edge 900 PSPE	1.1	99.7a	98.0a	97.7a	96.3a
4	Dev. Product PSPE	0.56	98.3b	97.3a	92.7a	91.7a
5	Dev. Product PSPE	1.1	99.7a	98.3a	95.3a	95.0a
6	Edge 900 Post	0.55	0.0c	0.0b	10.0c	73.3b
7	Edge 900 Post	1.1	0.0c	0.0b	10.0c	80.0b
8	Dev. Product Post	0.56	0.0c	0.0b	8.3cd	73.3b
9	Dev. Product Post	1.1	0.0c	0.0b	13.3c	80.0b
10	Edge + Clethodim	0.5 +0.5L	--	--	56.6b	98.3a
11	Dev. Prod. + Clethodim	0.5 +0.5L	--	--	58.3b	98.3a
		P value	<0.001	<0.001	<0.001	<0.001
		LSD	0.97	2.37	8.52	8.84

DAA = Days after Application

Ryegrass weed control

PSPE applications provided excellent early ryegrass control and significant residual with higher rates (2x label rate) providing better control (Table 4). Post-emergent at four leaf crop stage application significantly stunted ryegrass and with high rates (2x label) providing increased control.

Post emergent applications of Propyzamide and Clethodim gave the best overall ryegrass control compared to PSPE and PE application. The Development Product + Clethodim gave the highest control of all treatments.

PSPE provided statically significantly better ryegrass control compared to PE treatments (Table 4). As expected, PE application at four leaf crop stage only showed weed control after 20 plus days. The lack of early weed control is not ideal.

Comments

Caution is required if applying Propyzamide to Canola at PSPE (2 leaf- canola). Heavy rainfall after seeding can result in increased chemical solubility and moving into the root zone of emerging canola. Crop phytotoxicity can be further enhanced by transient water logging in young canola, due to hypocotyl damage.

No phytotoxic effects in these trials were observed with post-emergent applications (4 leaf - canola). Little to no biomass inhibition was evident for post-emergent applications applied 27 Days after PSPE application timings.

Propyzamide applications and further trials have shown excellent compatibility with Clethodim 240 g/L @ 500 ml/ha for excellent knockdown and residual annual ryegrass control.

Acknowledgements

Thanks to the Liebe Group and the Hyde family for hosting the trial at the Liebe Group Main Trial Site and thanks to Living Farm for site preparation, seeding and assisting in trial maintenance.

Peer review

Bill Campbell, Bill Campbell Consulting

Contact

Nathan Moyes, IMTRADE CropScience
nathan.moyes@imtrade.com.au
0457 774 787

Jeremy Samson, IMTRADE CropScience
jeremy.samson@imtrade.com.au
0481 170 277

Terrain Flow Demonstration Site - Pithara WA

Rex Cao, Field Development Officer, Nufarm Australia

Key Messages

- Terrain Flow applied standalone demonstrated effective activity on suppressing annual ryegrass.
- When tank mixed with other industry standard pre-emergent herbicides, Terrain Flow numerically improved annual ryegrass control.
- Terrain Flow did not display higher crop phytotoxicity than other popular herbicide treatments.

Aim

To demonstrate crop safety, and efficacy of Terrain Flow 480 applied prior to wheat; suggested tank mixes to broaden the weed spectrum and achieve high levels of efficacy in a sustainable manner for herbicide resistance management.

Background

Nufarm Terrain 500WG has existing pre-emergent use patterns for wheat, some pulse crops, established Lucerne and fence line. Terrain 500WG was the first group 14 (G) herbicide to be registered for residual control of grass and broadleaf weeds (including annual ryegrass and wild radish) in broadacre cropping. Group 14 herbicides are the protoporphyrinogen oxidase (PPO) enzyme inhibitors. There are currently no known populations of weeds resistant to Group 14 in Australia. Thus, it is a very promising tool for herbicide resistance management.

Nufarm Terrain Flow 480 (480 g/L flumioxazin) is a newly developed suspension concentrate (SC) formulation that is easier to handle compared to the previous granule package and shows improved efficacy compared to the water dispersible granule (WDG) formulation. This new formulation is anticipated to be available in Autumn 2023.

Trial Details

Trial location	McIlroy Property, Pithara
Plot size & replication	11m x 2.5m x 4 replications
Soil type	Sandy loam
Sowing system	Knife point and press wheel system on 25mm sowing depth and 200mm tyne spacing
Sowing date	11/05/2021 herbicide application was done within 12 hours prior sowing
Sowing rate	55 kg/ha Ninja wheat
Fertiliser	Agras at 100 kg/ha + Flexi N at 50 L/ha
Herbicides, Insecticides & Fungicides	2 L/ha Gladiator (450 g/L glyphosate) with a range of incorporated by sowing (IBS) herbicides on 11/05/2021 (See treatment list for details).

Treatments

	Treatment
1	Untreated Control (UTC)
2	Terrain Flow 125 mL/ha
3	Voraxor 200 mL/ha
4	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha
5	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha + Terrain Flow 125 mL/ha
6	Overwatch 1250 mL/ha
7	Overwatch 1250 mL/ha + Terrain Flow 125 mL/ha
8	Overwatch 1250 mL/ha + Voraxor 200 mL/ha
9	Sakura 118 g/ha
10	Sakura 118 g/ha + Terrain Flow 125 mL/ha
11	Sakura 118 g/ha + Voraxor 200 mL/ha

Results

The result with different letters means the treatments are statistically significant (Figure 1, Table 1, 2 and 3). In herbicide efficacy analysis, untreated control was excluded from the analysis (Table 2 and 3).

Table 1: Crop safety assessment at 21, 35 and 56 days after application (DAA).

Treatment		Crop Emergence/m^2	Crop Vigour (0-10)		
		21 DAA	21 DAA	35 DAA	56 DAA
1	Untreated Control	75-	9.5-	9.9-	9.8^{a}
2	Terrain Flow 125 mL/ha	75-	9.3-	9.5-	9.1^{abc}
3	Voraxor 200 mL/ha	82-	9.0-	9.9-	9.6^{ab}
4	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha	72-	9.0-	9.4-	9.3^{abc}
5	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha + Terrain Flow 125 mL/ha	71-	8.8-	9.1-	9.0b^{c}
6	Overwatch 1250 mL/ha	80-	9.0-	9.8-	9.8^{a}
7	Overwatch 1250 mL/ha + Terrain Flow 125 mL/ha	70-	9.0-	9.4-	9.8^{a}
8	Overwatch 1250 mL/ha + Voraxor 200 mL/ha	74-	9.3-	9.1-	8.8^{c}
9	Sakura 118 g/ha	76-	9.5-	9.9-	9.1^{abc}
10	Sakura 118 g/ha + Terrain Flow 125 mL/ha	76-	9.1-	9.3-	9.1^{abc}
11	Sakura 118 g/ha + Voraxor 200 mL/ha	75-	9.3-	9.6-	9.1^{abc}
	LSD	7.43	0.623	0.689	0.681
	P Value	0.0696	0.3733	0.1704	0.0454

- = No significant difference between all treatments

Table 2: Annual ryegrass early to middle control at 35 and 56 DAA

Treatment		Annual ryegrass / m2	
		35 DAA	56 DAA
1	Untreated Control	41	64
2	Terrain Flow 125 mL/ha	7^{ab}	1-
3	Voraxor 200 mL/ha	12^{a}	6-
4	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha	2^{b}	2-
5	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha + Terrain Flow	2^{b}	0-
6	Overwatch 1250 mL/ha	2^{b}	1-
7	Overwatch 1250 mL/ha + Terrain Flow 125 mL/ha	2^{b}	0-
8	Overwatch 1250 mL/ha + Voraxor 200 mL/ha	2^{b}	1-
9	Sakura 118 g/ha	3^{b}	1-
10	Sakura 118 g/ha + Terrain Flow 125 mL/ha	1^{b}	0-
11	Sakura 118 g/ha + Voraxor 200 mL/ha	0^{b}	0-
	LSD	6.94	2.25 - 4.40
	P value	0.0472	0.0673

- = No significant difference between all treatments

Table 3: Annual ryegrass late control at 90 and 113 DAA.

Treatment		Annual ryegrass tillers/ m2	Annual ryegrass spikes/ m2
		90 DAA	113 DAA
1	Untreated Control	110	109
2	Terrain Flow 125 mL/ha	12^{b}	12^{ab}
3	Voraxor 200 mL/ha	38^{a}	21^{a}
4	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha	11^{b}	9^{ab}
5	TriflurX 2000 mL/ha + Avadex Xtra 3200 mL/ha + Terrain Flow	7^{b}	3^{bc}
6	Overwatch 1250 mL/ha	13^{b}	9^{ab}
7	Overwatch 1250 mL/ha + Terrain Flow 125 mL/ha	7^{b}	3^{bc}
8	Overwatch 1250 mL/ha + Voraxor 200 mL/ha	12^{b}	9^{ab}
9	Sakura 118 g/ha	12^{b}	3^{bc}
10	Sakura 118 g/ha + Terrain Flow 125 mL/ha	7^{b}	2^{c}
11	Sakura 118 g/ha + Voraxor 200 mL/ha	5^{b}	3^{bc}
	LSD	12.8 - 20.4	5.7 - 15.0
	P value	0.0266	0.0169

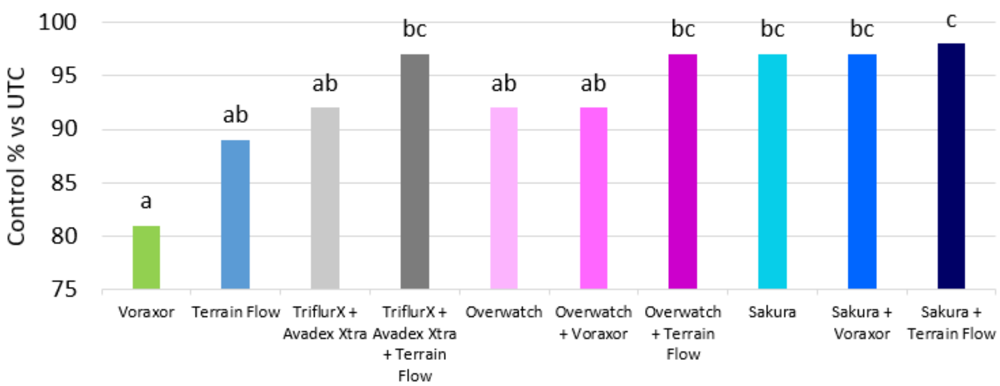


Figure 1: % final control of annual ryegrass spikes at 113 DAA.

The application rates of Voraxor, Terrain Flow, TriflurX, Avadex Xtra, Overwatch and Sakura rates were mentioned on the treatment list in previous tables.

Figure 2: Untreated control (left) compared to Terrain Flow at 125 mL/ha at 21 DAA.

Comments

Terrain Flow standalone did not show any significant higher vigour reduction than other herbicide treatments. When it was mixed with other herbicides, it did not significantly reduce the crop vigour either. At the last assessment, Overwatch + Voraxor showed the lowest vigour rating (Table 1).

This site had a low to moderate ryegrass population density. The weather condition in the 2021 season was very favourable for herbicide incorporated by sowing (IBS) application. The trial was sprayed when the soil was in good moisture; the site received 14mm rain in two weeks after sowing. The site also received above average rain from June to August. The higher than usual moisture improved the accessibility and mobility of the herbicide in soil. Thus, all treatments resulted in a very good level of annual ryegrass control across the early to late season (Figure 1, Table 2 and 3). Terrain Flow resulted in equivalent ryegrass plant and spike reduction against Voraxor by itself in this trial (Figure 1, Table 2 and 3). Figure 1 revealed how Terrain Flow significantly reduced annual ryegrass pressure in inter-rows compared against rows in untreated control plots. Terrain Flow and Voraxor on their own revealed consistent efficacy through early to late assessments. This suggested that the residual activity of Terrain Flow and Voraxor lasted for 16 weeks in this trial. The purpose of putting these standalone treatments was to compare their efficacy side by side. In commercial practice, Terrain Flow is recommended to be used as a tank mix with another IBS herbicide, not as a standalone. Sakura + Terrain Flow was the best treatment in this trial, revealing the highest final spike reduction. It was significantly better than TriflurX + Avadex, Overwatch and Overwatch + Voraxor. Terrain Flow mixed with TriflurX + Avadex or with Overwatch were the second-best treatments in this trial. (Figure 1 and Table 3).

Terrain Flow demonstrated a high level of crop safety in the wet season as well as the effective efficacy of suppressing annual ryegrass in this trial. Its performance was equivalent to Voraxor. This suggested that Terrain Flow could be an effective Group 14 herbicide alternative to Voraxor.

Acknowledgements

Thanks to Judy Storer, Danielle Hipwell and Lisa-May Shaw at Liebe Group for providing support on looking for a trial site and organising this trial report. Thanks to Pithara grower Brad Mcllroy for kindly providing this trial site and promptly collaborating on sowing and maintenance spray.

Peer review

Dr Danica Goggin, University of Western Australia
Dr Roberto Busi, University of Western Australia

Contact

Rex Cao, Field Development Officer
rex.cao@nufarm.com
0451 660 820

Lisa Furey, Business Development Manager
lisa.furey@nufarm.com
0429 223 579

AHRI Update on Herbicide Resistance Testing Across Multiple Weeds

Roberto Busi and Hugh Beckie, University of Western Australia (UWA), Australian Herbicide Resistance Initiative (AHRI)

Key Messages

- Annual ryegrass (ARG): there is no resistance to paraquat however there was an increasing and concerning level of glyphosate resistance (13% samples).
- Wild radish: herbicide mixtures (Group 6, 12, 4, 27) such as diflufenican + bromoxynil (Jaguar), Diflufenican + picolinafen + bromoxynil + MCPA (Quadrant) or pyrasulfutole + bromoxynil (Velocity) remain effective with low-level of resistance <15%.
- The resistance found in barley grass is similar to brome grass with 30% resistance to sulfonylureas (Group 2) and <5% resistance to imidazolinones, clethodim or quizalofop (Group 1).

Background

This project aimed to demonstrate to Western Australian growers and advisers the value of proactively testing for herbicide resistance in key weed species such as annual ryegrass, brome grass, barley grass, capeweed and wild radish impacting on their profitability on farm. The study determined the level of herbicide resistance of problem weeds across key properties in Western Australia.

Trial Details

Herbicide resistance was identified by applying the recommended label rate to a specific number of seeds (pre-emergence herbicides) or two-leaf plants (post-emergence herbicides). Plant survival in response to full labelled herbicide doses was assessed and recorded four weeks after herbicide treatments.

Three categories of plant survival were used to categorise and identify herbicide resistance: plant survival ranging from 0 - 5% indicates an herbicide 'susceptible' sample, survival of 6 - 19% identifies 'developing resistance' samples and plant survival ≥ 20% is interpreted as highly herbicide-resistant sample.

Individual seed samples of annual ryegrass, barley grass, brome grass, capeweed and wild radish were collected from approximately 50 farms at different locations across Western Australia at the end of the growing season in 2020 (Table 1). Fields were chosen according to the grower or agronomist's interests to better understand the herbicide resistance status of key weed species.

Results

Table 1: Number of seed samples tested at the Australian Herbicide Resistance Initiative (UWA).

Species	No. samples tested
Annual ryegrass	87
Wild radish	41
Brome grass	40
Barley grass	35
Capeweed	17

Annual ryegrass

Study findings are highlighted in the tables below. This study confirms the absence of evolved resistance to paraquat but reports an increasing and concerning level of glyphosate resistance (13% samples).

Resistance to clethodim is found to be >30% samples tested. When glyphosate is used in combination with clethodim resistance to either herbicide stand-alone is significantly reduced.

Resistance to trifluralin was found in approximately 15% of samples tested. There is increasing evidence of ARG populations to be highly resistant to trifluralin.

Resistance to prosulfocarb and bixlozone ranges between 5-8%, whereas resistance to pyroxasulfone or cinmethylin is negligible.

The ability of ARG to evolve resistance to herbicide mixtures or sequences is significantly less, with two-way combinations controlling resistant populations – ultimately extending the life of specific products. This reinforces the industry message and recommended practice of mixing modes of action (Table 2).

Table 2: Resistance observed in ARG in response to different herbicide modes of action tested (% of samples).

Group	Herbicide	Developing Resistant	Highly Resistant
	POST		
A /1 + A /1	Clethodim 500ml + butroxydim 180g/ha	2%	6%
A /1 + M /9	Clethodim 500ml + Glyphosate 1500ml/ha mix	0%	2%
A /1	Clethodim 500ml/ha	9%	25%
M /9	Glyphosate (Crucial 1.5L/ha)	5%	8%
L /22	Paraquat (Gramoxone 1L/ha)	0%	0%
	PRE		
J /15	Prosulfocarb (Arcade 3L/ha)	0%	5%
T /30	Cinmethylin (Luximax 500ml/ha)	0%	0%
T/30 + G /14	Cinmethylin + Voraxor 200ml/ha	0%	0%
Q /13	Bixlozone (Overwatch 1250 ml/ha)	0%	8%
Q /13 + D/3	Bixlozone 1250ml/ha + trifluralin 1500ml/ha	0%	5%
Q /13 + A /1	Bixlozone 938 ml/ha + 500ml clethodim POST	0%	7%
K /15	Pyroxasulfone (Sakura flow 210ml/ha)	0%	1%
D /3 + K /15	Sakura 210ml/ha + trifluralin 1500ml/ha	0%	0%
D /3	Trifluralin 3L/ha	0%	14%
G /14	Saflufenacil + trifludimoxazin (Voraxor 200ml/ha)	0%	1%

Wild radish

There is significant resistance to herbicide Group B, F and I in wild radish. Herbicide mixtures (6, 12, 4, 27) such as Diflufenican+bromoxynil, Diflufenican+picolinafen+bromoxynil+MCPA or Pyrasulfutole + bromoxynil remain effective with low-level of resistance <15%.

Resistance to Group C herbicides (atrazine and bromoxynil) remains low (< 3 or 20%, respectively). There is no resistance to Group G herbicides and glyphosate (Table 3). Group C atrazine continues to stand up with little resistance found. Group C bromoxynil continues to perform. Although only 80% susceptible can possibly be a warning sign.

It's probably no surprise that Group 2 (Triasulfuron) are failing together with Group 4 (2,4-D and MCPA). Group 12 (diflufenican and picolinafen) are under pressure but they work well when pre-mixed with bromoxynil.

No resistance to Tiafenacil (knockdown spike) and Fomesafen (pulse pre-emergent) with minimal Group 14 use and hence minimal resistance. Selection pressure may be driving resistance going forward.

Group 27 resistance remains relatively low but it appears to be an increasing problem due to the overreliance of this group for post-emergent control of wild radish (ie Pyrasulfotole + bromoxynil, Velocity®). Interesting to note that resistance to mesotrione + bixlozone is zero.

Group 9 glyphosate resistance continues to be rare in radish – 100% susceptible.

Table 3: Resistance observed in wild radish in response to a number of herbicide options (% of samples).

Group	Herbicide	Developing Resistant	Highly Resistant
B / 2	Triasulfuron (Logran 35 g/ha)	24%	44%
C / 6	Bromoxynil 1.4L/ha	20%	0%
C / 5	Atrazine 1.1kg/ha	0%	2%
F / 12	Diflufenican (Defcon 500 - 200ml/ha)	27%	24%
I / 4	2,4-D (Estercide Xtra 680 - 800mL/ha)	32%	24%
I / 4	MCPA (Polo 570 LVE 1L/ha)	39%	20%
H / 27	Mesotrione (Callisto - 200ml/ha)	7%	2%
H 27 +Q 13	Mesotrione 200ml + Bixlozone 1250ml/ha	0%	0%
F 12 + C 6	Diflufenican+bromoxynil (Jaguar - 1L/ha)	10%	2%
F+C+I	DFF+picol+ bromoxynil+MCPA (Quadrant - 800mL/ha)	10%	0%
H 27 + C 6	Pyrasulfutole + bromoxynil (Velocity - 670ml/ha)	12%	3%
H+C+I	Pyrasulfutole + Bromoxynil 670ml/ha + MCPA	5%	0%
G / 14	Fomesafen (Reflex 1500ml/ha)	0%	0%
G / 14	Tiafenacil (Terrad'or 20 g/ha)	0%	0%
M / 9	Glyphosate (Crucial 1.5L/ha) twice 10 days apart	0%	0%

The message of mix, mix, mix is critical with the combination of multiple modes of action and most importantly the inclusion of Group 12 (F) and 27 (H) with Group 6 (C - bromoxynil) and 4 (I - MCPA) as the back bone of effective control.

Brome grass

Resistance to Group B (sulfonylureas) herbicides is confirmed to be an increasing issue in brome grass (found in approx. 30% of samples tested). Resistance to Group A / 1 (clethodim and quizalofop) remains low with <3% of resistant samples (Table 4). One population appears to be multiple resistant to sulfonylureas and clethodim/quizalofop.

In collaboration with the consultant agronomist (Nicholas McKenna, Planfarm) we have inferred that one particular paddock has received 12 herbicide applications (shots) of Group 1 (DIM) herbicides in the last two decades. We are currently thoroughly investigating the genetic basis of that brome grass population in collaboration with a laboratory in Germany and the results obtained are providing insight into resistance management (results to be presented at Perth Grains Research Updates).

There was no resistance observed in response to glyphosate, imidazolinone herbicides or any of the pre-emergence herbicides tested (propyzamide, triallate, carbetamide, etc.). One population exhibited survival to imidazolinone and it will be further investigated in 2022.

Table 4: Resistance observed in brome grass in response to different herbicide modes of action (% of samples).

Group	Herbicide / dose	Developing Resistant	Highly Resistant
A / 1	Clethodim240, 250ml/ha	0%	2.5%
A / 1	Quizalofop100, 125ml/ha	0%	2.5%
A/1+A/1	Clethodim 250ml + quizalofop 125ml	2.5%	0%
B / 2	Imazamox + imazapyr (Intervix 750 ml/ha)	2.5%	0%
B/ 2	Sulfometuron 25g/ha	20%	7.5%
M / 9	Glyphosate (Crucial 800ml/ha)	0%	0%
D / 3	Propyzamide (Dargo 1L/ha)	0%	0%
E / 23	Ultro (carbetamide) 1.1kg/ha	0%	0%
J / 15	Triallate (Avadex 3L/ha)	0%	0%

Barley grass

The resistance status of barley grass is remarkably similar to brome grass with about 30% resistance to sulfonylureas and <5% resistance to imidazolinones, clethodim or quizalofop. No resistance to glyphosate and paraquat was found, despite previous reports of resistance to these two herbicides. The pre-emergence herbicide carbetamide (available from 2022) has shown 100% efficacy (Table 5).

Table 5: Resistance observed in barley grass in response to different herbicide modes of action (% of samples).

Group	Herbicide / dose	Developing Resistant	Highly Resistant
A / 1	Clethodim240, 250ml/ha	3%	3%
A / 1	Quizalofop100, 125ml/ha	0%	3%
B / 2	Imazamox + imazapyr (Intervix 750 ml/ha)	3%	0%
B / 2	Sulfometuron 25g/ha	24%	9%
L / 22	Paraquat (Gramoxone 1L/ha)	0%	0%
M / 9	Glyphosate (Crucial 800ml/ha)	0%	0%
E / 23	Carbetamide (Ultro 1.1kg/ha)	0%	0%

Capeweed

Some minor level of resistance was found in response to the herbicide metosulam stand-alone. No resistance was found to clopyralid or glyphosate.

Table 6: Resistance observed in capeweed in response to a number of herbicide options (% of samples).

Group	Herbicide / dose	Developing Resistant	Highly Resistant
B / 2	Metosulam (Eclipse 15g/ha)	12%	0%
I / 4	Clopyralid (Lontrel 100 g/ha)	0%	0%
M / 9	Crucial (glyphosate) 1,500 ml/ha	0%	0%

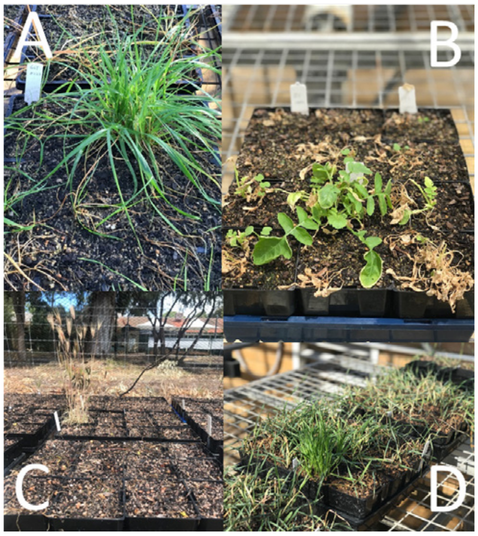


Figure 1: Glyphosate resistant ryegrass (A), Pyrasulfotole + Bromoxynil (Velocity®) resistant radish (B), Seed-producing quizalofop-resistant barley grass (C) and clethodim and quizalofop cross-resistant brome grass (D) identified at AHRI during 2021.

Acknowledgements

It was a pleasure to work closely with several WA growers (50+), consultants (17) and growers groups (4). The Australian Herbicide Resistance Initiative (AHRI) based at the University of Western Australia delivered herbicide resistance workshops and continues the research work with leading WA agronomists and growers. The study was an investment with the GRDC. A special thank to Liebe Group's participating growers and agronomists: Dylan Hirsch, Daniel & Rod Birch, Todd Carter, Steven Sawyer and Tristan Clarke.

Peer review

Jo Wheeler, GRDC

Contact

Roberto Busi
roberto.busi@uwa.edu.au
08 6488 1423.

Broadleaf Weed Control in Chickpea

Harmohinder Dhammu, Research Scientist, and Mark Seymour, Senior Research Scientist, Department of Primary Industries and Regional Development

Key Messages
- Chickpea varieties - CBA Captain and Neelam showed similar competitiveness against broadleaf weeds.
- Competition of RR canola (mimicked wild radish) and broad leaf weeds with these varieties to maturity accumulated 4.2 t/ha dry biomass and reduced chickpea seed yield by 35% compared to weed free plots.
- Majority of the herbicides and herbicide mixtures registered 95-100% weed control efficiency against RR canola and broadleaf weeds and yielded on par with weed free plots.
- Application of flumetsulam 800 at 25g/ha at 4-5 node stage of chickpea reduced canola/weed biomass by 69% and increased chickpea seed yield by 25%.
- Incorporated by sowing application (IBS) of herbicides/mixtures appeared safer than their post-seeding pre-emergent application (PSPE). IBS application of fomesafen, flumioxazin, terbuthylazine + isoxaflutole, and simazine + diuron + isoxaflutole had no significant negative effect on root nodules of CBA Captain.

Aim
To compare two chickpea varieties for their competitiveness against broadleaf weeds and evaluate efficacy of new and old herbicides and herbicide mixtures for broadleaf weed control in chickpea.

Background
Weeds are one of the main production problems in chickpeas and can reduce seed yield and quality significantly. New chickpea variety CBA Captain has better plant vigour and height than WA standard variety Neelam. Taller varieties with vigorous plant growth have been reported to be more competitive against weeds. Reflex®(fomesafen), Terrain (flumioxazin)® and Palmero® TX (terbythylazine + isoxaflutole) have recently been registered as pre-emergent herbicides in chickpeas for broadleaf weed control.

Trial Details
Trial location	Brad McIlroy, Pithara/Dalwallinu
Plot size & replication	1.8m centres x 10m sown x 3 replications, Criss-cross/split plot design
Soil type	Loam/Clay loam
Paddock rotation	2020 - Oats, 2019 - Wheat, 2018 - Wheat
Sowing date	12/05/2021
Sowing rate	CBA Captain 140 kg/ha and Neelam 90 kg/ha and target density was 45 plants/m².
Fertiliser	Superphosphate 100 kg/ha, (9.1P, 10.5S, 20.0Ca), applied at seeding
Seed treatment	The seed was treated with 200 mL/100kg seed thiram (360g/L) + thiabendazole (200 g/L). TagTeam® inoculant (Group N) at 5 kg/ha was applied at sowing.
Herbicides, Insecticides & Fungicides	Propyzamide 500 at 1 L/ha on 11/05/21, chlorothalonil (720 g/L) at 1.5 L/ha on 08/06/21, clethodim (240 g/L) 0.33L + buthroxydim (250 g/kg) 180 g/ha on 05/08/21, and alpha-cypermethrin (100 g/L) at 0.16 L/ha on 4/10/21.
Harvest date	29/11/2021

Treatments
Main plot herbicide treatments
Plus, and minus post-emergent Flumetsulam 800 (e.g., Broadstrike®) at 25 g/ha at 4-5 chickpea node stage across sub-plot treatments.

Sub-plot herbicide treatments			
	Herbicides	Product rate/ha	Timing
1	Untreated Control (Captain)	Nil	Nil
2	Untreated Control (Neelam)	Nil	Nil
3	Weed Free (Captain) - Simazine fb Isoxaflutole	835 g fb 100 g	IBS fb PSPE
4	Weed Free (Neelam) - Simazine fb Isoxaflutole	835 g fb 100 g	IBS fb PSPE
5	Fomesafen 240 (e.g., Reflex®)	1.5 L	IBS
6	Fomesafen 240	1.25 L	PSPE
7	Fomesafen fb isoxaflutole 750 (e.g., Balance®)	1 L fb 100 g	IBS fb PSPE
8	Fomesafen + isoxaflutole	1 L + 100g	PSPE
9	Fomesafen + isoxaflutole + Metribuzin 750	1 L + 100g + 180 g	PSPE
10	Fomesafen + simazine 900	1L + 835 g	IBS
11	Fomesafen + terbuthylazine 750	1L + 1 kg	IBS
12	Fomesafen + diuron 900	1 L + 835 g	IBS
13	Flumioxazin 500 (e.g., Terrain®)	180 g	IBS
14	Flumioxazin + simazine 900	180 g + 835 g	IBS
15	Flumioxazin fb isoxaflutole + metribuzin 750	1 kg fb 100 g + 180 g	IBS fb PSPE
16	Simazine900 + isoxaflutole 750	835 g + 100 g	IBS
17	Terbuthylazine 750 + isoxaflutole 750	1 kg + 100g	IBS
18	Simazine 900 + isoxaflutole 750	835 g + 100 g	PSPE
19	Terbuthylazine 750 + isoxaflutole 750	1 kg + 100g	PSPE
20	Simazine 900 + isoxaflutole + metribuzin	835 g + 100 g + 180 g	IBS
21	Simazine 900 + isoxaflutole + metribuzin	835 g + 100 g + 180 g	PSPE
22	Simazine 900 + diuron 900 + isoxaflutole	835 g + 333 g + 100 g	PSPE
23	Cyanazine 900 (e.g., Bladex®) fb isoxaflutole	1.1 kg fb 100 g	IBS fb PSPE
24	BADPI21	200 mL	IBS
25	REDPI21	1.25 kg	4-5 nodes

Cyanazine 900, Diuron 900, flumioxazine 500, fomesafen 240, isoxaflutole 750, metribuzin 750, simazine 900 and terbuthylazine 750 formulations were used. IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, fb = followed by. Terbuthylazine 750g + isoxaflutole 75g/kg = Palmero®TX 1Kg. Untreated control and Weed Free plots of CBA Captain and Neelam were paired plots in all three reps.

- **Treatments application dates:** IBS: 11 May 2021, PSPE: 13 May 2021 and 4-5 chickpea node stages: 16 June 2021.
- **Herbicide treatments application machinery:** A spray rig fitted with air induction nozzles (Teejet AIXR110-02) calibrated to deliver 100 L/ha water volume was used.
- **Canola seed spreading:** The trial site had very low weed burden, so to achieve trial objectives and mimic wild radish, Roundup Ready® canola (DG408RR) seed was spread on soil surface in each plot before application of IBS treatments and trial seeding aiming at 3-5 plants/m^2.
- **Trial seeding and soil moisture:** A cone-seeder fitted with knifepoints and press wheels was used for seeding chickpea at 5cm depth. There was very low level of stubble present in the paddock. Gravimetric soil moisture (on dry weight basis) at the time of seeding at 0-10cm and 10-20cm depth was 15.4% and 19.4%, respectively.
- **Canola/weed counts and dry weight:** In herbicide treatment plots, canola and weed count on 5 July and 21 Oct and weed biomass cut on 21st October were done from the whole plot (9 m^2) area. However, in untreated control plots first count on 5 July was on whole plot basis, but on 21st October, the count and biomass cut were from 0.5m x 0.75m quadrat per plot. The canola/weed count was converted to number/m^2 and dry weight to kg/ha.
- **Herbicides' effect on nodulation:** To determine the effect of five selected herbicide treatments (including untreated control) on nodulation, 20 CBA Captain plants at early podding stage were dug very carefully from each replicated treatment plot on 17th September 2021. The plant roots were assessed according to 0 to 8 nodule assessment scale as described by Howieson et. al. (2016), where 0 = no nodules and 8 = extremely abundant nodules.

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	7.1	22	730	5.3	11	1	0.156	1.09
10-20	7.5	11	661	8.9	10	< 1	0.178	0.92
20-30	7.0	7	542	13.3	7	1	0.238	0.59

Results and Discussion

The trial was sown into moist soil following 40mm of rainfall in the week prior to seeding. Chickpea plant establishment was excellent and on average it was 74 plants/m2 as compared to the target density of 45 plants/m2.

Effect of Chickpea varieties on suppression of canola/weeds

Untreated control plots recorded five canola plants/m2 on 5th July (7 weeks after sowing) which increased to 14 plants/m2 by 21st October. Weed count on 21st October had 90% proportion as canola plants and the remaining 10% of the weeds were wild radish, cape weed, doublegee and marshmallow. On average, uncontrolled weeds throughout life cycle of the crop produced 4.2 t/ha dry biomass and reduced seed yield of chickpea by 35% as compared to weed free plots.

The results indicate that CBA Captain and Neelam's ability to compete against weeds was on par in this trial as both varieties recorded similar canola/weed numbers and their dry weight. Resultant yield loss of both varieties was also similar - around 35%. CBA Captain grew significantly taller (68cm) than Neelam (60cm), but Neelam produced significantly greater number of branches per plant (3.4) than CBA Captain (2.4). Contribution of chickpea plant characters like height, branching, vigour etc in generating crop competition against locally important weeds need to be analysed in detail. This will help breeders to breed chickpea varieties that are more competitive against weeds.

Table 1: Chickpea varieties effect on weed number, weed dry weight and chickpea seed yield.

Weed Treatments	Chickpea Varieties	Weeds/m² 5 July 2021	Weeds/m² 21 Oct 2021	Weed Dry Weight (kg/ha) 21 OCt 2021	Chickpea Seed Yield (kg/ha)	Yield loss (%) over weed free
Weedy	Captain	5b	14b	3850b	687a	34.9
	Neelam	5b	14b	4563b	709a	35.3
Weed Free	Captain	0a	0a	0a	1056b	
	Neelam	0a	0a	0a	1095b	
***LSD* (0.05)**	-	-	-	-	313	-

On an average weed count and dry weight on 21st October 2021 had around 90% of proportion canola plants and the remaining 10% were wild radish, cape weed, doublegee and marshmallow weeds. Weed count per metre square and dry weight are back transformed values of log link and log (weeds dry weight+1) data transformations, respectively. Figures followed by same letters are not significantly different.

Effect of herbicides on canola/weeds and CBA Captain chickpea (Table 2 and 3)

Application of flumetsulam 800 at 25 g/ha did not reduce canola and weeds number/m2 but reduced weed dry biomass (69%) and canola plant height (19%) significantly resulting in chickpea seed yield improvement by 25% as compared to no flumetsulam use (Table 2). Interaction of flumetsulam with pre-emergent herbicides for weed dry weight and chickpea seed yield was not significant (Table 3, found on page 83). Flumetsulam is the only registered and available in the market post-emergent weed control option for chickpeas.

These results are in line with flumetsulam (e.g., Broadstrike®) herbicide label which states that it can reduce group B herbicide susceptible wild radish's biomass by 50-70% and plants may still set viable seeds.

Table 2: Effect of flumetsulam 800 at 25g/ha at 4-5 node stage of chickpea on weed number and dry weight, canola (as weed) plant height and chickpea seed yield.

Flumetsulam treatments	Weeds/m² 5 July 21	Weeds/m² 21 Oct 21	Canola height (cm)	Weeds Dry Weight (kg/ha) 21 Oct	Chickpea Seed Yield (kg/ha)	Yield loss (%) due to no flumetsulam use
Minus flumetsulam	3a	9a	109b	1737 b	787 a	25
Plus flumetsulam	2a	6a	88a	545 a	986 b	
LSD (0.05)	-	-	12	-	166	-

Weed count per metre square and dry weight are back transformed values of log link and log (weeds dry weight+1) data transformations, respectively. Figures followed by same letters are not significantly different.

All pre-emergent (pre-em) herbicide treatments and REDPI21 applied post-em reduced canola/weed numbers and their dry biomass significantly. Majority of the treatments registered weed control efficiency (WCF) in the range of 95-100%. Flumioxazin (e.g., Terrain) and BADPI21 applied before seeding, and formesafen 240 at 1.25L/ha applied PSPE recoded weed control efficiency between 91-95%.

Interestingly, new herbicides like fomesafen and flumioxazin either alone and in mixture with other herbicides had a few canola or other weeds survive, whereas simazine and terbuthylazine in mixture with isoxaflutole, metribuzin and diuron provided all most weed free conditions. These few weed survivals had no significant negative impact on chickpea seed yield but could have returned weed seeds to soil-seedbank which can contribute to continuous weeds problem in crop rotations. However, it has been observed that wild radish appears to be more susceptible to formesafen than volunteer canola especially hybrid canola.

Application of simazine 900 at 835 g/ha in mixture either with isoxaflutole or isoxaflutole + metribuzin or diuron + isoxaflutole and terbuthylazine 750 1kg + isoxaflutole 750 100 g/ha (e.g., Palmero® TX 1kg/ha) PSPE caused visible bleaching of chickpea leaves within one month of these treatments' application. These symptoms were outgrown with time without any negative impact on chickpea seed yield compared to weed free treatment.

Fomesafen 240 applied PSPE at 1.25 L/ha yielded significantly lower than weed free and on par with untreated control. This treatment also recoded significantly lower chickpea dry biomass as compared to weed free (data not shown). Interestingly, fomesafen applied PSPE at lower rate (1 L/ha) in mixture with other herbicides yielded at par with weed free treatment. Similarly, a mixture of simazine + isoxaflutole applied IBS and simazine IBS followed by isoxaflutole PSPE were comparatively better yielding than simazine + isoxaflutole applied PSPE. There was 13mm and 40mm rain fell within two and four weeks after pre-em treatments application, respectively. This caused seeding -furrow filling and it could have resulted in higher concentration of the herbicide in the furrows and yield loss. These results are in-line with the previous trial results and formesafen (e.g., Reflex®) label instructions.

REDPI21 at 1.25 L/ha applied at 3-5 node stage of chickpea resulted in severe desiccation of crop soon after application. However, it appears that due to good growing conditions during 2021, chickpea plants recovered quite well and there was no significant negative effect on seed yield. It is worth mentioning that visual negative effect on crop biomass and plant height was evident up to crop maturity.

A potential new pre-emergent herbicide BADPI21 recorded 94% weed control efficiency and yielded on par with weed free control plots. This needs further testing to confirm the results.

Effect of selected herbicides on root nodules of CBA Captain

Application of fomesafen, flumioxazin, terbuthylazine + isoxaflutole, and simazine + diuron + isoxaflutole before seeding (IBS) did not have significant negative effect on root nodules of chickpeas (at early podding stage) compared to untreated control. The nodule score ranged from 5.4 (simazine + diuron + isoxaflutole) to 6.2 (fomesafen), where 5 = ample and 6 = abundant nodules. These treatments also had no significant negative effect on plant shoot and root dry weight of chickpea (data not shown).

Acknowledgements

Thanks to DPIRD/GRDC co-investment funding (DAW1903-004RTX) for this research work. Thanks to Liebe Group and Brad McIlroy for the trial site, DPIRD Research Facility Wongan Hills, and Salzar Rahman and David Nicholson Technical Officers, Northam, for their excellent technical assistance. Thanks to Karyn Reeves, Research Scientist/Biometrician for data analysis.

References

Howieson, J.G. and Dilworth, M.J. (Eds.). 2016. Working with Rhizobia. Australian Centre for International Agricultural Research: Canberra.

Peer review

Mark Seymour, DPIRD

Contact

Dr Harmohinder Dhammu
harmohinder.dhammu@dpird.wa.gov.au
0403 156 942

Department of **Primary Industries and Regional Development**
GOVERNMENT OF WESTERN AUSTRALIA

Table 3. Effect of herbicide treatments on weed count, weeds dry weight, weed control efficiency (WCE), and seed yield of CBA Captain chickpea.

No	Herbicides	Product rate/ha	Timing	Weeds/m² No flumetsulam 21 Oct 2021	Weeds/m² Plus flumetsulam 21 Oct 2021	Weed dry weight (Kg/ha) 21 Oct 2021	WCE (%)	Seed yield (Kg/ha)	Yield (%) increase over UTC
1	Untreated Control (UTC)			20 a	11. a	3215.3 j	0.0	687 a	0
2	Weed Free - simazine fb isoxaflutole	835g fb 100g	IBS fb PSPE	0 a	0 a	0 a	100.0	1056 defg	54
3	Formesafen 240 (e.g., Reflex®)	1.5L	IBS	0.2 a	0.2 a	10.5 def	99.7	912 abcdef	33
4	Formesafen 240	1.25L	PSPE	1.6 a	0.1 a	197.9 hi	93.8	750 abc	9
5	Formesafen fb isoxaflutole 750	1L fb 100g	IBS fb PSPE	0.2 a	0.1 a	5.5 bcde	99.8	1113 defg	62
6	Formesafen + isoxaflutole 750	1L + 100g	PSPE	0.7 a	0.3 a	41.3 fgh	98.7	1126 efg	64
7	Formesa + isoxaflu + metribuzin 750	1L + 100g + 180g	PSPE	0.2 b	0 a	1.8 abcd	99.9	1109 defg	61
8	Formesafen + simazine 900	1L + 835g	IBS	0.4 a	0.4 a	48.2 fgh	98.5	1050 defg	53
9	Formesafen + terbuthylazine 750	1L + 1kg	IBS	0.3 a	0.2 a	27.1 efg	99.2	1208 g	76
10	Formesafen + diuron 900	1L + 835g	IBS	0.9 a	0.6 a	138.1 hi	95.7	1043 defg	52
11	Flumioxazin 500 (e.g.,Terrain®)	180g	IBS	0.9 a	0.6 a	272.1 i	91.5	867 abcd	26
12	Flumioxazin + simazine 900	180g + 835g	IBS	0.6 a	0.5 a	127.9 ghi	96.0	1232 g	79
13	Flumioxazin fb isoxaflu + metri 750	180g fb 100g + 180g	IBS fb PSPE	0 a	0 a	0 a	100.0	1084 defg	58
14	Simazine900 + isoxaflutole 750	835g + 100g	IBS	0.04 a	0.04 a	1.8 abcd	99.9	1053 defg	53
15	Terbuthylazine 750 + isoxaflutole 750	1kg	IBS	0.1 b	0 a	1.4 abc	100.0	886 abcde	29
16	Simazine 900 + isoxaflutole 750	835g + 100g	PSPE	0.1 b	0 a	1.6 abcd	100.0	889 abcde	29
17	Terbuthylazine 750 + isoxaflutole 750	1kg	PSPE	0 a	0 a	0 a	100.0	984 cdefg	43
18	Simazine 900 + isoxaflu + metri	835g + 100g + 180g	IBS	0 a	0 a	0 a	100.0	1033 defg	50
19	Simazine 900 + isoxaflu + metri	835g + 100g + 180g	PSPE	0 a	0 a	0 a	100.0	998 cdefg	45
20	Simazine 900 + diuron 900 + isoxaflu	835g + 333g + 100g	PSPE	0.1 b	0 a	0.7 abc	100.0	1152 fg	68
21	Cyanazine 900 (e.g., Bladex®) fb isoxaflu	1.1kg fb 100g	IBS fb PSPE	0.4 b	0 a	3.9 bcd	99.9	942 bcdef	37
22	BADPI21	200mL	IBS	1.2 a	0.7 a	183.7 hi	94.3	1065 defg	55
23	REDPI21	1.25kg	3-5 nodes	0.1 a	0.1 a	6.8 cde	99.8	1020 defg	49
	LSD (0.05)			5 (for interaction)		-		252	-

UTC = Untreated Control, IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, fb = followed by, fomesa = fomesafen, isoxaflu = isoxaflutole (e.g., Balance®), metri = metribuzin. On an average weed count and dry weight had around 90% of proportion canola plants and the remaining 10% were wild radish, cape weed, doublegee and marshmallow weeds. Weed count per metre square and dry weight are back transformed values of log link and log (weeds dry weight+1) transformations, respectively. Weed counts followed by same letters for each herbicide treatment across No flumetsulam and Plus flumetsulam are not significantly different. Weed dry weight and seed yield sharing common letters are not significantly different. WCE is based on weed dry weight.

The Opportunity Cost of Herbicide Residue Effects Across Crop Types (IMI Residue Trial)

Chris O'callaghan, Project Support Officer, Liebe Group

Key Messages
- The results are site and season specific.
- Clearfield varieties showed no differences between treatments.
- Yields of non-Clearfield varieties were reduced with some herbicides.

Aim
To compare the potential yield penalty incurred due to herbicide residues in comparison to the yield penalty inherent in growing a herbicide-resistant variety.

Background
Herbicides that have long carry over residues can often limit cropping options, investigating the potential yield lost is important for growers to understand when planning crop rotations for the long term. This trial has been developed by the Liebe Group R&D Committee and internally funded by the Liebe Group. Initial results are presented below with the intention to implicate the same trial design in 2022 before final results are collated and analysed.

Ten herbicides have been applied in the previous year (2020) in a fallow paddock. In 2021 seven different crops including canola, wheat, barley and lupins were sown over the herbicide residues, including both standard and imidazolinones (IMI) tolerant varieties.

The trial has been conducted on heavy clay soil with a pH >7, and above-average rainfall has fallen at the site this season. Results may differ significantly at sites with different soil profiles, as residual herbicides are broken down through a number mechanisms in the soil and, as such different soil profiles will influence how each residue is broken down.

IMI chemistry such as Intercept, Sentry and Claw are all broken down primarily through microbial activity and as such higher rainfall years where the soil has greater microbial activity will result in shorter residual activity and vice versa in dry years. Sulfonurea (SU) chemistry such as Associate and Monza are broken down through hydrolysis (chemical reaction of the interaction of chemical with water) and as such higher pH soils will result in prolonged residual activity.

Due to these factors, it is noted that a trial such as this should be conducted on multiple different soil types to gain an understanding of different residual carryover effects that can help to inform farmers decisions when choosing varieties.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu			
Plot size & replication	2.5m x 5m x 3 replications			
Soil type	Heavy red clay			
Paddock rotation	2020 chemical fallow, 2019 barley, 2018 wheat, 2017 field peas			
Sowing date	19/05/2021			
Sowing rate	Wheat	Barley	Lupins	Canola
	70 kg/ha	80 kg/ha	100 kg/ha	by seed weight
Fertiliser	100 kg/ha Urea 130 kg/ha MacroPro Extra	100 kg/ha Urea 130 kg/ha MacroPro Extra	130 kg/ha MacroPro Extra	100 kg/ha Urea 130 kg/ha MacroPro Extra
Harvest date	11/12/2021	10/12/2021	31/10/2021	31/10/2021

Treatments

Herbicides

	Product	Active	Rate g/ha	Abbreviation
1	Untreated	-	-	-
2	Intercept	Imazamox + Imazapyr	375	Imox12+Ipyr6
3	Intercept	Imazamox + Imazapyr	750	Imox25+Ipyr11
4	Sentry	Imazapic + Imazapyr	20	Ipic10+Ipyr4
5	Sentry	Imazapic + Imazapyr	40	Ipic21+Ipyr7
6	Claw	Imazamox	45	Imox16
7	Associate	Metsulfuron	5	Metsulf5
8	Monza	Sulfosulfuron	30	Sulfos30
9	Archer	Clopyralid	80	Clopyr80
10	Archer	Clopyralid	120	Clopyr120

Crops

Species	Variety
Wheat 1	Hammer CL
Wheat 2	Scepter
Barley 1	Maximus CL
Barley 2	Buff
Lupin	Jurien
Canola 1	540XC
Canola 2	410XX

Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	KCl S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)	PBI
0-10	5.8	26	159	4.4	31	3	0.08	0.89	61
10-20	7.7	7	66	1.9	12	2	0.16	0.45	85
20-30	7.7	4	67	1.9	7	2	0.15	0.35	84

Results

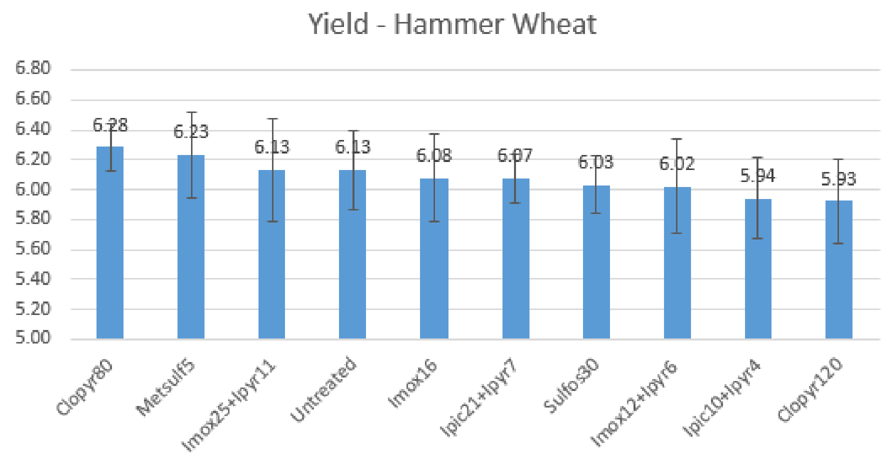


Figure 1: Yield results for Hammer CL Wheat.(Clearfield). P=N.S

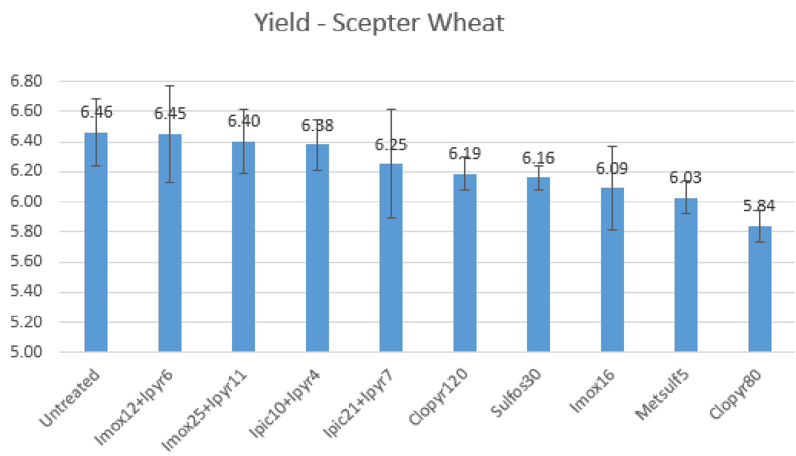


Figure 2: Yield Results for Scepter Wheat in 2021. P=N.S

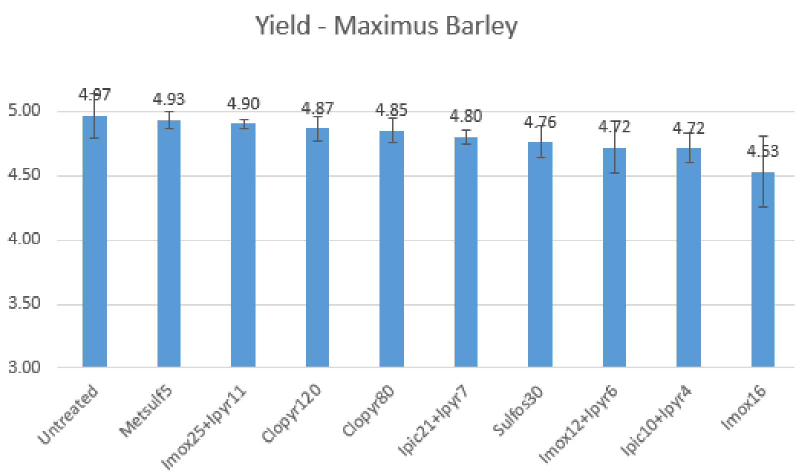


Figure 3: Yield Results for Maximus CL Barley (Clearfield). P=N.S

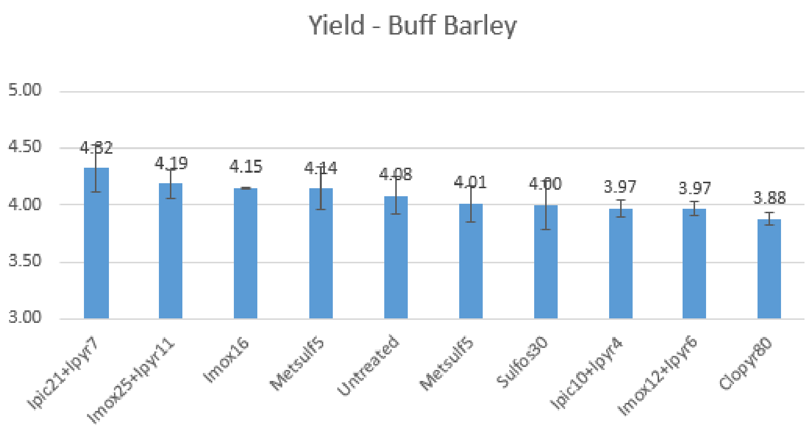


Figure 4: Yield Results for Buff Barley. P=N.S

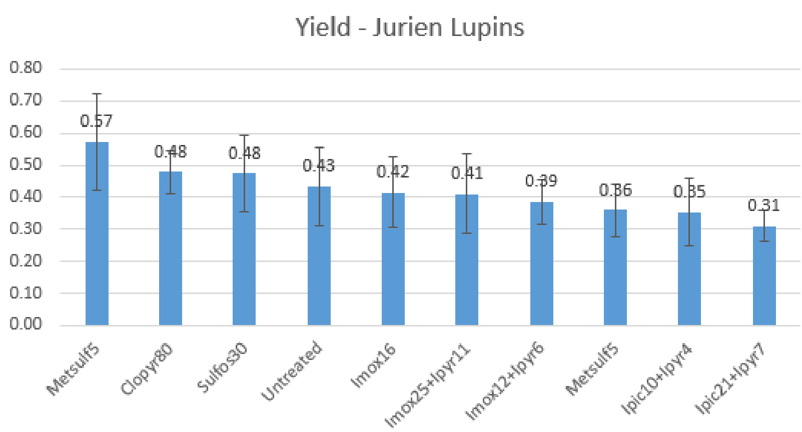


Figure 5: Yield Results for Jurien Lupins. P=N.S

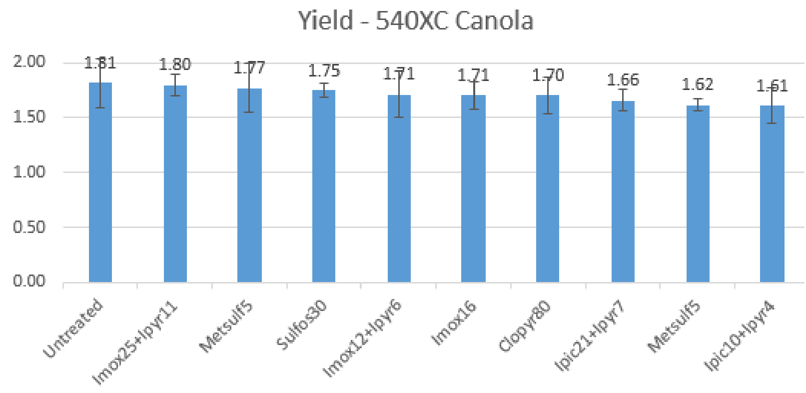


Figure 6: Yield Results for 540XC Canola (Clearfield). P=N.S

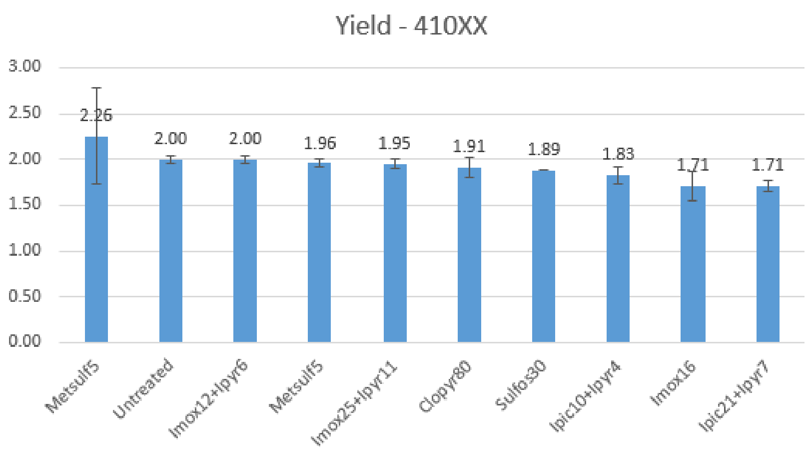


Figure 7: Yield Results for 410XX Canola (TruFlex). P=N.S

Comments

As expected Clearfield varieties yielded consistently across different herbicide residue treatments in all crop types.

For the non-Clearfield cereal varieties, there was suprisingly little crop effect from the herbicides, with minimal visual crop effect backed up by consistent yields. Minor yield penalties were observed in Scepter wheat with the 5g metsulfuron and 80mL clorpyralid treatments, however this result was statistically insignificant. The IMI chemistries did not appear to affect the non-Clearfield cereal varieties in any of the treatments for both wheat and barley at this trial.

In the lupins even though all chemical treatments were not registered, there was surprisingly little variation compared to the untreated plots. However it must be noted that lupins are not traditionally suited to this soil type and did not appear to handle the waterlogging conditions very well with relatively poor yields.

In the non-Clearfield canola there was some minor yield penatlies observed by some of the treatments, which was expected. However the penalties were not as large or obvious as expected compared to anecdotal observations by members and label warning and the results were not statistically different. The high rate of imizapic (40 g/ha Sentry) had the greatest negative effect on the 410XX canola as expected given the lack of tolerance to IMI chemistry in canola, and longer residual activity of imazapic compared to the other chemicals in the imi group.

Given the soil test results it can be seen that the pH of the site was quite high as is commonly seen on heavy red clay loam soil types in the area. At depth the pH increased quite significantly to 7.7. This is important to note and played a main role in the results. As IMI residues are broken down rapidly in high pH soil types and where there is abundant rainfall, it was an example of a year where imi residues were broken down rapidly in the soil and as such, a much smaller effect was noticed on the non-imi type crops than expected.

On the contrary to this, SU chemistry will prolong in the soil for longer if the pH is higher given its breakdown mechanism. Despite this, results seem varied across the different crop types and often did not match what would be normally expected.

Possible explanations of the lack of crop injury in sensistive crops at this trial could be;

- Weed control outweighing the potential yield penalty that was resultant of the chemical residue, however this was not obvious or measured, or
- Seasonal conditions mitigating the effect of residual chemicals.

Given the results a further replication of this trial will seek to clarify any potential questions that have been raised from this year with the opportunity to conduct statistical analysis between two years with a larger set of data. This will allow for more conclusive evidence of yield penalties associated with residual chemistry to be presented.

Please note this trial is season and site specific and results should be interpreted with caution. The trial will be run again in 2022 at the Miling Main Trial Site hosted by the Reynolds family.

Acknowledgements
This trial is led and funded by the Liebe Group under guidance of the Liebe Group R&D Committee and has been implemented on Matt Hyde's Property. Thanks to Nutrien Ag Solutions & Imtrade for the donation of chemicals, and thanks to Imtrade Australia for their assistance in designing and executing the trial.

Peer review
Tristan Clarke, Elders Scholz Rural Dalwallinu

Contact
The Liebe Group
research@liebegroup.org
08 9661 1907

DISEASE & PEST RESEARCH RESULTS

2021 Survey of the Summer/Autumn Brassica Refuges for Diamondback Moth to Predict Early Season Risk of Infestation

Christiaan Valentine, Research Scientist, Department of Primary Industries and Regional Development

Key Messages

- This is the second year of a four-year research project looking at the influence of a late summer, early autumn green bridge at predicting growing season diamondback moth (DBM) numbers.
- Initial results from 2020 and 2021 suggest that there are other factors influencing winter DBM populations.
- It is important to monitor DBM populations by sweep netting as numbers can quickly increase above thresholds.
- 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 can 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.

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, South East Agronomy Services and West Midlands Group identified and mapped DBM larvae in the March green bridge plants, specifically wild Brassicas (e.g., wild radish) and volunteer canola. Pheromone moth traps were then set up at sites where we found brassica plants and moths and caterpillars monitored until late October to get a better idea of their spatial distribution.

Results

This work consisted of two main surveying stages:

1. A Green Bridge and DBM Survey in March - April.
2. A Survey of DBM moths and Caterpillars on 44 'focus' canola crops from June to November.

1. Green Bridge Surveillance (March – April)

In 2021, the WA Grainbelt experienced significant rainfall during February and March which resulted in many positive brassica sites during mid-March. Within a two-week period from 15 March to 31 March, staff inspected 555 locations for the presence of brassica plants and DBM larvae, mostly from roadsides. Of the 555 sites inspected, only 66 sites (12%) had no living plant material (i.e., no green bridge), and 194 sites (35%) had live plant material but no brassicas. Most of these green bridge sites consisted of summer weeds such as fleabane, stinkwort and perennial grasses. Sites which had low occurrences of brassicas or no green bridge in 2021 were mostly in the Geraldton and Esperance port zones.

Radish was the most prevalent brassica found in the survey, with 239 sites containing radish, 52 canola, 26 turnip and several sites containing unknown cotyledons.

Of the 285 DBM pheromone moth (Delta) traps placed at brassica sites for 4 weeks, 57 traps had DBM moths ranging from 1 to 143. These locations are displayed in Figure 1. Pheromone moth traps are a much better indicator of DBM presence than vegetation assessments for larvae which can be difficult to detect in small young plants and cryptic especially when in low numbers.

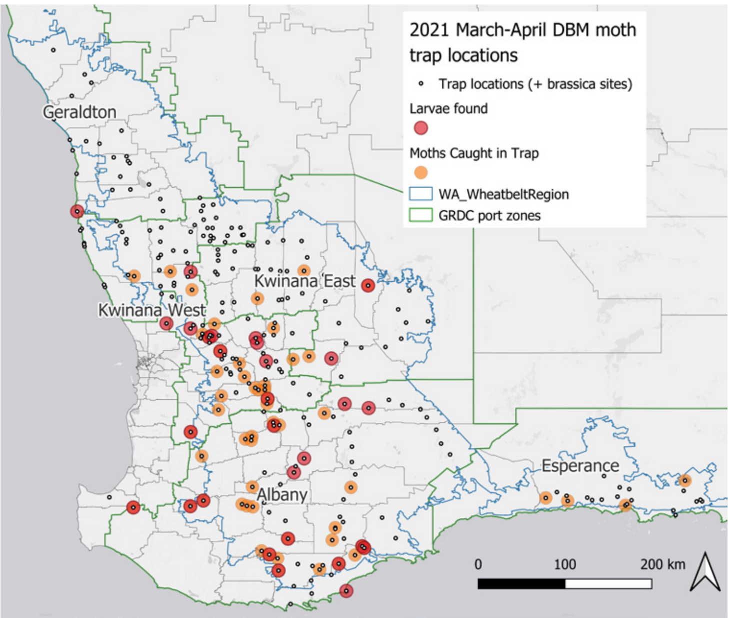


Figure 1: Map showing 285 DBM moth trap locations including locations with larvae found and with and without moths after a 4-week period during March-April 2021.

2. Growing Season Surveillance of Focus Crops (June – November)

Following on from the March-April green bridge surveillance, we chose 44 focus crops both near and far from DBM positive sites to investigate whether pre-season Brassicas harbouring DBM contribute to early crop colonisation and/or higher populations of caterpillars in spring (Figure 2). Strategic surveillance was conducted as soon as canola crops in the regions had established.

Mean bimonthly DBM moth and caterpillar results for the 44 focus crops are presented in Figure 3. 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. Interestingly high moth populations did not translate into high caterpillar numbers and focus site caterpillar number remained below the economic threshold to warrant spraying.

Moth populations developed earlier in Albany and Geraldton. Caterpillar numbers correlated with high moth numbers, although DBM caterpillars did not reach threshold numbers at any of the focus paddocks. We are currently collating grower insecticide data that may explain lower caterpillar numbers in some regions.

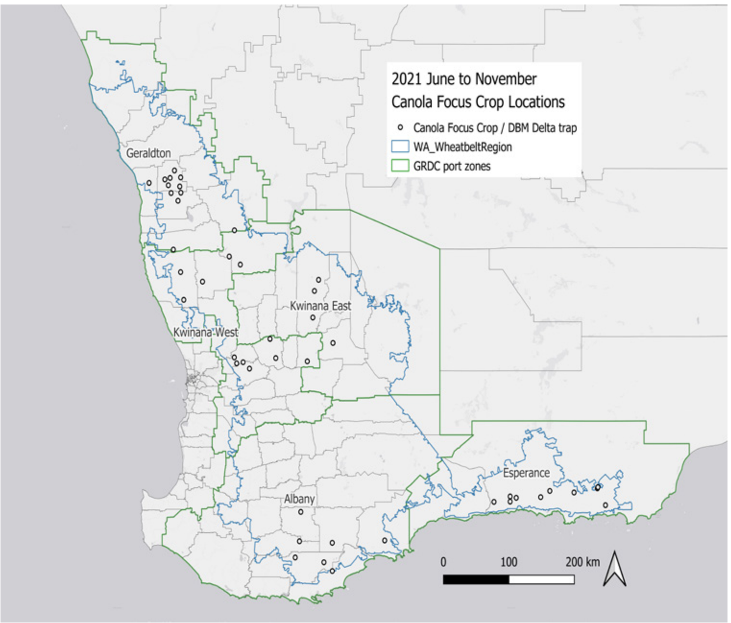


Figure 2: Map of DBM focus crops in each port zone of the WA Grainbelt in 2021

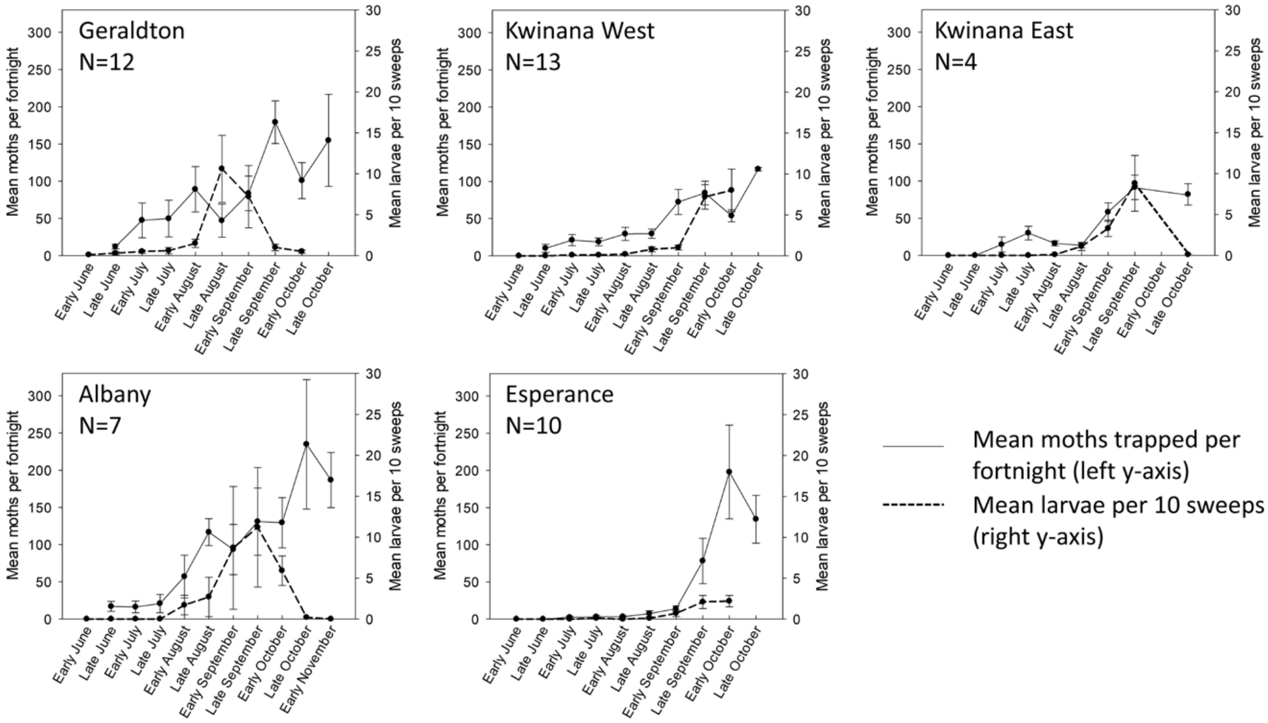


Figure 3: Mean DBM moth and caterpillars (+/- SEM) surveillance results for canola crops assessed from June to October 2021.

Comments

It was important to follow DBM moth and caterpillar populations for all focus crops during 2020 and 2021 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 harboured DBM. This indicates that other factors, in addition to DBM in the green bridge, are influencing DBM populations. There was not a clear correlation between green bridge and winter moth populations; but moth hotspots identified in June and July may be a predictor of more damaging moth numbers in those areas. Moths built up early at several trap locations in Geraldton and Albany and continued to build up at those locations, while focus crops that did not have large numbers early in the growing season, generally did not develop large numbers until late September or August.

Acknowledgements

This research was a co-investment by DPIRD and GRDC, project DAW1905-010RTX, Survey of the Summer/Autumn Brassica Refuges for Diamondback Moth in the Western Region to Predict Early Season Risk of Infestation. Technical and survey support from DPIRD staff, the Liebe Group, West Midlands Group, Mingenew Irwin Group and South East Agronomy Services.

Peer review

Dr Dustin Severtson, DPIRD

Contact

Christiaan Valentine
Christiaan.valentine@dpird.wa.gov.au
9690 2197

Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Making a Case for Foliar Fungicides for Yellow Spot Control in Wheat

Tom Shaw, Farm Services Agronomist, Nutrien Ag Solutions

Key Messages

- Fungicides reduced yellow spot infection in Scepter wheat.
- Reduced infection did not equal better yield, most likely because of a lack of August/September rainfall and good yellow spot resistance genetics in Scepter wheat.
- Growers might consider an application of propiconazole where a wet spring is expected or a variety is susceptible.
- It is hard to make a case for use of premium fungicides for yellow spot in Scepter wheat.

Aim

The aim of this trial is to see whether there is an economic response to foliar fungicide application to control yellow leaf spot. We also want to understand if there is value in spending more on a premium fungicide, over and above a standard propiconazole application.

Background

Fungicides are applied to protect yield. Disease reduces yield by competing with the crop for water and nutrition and reducing green leaf area available for photosynthesis. Roughly speaking, the photosynthetic process turns sunlight, water and carbon dioxide into oxygen and carbohydrate. Much of this carbohydrate is used to fill grain. If disease reduces green leaf area, it reduces photosynthesis and therefore carbohydrate production and therefore yield.

The flag leaf (final leaf to emerge) and flag -1 (2nd last leaf) are thought to contribute roughly 60% of yield between them, therefore these are the most important leaves to protect from disease. Another 20% of yield comes from the head, and the rest from the lower canopy.

Yellow leaf spot is a common disease of wheat in the northern growing regions of Western Australia. Liebe Group noted that yellow leaf spot was developing on the lower leaves of the canopy at the 2021 site, so an opportunity presented to test whether (a) yellow leaf spot will reduce yield in these specific set of conditions, (b) whether application of a fungicide will protect yield, and (c) whether application of a premium fungicide will protect more yield than a standard propiconazole.

The conditions most conducive to economic yield loss from yellow leaf spot are:

- Variety susceptibility.
- Wheat on wheat rotation with retained stubble.
- 6 hours of leaf wetness at temperatures from 15-28 C.
- 100 mm rainfall post flag leaf emergence
- Early flag leaf emergence
- Above average seasonal rainfall

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	10m x 3m x 3 replications
Soil type	Heavy red loam
Paddock rotation	2020 wheat, 2019 wheat, 2018 wheat
Sowing date	01/05/2021
Sowing rate	50 kg/ha Sceptre wheat
Fertiliser	As per grower application
Herbicides, Insecticides & Fungicides	As per grower application prior to Z37 (treatment applications). Treatments applied 12/08/2021 at flag leaf emergence.

Treatments

	Treatment
1	Untreated Control
2	285 mL/ha Propiconazole 435 g/L
3	300 mL/ha Aviator Xpro 225 g/L (75 g/L bixafen, 150 g/L prothioconazole)
4	420 mL/ha Radial 150 g/L (75 g/L azoxystrobin, 75 g/L epoxiconazole)

Soil Composition

Soil is a red loamy sand. Good pH to depth should mean good access to stored moisture during grain fill.

Results

An assessment of % leaf area infection (%LAI) was done 28 days after treatments were applied. There was a small amount of leaf infection at the top of the canopy at time of assessment, with greater infection in lower leaves. Flag-3 was quite senesced at the time of assessment.

Fungicides kept leaves cleaner from disease on each of the top four leaves, in comparison to treatments where no fungicide was applied. %LAI was minimal on the flag leaf for all treatments, but the premium fungicides were cleaner than the propiconazole and untreated treatments (Figure 1). All fungicides kept flag-1 cleaner than the untreated treatment. All fungicides reduced LAI% compared to where no fungicide was applied on flag -2. There were also differences between fungicides on flag -2. Radial kept flag -2 cleaner than propiconazole. All fungicides reduced LAI% on flag -3 compared to where no fungicide was applied.

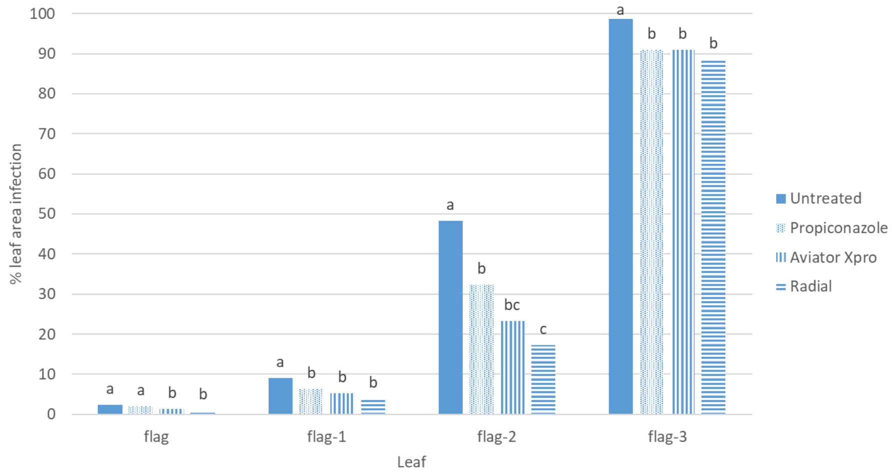


Figure 1: % leaf area infection 28 DAA (days after application). Fungicide application kept all leaves cleaner than where fungicide was not applied. Premium fungicides kept flag and flag-2 cleaner than propiconazole. [LSD P=.05 – 0.67 (flag), 2.67 (f -1), 9.16 (f -2), 5.57 (f -3); CV - 20 (flag), 21.62 (f -1), 15.11 (f -2), 3.02 (f -3)]

Fungicide treatments did not cause any difference in yield when compared to the untreated control, where no fungicide was applied. There was no difference between different fungicide treatments (Figure 2).

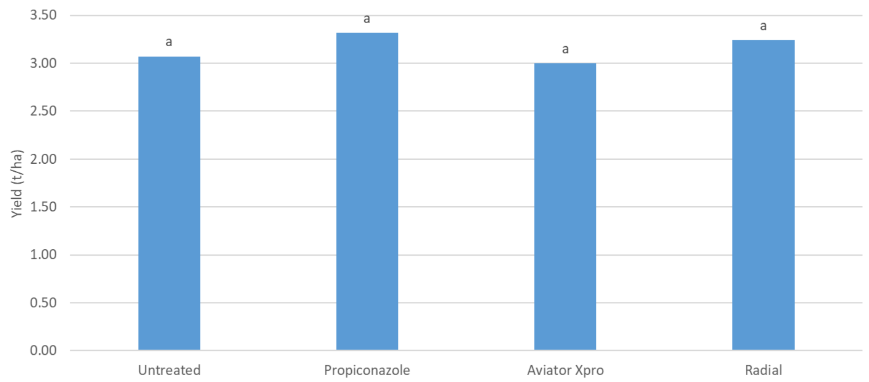


Figure 2: Average yield (t/ha) of treatments. Application of fungicide did not cause any difference in yield between treatments. (LSD P=.05 – 0.527; CV 8.36)

Comments
Of the six described factors which are conducive to yellow spot development, this season produced at least four. The wheat-wheat-wheat rotation in this paddock meant that it was likely there was yellow spot present in stubbles. Spore release from stubble is how the crop becomes infected. There would have been plenty of times during the season that leaves were wet for >6 hours at >15°C, which are the conditions required for the disease to develop. A 1st May sowing date also means an earlier than average emergence of the flag leaf (last leaf). This means that the flag leaf and flag -1, which contribute about 60% of yield, were exposed to disease conducive conditions for a greater proportion of the year than a standard mid-May sown crop. The year also produced above average seasonal rainfall.

As it turns out, there was no differences in yield between where we applied fungicide and where we didn't. The fungicides were clearly effective in reducing disease (Table 1), but this did not translate into yield benefit (table 2), likely because of two key factors. Firstly, there was only about 20mm rainfall from the date of application (12th August) and 19th October. As previously described, >6 hours of leaf wetness is required for disease to develop, and these conditions were rare after the application of the fungicide. DPIRD disease experts describe needing closer to 100mm of rainfall after flag leaf emergence before there is an economic impact from yellow spot. The other important factor in the lack of yield response to fungicide is genetic resistance. Sceptre is rated Moderately Resistant – Moderately Susceptible (MRMS) for yellow leaf spot, the equivalent of 1-2 fungicide sprays better than a SVS rated variety – think Yitpi. Even though there were differences in the area of leaf infected on flag and flag -1 between treatments, overall the level of infection in these leaves was low, probably did not impact on photosynthesis and consequently, did not reduce yield.

Early season rainfall cut-offs and good genetic resistance in commonly grown varieties means that it will be rare to see an economic response to a fungicide for yellow spot in Dalwallinu. Propiconazole is cheap, so in seasons where a wet spring is expected, it may be a good practice to apply a fungicide, otherwise it unlikely you will get a return. It is difficult to make a case for more expensive, premium fungicides for yellow spot control in Dalwallinu.

Acknowledgements
Thanks to Thomas Stanicich – Nutrien Graduate Agronomist, Wongan Hills and Richard Stone, Product Development Agronomist for drafting the protocol, applying treatments, managing the trial site, assessments and harvest. Thanks to Geoff Thomas, DPIRD, for reviewing the article and giving some helpful feedback.

References
Beard, Ciara, Andrea Hills, Kithsiri Jayasena and Geoff J. Thomas, Managing yellow spot and Septoria nodorum blotch in wheat, July 2021, DPIRD.

Peer Review
Geoff Thomas, DPIRD

Contact
Tom Shaw
tom.shaw@nutrien.com.au
0417 652 086

Nutrien Ag Solutions™

Survey of Invertebrate Pests and Beneficials Harbouring in Harvest Weed Seed Control System

Svetlana Micic, Entomologist, Department of Primary Industries and Regional Development

Key Messages

- Both invertebrate pests and beneficials are found in association with chaff in paddocks.
- Paddocks located in the Kwinana East port zone had the least pest densities and highest numbers of seed-harvesting ants associated with chaff.
- The most abundant beneficials were weed seed harvesting ants which were found in close association with chaff.
- Leaving chaff to rot-in-situ does not affect abundances of pests such as desiantha weevil. However, other pests do use chaff as refuges.

Aim

To determine whether there is a difference in invertebrate populations across different HWSC systems over the WA grain belt, specifically if there is a species change with accumulating chaff within paddocks and the impact on the following crop.

Background

There are three non-burning and non-mechanical techniques most commonly employed in harvest weed seed control (HWSC) systems: chaff dumping, chaff lining and chaff tram-lining. The highest adoption of HWSC is in the GRDC western region with an estimated 67% of all farmers undertaking at least one HWSC strategy in 2014.

Chaff dumping is the collection of the chaff fraction using a cart towed behind the harvester. The chaff in the cart is then dumped, usually in piles in the paddock. The chaff is then either burnt, grazed or left to decompose.

For chaff lining, the chaff and weed seeds are confined to a row directly behind the harvester using a narrow chute. The chaff and weed seeds are then left to decompose over time. To promote decomposition, the chaff lines need to be placed in the same location year after year by running the harvester on a controlled traffic system (CTF).

Chaff tramlining is a similar concept to chaff lining, but the chaff fraction is diverted from the chaff deck onto permanent wheel tracks in a CTF system. Wheel traffic creates a hostile environment that inhibits weed seed germination.

There has been a recent system change with more growers opting for leaving chaff in-situ to rot, whether in dumps or in lines, rather than burning. This investigation aimed to better understand invertebrate species and mice associated with these HWSC systems, which to date are poorly understood, in each of the five port zones: Albany, Esperance, Geraldton, Kwinana's East and West.

Trial Details

A total of 87 paddocks were surveyed during 2019-2020. An effort was made to identify a similar number of HWSC systems per port zone for this study. However, some HWSC systems are under-represented in certain zones. For instance, chaff tram lining is more common in the Esperance port zone than in the Kwinana port zones (Figure 1).

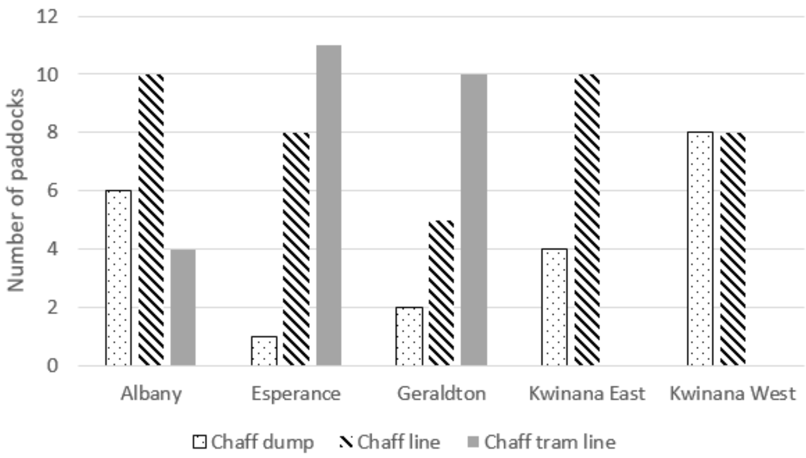


Figure 1: Number of paddocks with a harvest weed seed control (HWSC) system per port zone.

Two times of sampling occurred: prior to planting and post planting when crops were at the seedling stage Pitfall traps were placed at least 50 metres from any fence line or vegetation. These consisted of 250 mL containers, dug into the ground so the top lip was level with the surface. Pitfall traps were placed in two rows and kept open for 7 days. Each row consisted of 10 pitfall traps placed at least 10 metres apart.

One row was placed adjacent to chaff (near), at a distance of 5cm from chaff; the second row (far) was placed parallel to the first at a distance of 20m away. In paddocks with chaff lines or tram-lines, the chaff lines are spaced at least 6m apart. The 'far from chaff' pitfall trap rows were located between chaff lines and were at least 3m from a chaff line.

In paddocks with chaff dumps, the second row was located 20m from any chaff. Due to paddock variation, most chaff dumps were less than 100m in length. In this case, pitfall traps were placed 10m apart 5cm from the chaff (close) and at least 20m away from chaff (far) on the same side of multiple chaff dump.

Results

Pitfall traps captured invertebrates in every paddock including crop pests. However, significant differences in invertebrates captured between the different HWSC systems were not found.

Overall paddocks with tram-lines had 30% less pests than other HWSC systems However, the presence of chaff can lead to increases in some pests; pitfall traps adjacent to chaff on average ($P>0.05$) captured 70% more Rutherglen bugs and 40% more pest beetles, than pitfall traps located in standing stubble. Pest beetles, comprised of vegetable beetle, bronzed field beetle and its larvae, African black beetle; and weevils: vegetable weevil, Fuller's rose weevil, sitona weevil, lucerne weevil (Figure 2).

Desiantha weevil was not included in analysis with pest beetles, as this species was more likely to be found in standing stubble. Pitfall traps located in standing stubble on average captured 30% more ($P>0.05$) desiantha weevil than those adjacent to chaff (Figure 2).

Similarly, an association with chaff was not found for slaters or snails, with low numbers of these pests being captured in pitfall traps (Figure 2). If only the paddocks in which these pests were found are analysed ($P>0.05$), 30% more slaters and 70% more small pointed snails were found in pitfall trap catches located in standing stubble; whereas no differences in round snail captures were found in relation to the location of the pitfall trap.

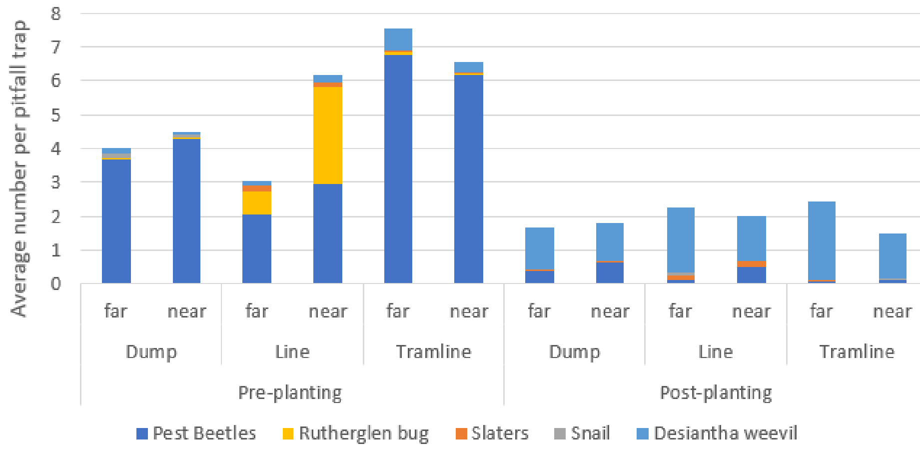


Figure 2: Average number of pests found in pitfall per pitfall trap located 5cm from chaff (near) or at least 3m away from chaff (far) in paddocks with HWSC systems of either dumps, chaff lining or chaff tram-lining, sampled at two different times.

Another pest, the European earwig, is not shown due to very low numbers being captured in pitfall traps as it was only found in 10% of paddocks (9 paddocks) surveyed. Even so, if only the paddocks in which it was found are analysed, 50% more European earwigs were found in pitfall traps located near chaff than in standing stubble.

Unlike European earwigs, native earwigs did not show a preference for chaff. Native earwigs are predatory and were found in 45% of all paddocks surveyed in very low numbers ie an average of <1 per pitfall trap. Even so, pitfall trap located near chaff captured similar numbers of predatory earwigs as those in standing stubble.

Similarly, the location of the pitfall trap did not influence catches of other predatory species such as ants, assassin bugs from family Reduviidae and centipedes. Like predatory earwigs these were found in low numbers and in order to be graphically represented are denoted as other predatory invertebrates in Figure 3.

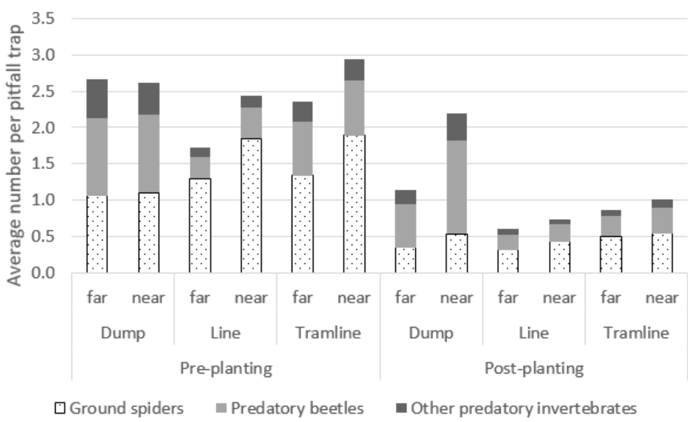


Figure 3: Average number of beneficials per pitfall trap located 5cm from chaff (near) or at least 3m away from chaff (far) in paddocks with HWSC systems of either dumps, chaff lining or chaff tram-lining, sampled at two different times.

Other beneficial species were found in association with chaff. Pitfall traps located near chaff captured on average 25% more ground beetles, spiders and weed seed harvesting ants, than traps in standing stubble. Weed seed harvesting ants comprise of ants from the genus Pheidole, Rhytidoponera, Monomorium or Melophorous that predate on weed seeds. This group was the most plentiful comprising of 80% of all pitfall trap (Figure 3).

Timing of the deployment of the pitfall traps also influenced invertebrate catches. Before planting, pitfall traps captured on average 90% more beneficials invertebrates and pest beetles, and only Rutherglen bugs were found in catches before planting occurred. However, 90% more desiantha weevils were in pitfall traps after planting had occurred (Figures 2, 3).

The location of paddocks also influenced the diversity of invertebrates that were captured in pitfall traps. Pitfall traps located in paddocks in the Albany port zone on average captured 90% more pests compared to pitfall traps located in other port zones. In this port zone pitfall trap 80% of catches were comprised of pest beetles (Figure 4).

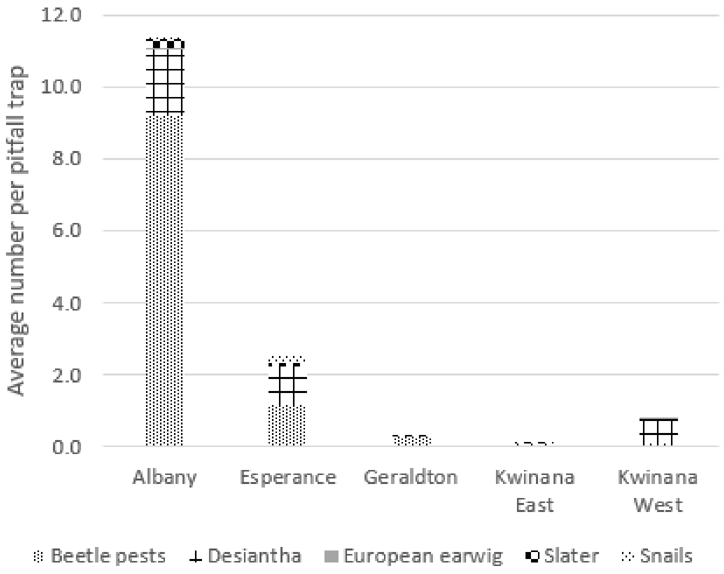


Figure 4: Average number of pests found in paddocks per pitfall trap by port zones.

Whereas, the dominant group of beneficials captured were weed seed harvesting ants, with an average of 70% more of these ants captured in pitfall traps located in the Kwinana East Port Zone (Figure 5).

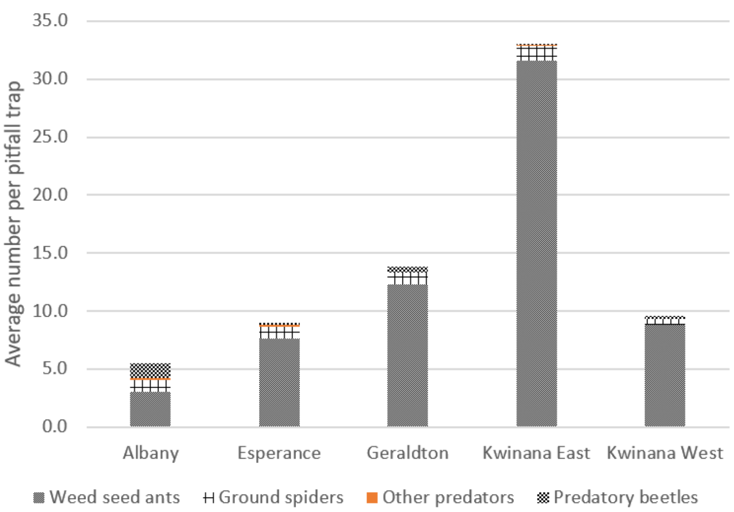


Figure 5: Average number beneficials per pitfall trap by port zones.

Comments

Both invertebrate pests and beneficials are found in association with chaff in paddocks. However, the species composition depends on the location of the paddock. Paddocks located in the Albany port zone are more likely to have higher densities of pests associated with chaff, whereas paddocks located in the Kwinana East port zone had the least pest densities and highest numbers of seed-harvesting ants associated with chaff.

The most abundant beneficials were weed seed harvesting ants which were found in close association with chaff. As these ants predate on weed seeds and live in holes in the ground, it is unlikely they are using chaff as a refuge, it is more probable that they are foraging in the chaff. This trend presents an opportunity to investigate in greater detail whether seed-harvesting ants provide an economic benefit to growers by consuming weed seeds from HWSC systems left to rot-in-situ.

Pitfall trapping was able to capture a higher diversity of invertebrate species than direct sampling of chaff. As pitfall trapping did not rely on samplers locating an invertebrate, it is more likely to be a more accurate representation of species presence and diversity in a paddock. However, this technique does rely on invertebrates moving and falling into a pitfall trap.

Leaving chaff to rot-in-situ does not affect abundances of pests such as desiantha weevil. However, other pests do use chaff as refuges. For instance, pest beetles, Rutherglen bugs, European earwigs were found in association with chaff. It is unlikely these species are feeding on chaff, but rather are using chaff as a refuge. This survey was not able to determine if long term retention of chaff will increase abundances of these pests.

Acknowledgements

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

This project would not have been possible without the invaluable assistance of: Minginew Irwin Group, The Facey Group, Anastazi Agronomy, Stirlings to Coast Farmers, Fitzgerald Biosphere Group, South East Premium Wheat Growers Association, Southern Dirt, The Liebe Group, and Corrigin Farm Improvement Group.

Peer review

Sally Peltzer, DPIRD

Contact

Svetlana Micic

svetlana.micic@dpird.wa.gov.au

0427 772 051

Department of
Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

Soilborne Pathogen Identification and Management Strategies Project

Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages

- Deep ripping reduced Rhizoctonia levels, however, negatively impacted yield.
- Work is ongoing by DPIRD pathologists to assess impact of treatments on yields in the following year.
- This is the set-up year of a two-year project.

Aim

This project aims to provide growers with knowledge and experience in diagnosing soilborne pathogens from symptom expression on plant roots. It will also provide them with knowledge of management of these pathogens and demonstrate some management options in field situations and deliver extension activities nationally.

Background

Despite the significance of the issue, diagnosing soilborne pathogens can be difficult. Currently, the presence or absence of soilborne pathogens can be ascertained through diagnostic services (e.g. PREDICTA B, DDLS), through the observation of root symptoms, and to a lesser extent, above-ground crop symptoms. Unfortunately, it has become apparent that growers frequently rely on above-ground crop symptoms to diagnose crop issues.

Above-ground symptoms for soilborne disease diagnosis can be problematic and incorrect for several reasons. Firstly, several of the observable crop symptoms can be similar between different pathogens and plant parasitic nematodes and even other crop issues such as nutrient deficiency. Secondly, some in-crop symptoms of soilborne disease expression can be impacted by seasonal conditions such as 2021's higher rainfall resulting in patches not being obvious in the field.

Thirdly, some pathogens co-exist and impact cereals in a complex interaction that may increase the complexity of visual identification above and below crop. Reliance on a single method of identification increases the likelihood of incorrect management strategies being implemented, and a holistic approach to identification with all available tools is ideal.

As soilborne disease management is reliant on correct identification of the causal pathogen, it is important that growers and advisors are supplied with the knowledge and experience to be able to achieve this. The purpose of this investment is to extend to growers and advisors the different methods for correctly identifying soilborne pathogens.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	36m x 10m x 1 replication
Soil type	Red loam
Paddock rotation	2020 fallow, 2019 barley, 2018 wheat, 2017 field peas
Sowing date	17/05/2021
Sowing rate	70 kg/ha Mace wheat; 100 kg/ha Twilight field peas
Fertiliser	17/05/2021 - 50 kg/ha MAP Zinc, 23/06/2021 - 60 kg/ha Urea
Herbicides, Insecticides & Fungicides	Double Knockdown ***Wheat*** 17/05/2021 - 2 L/ha Trifluralin, 2.5 L/ha Prosulfocarb, Flutriafol 0.4 L/ha 03/07/2021 - 1 L/ha Bromoxinil ***Field Pea*** 17/04/2021 - 1 L/ha Propyzamide, 1 L/ha TriflurX, 0.5 L/ha Chlorpyrifos PSPE - 0.12kg/ha Balance Post - 0.25 L/ha Clethodim, 0.6 L/ha Aviator, 0.25 L/ha Clethodim, 0.6 L/ha Aviator, 0.1 L/ha Diflufenican, 0.1k g/ha Metribuzin, 0.54 L/ha Veritas

Treatments

	Crop	Treatment
1	Pea, Twilight	Brown Manured Field Pea Crop
2	Wheat, Mace	Fungicide (Uniform) applied in furrow
3	Wheat, Mace	Pre-Seeding Deep Ripping
4	Wheat, Mace	Untreated Control

Results

Table 1: Baseline PREDICTA B measurements at the start of the trial sown in 2021. Soil samples were collected in May 2021.

	Pathogens detected from PREDICTA B tests		
Treatments	**Rhizoctonia solani AG8 pgDNA/g sample**	**F. pseudograminearum pgDNA/g sample**	**Pratylenchus neglectus nematodes/ g soil**
4: Control (untreated)	0	2	7
3: Deep Ripping	0	1325	10
2: Uniform in furrow	0	4	9
1: Field peas	35	0	9

At the start of season both R. solani AG8 and F. pseudograminearum DNA was not found at equivalent amounts throughout the trial (Table 1). There was a medium level of R. solani DNA in the field pea treatment with the other treatments having no detections. For F. pseudograminearum, there was a high level of DNA present in the deep ripping treatment with the remaining treatments having low or below detection level. Pratylenchus neglectus was found at medium levels at all treatments.

Table 2. Results of live plant sampling in July 2021 at GS30. Samples were processed through DDLS.

	Live plant results			
Treatments	**Rhizoctonia solani**	**Fusarium sp.**	**Pithium Root rot**	**Root lesion nematode (Pratylenchus neglectus/g of root)**
4: Control	Detected	Not detected	Not detected	2,166
3: Deep Ripping	Detected	Not detected	Not detected	1,028
2: Uniform in furrow	Detected	Not detected	Not detected	1,756
1: Field peas	Not detected	Not detected	Not Detected	6,317

Results from live plant sampling collected on the 17th July 2021 showed that Pratylenchus neglectus was detected in all wheat plots at a low level (<2,100 nematodes per g of root) except for in the pea plots (table 2). Nematode numbers were moderate at 6,317 nematodes per g of root which was unexpected because field peas are a good resistant rotation crop to reduce RLN levels in a paddock. The higher result in peas may be a consequence of hitting a 'hot spot' as nematodes have a patchy distribution by nature. No other nematode species were detected in the samples submitted.

Table 3: PREDICTA B results from treatments at the end of the trial. Soil was sampled on 2nd December 2021.

	Pathogens detected from PREDICTA B tests		
Treatments	**Rhizoctonia solani AG8 pgDNA/g sample**	**F. pseudograminearum pgDNA/g sample**	**Pratylenchus neglectus nematodes/ g soil**
4: Control (untreated)	55	1436	17
3: Deep Ripping	0	3536	5
2: Uniform in furrow	4	71.67	24.33
1: Field peas	10.67	14	12.67

At the end of season testing, the R. solani levels increased to a medium level in the control as anticipated. R. solani levels increase significantly under a cereal crop compared to other broadacre crops (table 3). Under field peas, the DNA levels decreased from a medium risk to a low risk when the start of season was compared to end of the season levels. Since the peas were manured, this may explain the decrease in DNA levels as the rye grass would have contributed to a large increase in R. solani if the crop was not sprayed out.

Both Uniform and deep ripping did not increase levels, and these treatments are used to keep the disease under control but do not eliminate the disease. F. pseudograminearum levels were patchy as they were at the start of the season which suggests the two times of samplings hit hot spots of infected cereal stubble. For field peas, F. pseudograminearum levels did not increase as much as other treatments. Broadleaf crops are not good hosts and do not build up the inoculum into the following season. P. neglectus levels remained in the medium risk levels as at the start of the season for each treatment.

Table 4: Grain yield of wheat treatments.

Treatment	Yield (t/ha)
2 Uniform In-Furrow Fungicide	3.0
3 Pre-Seeding Deep Ripping	2.3
4 Untreated Control	2.8

The wheat grain yields were reduced in the deep ripping plot most likely due to establishment issues associated with the ripping (Table 4). The field peas were brown manured for weed control purposes. This trial will be planted to wheat in 2022 to assess second year impacts of the 2021 treatments.

Acknowledgements
This trial is part of a GRDC funded project, led by the Grower Group Alliance and managed by the Liebe Group. Thanks to the Hyde family for their assistance, hosting, implementing and managing the trial.

Peer review
Daniel Huberli, DPRID
Dominie Wright DPIRD
Sarah Collins DPIRD

Contact
The Liebe Group
research@liebegroup.org.au
08 9661 1907

NUTRITION RESEARCH RESULTS

Nitrogen Strategies for Early Sown Long Season Wheat Varieties

Angus McAlpine, Corporate and Regional Agronomy Support, CSBP

Key Messages

Illabo, Denison and Rockstar sown on the 8th of April yielded 5.2 to 5.6 t/ha.
Water use efficiency increased with the higher rates of applied nitrogen (N).
Illabo and Denison were very responsive to N fertiliser and applications were profitable.
Responses to N in Rockstar were variable and generally unprofitable.

Aim

To demonstrate what the yield potential is of three long season wheat varieties new to WA, and to compare the effectiveness of various nitrogen fertiliser strategies.

Background

The opportunity to capitalise on early autumn rains through earlier sowing of crops can be a useful strategy for spreading the sowing window.

Illabo (AGT) is a winter wheat variety with a vernalisation 'cold' requirement before entering into reproductive growth stages (APW/AH). Denison (AGT) is a very long season spring wheat (APW). Rockstar (Intergrain) is a medium-long season spring wheat (APW/AHN).

These new varieties are largely untested in the northern wheatbelt and understanding their crop phenology in the local environment and the effects of various nitrogen strategies will fill a research gap.

This trial aims to provide some local data that will help growers to assess their potential and N requirements.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	15m x 2.5m x 3 replications
Soil type	Red brown alkaline clay
Soil pH ($CaCl_2$)	See soil analysis
EC (dS/m)	See soil analysis
Paddock rotation	2021 wheat, 2020 wheat, 2019 chemical fallow
Sowing date	08/04/2021
Sowing rate	53 kg/ha Illabo, Denison and Rockstar wheat
Fertiliser	Treatments 1 and 9 were sown with 97 kg/ha TSP; other treatments were sown with 100 kg/ha Agflow Boost Nitrogen treatments in table below
Herbicides, Insecticides & Fungicides	08/04/2021 - 2L/ha Roundup Ultra, 2L/ha Treflan, 0.4L/ha Lorsban, 0.115kg/ha Sakura, 1% Sulphate. 03/06/2021 - in season Flexi-N (FN) applications as per table below 17/06/2021 - in season Flexi-N applications as per table below, 0.3L/ha Aviator, 0.02L/ha Trojan. 07/08/2021 - 0.4L/ha Prosaro, Trojan 13/09/2021 - 1kg/ha Mouseoff
Harvest date	04/11/2021

Soil Composition February 2021

Depth (cm)	pH ($CaCl_2$)	OC (%)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	Col P (mg/kg)	PBI	Col K (mg/kg)	S (mg/kg)	ESP (%)	B (mg/kg)
0-10	7.4	0.8	8	2	35	100	365	3	3	4
10-20	7.9	0.5	6	2	11	154	165	5	-	-
20-30	7.8	0.6	2	2	15	143	212	16	12	10
30-40	8.1	0.5	2	2	11	141	202	33	16	17

*ESP is Exchangeable Sodium Percentage, an indicator of sodicity; above 6% is considered sodic.

Treatments

The effects of nitrogen (N) applications on grain yield, protein, nitrogen use efficiency (NUE) and water use efficiency (WUE) of Illabo, Denison and Rockstar wheat.

Trt	Variety	Banded (L/ha)	3 Jun (Z22-26) (L/ha)	17-Jun (L/ha)	N (kg/ha)	Yield (t/ha)	Protein (%)	NUE* (%)	WUE** (kg/mm)
1	Illabo	-	-	-	0	3.1[g]	8.8[f]	-	8
2	Illabo	100 FN	-	-	54	4.1[ef]	9.0[ef]	31	11
3	Illabo	50 FN	50 FN	-	54	5.0[a-d]	9.3[c-f]	33	13
4	Illabo	100 FN	100 FN	-	96	5.2[abc]	9.3[c-f]	39	14
5	Illabo	50 FN	150 FN	-	96	4.8[b-e]	9.2[def]	31	13
6	Illabo	100 FN	200 FN	100 FN (mid tillering)	180	5.2[abc]	11.1[ab]	29	14
7	Denison	100 FN	100 FN	-	96	4.7[b-f]	10.8[b]	-	13
8	Denison	100 FN	200 FN	100 FN (late tillering)	180	5.6[a]	11.5[a]	-	15
9	Rockstar	-	-	-	0	4.3[def]	9.1[def]	-	11
10	Rockstar	100 FN	-	-	54	4.0[f]	9.6[cde]	-4	11
11	Rockstar	50 FN	50 FN	-	54	4.5[c-f]	9.1[def]	4	12
12	Rockstar	100 FN	100 FN	-	96	5.3[ab]	9.6[cde]	20	14
13	Rockstar	50 FN	150 FN	-	96	4.5[c-f]	9.7[cd]	7	12
14	Rockstar	100 FN	200 FN	100 FN (first node)	180	5.2[abc]	9.9[c]	12	14
					Prob	<0.01	<0.01		
					LSD	0.7	0.6		

Treatments 1 and 9 were sown with 97 kg/ha TSP; other treatments were sown with 100 kg/ha Agflow Boost
**NUE assumes 75% of N taken up is recovered in grain*
*** based on one third summer rainfall + GSR / grain yield*

Results

- Without N applied, the yield of Illabo was about 1 t/ha lower than that of Rockstar.
- With 180 kg N/ha applied, the yields of Illabo, Denison and Rockstar were similar (5.2 to 5.6 t/ha).
- Water use efficiency increased in all varieties with the higher N rates.
- The highest WUE of 15 kg/mm was achieved by the variety Denison with the application of 180N.
- Illabo had the biggest increase in WUE 8 to 14 kg/mm with the application of 96N.
- In Illabo, splitting Flexi-N between seeding (50 L/ha) and mid-tillering (50 L/ha) was more effective than banding 100 L/ha at seeding.
- In Rockstar, banding 100 L/ha Flexi-N at seeding with another 100 L/ha at early tillering was more effective than banding 50 L/ha at seeding with 150 L/ha at first node.
- Grain protein increased with the rate of N applied.
- The recovery of fertiliser N in the grain was 30-40% in Illabo but less than 20% in Rockstar.
- In Rockstar, screenings were 4-6% and hectolitre weights 79-81 kg/hL. Neither was adversely affected by high N rates.
- In Illabo, screenings were 2-3% and hectolitre weights 77-81 kg/hL. Hectolitre weights were higher with increasing N supply.
- In Denison, screenings were 3-4%; hectolitre weights 82-83 kg/hL.

Observed crop phenology

Variety	Stem Elongation Z30-31	Flag Leaf Z39	Ear Emergence Z50	Flowering Z60
Illabo	14 July	3 August	18 August	8 September
Denison	15 June	14 July	21 July	18 August
Rockstar	28 May	23 June	14 July	21 July

Nitrogen Economics *

Trt	Variety	Banded (L/ha)	3-Jun (L/ha)	17-Jun (L/ha)	N (kg/ha)	Yield (t/ha)	Protein (%)	N Revenue ($/ha)	N Cost ($/ha)	N Returns ($/ha)
1	Illabo	-	-	-	0	3.1^{g}	8.8^{f}	-	-	-
2	Illabo	100 FN	-	-	54	4.1^{ef}	9.0^{ef}	299	162	137
3	Illabo	50 FN	50 FN	-	54	5.0^{a-d}	9.3^{c-f}	556	162	394
4	Illabo	100 FN	100 FN	-	96	5.2^{abc}	9.3^{c-f}	625	288	337
5	Illabo	50 FN	150 FN	-	96	4.8^{b-e}	9.2^{def}	506	288	218
6	Illabo	100 FN	200 FN	100 FN	180	5.2^{abc}	11.1^{ab}	822	540	282
7	Denison	100 FN	100 FN	-	96	4.7^{b-f}	10.8^{b}	-	-	-
8	Denison	100 FN	200 FN	100 FN	180	5.6^{a}	11.5^{a}	324	252	72
9	Rockstar	-	-	-	0	4.3^{def}	9.1^{def}	-	-	-
10	Rockstar	100 FN	-	-	54	4.0^{f}	9.6^{cde}	-100	162	-262
11	Rockstar	50 FN	50 FN	-	54	4.5^{c-f}	9.1^{def}	40	162	-122
12	Rockstar	100 FN	100 FN	-	96	5.3^{ab}	9.6^{cde}	279	288	-9
13	Rockstar	50 FN	150 FN	-	96	4.5^{c-f}	9.7^{cd}	35	288	-253
14	Rockstar	100 FN	200 FN	100 FN	180	5.2^{abc}	9.9^{c}	268	540	-272
					Prob	<0.01	<0.01			
					LSD	0.7	0.6			

**Assumes ASW @ $300/t, APW at $340/t and N @ $3/kg*

Comments

The results from this trial indicate that winter wheats such as Illabo may have a higher requirement for N fertiliser than spring wheats such as Rockstar.

The variation in crop phenology between the longest (Illabo) and shortest (Rockstar) varieties did not have a significant impact on WUE observed in this trial.

The grain quality traits of screenings and hectolitre weights were not adversely affected by the high rates of N applied.

Acknowledgements

CSBP Field Research for sowing and managing the trial and the Hyde family for hosting the trial site.

Paper reviewed by

James Easton, CSBP

Contact

Angus McAlpine
angus.mcalpine@csbp.com.au
0437 222 419

Lois Kowald
lois.kowald@csbp.com.au
0428 080 004

SOIL HEALTH RESEARCH RESULTS

Early post emergent (EPE) deep ripping

Liebe Group and Dylan Hirsch, Hirsch Farms, Latham

Key Messages

- There was no yield benefit to early post emergent ripping at 1, 3, or 6 weeks following seeding
- Plant establishment and grain yield was reduced when ripped 1 week after sowing.

Aim

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

Background

The Hirsch's 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. Reduced plant establishment can undo the yield response of canola in this system. Ripping post seeding, when there is adequate subsoil moisture available is considered an option to alleviate this however this comes with significant logistical issues ie machinery and labour availability as well as the risk of seedling mortality.

After seeing the effects of EPE deep ripping trial strips on previous canola crops, Dylan implemented this trial (as well as others across the property) to better assess the effects of different timings of post emergent 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 location	Hirsch Property, Latham
Plot size & replication	18.3m x 200m x 2 replications
Soil type	Sandy loam
Paddock rotation	2020 wheat, 2019 wheat, 2018: Canola
Sowing date	20/04/2021
Sowing rate	1.4 kg/ha 4022P Canola
Fertiliser	15/03/2021 - 80 kg/ha MOP, 80 kg/ha Superphosphate 14/05/2021 - 45 L/ha UAN 05/06/2021 - 65 L/ha UAN
Herbicides, Insecticides & Fungicides	14/05/2021 - 1.2 L/ha Glyphosate 450 05/07/2021 - 1.2 L/ha Glyphosate 450 18/09/2021 - 1.5 L/ha Glyphosate 450
Harvest date	04/11/2021

Treatments

	Treatment
1	Unripped
2	Ripping 1 week post seeding
3	Ripping 3 weeks after seeding
4	Ripping 6 weeks after seeding

Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	KCl S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	6.9	39	95	3.6	6	1	0.056	0.66
10-30	5.2	20	63	12.8	3	< 1	0.038	0.45

Results

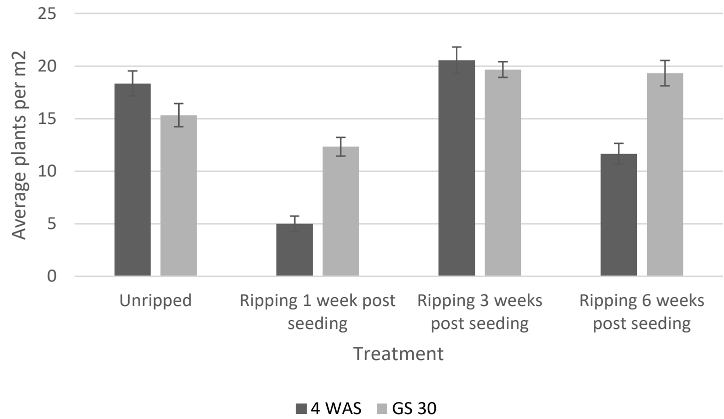


Figure 1: Average plants per m^2 4 weeks after sowing (WAS) and at Growth Stage 30 when ripped at different time intervals after seeding in the Ripper Gauge trial at Latham 2021. Error bars are ± 1 S.E.

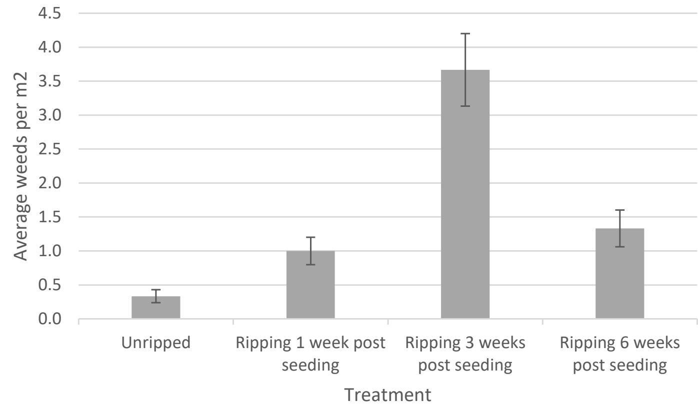


Figure 2: Average weeds per m^2 when unripped and ripped at different time intervals after seeding in the Ripper gauge trial at Latham 2021. Error bars are ± 1 S.E.

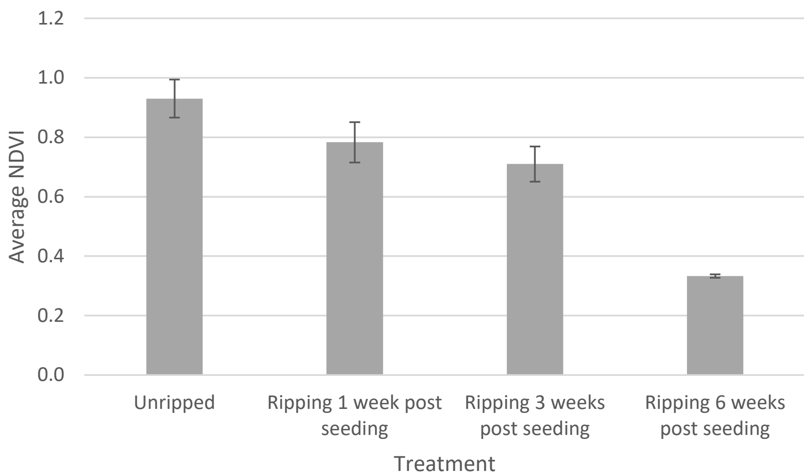


Figure 3: Average NDVI at GS30 for unripped and ripped treatments in the Ripper gauge trial at Latham in 2021. Error bars are ± 1 S.E.

Table 1: Grain yield of ripping treatments vesus the control (unripped) at the Ripper Gauge site at Latham in 2021.

Treatment		Yield (t/ha)	Oil %
3	Ripping 3 weeks after seeding	0.89	45.2
1	Control - Unripped	0.85	44.8
4	Ripping 6 weeks after seeding	0.75	44.9
2	Ripping 1 week post seeding	0.61	44.6

Comments
Plant establishment and grain yield was greatly reduced where canola was ripped at 1 week post seeding (Figure 1, Table 1). Plant numbers were slightly increased with ripping at 3 and 6 weeks and this may have been due to a change in soil conditions at the soil surface; a change clay content from subsoil clay being lifted to the surface.

It was observed that in some parts of the plots there was better plant numbers. This was attributed to the ripper position relative to the crop row, as gaps in crop rows were evident where the ripper tine aligned with the crop row.

Ripping 3 weeks after sowing showed some areas that responded to the deep ripping, but this was off-set by some areas where plant death was quite high which limited yield. Higher weed numbers were also noted in the 3 weeks after seeding treatment (Figure 3).

Ripping 6 weeks after sowing showed higher plant numbers at GS30 however did not show a yield response. This result is likely due to the variability of establishment across the paddock. NDVI was measured at the end of the ripping window for all treatments (start of flowering) and declined with each ripping treatment which likely indicates the different stages of recovery after ripping.

Acknowledgements
This project (WMG1803-002SAX) is a GRDC investment that is led by the West Midlands Group and this site is managed by the Liebe Group. This site is one of four trial sites across the Wheatbelt that has investigated the use of early post emergent (EPE) deep ripping on grain yield. Thank you to the Hirsch family for hosting the trial site.

Peer review
Nathan Craig, West Midlands Group

Contact
The Liebe Group
research@liebegroup.org
08 9661 1907

Deep Soil 'Reengineering' to Optimise Grain Yield Under Low Rainfall Conditions: Season 2021

Dr Gaus Azam and Chris Gazey, DPIRD, and Bob Nixon, Robert Nixon & Co

Key Messages

- Wheat and barley grain yields were at least doubled, and water use efficiency (WUE) was as high as 21 and 24 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 120% (wheat) and 115% (barley) of the estimated water-limited yield potential.
- Deep incorporation of lime increased soil pH closer to the minimum target pH of 4.8 and decreased Al concentration to below toxic levels within two months of lime incorporation.
- Deep amelioration of either compaction, or compaction and acidity together helped wheat plants to produce root systems to 60–65cm depth 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 wheat and barley crops were 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 and almost 50% of subsoil (10–20 and 20–30cm) 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 look 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 using strategic deep tillage 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 to mix the lime to the depth where the soil pH constraint occurs, then an immediate payback on lime and cultivation is possible. However, current soil amelioration practices including deep ripping and liming are found to remediate soil acidity and compaction partially. Moreover, such soil renovations generate variable crop yield responses as observed from various long-term field trials (Davies 2015).

Most crop roots are confined within 20–30cm of the surface in problematic paddocks where multiple soil constraints, such as compaction and subsoil acidity, are present, (Azam and Gazey 2020). With such shallow roots, a large proportion of growing season rainfall quickly drains away beyond the root zone.This field trial aimed to test whether ‘Reengineering’ (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 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	2020 barley, 2019 canola, 2018 wheat, 2017 wheat
Sowing date	01/06/2018 wheat, 28/05/2020 canola, 30/04/2021 barley, 30/04/2021 wheat
Sowing rate	2018 - 60 kg/ha Mace wheat, 2020: 84 kg/ha Spartacus barley, 2021 - 60 kg/ha Scepter wheat
Fertiliser	MAP 37 kg/ha, Urea 57 kg/ha at sowing

Treatments

Control	**Zero grading, zero lime**
1	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.
2	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.
3	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 (0–10 cm) and incorporate 1.5 t/ha lime with a rotary hoe.
4	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 (0–10 cm) and incorporate 1.5 t/ha lime with a rotary hoe.

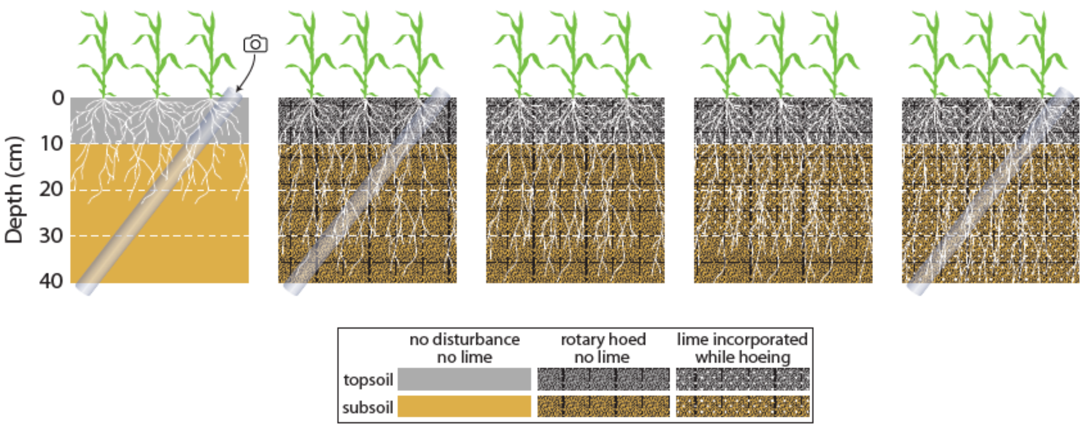


Figure 1: A schematic diagram of the four amelioration treatments and the control.

Results

Seasons

Both seasons 2018 and 2020 began with average rainfall, whereas season 2021 received more than average rainfall, especially in April, May and July. However, the rainfall in spring, especially the month of September, was well below average for all seasons. For 2021 season, August rainfall was below average. The total rainfall for the shortened growing seasons (Apr-Oct) was 211mm in 2018, 155mm in 2020 and 324mm in 2021 (Figure 2a). In 2018 and 2020, the minimum temperature was not low enough to cause any crop damage by frost, but in 2021 there were at least eight days where the daily minimum temperature fell well below zero degrees, causing severe frost damage to the wheat crop (Figure 2b).

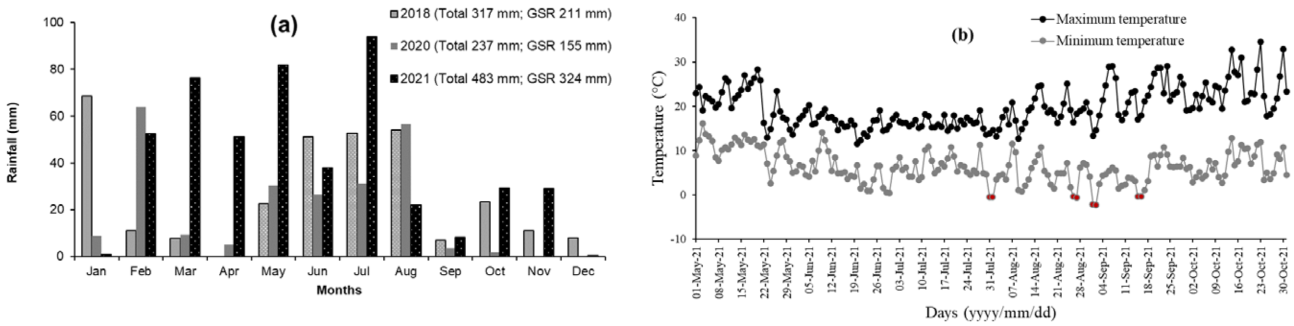


Figure 2: Monthly cumulative rainfall in 2018, 2020, and 2021 seasons (a) and daily maximum and minimum temperatures at the trial site in 2021 (b).

Soil properties

Soil excavation completely removed compaction to the depth of excavation and was maintained below the threshold level even 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). Next soil sampling will be conducted in July 2022.

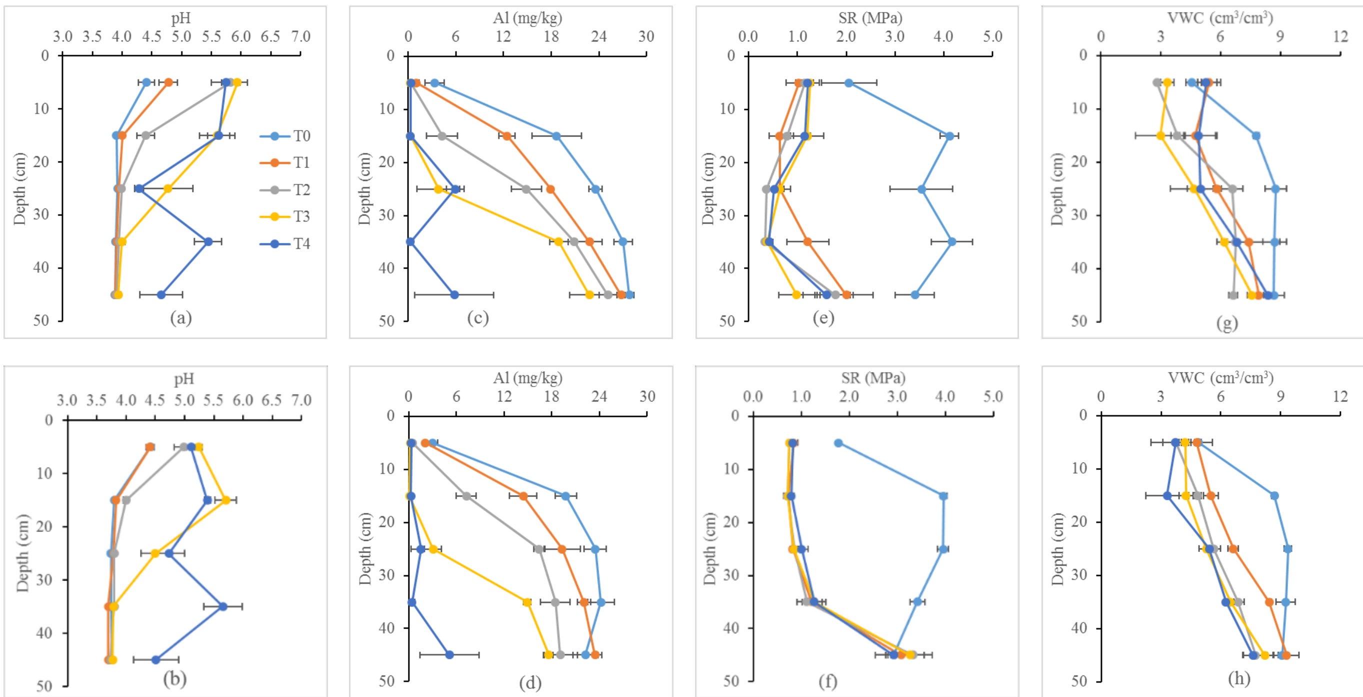


Figure 3: Effect of excavation and incorporation of lime on soil pH (a & b) , aluminium (c & d), soil resistance (e & f) and water content (g & h) under different treatments at 2-months (July 2018) after lime incorporation (a, c, e, & f) and at 26-months (July 2020) after lime incorporation (b, d, f & h). Horizontal error bars represent standard error of the mean values of the respective variables.

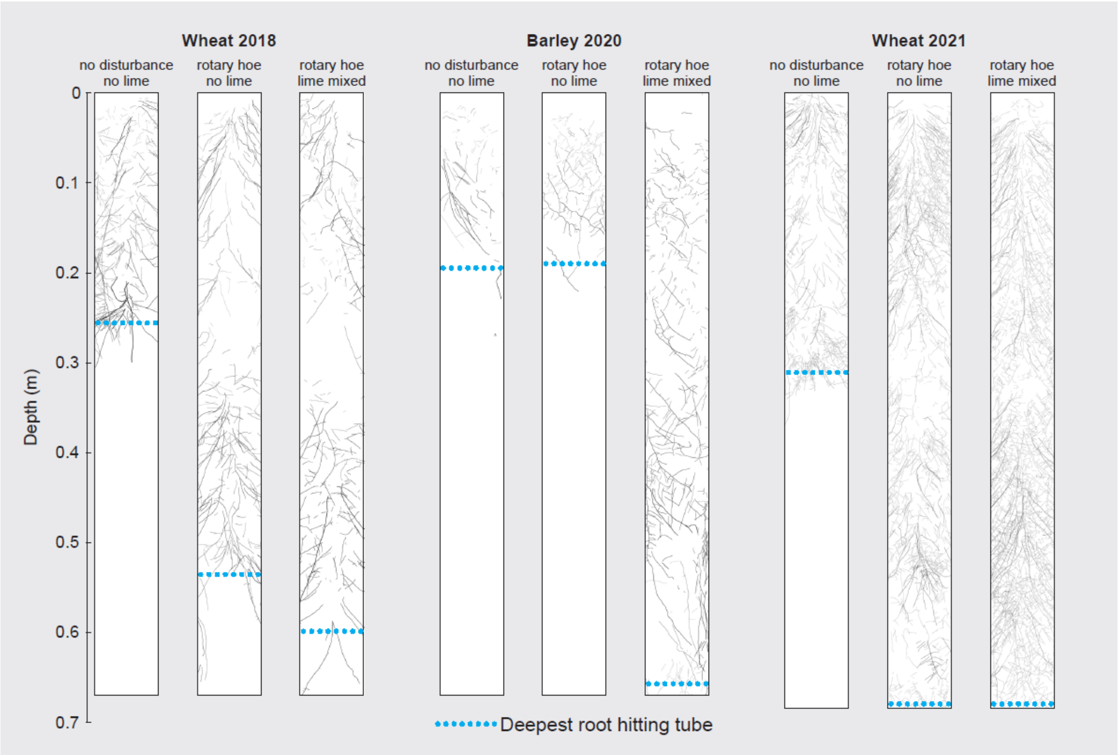


Figure 4: Wheat (2018), barley (2020) and wheat (2021) root growth under different soil amelioration treatments

Root growth and water uptake

Due to the improvement in soil chemistry and physics, there was a significant improvement in root growth. Wheat (in both seasons) and barley root growth was restricted to within 20–30cm depth for the untreated control (T0, Figure 4). For treatments T1–T4, Mace and Scepter wheat roots grew up to 60–70cm depth, where lime was incorporated at depths (T3 and T4), there were more fine roots and roots hairs in the deeper horizons. There were more roots and deeper depth in 2021 season than in 2018 season suggesting there could be further improvement in soil pH profile. However, removal of compaction only (T1) did not improve the growth of acid-sensitive Spartacus barley crop in 2020 season. 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 were found to extract more water, whereas in the untreated control plots, a large proportion of the soil water remained unused (Figure 3g & h).

Yield and WUE

In 2018, ear 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). Wheat yield was only 52% in the control compared to the water limited yield potential calculated using the French and Schultz (1984) method. Wheat yield was 97% in T1, and 120% in T4 (Figure 5f) compared to the water limited yield potential calculated by French and Schultz (1984) method. Similarly, WUE increased from 10 kg/mm in the control to 19 kg/mm in T1,and 24 kg/mm in T4 treatment.

In 2020, ear count, biomass and grain yield of barley increased significantly for all lime related treatments (T2–T4) except for T1. In T4 treatment these increments were 46%, 110%, 86%, respectively, compared to the control. Similar improvements were also noticed in actual yield potential (Figure 5f) and WUE (Figure 5e) of barley due to improvement in soil pH and Al toxicity in T2–T4.

In 2021, biomass yield increased by 230% but ear count and yield increased by around 50% in the ameliorated soil profiles compared to the control (Figure 5a, b & c). Despite being a high rainfall season, the crop was severely damaged by frost due to multiple events of low temperature (Figure 2a). Wheat yields were 18% in the control and around 28% in in T1–T4 compared to the water limited yield potential calculated using French and Schultz (1984) method. The improvement was also evident in WUE, which increased from 4 kg/mm in the control to up to 6.7 kg/mm T3 treatment.

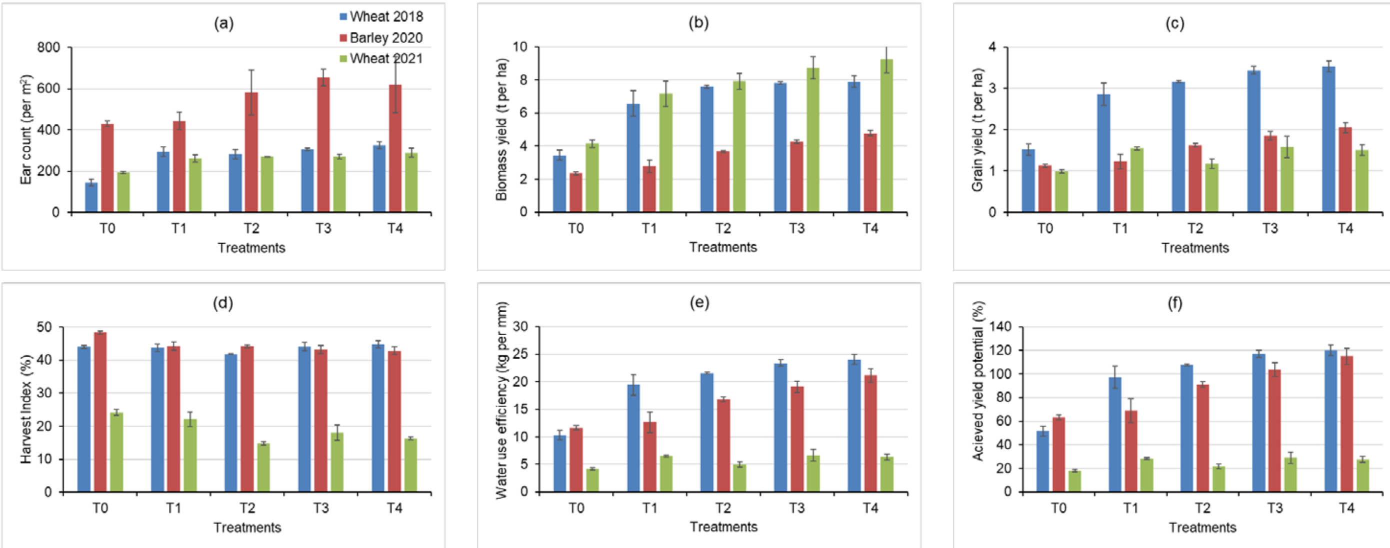


Figure 5: Improvement in (a) tiller count, (b) biomass yield, (c) grain yield, (d) harvest index and, (e) water use efficiency (WUE), and (f) actual water limited yield potential for wheat in 2018, barley in 2020 and wheat in 2021 seasons as a result of deep incorporation of lime. Vertical bars represent ± 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

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 facilitated developing deep root systems for both wheat and barley (with fine roots and root hairs) over three growing seasons, 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, 2020 and 2021. Despite severe frost damage in 2021, the deep amelioration of compaction and acidity treatments significantly yield higher than the untreated control.

This trial demonstrated that deep amelioration of soil compaction and acidity could 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 up to 24 and 21 kg/mm, respectively, which surpassed the expectation of the local grower. The benefits of deep soil amelioration sustained for four growing seasons, showing the potential for long-lasting effect once these soil constraints are corrected effectively. 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.

Acknowledgements

The research undertaken as part of GRDC invested project DAW00252 and DAW1902_003RTX, the author would like to thank DPIRD and GRDC for their continued support. We would also like to thank staff at DPIRD Northam and Wongan Hills. We are also very grateful to Nixon family for allowing us to conduct this trial on their paddock and for providing machinery support. The authors are thankful to Dr Mario D'Antuono and Mr Andrew van Burgel for their advice on trial design and data analyses. Our sincere thanks to Dr Sultan Mia for reviewing this paper.

Peer review

Dr Sultan Mia, University of Western Australia

Contact

Dr Gaus Azam
gaus.azam@dpird.wa.gov.au
08 9690 2159

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

Chris O'Callaghan, Project Support Officer, Liebe Group

Key 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 aluminium 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

To demonstrate the soil health and crop growth benefits of using soil ameliorants combined with cultivation to depth to address subsoil aluminium toxicity. 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 Western Australian Wheatbelt. In most Wheatbelt soils, where the subsoil pH is below 4.8, aluminium 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 aluminium toxicity.

Demonstration of practices to identify aluminium 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 environments.

In the trial, three ameliorants (lime, gypsum & biochar) were applied to address the aluminium constraint. The 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 aluminium to form inert non-toxic aluminium 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 investigating these ameliorant options for reducing toxic aluminium in the soil, and which is the 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	2020 wheat, 2019 wheat, 2018 wheat
Sowing date	24/05/2021
Sowing rate	50 kg/ha Scepter Wheat
Fertiliser	24/05/2021 - 45 kg/ha Urea; 40 kg/ha MAPSZC3:1DAPSZC 29/06/2021 - 50 kg/ha Urea 08/07/2021 - 20 L/ha UAN
Herbicides, Insecticides & Fungicides	30/03/2021 - 2 L/ha Glyphosate 450, 500 ml/ha Ester 680 23/05/2021 - 2.4 L/ha Glyphosate 450, 300 ml/ha Ester 680, 2.4 L/ha Boxer Gold, 1.6 L/ha Trifluralin 08/07/2021 - 1 L/ha Jaguar, 300 ml/ha LVE Ester

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 Analysis

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

2020 Yield

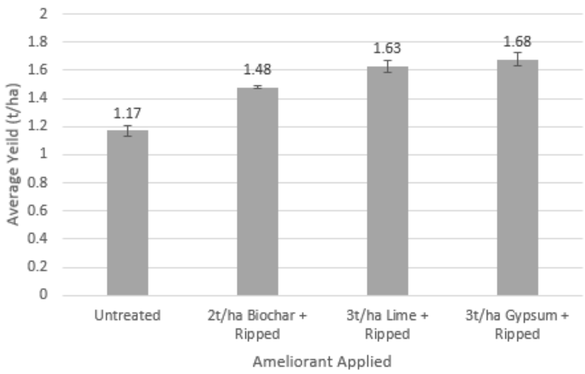


Figure 1: Yield (t/ha) of Scepter Wheat in the aluminium toxicity trial at Dalwallinu in 2020. Error bars are ± 1 S.E.

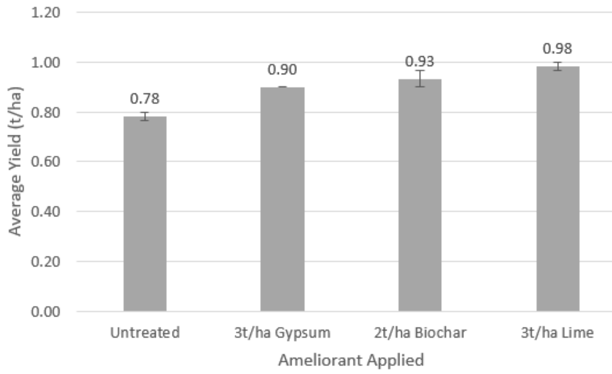


Figure 2: Yield (t/ha) of Scepter Wheat in the aluminium toxicity trial at Dalwallinu in 2021. Error bars are ± 1 S.E.

All ameliorants had a positive yield effect (1 and 2) over the untreated control in both seasons. The biochar treatments had lower yields than the lime and gypsum treatments in 2020, however this trend was not as apparent in 2021. There was not much difference in yield between lime and gypsum in either year.

Table 1: Soil composition test results in the aluminium toxicity trial at Dalwallinu taken 1 year apart, pre (2020) and post (2021) treatment.

Treatment	Nil Control		Lime		Gypsum		Biochar	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
pH 0-10cm	5.1	6.3	5.1	6.2	4.1	5.8	5.8	5.8
pH 10-20cm	4.9	5.7	5.3	5.5	6.1	5.6	4.4	4.9
pH 20-30cm	4.4	5.6	4.3	5.4	4.3	5.3	4.4	4.6
pH 30-40cm	4.2	5.3	4.2	5.6	4.3	5.1	4.2	4.7
pH 40-50cm	4.2	5.0	4.1	5.1	4.1	4.9	4.3	4.6
NO3 (mg/kg)	11	8	9	6	8	6	10	4
NH4 (mg/kg)	3	1	4	1	2	1	2	1
Col P (mg/kg)	23	37	25	37	32	35	21	34
Col K (mg/kg)	20	38	23	34	16	21	23	25
KCl S (mg/kg)	29	3	31	6	35	47	33	6
OC (%)	0.3	0.5	0.3	0.6	0.2	0.4	0.3	0.4
EC (dS/m)	0.04	0.05	0.04	0.05	0.04	0.10	0.04	0.03
PBI	N/A	26.8	N/A	29.7	N/A	26.9	N/A	30.9
Exc. Al 0-10 cm (meq/100g)	0.49	0.16	0.48	0.15	0.80	0.21	0.10	0.16
Exc. Al 10-20 cm (meq/100g)	0.31	0.09	0.25	0.08	0.09	0.04	0.58	0.08
Exc. Al 20-30 cm (meq/100g)	0.37	0.11	0.45	0.11	0.45	0.08	0.52	0.30
Exc. Al 30-40 cm (meq/100g)	0.62	0.15	0.69	0.12	0.64	0.09	0.73	0.16
Exc. Al 40-50 cm (meq/100g)	0.59	0.20	0.75	0.10	0.71	0.22	0.76	0.33

Both pH levels and exchangeable aluminium concentrations improved across the site from year one to year two regardless of treatment (Table 1). Differences between treatments were less pronounced, and no clear treatment effects can be observed from these tests.

Comments

Aluminium is considered to have a negative impact on the growth of susceptible plant species when it reaches concentrations above 5mg/kg (in CaCl2). At the site, before the application of ameliorants, aluminium levels were above 5mg/kg (CaCl2) throughout the subsoil (10-50cm). Therefore, subsoil aluminium toxicity could be considered a significant constraint to crop performance.

Changes to soil pH and Aluminium from year one to the year two sample times are likely due to the high rainfall over summer (>100mm). High summer rainfall can wash both hydrogen and aluminium ions through the soil profile and out of the soil testing zone, however, these constraints still exist at depth and may be drawn back up through the soil profile in subsequent years through evaporation.

It also is worth noting the soil testing and plant tissue testing conducted in 2020 identified potassium (K) as being deficient in all treatments. With no additional K fertiliser applied in 2021 it is likely that this would have again limited the potential for any responses to the amelioration treatments indicating that K supply may be one of the major constraints to productivity.

Furthermore, In this trial it is difficult to ascertain the benefits of the ameliorants over and above the deep ripping effect as the 'nil' treatment was not ripped and there was no 'ripping only' treatment, as such results must be interpreted with this in mind.

Poor yield results could have been the result of a combination of frost damage, issues with pre-emergent herbicides washing into the furrow at seeding time, fertiliser leaching and potassium deficiency.

Acknowledgements
Thanks to the Shannon and Jodi Fry 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. Thanks to Angus McAlpine CSBP for assistance with the analysis of the soil sample testing results.

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.

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
Angus McAlpine, CSBP

Contact
The Liebe Group
research@liebegroup.org.au
08 9661 1907

Australian Government | National Landcare Program | LiEBE GROUP Working together in Agriculture

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

Casey Shaw, Jindarra Cropping Co, and Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages
- Composted strips showed higher biomass maintained throughout the season.
- 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

Improve consistency of crop performance by alleviating salinity and non-wetting issues at an old salt land site.

Background

Farmers are very good at trialling best practice soil management in their own environment, however 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.

This trial 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 was implemented in the paddocks 5^{th} year of cropping), as the business no longer produce livestock in their enterprise mix. Compost has been employed in an effort to help boost Soil Organic Carbon (OC) and reduce evaporation over summer to limit the salt that rises to the soil surface and improve crop germination and therefore overall performance. This is the second year of the trial, with the first showing no obvious improvement over the control.

Trial Details

Trial location	Shaw Property, Buntine
Plot size & replication	18m x 500m x 1 replication
Soil type	Sandy Loam
Paddock rotation	2021 wheat, 2020 barley, 2019 barley
Sowing date	26/05/2021
Sowing rate	55 kg/ha
Fertiliser	50 kg/ha K-Till Post: 50k g/ha urea
Herbicides, Insecticides & Fungicides	Pre Em: Trifluralin 2L/ha Post: Trident 1L/ha

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

	Treatment	Yield (t/ha)
1	Untreated Control	1.75
2	3t/ha compost, unripped	1.58
3	3t/ha compost, deep ripped	1.85
4	5t/ha compost, deep ripped	1.27

Comments

With a high rainfall season including very good germinating rains the site showed visual improvement in season with the treated strips having a higher visually observable biomass (NDVI) and seeming to maintain biomass further into the season. However yield results were varied at harvest with no obvious benefit to the treated strips over the control.

Throughout the trial there were areas of salt scald that limited germination. There was no clear reduction in salt scalds with the treated strips. The site had a high weed burden consisting primarily of ice plant. These seemingly contributed to the varied yield results throughout the trial.

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

Acknowledgements

This project is supported by Liebe Group, through funding from the Australian Government's National Landcare Program. The Liebe Group would like to thank Casey Shaw for the extensive time and effort invested into participating in this project over the past two seasons.

Peer review

Chris O'Callaghan, The Liebe Group

Contact

The Liebe Group
research@liebegroup.org.au
08 9661 1907

Casey Shaw
casey@jindarrafarms.com.au
0428 575 851

The Gen Y Paddock Challenge - Pushing Deep Ripping Deeper in Sandy Plain Soil

Shaun Fitzsimons, Wicklow Farms, and Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages

- 'Deeper' Deep Ripping can allow for crop roots to access deep soil moisture and nutrients.
- In this trial there were no significant differences between the treatments.
- Greater benefit might be seen in years with a tighter finish.

Aim

Evaluate the economics of pushing deep ripping to a deeper depth in sand plain soil

Background

Farmers are very good at trialling best practice soil management in their own environment, however 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.

This trial aims to assess the benefits of 'deeper' deep ripping down to 600mm. There are three depth treatments in this trial which 300-400mm, 500mm and 600+mm. The machinery used for this operation was a Nufab 6m Deep Ripper with hydraulic breakout with shallow leading tynes.

Trial Details

Trial location	Fitzsimons Property, Buntine
Plot size & replication	12m x 200m x 3 replications
Soil type	Loamy sand over gravel
Paddock rotation	2020 pasture, 2019 wheat, 2018 canola
Sowing date	05/05/2021
Sowing rate	Havoc Wheat 55 kg/ha
Fertiliser	Seeding – 40 kg DAP, 20 kg Potash, 30 L Flexi N Post Seeding – 20 L Flexi N
Herbicides, Insecticides & Fungicides	Pre Em – 1.5L Glysophate 450, 1.5L Trifluralin 480, 0.3% Li 700, 118g Sakura 850, 1% AS 04/06/2021 – 1L Triathlon 19/07/2021 – 0.150 Teb

Treatments

	Treatment
1	300-400mm Deep Ripping
2	550mm Deep Ripping
3	600mm+ Deep Ripping

Results

Table 1: Yield, Protein & Screening results at Buntine 2021.

Depth	Yield (t/ha)	Protein (%)	Screenings (%)
3-400mm	3.42	9.6	1.53
550m	3.47	9.4	1.65
600+mm	3.47	9.3	1.45

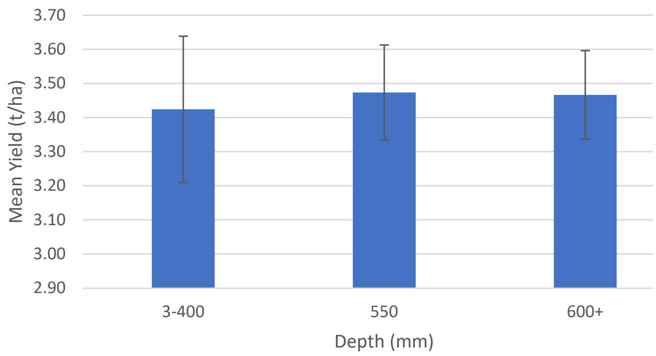


Figure 1: Mean yields at three different deep ripping depths at Buntine 2021.

Comments

No significant difference were observed between the treatments in this season. Weed burden in the trial plot was a lot higher than rest of paddock which was not deep ripped.

Acknowledgements

This project is supported by Liebe Group, through funding from the Australian Government's National Landcare Program. The Liebe Group would like to thank Shaun Fitzsimons for the extensive time and effort invested into implementing and managing the trial, and for their continued participation in the Gen Y Paddock Challenge.

Peer review

Chris O'Callaghan, The Liebe Group

Contact

The Liebe Group
research@liebegroup.org.au
9661 1907

Shaun Fitzsimons
stfitzsimons1988@hotmail.com
0427 083 105

The Gen Y Paddock Challenge - Deep Ripping Non Typical Soils

Blair Stone, PR & CJ Stone, and Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages

- Deep Ripping had a significant yield benefit over unripped across all three sites.
- Site 3 was frost affected, with the ripped plots exhibiting less frost.

Aim

Evaluate the economics of pushing deep ripping to a deeper depth in sand plain soil.

Background

Farmers are very good at trialling best practice soil management in their own environment, however 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.

This trial assessed the yield benefits of a terraland deep ripper over an unripped control. The trial was repeated in three different paddocks.

Trial Details

Trial location	Stone Property, Marchagee		
Plot size & replication	Farm Scale Demonstration		
Soil type	Various Sandy Loams		
Paddock rotation	Site 1: 2021 wheat, 2020 wheat, 2019 wheat, 2018 lupins Site 2: 2021 wheat, 2020 lupins, 2019 wheat, 2018 wheat Site 3: 2021 wheat, 2020 lupins, 2019 wheat, 2018 wheat		
Sowing date	All sites: 15/05/2021		
Sowing rate	55 kg/ha Sceptre		
Fertiliser	Site 1 Seeding- 40kg Urea 75kg Agstar Extra/Potash 73/27% Post Seeding- 80L Flexi N	Site 2 Seeding- 40kg Urea 75kg Agstar Extra/Potash 73/27% Post Seeding- 40L Flexi N	Site 3 Seeding- 40kg Urea 75kg Agstar Extra/Potash 73/27% Post Seeding- 40L Flexi N
Herbicides, Insecticides & Fungicides	Site 1 Summer Spray- 1L Roundup, 500ml Ester 680, 100ml Garlon, 5g Metsulfuron, .03% Liberate, 1% Amsul Seeding- 2L Boxer Gold, 2L Trifluralin, 1L Roundup, 250ml Chlorpyriphos, 1% Amsul Post Seeding- 1L Trident	Site 2 Summer Spray- 1L Roundup, 500ml Ester 680, 100ml Garlon, 5g Metsulfuron, .03% Liberate, 1% Amsul Seeding- 2L Boxer Gold, 2L Trifluralin, 1L Roundup, 250ml Chlorpyriphos, 1% Amsul Post Seeding- 1L Trident	Site 3 Summer Spray- 1L Roundup, 500ml Ester 680, 100ml Garlon, 5g Metsulfuron, .03% Liberate, 1% Amsul Seeding- 2L Boxer Gold, 2L Trifluralin, 1L Roundup, 250ml Chlorpyriphos, 1% Amsul Post Seeding- 1L Trident

Treatments

#	Treatment
1	Deep Ripped (Terraland)
2	Unripped

Results

Treatment	Yield (t/ha)		
	Site 1	Site 2	Site 3
Deep Ripped	5.11	5.48	4
Unripped	4.55	4.82	2.96

Comments

All trial plots were graded as ASW with around 8.5% Protein, 2% Screenings. Trial 3 was significantly frost-affected and the ripped plot showed clearly less frosted heads in comparison to the unripped plot. Possibly due to delayed/uneven flowering times in the ripped plots. Throughout the year the ripped plots looked remarkably healthier than the unripped plots. There was no noticable influence of weed burdens on results.

Germination/plant numbers were excellent on ripped and unripped plots.

Note this is an unreplicated farmer demonstration and results must be interpreted with care.

Acknowledgements

This project is supported by Liebe Group, through funding from the Australian Government's National Landcare Program.The Liebe Group would like to thank Blair Stone for the extensive time and effort invested into implementing and managing the trial, and for their continued participation in the Gen Y Paddock Challenge.

Peer review

Chris O'Callaghan, Liebe Group

Contact

Blair Stone
blair.stone@hotmail.com
0459 920 479

Liebe Group
research@liebegroup.org.au
96611907

FARMING SYSTEMS RESEARCH RESULTS

Managing Impacts of Wind Erosion in the NAR of WA

Katrina Venticinque, Executive Officer, Liebe Group

Key Messages

- Paddock-scale site in Beacon established successfully to compare self-sown pasture to a mixture of shrubs across a wind-erosion prone paddock.
- The site will be continued to be monitored in 2022 for further results.

Aim

To identify locally-relevant management practices to combat the effects of wind events on soil health.

Background

Erosion has been acknowledged by researchers and farmers to be a significant factor contributing to land degradation. In the past few years, severe wind and rain events have been more common due to the changing climate throughout Western Australia. Whilst most research is seen to have been conducted in the more southern areas of Western Australia the impact throughout the Wheatbelt is increasing. As such, it is important to demonstrate these mitigation practices for the local region to address.

Trial Details

At the site in Beacon, the paddock host has observed that a low lying area with poor infiltration is highly prone to erosion events when significant rainfall events occur. To address this he has both installed a deep drainage ditch, and planted shrubs on either side, taking the area out of his cropping rotation. He is hopeful the treatment will be effective in developing a multistory pasture and providing year round ground cover in the area to minimise erosion risk.

Treatments

	Treatment
1	Shrubs including Oldman Salt Bush (Atriplex nummularia), Anameka Forage Shrub and Oil Mallee (Eucalyptus plenissima kochii)
2	Self Sown

Site 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 (%)	Cover (kg/ha)
0-10	6.3	18	212	127	2	5	0.939	0.47	90
10-20	5.9	6	140	108	3	4	0.609	0.25	
20-30	6.0	4	141	49	3	3	0.659	0.16	
30-40	6.0	4	245	79	4	2	0.844	0.16	
40-50	6.5	4	254	116	4	2	1.323	0.15	

Figure 1: Saltbush being sown at the Kirby site, Beacon, September 2021.

Figure 2: Establishment counts taken, with wind erosion pegs implemented for the capture of data over the summer period, 20/12/2021.

Comment

The implementation of the site was successful following a short delay due to a large rainfall event which waterlogged the paddock, restricting vehicle access to the site. The self-sown treatment shows high visual ground cover. This site will continue to be monitored to assess saltbush development over the coming seasons and the impact it has on soil health and erosion established.

Acknowledgements

This project is funded through the Australian Government Future Drought Fund and is being overseen by the Northern Agricultural Catchment Council (NACC). Thanks the the Kirby family for their support of the project and their hard work in implementing and managing the demonstration area.

Peer review

Chris O'Callaghan, Liebe Group

Contact

The Liebe Group
research@liebegroup.org.au
08 9661 1907

Australian Government | Future Drought Fund | NACC | LIEBE GROUP Working together in Agriculture

Herbicide Damage and Seeding Interaction

Tristan Clarke, Agronomist, Elders Scholz Rural

Key Messages

- Inter-row sowing showed greatest safety from herbicide damage.
- On row sowing led to few benefits given adequate levels of soil moisture this season.
- On/edge row sowing can affect herbicide effectiveness with more clods and unevenness of herbicide incorporation with uneven soil throw.

Aim

To demonstrate the different effects that row placement (interrow/on row/edge row) of seed has on chemical damage and establishment of wheat.

Background

With an increase in stubble retention in continuous cropping systems as well as decreasing reliability of opening rains growers focus on establishment of plants is increasing with the ability to now accurately plant crops within 2cm of target. This has however come with some challenges as IBS (incorporated by sowing) herbicides rely on soil throw to effectively move chemically treated soil from the furrow where the crop is going to emerge from. Edge and on row sowing may result in some of that soil not being able to move out of the furrow and in turn negatively affect the crops establishment and weed control. Sowing on or edge row however does provide a benefit where there is a lack of moisture as the previous year’s furrow will have harvested rainfall and is often the place where the highest amount of moisture can be found.

Investigating the interaction between these two effects will aid growers when making decisions regarding seeding set up and seed placement.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	18m x 12m. No replication.
Soil type	Heavy red loam
Paddock rotation	2021 wheat, 2020 wheat, 2019 fallow
Sowing date	14/05/2021
Sowing rate	70 kg/ha Mace Wheat
Fertiliser	50kg MAP/MOP blend (70:30) and 60Kg Urea banded at seeding.
Herbicides, Insecticides & Fungicides	Knockdown – 2 L/Ha Glyphosate 450. Bixlozone 1250 ml/ha, Cinmethylin 500 ml/ha and Saflufenacil + Trifludimoxazin 200 ml/ha.

Treatments

	Treatment
1	Interow seeded with Bixlozone applied @1.25l/ha (Overwatch)
2	On row seeded with Bixlozone applied @1.25l/ha (Overwatch)
3	Edge row seeded with Bixlozone applied @1.25l/ha (Overwatch)
4	Interow seeded with Cinmethylin applied @ 500ml/ha (Luximax)
5	On row seeded with Cinmethylin applied @ 500ml/ha (Luximax)
6	Edge row seeded with Cinmethylin applied @ 500ml/ha (Luximax)
7	Interow seeded with Saflufenacil + Trifludimoxazin applied @200ml/ha (Voraxor)
8	On row seeded with Saflufenacil + Trifludimoxazin applied @200ml/ha (Voraxor)
9	Edge row seeded with Saflufenacil + Trifludimoxazin applied @200ml/ha (Voraxor)

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	7.5	27	532	3	8	2	0.2	0.9
10-20	7.8	8	362	5	5	1	0.2	0.7
20-30	7.8	10	328	11	2	2	0.2	0.7

Results

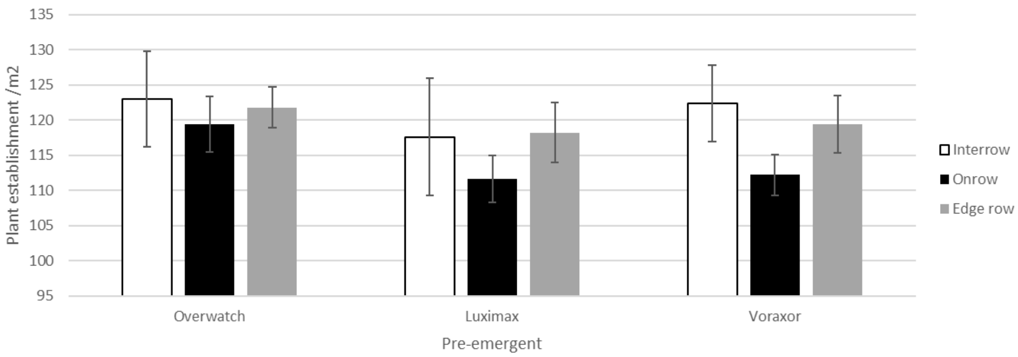


Figure 1: Plant establishment counts of wheat using different seeding placements. Error bars = S.E

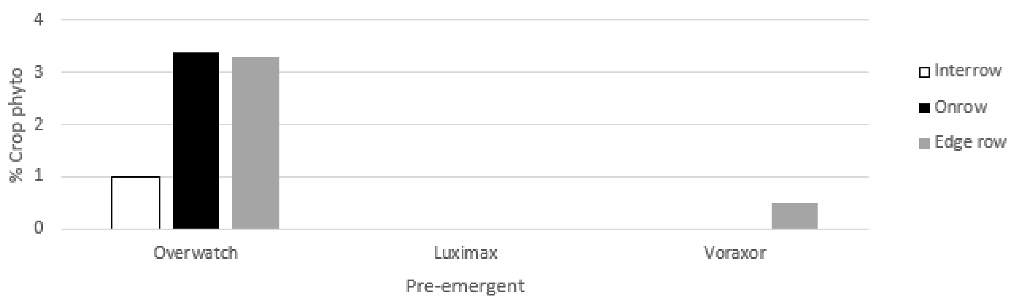


Figure 2: Crop phytotoxicity two weeks after application.

Comments

Figure 1 demonstrates that interrow sowing has proven to be the safest treatment with the greatest plant establishment across all three herbicides as well as having the lowest phytotoxicity recorded. This is likely due to the interrow treatment giving the best soil throw as there is reduced stubble that could possibly result in soil falling back into the furrow.

On-row treatments expressed the lowest establishment and it is thought that this was likely due to the heavy red loamy soil type that is high in clay content resulting in quite a few clods being bought up when seeding on last years stubble, this meant that establishment was much lower due to clods adding to herbicide damage as well as meaning seed soil contact and seed depth was not ideal for establishment.

It is noted that the establishment was slightly behind with on-row sowing and likely an effect of the season break with good soil moisture meaning that edge row sowing did not experience any of the typical benefits that one would expect from planting the crop where the greatest stored moisture is found without compromising seeding by planting on-row. On different soil types with lower water holding capacity or years where there is not as much soil moisture at the beginning of the season it may be expected that establishment will be positively affected by on-row or edge row sowing.

Herbicide damage was limited at the site given the soil type and growing conditions were almost perfect all year meaning herbicides worked well and did not move into the crop row affecting growth or establishment. Plant numbers were slightly down in the Luximax treatment however this was not expected to be of significant difference. Phytotoxicity was observed, on a very low number of plants, in the Overwatch treatment primarily in the on row and edge row treatments where treated soil had moved back into the furrow however this bleaching was transient and had disappeared a few weeks following.

It is evident that choosing a seeding placement based on soil type and soil moisture is important for growers if they are to maximise establishment and minimise herbicide damage. Strategies to minimise herbicide damage should be carefully considered with all of the individual factors accounted for before choosing one system.

Acknowledgements
Thank you to the Hyde family for hosting the Liebe Group trial site and seeding the trial.

Peer review
Shannon Meyer, Elders Coorow

Contact
Tristan Clarke
tristan.clarke@elders.com.au
0417 253 586

Demonstration of Pre-Emergent Herbicides in a Disc Seeding System

Shannon Meyer, Agronomist, Elders Coorow

Key Messages

- Due to crop safety concerns most pre-emergent herbicides are not currently registered for use with disc systems.
- Herbicide choice for pre-emergent weed control when using disc systems can have a significant impact on crop establishment.

Aim

To demonstrate pre-emergent herbicide tolerance in wheat using a disc seeding system.

Background

There has been an increase in farmers using disc machines as stubble retention has increased and with the need to cover large areas quickly. Many pre-emergent herbicides rely on treated soil being moved away from the wheat seed and the seed being planted at an adequate depth to improve crop safety. Disc seeding causes low disturbance and the herbicide may not be adequately moved out of the seed row. Due to this, most new herbicides are not registered for use in disc seeding systems. Careful consideration should be given to known herbicide crop effect potential before a particular herbicide is applied using a disc system.

Trial Details

Trial location	Hirsch Property, Latham
Plot size & replication	10m x 2m x 3 replications
Soil type	Acidic yellow sand
Paddock rotation	2020 wheat, 2019 canolda, 2018 fallow
Sowing date	25/05/2021 using Double Disc with KHart 8612 Gent Opener 600mm spacing
Sowing rate	60 kg/ha Scepter wheat
Fertiliser	25/05/2021 - MAP 45 kg/ha, 05/07/2021 - UAN 50 L/ha
Herbicides, Insecticides & Fungicides	25/05/2021 - Trifluralin 2000 ml/ha, Prosulfocarb + S-Metalachlor 2500 ml/ha, Pyroxasulfone 210 ml/ha, Mesotrione 200 ml/ha, Cinmethylin 500 ml/ha, Pyroxasulfone + Diflufenican + Aclonifen 1000 ml/ha, Pyroxasulfone 210 ml/ha, Saflufenacil + Trifludimoxazin 200 ml/ha, Bixlozone 1250 ml/ha, Mesotrione 200 ml/ha, Prosulfocarb 3000 ml/ha Saflufenacil + Trifludimoxazin 200 ml/ha, Pyroxasulfone 210 ml/ha Mesotrione 200 ml/ha, Saflufenacil + Trifludimoxazin 200 ml/ha Cinmethylin 500 ml/ha, Bixlozone 1250 ml/ha Mesotrione 200 ml/ha 27/05/2021 - Diflufenican 100 ml/ha, Pyroxasulfone 210 ml/ha Diflufenican 100 ml/ha, Bixlozone 1250 ml/ha, Pyroxasulfone 210 ml/ha

Treatments

1	Control
2	Treflan 2000 ml/ha IBS (incorporated by seeding)
3	Boxer Gold 2500 ml/ha IBS
4	Sakura 210 ml/ha IBS
5	Callisto 200 ml/ha IBS
6	Luximax 500 ml/ha IBS
7	Mateno Complete 1000 ml/ha IBS
8	Sakura 210 ml/ha IBS, Brodal 100 ml/ha PSPE (post seeding pre-emergent)
9	Sakura 210 ml/ha + Brodal 100 ml/ha PSPE
10	Voraxor 200 ml/ha IBS
11	Overwatch 1250 ml/ha IBS
12	Overwatch 1250 ml/ha PSPE
13	Callisto 200 ml/ha IBS, Sakura 210 ml/ha PSPE
14	Prosulfocarb 3000 ml/ha + Voraxo 200 ml/ha IBS
15	Sakura 210 ml/ha + Callisto 200 ml/ha IBS
16	Voraxor 200 ml/ha + Luximax 500 ml/ha IBS
17	Overwatch 1250 ml/ha + Callisto 200 ml/ha IBS

Results

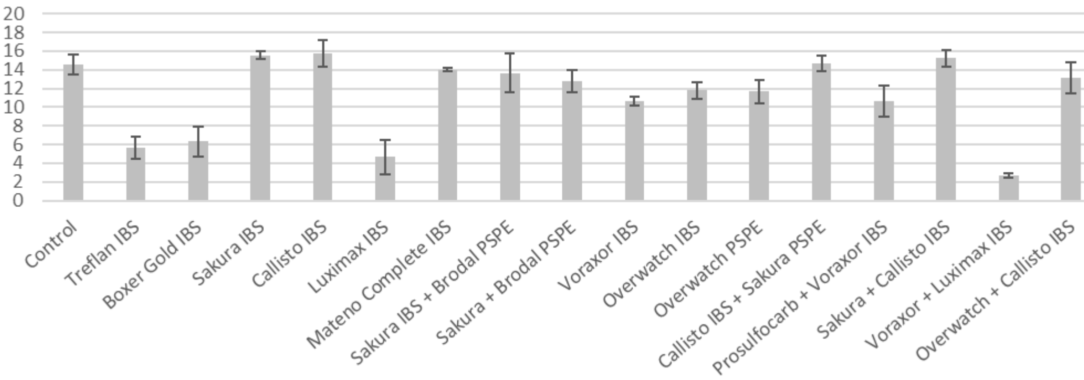


Figure 1: Plant establishment counts 26/06/2021 per 25cm furrow length. Error bars = S.E

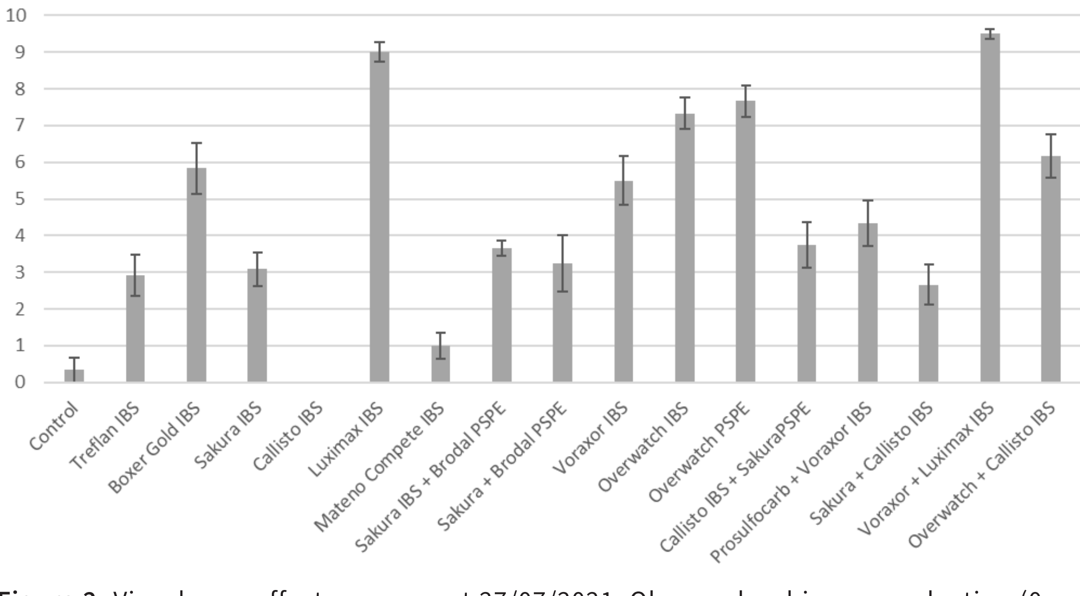


Figure 2: Visual crop effect assessment 27/07/2021. Observed as biomass reduction (0 = no biomass reduction 10 = complete biomass reduction). Error bars = S.E.

Comments

There is large variability of plant establishment and biomass between treatments. Rainfall events following application would have contributed to movement of herbicides in the soil.

Figure 1 results show low plant establishment in Luximax, Boxer Gold and Trifluralin treatments. Herbicide treatments containing Luximax had the largest visual biomass reduction however this was expected as cinmethylin is known to be very mobile in the soil and the label states that seed should be planted well below the treated soil (minimum 3cm sowing depth). Biomass reduction can also be seen with the Boxer Gold result with the s-Metalachlor being mobile in the soil. A small amount of soil throw identified at seeding may have moved enough trifluralin out of the furrow to reduce the amount of crop effect observed in Figure 2.

The Overwatch treatments had reasonable plant establishment in Figure 1 but were showing significant early crop effect which relates to the visual biomass reduction observed in Figure 2.

Mateno Complete had low biomass reduction compared to Sakura alone and Sakura and Brodal mixes. Rainfall following seeding may have contributed to Sakura causing lower plant establishment than expected.

The results indicate there is the opportunity to explore prosulfocarb more closely as a pre-emergent herbicide in disc systems and should be investigated further.

These results highlight the importance of having thorough weed control management strategies to keep weed numbers low, particularly in a long-term disc system.

Treatments in this demonstration are not registered and results should be used cautiously considering individual circumstances. When determining likely crop safety, check label registrations and take into account soil type, herbicide properties, machine set-up, soil moisture levels, forecast rainfall and the level of stubble retention.

Weed control was not assessed as part of this demonstration.

Acknowledgements

Thank you to Dylan Hirsch for seeding the trial and Nick Eyres for organising the herbicides.

References

GRDC – Understanding pre-emergent herbicide availability, selectivity and persistence and how we can use this knowledge to predict behaviour of new herbicides.

Peer review

Nick Eyres, Elders Geraldton, and Tristan Clarke, Elders Scholz Rural

Contact

Shannon Meyer
shannon.meyer@elders.com.au
0436 030 862

Comparison of Tine and Disc Seeder Implements in a Minimum Till Application

Dan Jolly, Branch Manager, AFGRI Equipment Dalwallinu

Aim

This demonstration trial compared the two types of seeding implements in terms of both productivity and agronomic benefit.

Background

Disc seeding is gaining popularity in Australian broadacre cropping. Understanding the implications of changing to such a system is vital to growers in lower rainfall areas. As a rule, disc seeders are better able to handle higher stubble loads than tine and press wheel implements.

Crop residues, or stubble, can potentially play an important role in contributing to soil health and nutrient cycling in broadacre cropping. Further positive factors such as improved rainfall infiltration and soil moisture retention make stubble retention desirable. The challenge however is that, while the benefits of stubble retention are widely recognised, growers are faced with significant issues that can arise when stubble is retained. These issues include problems with weed, pest and disease control, crop nutrition and the logistics of sowing the following years crop into potentially high stubble loads.

Trial Details

Trial location	Main Trial Site, Hyde Property, Dalwallinu
Plot size & replication	1.5km strip x 12 replications
Soil type	Heavy red loam
Paddock rotation	2020 field peas, 2019 wheat, 2018 wheat
Sowing date	18/05/2021
Sowing rate	70 kg/ha Mace Wheat
Fertiliser	50kg/ha MAP at sowing, 40 L/ha Flexi N
Herbicides, Insecticides & Fungicides	18/05/2021 - 2 L/ha Prosulfocarb & 2 L/ha Trifluralin PreEm 16/06/2021 - MCPA, Bromoxynil and Diflefenican PostEm
Harvest date	02/12/2021

Treatments

	Treatment
Tine8	3 Strips seeded with 12m tine bar at 273mm spacing at 8 km/h
Disc8	3 Strips seeded with 12m disc bar at 200mm spacing at 8 km/h
Disc12	3 Strips seeded with 12m disc bar at 200mm spacing at 12 km/h
Disc18	3 Strips seeded with 12m disc bar at 200mm spacing at 18 km/h

Crop Establishment

Table 1: Wheat emergence (plants/m^2) from strips seeding by two types of seeding bars. The trial was planted on the 18th May 2021 and the emergence data was collected on 23rd June 2021.

Seeding Bar	Tine/Disc	Speed (km/h)	Plots Sampled	Mean (Plants/m²)	Std. Dev
Equalizer	Tine	8	30	131	28
Horsch	Disc	8	30	111	27
Horsch	Disc	12	30	114	27
Horsch	Disc	18	30	111	25

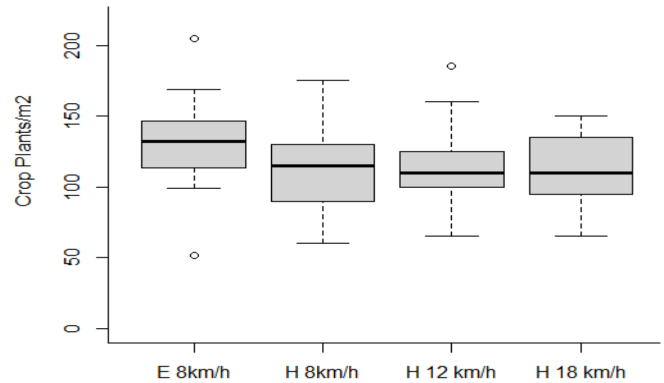


Figure 1: Wheat emergence from a tined Equalizer seeding bar at 8 km/h and from a disc Horsch seeding bar at 8, 12 and 18 km/h.

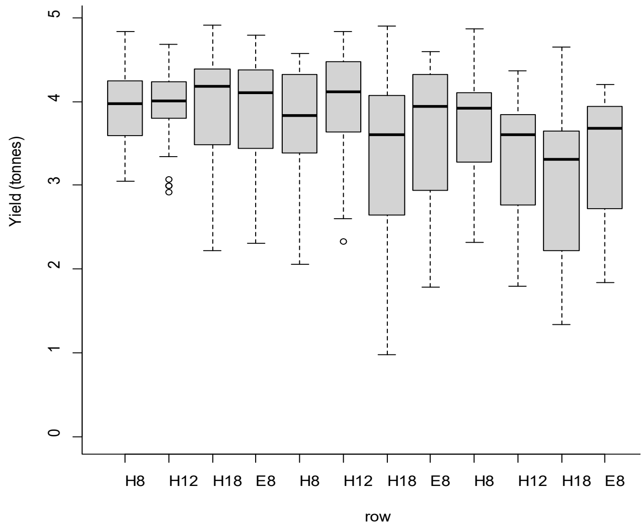


Figure 2: 2021 Wheat yield of 12 consecutive runs, different seeding bars were used, a 12m disc Horsch air seeder (H) and a 12m tined Equalizer bar (E). The Horsch bar was used at 3 different speeds; 8, 12 and 18 km/h.

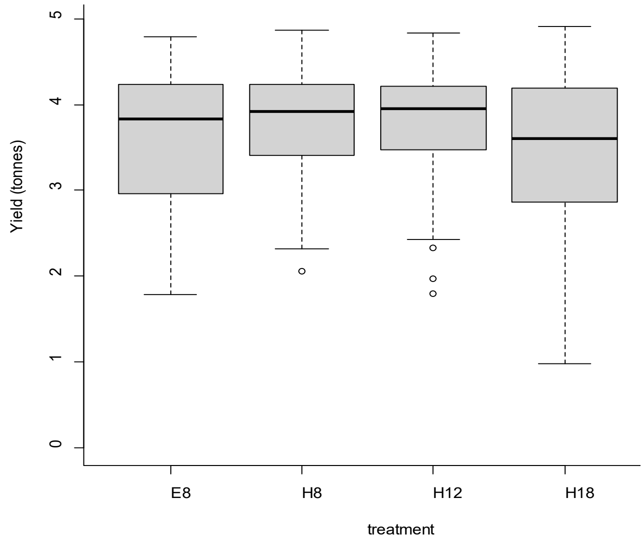


Figure 3: 2021 Yield averages from the four different seeding treatments.

Table 2: 2021 Wheat yield (t/ha) from four different seeding treatments. The Horsch bar was used at multiple speeds. SD stands for standard deviation and CV stands for coefficient of variance.

Treatment	Mean (t/ha)	SD (t/ha)	CV (%)
Equilizer (8 km/h)	3.6	*0.8	21
Horsch (8 km/h)	3.8	*0.6	16
Horsch (12 km/h)	3.8	*0.7	17
Horsch (18 km/h)	3.4	*0.9	27

Comments

There was no significant difference between the disc and tyne treatments. However there was large variation observed in the yields of the 18 km/h plots (Table 2). The Horsch Disc Seeder and the Equalizer Tine gave 0.1 yield difference at 8 km/h. There was no yield penalty to go 12 km/h with the disc and only a small yield penalty to go 18 km/h. The two runs with the largest yield variance were both the 18km/h treatments. This may be due to reduced performance of the disc seeding system in variable soil types at higher speeds, however the treatments still yielded similarly to the slower speeds and the tine seeder. This test should be run again in a dry year to see if the same result is achieved.

This year was abnormally wet, which probably favored the Horsch disc because this set more tillers early on. In a drier year the result may have been significantly different. The advantages of a disc system for handling crop residue was not demonstrated in the trial as the field pea stubble was easily handled by both seeders.

Acknowledgements
Thanks to Uys Lorens and Jonathon Kammermann.

Peer Review
Dylan Hirsch, Liebe Group member, Hirsch Farms

Contact
Dan Jolly
djolly@afgri.com.au
0418 928 489

MACHINERY AND TECHNOLOGY

Seeing into Soils: Adoption of a Soil Moisture Probe Network for Increased Water Use Efficiency in the Low Rainfall Region of WA

Rebecca Wallis, Development Officer, Liebe Group

Key Messages
- The key barrier to utilising soil moisture probe and automatic weather station technology was determined to be the perceived return on investment.
- This project provided value to participating growers in the first year by providing real time seasonal data from their paddocks.

Aims
- To increase grower awareness and knowledge of soil moisture probe technology with the establishment of a sustainable local ‘network’ for best practice decision support; and
- To build the capacity of growers to better understand water use efficiency (WUE) on various soil types, for increased confidence in adapting to changing climate conditions and the protection of natural assets.

Background
Soil moisture probe technology has been utilised extensively in viticulture and horticulture since the mid-1990s, however it has only been within the last ten years that broadacre agriculture has begun to adopt these practices. Alongside recent advances in connectivity and various other capabilities, the implementation of ‘networks’ of moisture probes and weather stations can provide significant insight into the management of natural resources.

Whilst this technology is readily available, there is still observable reservation by growers to invest in these systems within the low and medium rainfall zones of the NAR of the Western Australia wheatbelt. This project will highlight how the incorporation of these types of technologies into their enterprises can add value and complement existing knowledge and tools, such as the Yield Prophet Production model.

This project will establish a collaborative network of soil moisture probes in the NAR, with the aim of providing growers with information on how they can use the near real-time soil moisture probe and weather data to improve their enterprise profitability through more informed decision making.

Project Details
A total of fourteen automatic weather stations and rain gauges have been installed in the Liebe Group region in 2021 via a co-funding agreement with the host growers. An additional 10 automatic rain gauges were also included as part of the network. The geographical spread of the stations range from Perenjori to Ballidu and from Watheroo to Xantippe.

The Liebe Group engaged Perth based service provider Wildeye to supply and install the technology that connects to IoT cellular networks through specialised telemetry units. The equipment that was installed includes;
- Enviropro soil moisture sensor, 80cm long (with some opting for 120cm length probe), which measures plant available water in the profile; and
- Wildeye standard dryland weather station, which measures rainfall, air temperature, humidity, wind speed, Delta T, Fire Index.

This technology was installed prior to Tropical Cyclone Seroja (early April 2021) and the season break. All soils were fully characterised prior to installing to enable accurate calibration, with assistance from DPIRD. A full season of weather and rainfall data has been collected, with some probes appearing to have some settling in time to get accurate readings. Initial manual rainfall calibrations were undertaken in the first three months.

Access to the network of weather stations, probes and rain gauges has been made publicly available to all Liebe members and partners via the Liebe Group website. An in-season soil moisture update newsletter commenced and will continue in 2022.

Survey
A survey was conducted to understand the technology adoption barriers and knowledge of the technology growers had at the start of the project.

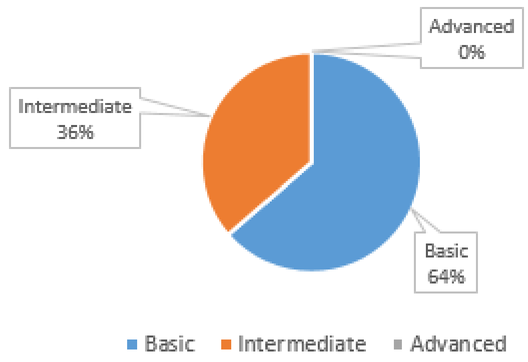


Figure 1. Survey results showing current level of understanding around soil moisture probe technology, June 2021.

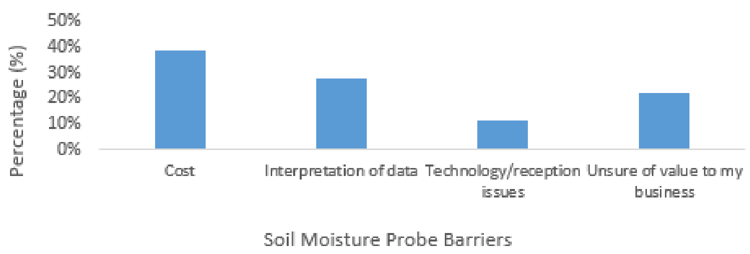


Figure 2. Survey results indicating barriers to installing soil moisture probes on farms, June 2021.

Comments
The group of 14 growers that have been involved in the project have been engaging in discussions on WhatsApp and have met at the Liebe office in July 2021 to learn about the basics of soil water and data interpretation from the probes. The technology has provided a real time discussion tool for seasonal weather events, such as the cyclone, frost and heat stress events experienced in 2021 season. The 2021 season also provided the opportunity to see soil profiles full and understand the drained upper limit of the different soil types – which will provide a good reference for future seasons.

General feedback received throughout the project to date has indicated value gained by the farm businesses who are participating in the project, along with other local farmers. This has included support to decision making points during the year such as spray conditions and seeding timing. There is an expectation that as the project evolves and understanding of the technology increased, this too will increase the value to the farming community.

Mike Dodd, participating farmer from Niribi Farms in Buntine provided the following comment: "Although we don't have an economic value we can place on the project, the ongoing utilisation of the soil moisture probe on our farm can only lead to a greater understanding our soil's water holding capacity and therefore confidence in decision making. The interaction with fellow growers, WUE within soil types, amelioration options and interpretation of how that works within the Liebe probe network can only add value to all members. I look forward to our workshop in February and following this project as it progresses".

This project is in its second and final year, which will see a workshop held in early 2022. The Liebe Group is investigating future opportunities to continue and expand the network.

Peer Review
Mike Dodd, Liebe Group Member

Acknowledgements
This project is funded through the Australian Government's National Landcare Program Smart Farms Small Grants Program. The Liebe Group acknowledges the contributions growers have provided to the project. Thanks also to Caroline Peek, DPIRD that has provided technical insights and supported the soil characterisations, and Kieran Coupe from Wildeye for ongoing technology support.

Contact
Liebe Group
research@liebegroup.org.au
08 9661 1907

Australian Government | National Landcare Program | LIEBE GROUP Working together in Agriculture

Measuring Harvest Losses in Western Australia

Chris O'Callaghan, Project Support Officer, Liebe Group

Key Messages

- Front losses in lupins and pulses were often higher than expected.
- Canola losses were generally low but worth taking time to minimise.
- There is a balance between optimising capacity and machine losses.
- Full data analysis is ongoing.

Aim

Grain growers in the Western Region will understand the current level of grain losses (tonnes and $) during harvest for all of the major grain crops in Western Australia and understand where these losses occur. Growers will be able to calculate acceptable losses irrespective of varying yield levels.

Background

Grain losses at harvest directly impact the amount of grain captured and sold. It is understood that losses occur at the front as well as the rotor and sieves, but these are only sporadically measured. There are acceptable losses and different thresholds for each grain crop, which represent the optimum balance between grain loss and harvest efficiency (speed, logistics etc.). Optimising this balance will ensure growers can minimise losses while maximising profit.

This investment by the GRDC aims to quantify the losses in each of the major grains crops in the Western Region and create a benchmark for losses, rather than relying on anecdotal evidence or farmer-collected data in investment analysis. The data captured will focus on the front and back losses, with an analysis to summarise the findings and help guide further investment in minimising harvest loss.

Results

The Liebe Group team conducted harvest loss sampling activities at 30 sites throughout the Kwinana East and Geraldton Port Zones. Visiting individual farms during their harvesting period, drop pans were utilised to measure front and machine losses.

Full results are currently being collated and analysed by the project team however there are a few observations that have been made whilst completing the tests:

- Front losses were high in many lupin crops, highest losses equating to nearly 1 t/ha.
- Growers who have adopted stripper fronts found that sieve losses can be high and need to adjust the machine accordingly.
- Canola losses were generally low, although with higher prices associated with the crop, growers were keen to minimise losses to around 1-2%.
- Some growers were faced with balancing the trade-offs between ground speed and losses, particularly when faced with impending inclement weather events.
- Many growers were interested in finding the balance between optimising harvester capacity and increasing losses. In some cases harvesters could handle the extra throughput associated with higher ground speeds, however this can also result in increased machine losses.
- Sieves and fan speed settings play an important role in minimising losses.

Liebe team in paddock during harvest 2021 conducting harvest loss measurements.

Comments

Full analysis on the data collected through this project is underway, with results to be presented later in 2022.

Peer Review

Ben White, Kondinin Group

Acknowledgements

This is a GRDC funded project, WMG2003-001SAX, led by the Grower Group Alliance. The Liebe Group acknowledges the contributions participating growers have provided to the project activities. Thanks also to Ben White, Kondinin Group, and Primary Sales Australia for their support.

Contact

The Liebe Group
research@liebegroup.org.au
08 9661 1907

GENERAL INFORMATION

Benchmarking with Aglytica

Aglytica is a specialist benchmarking company which produces the Farm Profit SeriesTM. The Profit SeriesTM is a powerful benchmarking tool, used by hundreds of businesses across Australia. This specialist publication is designed to help producers compare results to other businesses and has been produced (as the Farmanco Profit Series) for nearly 25 years.

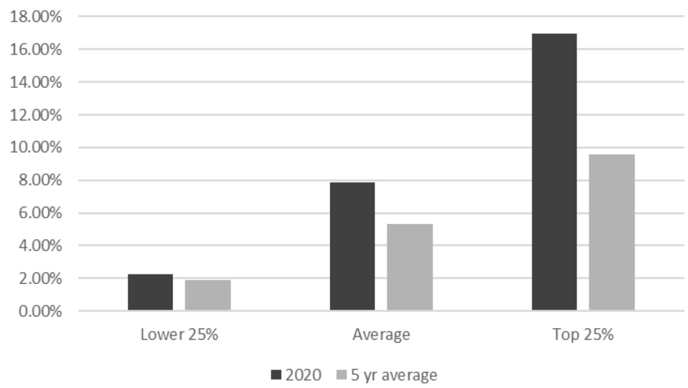
Benchmarking is designed to give those who participate a competitive edge. Benchmarking is a process that uses key performance indicators to better understand how the physical and financial activities of a farming business impact the profitability of the business. It is a tool used to compare your business externally to similar businesses or to make comparisons within the business itself. This comparison can then be used to identify business strengths and areas for improvement to help make decisions 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, create best practice, improve the business bottom line, improve awareness, and allow farm owners and managers to better align their performance with their business objectives.

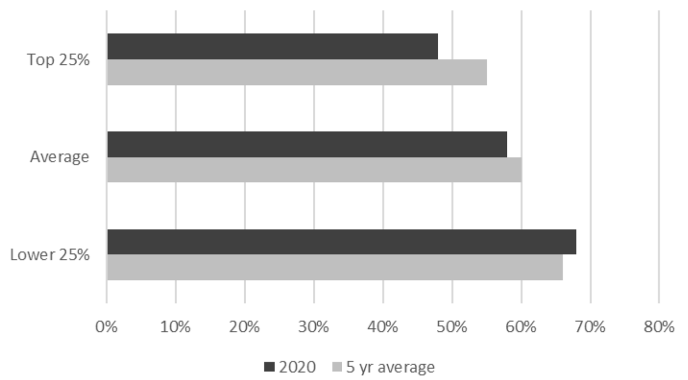
The following data has been extracted from the 2020/2021 edition and is based on the shires covered by the Liebe Group. For further information please contact Glenn Briggs on 0438 976 910 or info@aglytica.com.au

Table 1: Business Performance Measures for 2020.

A SnapShot of the Liebe Region Farm Business in 2020			
	Lower 25%	**Average**	**Top 25%**
Area Owner	5,035	4,748	6,311
Area Farmerd (inc Lease and Sharefarm)	5,316	5,897	7,024
Labour - Full Time Equivalents	3.1	2.9	2.8
Crop %	84%	88%	93%
Machinery Value $/ha	$494	$424	$381
Business Equity	11.74M	11.45M	12.82M
Net Equity %	82%	86%	89%
Growing Season Rain	193	186	175
Income$/100mm of Effective Rain	$296	$335	$378
CASHFLOW MEASURES			
Farm Income	**573**	**621**	**649**
Wages $/ha	18	16	11
Fertiliser $/ha	99	88	82
Pesticides $/ha	77	74	65
Fuel and Oil $/ha	16	16	16
Repairs and Maintenance $/ha	35	31	19
Total Variable Costs $/ha	**389**	**349**	**303**
Overheads	44	39	28
Drawings/Management	29	34	41
Machinery Capital	66	49	45
Farm Infrastructure Expenditure	10	7	7
Total Fixed Costs $/ha	**190**	**166**	**145**
Operating Surplus $/ha	**-6**	**105**	**200**
PROFIT MEASURES			
Operating Profit $/ha	**42**	**151**	**260**
Return on Assets Managed % (ROAM)	**1.58%**	**5.86%**	**12.81%**



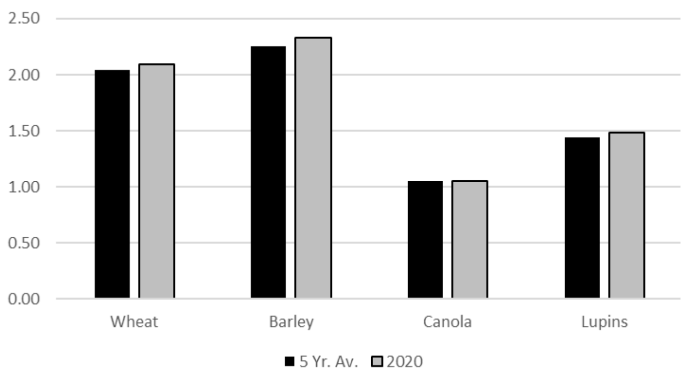
Graph 1: Return On Assets Managed for 2020 compared to the five year average.



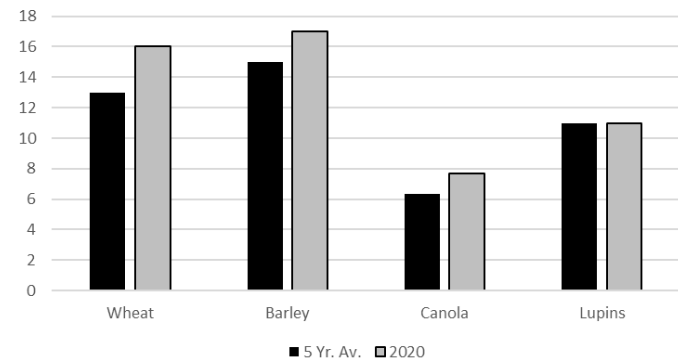
Graph 2: 2020 Variable Cost % compared to the five-year average.

Return on Assets Managed (ROAM) is one of the best benchmark measures to assess the ability of a business to expand and grow profits into the future. In general, 2020 was a good year for farm businesses in the Zone covered by the Liebe Group. The average business produced a very respectable 12.8% ROAM while the Lower 25% were less than a third at 1.58% while the Top 25 were more than double the Average. This result doesn't surprise us, as better management over time will set the top 25% farms up to realise more of the potential of a good year. The differences in the five-year average performance have remained at a similar ratio for as long as we have been looking at these ratios. The top 25% will be almost double the average while the bottom 25% will less than half the average.

The Operating Variable Costs as a % of Income graph above 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%. Only the top 25% are able to consistently perform at these levels, while the Lower 25% are well over 65%.

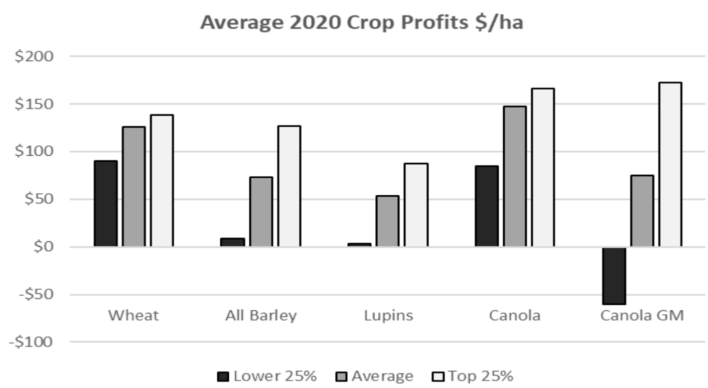


Graph 3: 2020 Yields compared to the five-year average.



Graph 4: 2020 Crop WUE compared to the five-year average.

The 2020 yields were all slightly above the five-year average. These yields were produced with below average rainfall, so the WUE was well above average for all the crops.



Graph 5: The Average Crop Profits for the Client Groups.

The range in profitability across the major crops grown last year from the Lower 25% to the Top 25% is significant for all crops, with the smallest difference being in Wheat.

This is not surprising as wheat is the most resilient of the crops. As you move from left to right the penalties from not getting the agronomy and cost management right increases, with GM Canola showing the difference from not getting it right with a loss of $60/ha to getting it right with a profit of $170/ha is a staggering $230/ha.

Table 2: The 2020 Wheat Enterprise Analysis compared to the five-year average.

Farmanco Profit Series		**All Clients Average**	
Wheat Enterprise Analysis		**5 Yr. Av.**	**2020**
Area	ha	2,912	3,121
Yield	t/ha	2.04	2.09
Equivalent Cash in Bank Price	$/t	$326	$325
Income	**$/ha**	**$665**	**$680**
Variable Operating Costs	$/ha	$373	$391
% of Income		56%	58%
Operating Gross Margin	**$/ha**	**$292**	**$289**
Fixed Operating Costs	$/ha	$166	$126
Total Operating Costs	**$/ha**	**$539**	**$517**
Operating ProfitCrop (BIT)	**$/ha**	**$126**	**$163**

The wheat enterprise in 2020 did produce a better result than average with an Operating Profit of $163/ha which was $37/ha above the five-year average. This result was from the slightly higher yield and a similar price giving an increase in income of $15/ha.

Variable costs were higher however the drop in fixed costs more than made up for this increase which meant total costs were down $22/ha.

Table 3: The 2020 Sheep Enterprise Analysis compared to the five-year average.

Farmanco Profit Series		**All Clients Average**	
Sheep Self-Replacing Wool Flock Enterprise		**5. Yr. Av**	**2020**
Sheep Grazed Area	ha	1,138	1,138
Stocking Rate	wg dse/wg ha	3.35	3.82
Weaning Percentage	%	94%	95%
Lambs weaned per ha	hd/ha	1.40	1.59
Average Sale Price	$/hd	$112	$126
Average Greasy PRice	$/kg	$8.60	$7.76
Average Clean Wool Price	$/ka	$14.30	$12.50
Greasy Wool Cut	kg/wgha	14.46	14.46
Clean Wool Cut	kg/wgha	8.97	8.58
Clean Wool Water Use Efficiency	kg/ha/100mm	4.82	4.95

The above table is focused on the sheep enterprise within the Liebe area. Pleasingly, in 2020 the average sheep enterprise made an operating profit of $86/ha, this is $40/ha above the five-year average and is due to the above average sale numbers at above average prices per head. As with the cropping enterprises, cost control is the key component to the success of the sheep enterprise.

Table 4: 2020 Total Machinery Costs which include Capital, Running Costs, Management and Contract.

2020 Total Machinery Costs in $/ha			
	Lower 25%	**Average**	**Top 25%**
Machinery Depreciation	$97	$85	$75
Management Allowance	$50	$39	$23
Wages, F&O< R&M, Contract	$89	$77	$53
CPML (Total Cost of Machinery)	**$236**	**$199**	**$146**
CPML as a % of Income	**40%**	**32%**	**23%**
Crop Income ($/ha)	$597	$643	$652
Crop Area (ha)	4,806	5,121	7,369

As you can see in table 4 the most profitable businesses run large and very cost-efficient businesses.

Scale helps to reduce the Management costs and to a lesser degree the Capital cost of machinery (Depreciation), however these businesses also have lower running costs.

Looking at the difference in these costs as a percentage of income highlights how big an impact these costs have on the operating profits of a business.

The Top 25% are only spending 23% of their revenue on Total Machinery Costs while the Lower 25% are spending 40%.

The difference in operating profit between the Top 25% and Lower 25% was $218/ha. The difference in machinery costs explains $90 (over 40%) of the difference in the operating profit.

2021 RAINFALL REPORT

	Dalwallinu	Kalannie	Coorow	Carnamah	Latham	Perenjori	Wongan Hills	Goodlands
Jan	0.8	1.6	5.4	5.5	24.8	1.8	2.2	0.2
Feb	33.2	73.6	37.8	28.2	30.8	58.4	37.8	31.8
Mar	114.8	77.0	42.5	21.7	68.8	44.2	69.0	59.8
Apr	39.2	42.0	27.0	40.0	56.0	19.6	20.2	44.4
May	80.2	72.6	65.6	51.6	71.0	62.1	53.8	71.0
Jun	33.6	42.6	43.6	47.9	53.2	34.6	32.8	28.2
Jul	114.4	94.4	100.8	105.9	89.6	100.0	100.9	78.2
Aug	25.8	25.5	41.6	39.9	18.4	17.0	36.6	12.8
Sep	5.2	4.3	12.5	13.1	19.0	12.0	11.8	14.4
Oct	35.2	29.4	-	-	33.0	23.0	45.6	-
Nov	44.0	16.8	-	-	23.2	9.4	5.4	-
Dec	2.4	0	-	-	2.0	0	3.2	-
GSR (Apr - Oct)	333.6	311.8	291.1*	298.4*	340.2	268.3	310.0	249.0*
Total	528.8	480.8	276.8*	353.8*	489.8	382.1	427.6	340.8*

*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.

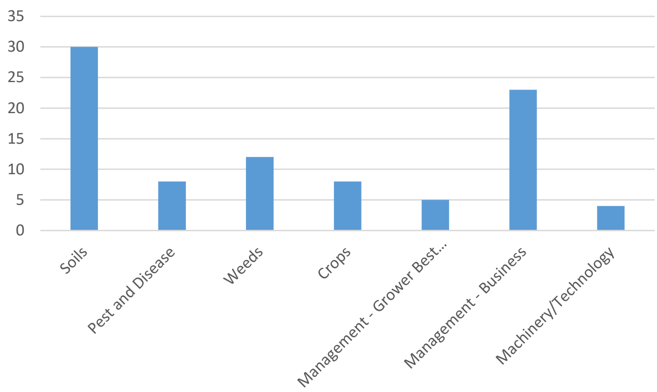
Contact the Bureau of Meteorology by phone (08) 9263 2222, by fax on (08) 9263 2233 or by email at climate.wa@bom.gov.au

The Liebe Group have taken all due care but cannot provide any warranty nor accept any liability for this information.

2021 LIEBE GROUP R&D SURVEY RESULTS

Conducted September 2021 at the Liebe Group Spring Field Day.

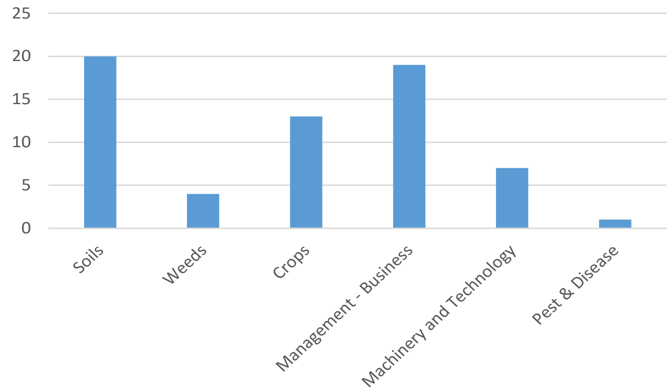
What are the key challenges affecting your farm business that could be addressed by the Liebe Group?



What are the key areas in relation to soils?

- Salinity
- Soil constraints
- Sub-soil acidity and repair
- Compaction

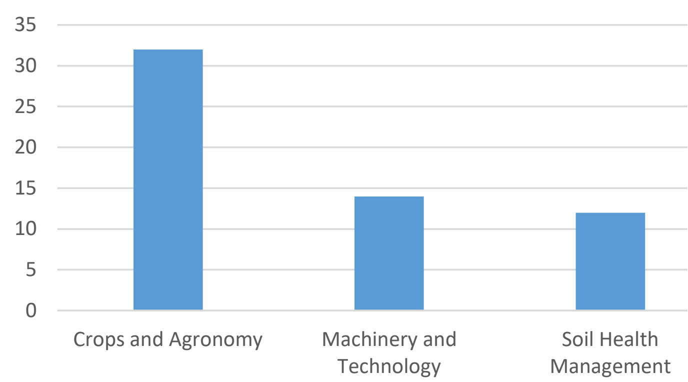
What are the key areas of knowledge or skills you wish to build on through training and workshops?



What are the key areas in relation to soils?

- Understanding soil structures
- Soil nutrition
- Amelioration
- Nutrient use efficiency

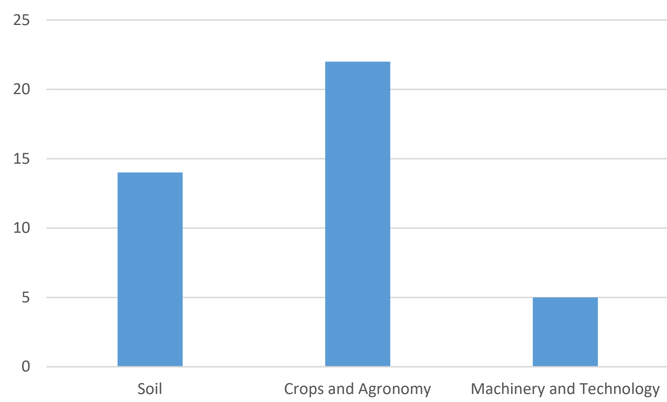
What particular concepts/products/practices would you like to see demonstrated by the Liebe Group?



What are the key areas in relation to crops and agronomy?

- Canola NVT
- How to utilise pulses in farming systems
- Diverse rotations

What long term research would you like to see the Liebe Group invest in?



What are the key areas in relation to crops and agronomy?

- Long term legume rotations
- Rotation economics
- Herbicide residues

LIEBE GROUP STRATEGIC PLAN 2022 - 2026

LIEBE GROUP
Working together in Agriculture

PURPOSE

Collective local knowledge that advances, unites and reduces risks for our members

VISION

Vibrance and Innovation for Rural Prosperity

MISSION

To facilitate grower prioritised research, development and extension to support our members to be profitable and sustainable.

COMMITMENT TO MEMBERS

- We are a welcoming, inclusive and forward thinking grower group
- We are focused on supporting members and providing an enjoyable member experience
- Research, development, extension and adoption will have local significance and relevance to members
- We collaborate for mutually beneficial outcomes
- We will protect the integrity and professionalism of our research, development and extension
- We will deliver value and return on our investments (people, resources, projects)
- We will support our staff to help us deliver upon our purpose, mission and vision
- We will have a professional and capable Board

STRATEGIC OBJECTIVES	STRATEGIES
Membership 1.1 Members are engaged and active in the Liebe Group	• Communication Strategy developed and implemented • Diverse engagement opportunities are offered • Members have timely access to R,D,E and A as well as other services that will benefit their farm business
Research, Development, Extension and Adoption 2.1 Skilled, professional and capable team that can deliver R,D,E and A 2.2 Our R,D,E and A is leveraged for member benefit	• Organisational structure reflects member and industry priorities in R,D,E and A • Liebe Group team is up-skilled and exposed to new experiences and learnings to be able to deliver locally significant R,D,E and A • R&D Sub Committee prioritise and present ideas and concepts to the Board to consider • Work towards a Liebe Group collaborative R and D hub
Partnerships 3.1 Our partners deliver value to our members	• Partnership Strategy is developed and implemented • Identify and approach new partners that help us deliver upon our purpose and vision
Governance 4.1 We demonstrate best practice not for profit governance	• Investment into the capacity and capabilities of the Liebe Board • Active succession planning by the Board and Executive Officer • Sub Committees are active and communicate strategic and operational challenges and opportunities to the Board • Highly skilled finance sub committee to oversee finances

BACKGROUND

The Liebe Group Board endorsed the 2022-2026 Strategic Plan in October 2021, following several months of comprehensive consultation with members, partners and the wider agricultural industry. With assistance from experienced consultant Caroline Robinson, this new plan marks the sixth strategic planning exercise that the Liebe Group has conducted.

Taking on a more concise format, the 2022-2026 plan highlights future opportunities for the group which will be guided by four main strategic objectives. The plan will assist the group in achieving its vision of farming communities and family businesses that are vibrant, innovative and prosperous. 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 THE 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 ensures regular consultation with members and industry to guarantee the group remains relevant. Liebe is governed by a central Board which is informed by a range of operational sub-committees that 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.

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 prioritized 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.

Professionalism
The group is professional which is encouraged and nurtured in the membership. The group is driven by the decision-making capacity of the Board and its supporting sub-committees which use accountable and transparent processes. We expect staff to be confidential in their dealings within the group.

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.

Respect
The group values and respects its 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.

Independence
The group is independent and acts under direction from the 'grass roots.' The group is objective in its views and stance.

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.

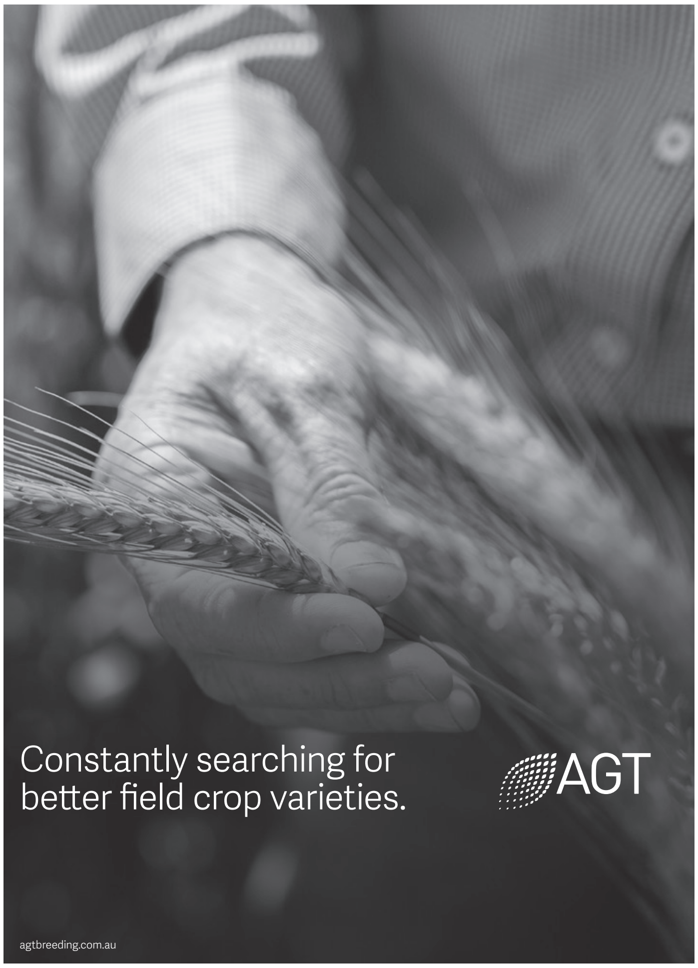
Collaborative
Effective networking and links to beneficial partnerships is encouraged to add value and opportunities. The group works collaboratively within the agricultural industry to value add. The group maintains an ethos of team work and cooperation within the group and values peer to peer learning.

Empowerment
Empowerment and capacity building is encouraged of members and staff to ensure everyone reaches their potential and supports their personal development.

Enjoyment
There is a social and fun philosophy within the group.

ACKNOWLEDGEMENTS

The Liebe Group would like to thank those who contributed to this Strategic Plan, and for continuing to support the group with passion and enthusiasm. We look forward to continuing this journey with you all.


Constantly searching for
better field crop varieties.
AGT
agtbreeding.com.au

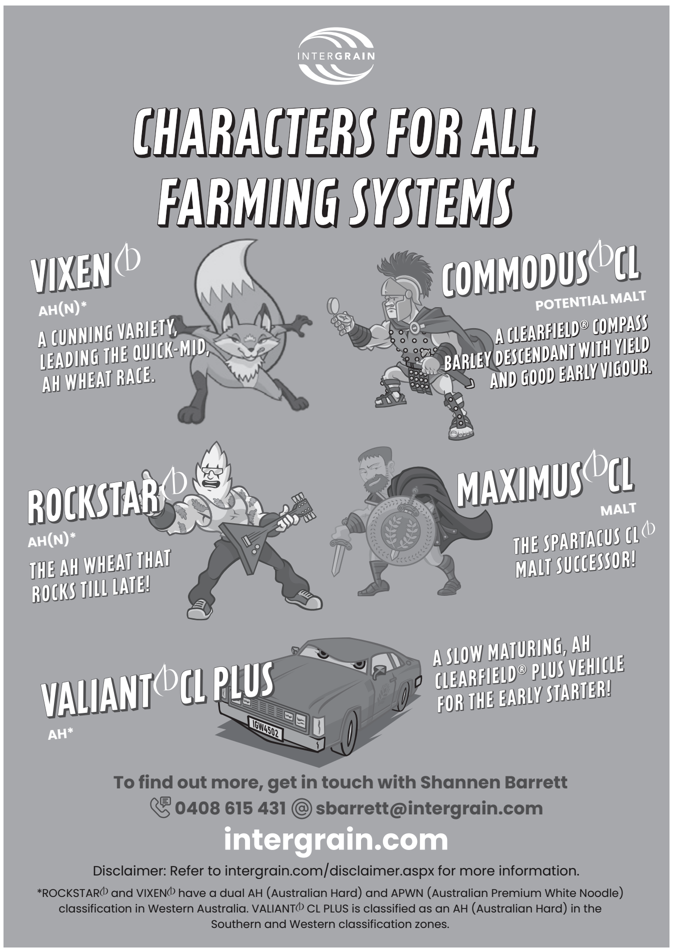

50 YEARS 1968 - 2018
Boekeman Machinery
Boekeman Machinery
Dalwallinu
Family Run, Farm Machinery Dealership Serving The
Central Wheatbelt, Western Australia
Branch Phone - (08) 9661 1002
1A Johnston Street,
DALWALLINU WA 6609
Www.boekemans.com.au
sales@boekemans.com.au


BAYER
Mateno® Complete
THE
COMPLETE PACKAGE
TO CONTROL A BROAD SPECTRUM
OF GRASS AND BROADLEAF WEEDS
HAS ARRIVED
Use in wheat (IBS - Incorporated By Sowing or EPE - Early Post-Emergence) and barley IBS
EPE application allows weed control in-furrow, on furrow shoulder, and in the inter-row
Long residual weed control
Flexible application timings and use rates
Combines 3 powerful active ingredients, including aclonifen, a NEW mode of action (Group 32)
CONTAINS A NEW MODE OF ACTION
AVAILABLE IN 10 L & 100 L PACKS
WEED smart
FOR MORE INFORMATION
visit matenocomplete.com.au or speak to your local reseller or agronomist
Mateno® is a Registered Trademark of the Bayer Group. © 2021 Bayer Group. Bayer CropScience Pty Ltd ABN 87 000 226 022. Level 1, 8 Redfern Road, Hawthorn East, Vic 3123. Technical enquiries: 1800 804 479 enquiries.australia@bayer.com


REFUEL
AUSTRALIA
Dedicated to refueling the local agriculture industry & supporting your community for over 45 years.
24 Hour Refuel Sites
Bulk Fuel
Fuel Tank Storage Solutions
Lubricants
Local people, personal service & local depots.
Luke Nicholls
0457 715 576
Dave Evans
0419 257 256
www.refuelaus.com.au

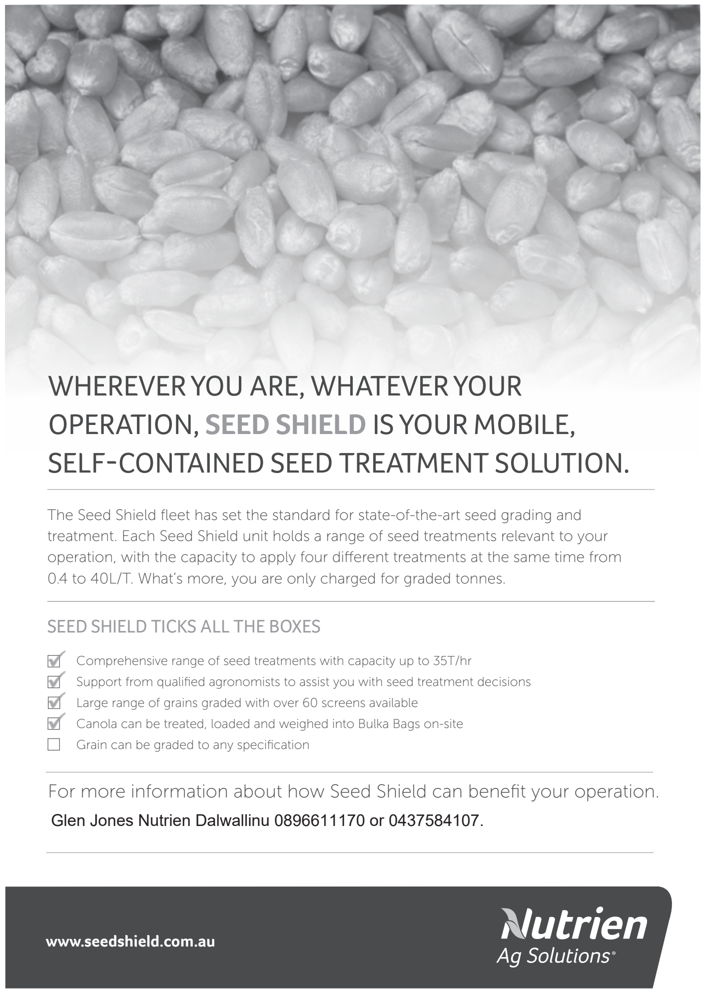

See THE DIFFERENCE WHEN YOU DO THINGS differently.
Overwatch® HERBICIDE
FMC's Overwatch® Herbicide has been reframing success in wheat, Barley and Canola crops. With up to 12 weeks of control, more flexibility and robust resistance management of ryegrass and certain broadleaf weeds you will see the difference in the paddock.
Contact your local FMC representative for more information or go to
overwatchherbicide.com
FMC
FMC and Overwatch are trademarks of FMC Corporation or an affiliate. ©2021 FMC Corporation. All rights reserved.


PODCAST
SUBSCRIBE ON YOUR FAVOURITE PLATFORM
STATE OF THE AUSTRALIAN GRAINS INDUSTRY Podcast
Listen to GrainGrowers' Zach Whale as we travel across Australia, talking with growers and key industry players about the challenges and opportunities facing our grain industry.
Want to know more about what's to come for Aussie Grains? This podcast, in conjunction with GrainGrowers' State of the Industry Report, looks at where we've been, where we're going and what's changed.
Listen now!
GrainGrowers

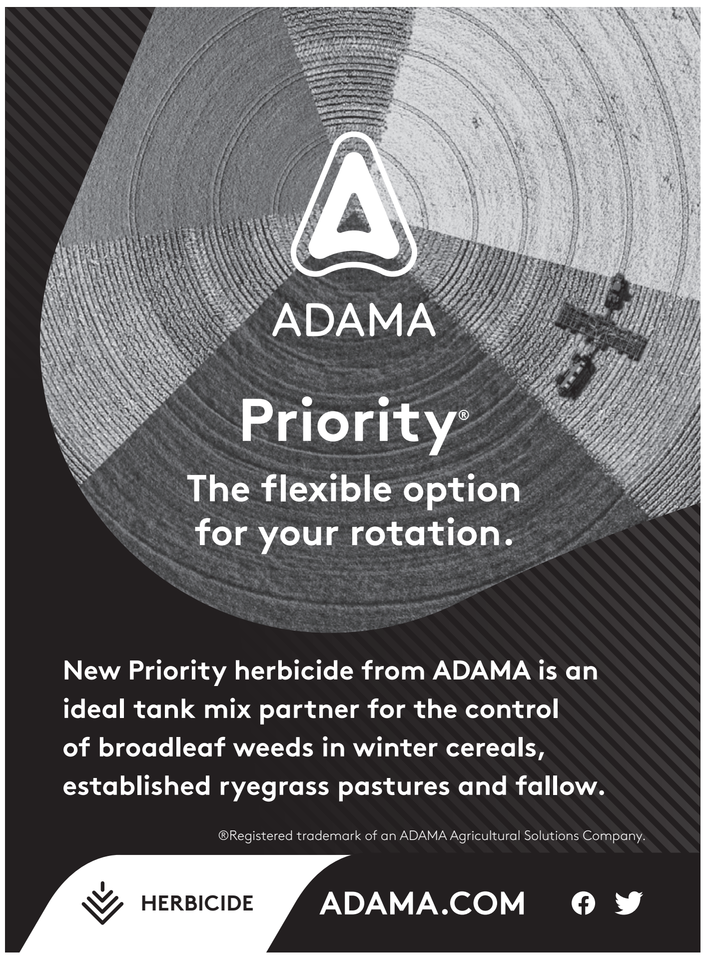

INTERGRAIN
CHARACTERS FOR ALL FARMING SYSTEMS
VIXEN
AH(N)*
A CUNNING VARIETY, LEADING THE QUICK-MID AH WHEAT RACE.
COMMODUS CL
POTENTIAL MALT
A CLEARFIELD® COMPASS BARLEY DESCENDANT WITH YIELD AND GOOD EARLY VIGOUR.
ROCKSTAR
AH(N)*
THE AH WHEAT THAT ROCKS TILL LATE!
MAXIMUS CL
MALT
THE SPARTACUS CL MALT SUCCESSOR!
VALIANT CL PLUS
AH*
A SLOW MATURING, AH CLEARFIELD® PLUS VEHICLE FOR THE EARLY STARTER!
To find out more, get in touch with Shannen Barrett
0408 615 431 sbarrett@intergrain.com
intergrain.com
Disclaimer: Refer to intergrain.com/disclaimer.aspx for more information.
*ROCKSTAR and VIXEN have a dual AH (Australian Hard) and APWN (Australian Premium White Noodle) classification in Western Australia. VALIANT CL PLUS is classified as an AH (Australian Hard) in the Southern and Western classification zones.


McINTOSH & SON
Miller Since 1899
NITRO 7000 SERIES
STILL IN FRONT!
Leaders in application tech
Up to 434hp for extra grunt
Industry-leading ground clearance
Front-mount with superior visibility & stability
Increased fuel savings
Boom options
30m, 36m, 41.15m or 48m
Miller Intellispray PWM system, Staged Spray Control, WeedSeeker 2 or Spray-Air
NEW! bilberry
Ask us about Green-on-Green spot spray tech
Limited systems available for 2022
Available now at McIntosh & Son
LOCK IN YOUR ORDER TODAY TO SECURE STOCK
McINTOSH & SON
www.mcintoshandson.com.au


Nufarm
AUSTRALIAN THROUGH & THROUGH
THROUGH SUPPORTING NUFARM YOU SUPPORT AUSTRALIAN JOBS.
Did you know that Nufarm has a local manufacturing facility in Kwinana? As well as national scale, Australia-wide?
We have local knowledge. And national support.
Local manufacturing. National supply chains.
Local boots. National strength.
So choosing Nufarm isn't just the reassurance of a manufacturer with size, reliability and quality. It's also the support and expertise of a local.
Ask for Nufarm.
Learn more today, visit nufarm.com.au


WHEREVER YOU ARE, WHATEVER YOUR OPERATION, SEED SHIELD IS YOUR MOBILE, SELF-CONTAINED SEED TREATMENT SOLUTION.
The Seed Shield fleet has set the standard for state-of-the-art seed grading and treatment. Each Seed Shield unit holds a range of seed treatments relevant to your operation, with the capacity to apply four different treatments at the same time from 0.4 to 40L/T. What's more, you are only charged for graded tonnes.
SEED SHIELD TICKS ALL THE BOXES
Comprehensive range of seed treatments with capacity up to 35T/hr
Support from qualified agronomists to assist you with seed treatment decisions
Large range of grains graded with over 60 screens available
Canola can be treated, loaded and weighed into Bulka Bags on-site
Grain can be graded to any specification
For more information about how Seed Shield can benefit your operation.
Glen Jones Nutrien Dalwallinu 0896611170 or 0437584107.
www.seedshield.com.au
Nutrien Ag Solutions


PRE IS THE NEW POST
STOP BROADLEAF WEEDS BEFORE THEY START.
Shift your thinking to CALLISTO® in cereals. The new mode of action in pre-emergent broadleaf weed management.
For further information talk to your local Syngenta representative or visit preisthenewpost.com.au
Callisto Herbicide
20 LITRES
Callisto®
syngenta.
GROUP 27(H) HERBICIDE
Partner of WEED smart every weed every seed every farm every year
Syngenta Australia Pty Ltd, Level 1, 2-4 Lyonpark Road, Macquarie Park NSW 2113. ABN 33 002 933 717. ® Registered trademark of Syngenta Group Company. TM Trademark of a Syngenta Group Company. © 2021 Syngenta. AD 21-064.


ADAMA
Priority®
The flexible option for your rotation.
New Priority herbicide from ADAMA is an ideal tank mix partner for the control of broadleaf weeds in winter cereals, established ryegrass pastures and fallow.
®Registered trademark of an ADAMA Agricultural Solutions Company.
HERBICIDE
ADAMA.COM